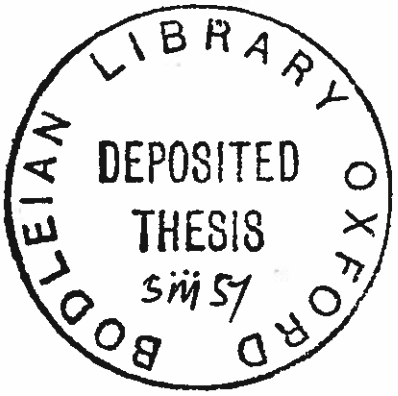
EARLY FOURTEENTH CENTURY PHYSICS OF THE MERTON 'SCHOOL' with special reference to DUMBLETON and HEYTESBURY



by

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ABSTRACT

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I In the Middle Ages the natural sciences were taught in the Faculty of Arts, and were largely based upon the libri naturales of Aristotle. Relatively little is known about the Medieval Faculty of Arts, but to appreciate the importance of physics in the Middle Ages and to study its development it is necessary to reconstruct the curriculum of studies leading through the undergraduate stages to the baccalaureate, and finally to the mastership in arts. The function of a master was to lecture upon certain set books and to determine questions in solemn disputations. At Oxford in the early fourteenth century the main interest of the Masters of Arts was in logic and in physics. The texts lectured upon were not only the traditional books, but also the new treatises which were absorbing the interest of masters here and on the continent.

II Many of the famous Oxford Masters in the early fourteenth century were Fellows of Merton College, though the most influential personality of that period, William of Ockham, was neither a Master in Arts, nor a Fellow of Merton. The best known of the Merton Fellows is Walter Burley, who lectured in arts at Oxford from about 1300 until 1310, when he went to Paris to study theology. Although he was a Master in Theology, Burley had a life long interest in logic and physics; in his writings after 1320 he frequently opposed the view of Ockham. Among all the early Mertonians the one who most influenced the reputation of the College and directed the development of physical science was Thomas Bradwardine. By his treatise De proportione velocitatum in motibus, published in 1328, he inaugurated a new phase in the study of physics. In it he attempted

to determine the mathematical laws governing terrestrial dynamics. Among the disciples who developed Bradwardine's mathematical views, three Fellows of Merton College deserve to be studied, William Heytesbury, John Dumbleton and Richard Swineshead. Very little is known about these Merton Masters. Heytesbury is first noted at Merton in 1330. His important treatise, Regulae solvendi sophismata, was written at Oxford in 1335. In the last chapter of this logical treatise Heytesbury applied Bradwardine's views to the study of kinematics and related problems. John Dumbleton, a contemporary of Heytesbury, is first mentioned at Merton in 1338. His large work, Summa logicae et philosophiae naturalis, was composed during the years 1335 and 1349, the presumed date of his death. The writings of the famous Merton Calculator, Richard Swineshead, must be distinguished from those of an earlier Oxford Master, Roger Swineshead. The writings of Roger seem to date between 1330 and 1335. Richard is first mentioned in the Merton rolls for 1344-5, and his influential Liber calculationum seems to have been written about 1350.

III In the thirteenth century there were two predominant views concerning the division of the sciences. One was represented by the Parisian teaching of Albertus Magnus and Thomas Aquinas, which considered mathematics subsidiary to natural philosophy. The other was represented by the Oxford teaching of Grosseteste, Kilwardby and Roger Bacon, which considered mathematics to be a higher science and a key to the study of nature. In the early fourteenth century Oxford contributed a large number of new treatises in logic and physics. These treatises represent the contribution of the Oxford Faculty of Arts to a linguistic

and mathematical study of science. Most important for the history of physics are Bradwardine's treatise De proportione velocitatum and the numerous treatises, summaries and developments of this new approach to the study of nature. Although Bradwardine himself favoured a purely mathematical approach to science, the typical Oxford approach was a combination of logical subtelties and mathematical rules.

IV In early fourteenth century physics there were two fundamental groups of problems, those concerning the nature of quantified substance, and those concerning the velocity of motion. For Aristotle and the early tradition in the schools, quantity was an accident really distinct from material substance. But even for Aristotle the 'amount' of first matter remained the 'same' in substantial changes, as well as in condensation and rarefaction. Averroes was the first to give intelligibility to the Aristotelian doctrine by suggesting that first matter has in itself dimensiones interminatae. This was taken up by Giles of Rome, who developed the view of Averroes more concretely. In the early fourteenth century William of Ockham rejected the traditional distinction between substance and quantity; for him quantity was a term, a noun, designating material substance in space. But Ockham was unable to give a physical explanation of the phenomena of condensation and rarefaction. It was in their discussion of these phenomena that the Mertonians, particularly Dumbleton and Swineshead, moved towards the concept of mass.

V The main interest of the Mertonian physicists was in problems of physical motion. The earlier discussion of motion as a fluxus formae

or a forma fluens yielded to the new views of Ockham on the one hand, and of Thomas Bradwardine on the other. For Ockham motion was merely a noun, designating individual material substances and qualities together with a denial of rest, and having only a logical and grammatical usefulness. For Bradwardine motion itself was a ratio, a velocity, a proportion. In the development of this view the traditional consideration of motion as a qualitative accident, a process, was replaced by an entirely quantitative consideration. In Bradwardine's treatise De proportione velocitatum a new mathematical function was proposed to explain terrestrial dynamics; this function was not based upon empirical evidence, but upon the demands of mathematical consistency. Dumbleton and Heytesbury accepted Bradwardine's dynamics, and proposed new problems in kinematics, applicable to local motion, alteration, condensation and rarefaction. By this extension of Bradwardine's view the whole of natural philosophy came under the domain of mathematical representation.

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" Summa Logicae et Philosophiae Naturalis, P.III, cap.7-12 409

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LIST OF ABBREVIATIONS

AFH	Archivum Franciscanum Historicum (Quaracchi)
AHDLMA	Archives d'histoire doctrinale et littéraire du Moyen Age (Paris)
AL	Aristoteles Latinus (Corpus Philosophorum Medii Aevi), ed. G.Lacombe, etc. Pars Prior, Rome 1939; Pars Posterior, Cambridge 1955.
B.G.P.M.A.	Beiträge zur Geschichte der Philosophie des Mittelalters (Münster i W.)
Bibl. Brit.-Hib.	Bibliotheca Britannico-Hibernica, sive de Scriptoribus, T.Tanner, London 1748
Cal. Pap. Let.	Calendar of Papal Letters, vol.II-III, ed. W.H. Bliss, London 1895, 1897.
Cal. Pap. Pet.	Calendar of Papal Petitions, vol.I, ed. W.H. Bliss, London 1897.
Cant. & York Soc.	Canterbury and York Society publications.
Chart. U.P.	Chartularium Universitatis Parisiensis, ed. H. Denifle, 2 vols. Paris 1889,1891.
DNB	Dictionary of National Biography (London)
Duhem, Études	P.Duhem, Études sur Léonard de Vinci I. Première Série, Paris 1906 II. Second Série, Paris 1909 III. Troisième Série: Les Précurseurs Parisiens de Galilée, Paris 1913.
GW	Gesamtkatalog der Wiegendrucke, Leipzig 1925 ff.
Maier, Studien	A.Maier, Studien zur Naturphilosophie der Spätscholastik I. Die Vorläufer Galileis im 14. Jahrhundert, Roma 1949. II. Zwei Grundprobleme der scholastischen Naturphilosophie, (2nd edition), Roma 1951. III. An der Grenze von Scholastik und Naturwissenschaft, (2nd edition) Roma 1952. IV. Metaphysische Hintergründe der spätscholastischen Naturphilosophie, Roma 1955.

Mert. Rec.	Merton Records (Merton College Library, Oxford).
MOPH	Monumenta ordinis fratrum Praedicatorum historica (Rome)
Mun. Acad. Oxon.	Munimenta Academiae Oxoniensis (R.S.), ed. H.R. Luard, London 1868.
Mun. Civ. Oxon.	Munimenta Civitatis Oxonie (O.H.S.), Oxford 1917.
O.H.S.	Oxford Historical Society publications 1884 ff.
R.S.	Rolls Series, The Chronicles and Memorials of Great Britain and Ireland during the Middle Ages, London 1858 ff.
RTAM	Recherches de Théologie ancienne et médiévale (Louvain).
Surt. Soc.	Surtees Society publications, London 1838 ff.
Sitz.d.Bay.Akad.	Sitzungsberichte der Bayerischen Akademie der Wissenschaften. Philosophisch-historische Abteilung (München).
Stat. Ant.	Statuta Antiqua Universitatis Oxoniensis, ed. S.Gibson, Oxford 1931.
TNS	The New Scholasticism (Washington, D.C.).

NOTE

In the editing of texts, words enclosed in square brackets [ ] are not found in the codex, but inserted in order to render better sense; words enclosed in angle brackets ⟨ ⟩ are found in the codex, but which I think ought to be eliminated.

PREFACE

Until early in this century it had been customary (and in certain writings it still is) for histories of science to speak of Galileo Galilei as the father of modern physics as though nothing preceded him, except the downfall of Aristotle. During the first two decades of this century Pierre Duhem devoted untiring energy to the study of "les précurseurs parisiens de Galilée". Among other significant discoveries, he thought that he had found in the theory of 'impetus' defended by Jean Buridan and his 'school' in the early and mid-fourteenth century the modern principle of inertia, which Galileo expressed by impeto, or momento.(1) Constantine Michalski's studies on the theological movements of scepticism and criticism during the fourteenth century did not affect Duhem's thesis, but Michalski did point out that the Franciscan, Francis de Marchia, proposed the theory some years before Buridan.(2) The acceptance of Duhem's thesis encouraged historians of science, a growing group, to see other points of similarity, and even identity, between the 'school' of Jean Buridan in the Parisian Faculty of Arts and the seventeenth century founders of classical physics.

After rejecting Duhem's exaggerated position some fifteen years ago,(3) Anneliese Maier came to realize more and more that considerable intellectual activity was going on at Oxford much earlier than Duhem

(1) Especially, Études sur Léonard de Vinci, 3e Serie, Paris 1913.
(2) "La physique nouvelle et les différents courants philosophiques au xive siècle", Bulletin de l'Academie Polonaise des Sciences et des Lettres. Classe d'histoire et de philosophie. 1927. p.93 ff. (reprint 1928).
(3) Die Impetustheorie der Scholastik, Leipzig-Wien 1940; enlarged in Studien II, 113-314.

had suspected. This intellectual activity was concerned, to a large extent, with logical sophismata and with problems of motion and quantity. She found that Heytesbury's influential Regulae solvendi sophismata should be dated 1335,[4] and she was the first to appreciate the significance of Bradwardine's well known treatise of 1328.[5] From these studies there emerged a vague picture of Thomas Bradwardine and the Merton 'school' of physics. The idea of a Merton 'school' has been continued by historians of medieval science, particulary in the United States and on the continent.

Simultaneously the researches of Philotheus Boehner, OFM, Léon Baudry and others have revived interest in the non-polemical writings of William of Ockham. And certain historians of science see in Ockham a forerunner of modern physics, because of his views of motion, causality and quantity. Some have considered the philosophy of Ockham to be a preparation for the Merton 'school'.

The purpose of the present study is to discover the actual situation in Oxford concerning physics in the early fourteenth century. Instead of reading the history of physics backwards from the ideas of the seventeenth century, as historians of science tend to do, an attempt has been made to understand early fourteenth century teaching in the Faculty of Arts at Oxford as a development of earlier centuries, and within the context of problems discussed by the Oxford Schoolmen themselves. By 'physics', of course, is meant those problems discussed

(4) An der Grenze von Scholastik und Naturwissenschaft, Essen 1943; the second edition of this is Studien III.
(5) "Der Funktionsbegriff in der Physik des 14. Jahrhunderts", Divus Thomas (Fribourg), 3rd series, XXIV (1946), 147-166; republished in Studien I, 81-110.

in the schools in connection with Aristotle's Physica de Auditu, particularly the fundamental problems of quantity and motion. Problems of astronomy, chemistry and biology are not examined in the present study, because such an examination, it was thought, would have obscured the main purpose of this study.

Dumbleton and Heytesbury have been chosen as special points of reference, not because they were the outstanding personalities of the early fourteenth century, but because these little known Masters can help to give a fuller picture of the intellectual activity "in scholis phisicis Oxon".(6) Both Dumbleton and Heytesbury were Fellows of Merton College, and hence offer an opportunity to examine the Merton 'school'. But this study tries to place them both in the greater scientific movement typical of Oxford at the period, and vastly different from the spirit of physical science before Bradwardine.

There can be no doubt that the leading personalities of early fourteenth century Oxford physics were William of Ockham and Thomas Bradwardine. No study of early fourteenth century Oxford can avoid a careful analysis and delineation of their doctrine. But this study in particular must take into consideration the scientific teaching of Ockham and Bradwardine, because the views of both influenced the writings of Dumbleton and Heytesbury. The problem is to examine the extent of those influences in order to describe the characteristic spirit of the Merton 'school'.

The present study is divided into five chapters, proceeding from the general to the particular.

(6) In the colophon to the Questiones super octo libros phisicorum of John Scharpe, Oxford MSS, Balliol College 93, fol.91r, and New College 238, fol. 208v.

Since medieval science was largely a product of University teaching, it is necessary first of all to examine the curriculum of studies in the Faculty of Arts at Oxford in the early fourteenth century. Lectures and disputations were always presented in connection with set books; therefore it is necessary to discover what books were in use at Oxford, as well as the normal cursus leading to the Degree of Master in Arts. This context of medieval science has been, for all practical purposes, neglected by historians of physics.

The personalities are then considered. The life and works of William of Ockham and of five prominent Fellows of Merton College are presented from existing records and manuscript evidence, much of which is entirely new. Although Ockham has been the subject of numerous studies, relatively little is known of the five Mertonians, Walter Burley, Thomas Bradwardine, William Heytesbury, John Dumbleton and Richard Swineshead. In this biographical chapter the main concern has been the chronology of their more important writings concerning physics, and no attempt has been made to estimate the influence of these personalities in the political, social or ecclesiastical spheres.

In order to understand the general continuation as well as the subtle change from the thirteenth century to the early fourteenth century, the two outstanding views of physical science, typified by Oxford and Paris in the thirteenth century, are examined, and the new libri logicales and naturales of early fourteenth century Oxford are discussed. The numerous new treatises of logic emanating from the schools of Oxford reveal the importance of logic in the curriculum, and the basis for the world-wide reputation of the "English subtleties".(7)

(7) The Philobiblon of Richard de Bury, ed. and trans. by E.C.Thomas, London 1888, p.212.

But the number of new treatises listed and discussed does not pretend to be complete; they are mentioned only to present an accurate context for the problems of physics.

The last two chapters deal with concrete problems of quantity and local motion, as discussed by Ockham and the Mertonians. An attempt is made to analyse these fundamental problems of the early fourteenth century in their historical context, and to determine the precise novelty of the Ockhamist and Mertonian views of those problems. In both of these chapters I propose to examine the contributions of Dumbleton and Heytesbury to the Mertonian solution, and the significance of that solution.

Apologies must be made for not tracing the historical connection between the Mertonian writings on physics and the seventeenth century founders of classical physics. Before any definitive statement could be made, one would have to study the Italian university curriculum and the writings of the seventeenth century; and this requires far greater time for research than I have had. I have limited the present study to the period suggested in the title, roughly from 1300 to 1350.

In all my quotations from original sources, the general principle has been to preserve the spelling of the manuscript or printed edition referred to. But in quotations from John Dumbleton's Summa (MS Vat.lat. 6750 collated with other MSS), I have generally used the modern -tius and -tio for the inconsistent use of -cius and -cio in the manuscripts; quotations from printed sources, though collated with manuscripts, follow the spelling of the printed edition.

Two appendices are added, not as part of the thesis, but as incidental material collected during the course of the research or transcribed as of particular interest. The first appendix is an incomplete Repertorium Mertonense being a list of manuscript writings of certain Merton Masters encountered in the composition of the thesis. The second appendix contains a number of selected unpublished texts, which would have been too cumbersome and incomplete in footnotes; but there is no pretence of presenting a 'critical' edition of any of the texts.

I would like to acknowledge my deep debt of gratitude to the many scholars, librarians and friends here and abroad without whose help and encouragement this study would have been impossible. But among the many I particularly acknowledge my indebtedness to the Very Rev. Dr. Daniel A.Callus, O.P., Prof. Anneliese Maier, and the Rev. Timothy S. McDermott, O.P., for constant encouragement and for constructive criticisms and suggestions during the composition of this study; their criticisms and suggestions have been incorporated in the present text. I am also indebted to Mr. A.C.Crombie for general supervision of the research, and in a special way to Mr. A.B.Emden, who so graciously and generously offered me his wealth of biographical information concerning the early Merton Masters. I am deeply indebted to the Rev. Raphael Gallagher, O.P. for his ever willing and invaluable assistance in the painstaking task of preparing the final copy for presentation. Acknowledgement of special assistance or information is made in the relevant context. To these and to many others I acknowledge my deepest gratitude.

CHAPTER I

THE CURRICULUM OF STUDIES IN THE FACULTY OF ARTS IN THE EARLY FOURTEENTH CENTURY

The meagre statutes of the medieval university do not present a very clear picture of the organization of the Faculty of Arts in the early 14th century. Even the studies of Denifle, Rashdall and Gibson leave much to be desired in the way of showing the normal course of studies leading to the mastership in arts. Considerable research is still needed to clarify details and to rectify confusions and misunderstandings which arise from the use of technical terms. Our concern here is not with the legislative and disciplinary aspects of the faculty, but only with the organization of the curriculum and the method of teaching. The medieval university always followed legitimate custom and "the common practice in the schools"; and it is clear that statutes were enacted by the university, faculty or nation only to correct abuses or to clarify obscure points then in dispute. In order to obtain a clear picture of the common practice in the schools we must piece together bits of information contained in a great variety of sources. Whatever may be said of the Faculty of Arts after the middle of the 14th century, it is safe enough to assume that the general practice at Oxford closely resembled that of Paris, and by way of Paris that of Toulouse, Montpellier and other continental universities. Furthermore it may safely be assumed that the practice in the early 14th century did not differ from that of the 13th century, unless there is evidence to the contrary.

Every student coming to the university in the middle ages had first of all to be enrolled under some master, just as he was under some master

during his studies at the grammar school. This was an unaltered law dating at least to Robert Curzon's statute for Paris in 1215; and it had been the universal practice of the early middle ages for a student to attach himself to a particular master. Just how old a boy would be when he came to the university is not clear. It seems that he would be about 13 or 14 years of age. The Parisian statutes of 1215 specify that no one is to read "de artibus citra vicesimum primum etatis sue annum." (1)

That is, no one is to lecture as a master in arts before he had completed his 20th birthday. The statutes of the English nation at Paris in 1252 state that one about to determine as bachelor must be 20 years old, or at least must have entered upon his 20th year, (2) that is, he must have passed his 19th birthday. But as one year at least, and more often three, would have elapsed between this vote of the masters and his inception, the candidate would be in his 20th year by the time he lectured as master, if not older. (3) The statutes of 1215 further specify that he must have heard lectures in arts for six years "ad minus"; no mention is made of a bachelor in arts at this time. But according to the statutes of 1252 before bachelors may be allowed to determine they must have heard

(1) Chart. U.P., I, n.20, p.78
(2) Chart. U.P., I, n.201, p.226
(3) The age of "14" found in the oath of the English nation at Paris (Chart. U.P., II, App.4, p.673) must be a scribal error, as the whole of this oath corresponds perfectly to the statute of the same nation in 1252, and contradicts the accepted age in all other documents for Paris and Oxford. A.L. Gabrial not only accepts the age of "14", but he considers this the age for the determinatio during the fourteenth century. Cf. Student Life in Ave Maria College, Mediaeval Paris, Notre Dame, Indiana 1955, p.187

the required books for five years "vel quatuor ad minus". The Oxford statutes promulgated before 1350 also note that he must have heard certain books in the schools "ad minus per quadriennium."(4) If however the candidate failed to pass this vote, or if a scholar did not wish to determine, the period for attending lectures was prolonged. In the latter case a scholar must have heard the books for at least eight years before his inception.(5) One can therefore say that the arts course at Oxford in the early 14th century took from six to eight years (the normal course seems to have been seven years prior to inception), and that the scholar was at least 20 years old when he incepted as Master in Arts (normally 21).

The course of studies in arts can be divided into three periods: undergraduate, bachelor, and master.

a. The Undergraduate.

From the time a student enrolled under a master until his examination ad gradus. he was an undergraduate. In general he had to attend both ordinary and cursory lectures on the trivium, quadrivium and the three philosophies; he had also to attend disputations, to respond

(4) Statuta Antiqua Univ. Oxon., ed S.Gibson, Oxford 1931, p.24, line 11-12. This is still in force in 1409: "et per quatuor annos ante festum sancti Michaelis preteritum in scolis, ubi viget studium generale facultatem artium audiuisse." (ibid., 200, 11-13). He would then determine during Lent of his fifth year in arts. Cf. ibid., p.192, dated 1407.

(5) According to this same statute which Gibson dated "before 1350" with a query, it was the custom that no one who determined for himself should incept in arts until the end of three years after determination, while one who determined for another could incept at the end of two years after his own determination. Unless the bachelor determined both for himself and for another in the same Lent, the course for both bachelors would be seven years before inception, unless, however, the one who determined for another was dispensed from the required years or books because of his ability (cf. Chart. U.P., I,n.201,p.228).

de sophismatibus for at least one year, and to respond de questione at least during the summer term preceding his determination.

It is not clear whether the student studied the various subjects in any particular order which was strictly adhered to. It is certain that the ideal order of studies could not be followed in seven years; we also know that the libri logicales were heard at least during the first four years of the course and that the libri naturales were heard simultaneously for at least the first three years.

The Faculty of Arts at Toulouse decreed on April 10, 1309,(6) that the morning lectures from the feast of St. Luke (Oct. 18) until the feast of St. John the Baptist (June 24) were to be on the new logic: the first year on the Prior and Posterior Analytics of Aristotle, the second year on the Topics and Sophistici Elenchi, the third and fourth years were to be a repetition of these books. "Et sic continue procedatur singulis annis alternatim incipiendo." From the feast of St. John until the feast of St. Luke(7) the first five books of the Ethics were to be read during the first year, the last five during the second year, and Libor de Anima during the third. "Deinde sicut prius, circulando procedatur predictos libros legendo complete." After the morning lectures the three books of the logica vetus and Priscianus minor were read every year from the feast of St. Luke until the feast of St. John,

(6) M.Fournier, Les Statuts et Privilèges des Universités françaises depuis leur fondation jusqu'en 1789, Paris 1890-2, I, n. 542,p.465.

(7) The punctuation of Fournier is not followed here because it makes no sense to read "a festo beati Johannis usque ad festum beati Luce" as part of the preceeding sentence.

and at the same hour the Liber de sex principiis with Boethius' de Divisione or with the first three books of Boethius' Topics were to be read from the feast of St. John until the feast of St. Luke. The real sciences (physica realis) were to be read extraordinario, presumably in the afternoon, by regent masters or by other capable masters or bachelors deputed by the regent masters beginning every year on the first dies legibilis after All Saints. During the first year the books of the Physics were to be taught. During the second year the Liber de generatione et corruptione, the books of the Parva Naturalia, (8) the Liber de causa motus animalium, and the Liber de progressu animalium were to be lectured upon. "Et isti qui spectant ad secundum annum sunt de forma, positi loco quorumdam aliorum qui modicum utilitatis videbantur habere." During the third year the books De coelo et mundo and the Metheora were to be taught, while the fourth year was devoted to the Metaphysics. One can already see at Toulouse a general grouping of books into the libri logicales and the libri naturales, which were to be the two pillars of the arts course in 14th century Oxford.

Before 1431 Oxford Masters were apparently free to choose their own subjects upon which to lecture, although those lectures required pro forma would naturally be the more popular. The books required pro forma should not be confused with the full teaching of the arts faculty; they were merely set books required for the degree. Depending

(8) Fournier reads: "secundo anno liber de Gen. et Corrup., et primi libri naturales qui sequuntur, scilicet liber de Sensu et Sensato, liber de Memoria et Reminiscentia, liber de Somno et de Vigilia, liber de causis longitudinis et brevitatis Vite, liber de Morte et Vita, Respiratione et Expiratione, Juventute et Senectute, liber de causa motus animalium, liber de progressu animalium." (loc. cit.) There can be no doubt that primi should be read parvi.

upon the number of regent masters and their personal inclinations, lectures would be given on all the approved books of the Trivium, quadrivium and the three philosophies. An examination of the writings of Walter Burley and other masters at Oxford in the first half of the 14th century makes it abundantly clear that the lectures required pro forma were not by any means the only lectures given. As we shall see, a great number of new books originated at Oxford at this time and were lectured upon long before any of them were required pro forma in any university. Normally students were expected to attend the ordinary lectures of their own masters every dies legibilis. But the Oxford statutes add, "vel saltim sue questioni et ordinacioni textus complete insistant."(9) This implies that a master could allow his student to attend the lectures of another master, although the student was obliged to be present for his master's questiones and ordination of the text. This would be necessary to allow the student to hear all the books required pro forma.

The statutes of the English nation at Paris (1252) required that before determination undergraduates must have heard certain books at least twice ordinarie and at least once cursorie. For example, of the logica vetus the Predicamenta and Perihermeneias had to be heard "bis ad minus ordinarie" and "semel cursorie"; the Liber de sex principiis had to be heard "semel ordinarie ad minus et semel cursorie." The Oxford statutes of 1268 merely state that all the books of the old logic must have been heard "ad minus bis", excepting the books of Boethius, which it was sufficient to have heard once.(10) The Oxford

(9) Statuta Antiqua Univ. Oxon., op. cit., 24,3-4
(10) Ibid., 26,1-3.

statutes make no mention of lectiones cursoriæ. Undoubtedly the Oxford forma at this time required such books to be heard ordinarie. But it should not be assumed that cursory lectures were not given at Oxford. For the early 14th century there is abundant evidence to the contrary.

To understand the difference between ordinary and cursory lectures we must remember that ordinary lectures could only be given by a master lecturing magistraliter. It had always been customary that masters lecture at a determined time in the morning on dies legibiles from the resumptio magistrorum at the beginning of each term until the cessatio magistrorum at the end of each term.(11) No bachelor was allowed to lecture simultaneously with the master. According to the Paris statutes of March 1255 no one was allowed to deliver more than two courses of ordinary lectures, or make them extraordinary, or to deliver them at any other time than the usual time and in the usual garb.(12) Even the statute of Robert Curzon implies that ordinary lectures must be magisterial: "Et quod legant [magistri] libros Aristotelis de dialectica tam de veteri quam de nova in scolis ordinariis et non ad cursum."(13) Rashdall was correct in thinking that the difference between ordinary and cursory lectures was mainly one of time.(14) But the temporal difference is based on the traditional idea that a master's

(11) For the length of these terms, cf. Statuta Antiqua, ed. cit., 55, 10 ff., 54-55, also C.Wordsworth, The Ancient Kalendar of the University of Oxford, (O.H.S.).

(12) Chart. U.P., I, n.246,p.278. For time of cursory lectures at Paris around 1245, cf. ibid., I, n. 137,pp.178-9.

(13) Ibid., I,n.20,p.78.

(14) H.Rashdall, The Universities of Europe in the Middle Ages, ed. F.M.Powicke and A.B.Emden, Oxford 1936, I, 433-434.

function is to lecture magistraliter at the best time of day when all are free to hear him. The ordinary or magisterial lectures of a master would not only involve a detailed exposition of a text or of the numerous problems which arose out of the text expounded, such as we find in Burley's early commentary on the Physics, but his decisions were definitive. A master was not under anyone's supervision; therefore his opinions could only be attacked by other masters in their own lectures or disputations, or they could be censured by a body of masters.

While bachelors could not deliver ordinary lectures, masters could lecture cursorily in the extraordinario magistrorum.(15) But it was the proper function of the bachelor to lecture cursorie. A cursory lecture ment an unpretentious reading and paraphrase of the actual text.(16)

This will be clarified later. For the present it is sufficient to note that bachelors could give only cursory lectures; they were obliged to give cursory lectures before inception on certain books of the old and new logic. Under the direction of their masters bachelors could lecture at any time not closed to them by custom or the statutes. The advantage of cursory lectures was that it made the student familiar with the text without going into the special difficulities which always arose in an ordinary lecture. It was a great advantage to a student to hear the actual text of Aristotle, for example, and to have it clearly paraphrased and summarized.

Besides attending lectures the undergraduate was also obliged

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(15) At Toulouse this was in the late afternoon, at the same time as the extraordinario doctorum legum, which would have been about five o'clock; cf. statute of 1309,n.VII, Fournier, op.cit.,p.465.

(16) This was analogous to the cursor biblicus in the Faculty of Theology.

to attend disputations and to take an active part in some of them before he could be presented for determination. The Parisian statutes of 1252 state that he must have attended the disputations of the masters for two years: "per duos annos diligenter disputaciones magistrorum in studio solempni frequentaverit."(17)

The disputationes magistrorum which the undergraduate was obliged to attend were more than the morning questions which were part of the ordinary lecture. He had to attend the disputatio ordinaria, or solemnis which every master was supposed to hold at least once a week on a dies disputabilis in the afternoon. The ordinary lecture in the morning consisted not only of an exposition of the text, but also of a discussion, or disputation of a question pertinent to the text previously expounded. The Oxford statutes promulgated before 1407 declare that no book can be considered as heard pro forma unless it is properly read "cum debita et sufficiente expositione textus et questione pertinente, cum suis argumentis pertinentibus ad materiam libri in quo legitur et ad processum."(18) A very clear example of this method of exposition

(17) Chart.U.P., I,n.201, p.228; also II,App.,p.673, the oath to be taken by determiners in the English nation: "Item quod frequentaveritis per duos annos disputationes magistrorum in studio solempni."

(18) Statuta Antiqua Univ. Oxon., ed.cit., 192,29-31; also 194, 21-22: "et ad questionem et expositionem completam textus sequentem expectet." For Paris note the oath taken before determination: "quod respondistis magistro legenti ordinarie et disputanti scolaribus presentibus." (Chart. U.P., II,p.673) The 14th century Oxford statutes (probably before 1350) declare that before inception bachelors must publicly read "aliquem librum Aristotelis, textum videlicet cum questionibus." (Stat. Ant., 34,16-17) These morning questions, strictly speaking, were not disputations in the full sense of the word. For the Faculty of Theology the numerous Questiones in libros Sententiarum provide a good example of the bachelor's method of lecturing on the text by way of summary "cum questionibus pertinentibus"; these are not determinationes, nor questiones disputatae.

"cum questione pertinente" is preserved in an early redaction of Walter Burley's Expositio Omnium librorum Physicorum "cum questionibus optime disputatis."(19) After a detailed exposition of a number of textus a question was posed with arguments against, then usually one authority "ad oppositum" (e.g. "Ad oppositum est Aristoteles hic"), and finally the solution. These morning quaestiones on the text were literary productions, that is, they were dictated by the master as part of his lectio, and they do not represent solemn quaestiones disputatae. It seems most likely that the usual Questiones on various books of Aristotle and other accepted authors arose out of this morning disputation following an exposition of the text.(20)

The nature of scholastic disputations will be considered later. Here we merely call attention to the fact that undergraduates were obliged to attend the afternoon disputations of their masters. These public disputations of the masters were of two kinds: de sophismatibus (or de problemate), and de questione. Disputations de sophismatibus pertained to logic, while those de questione pertained to mathematics, natural philosophy, metaphysics or any other branch of philosophia realis.

After about two years of attending ordinary lectures and disputations,(21) the undergraduate was expected to take an active part in the disputations de sophismatibus, for which reason they were known as

(19) MS Cambridge, Caius College 448/409, pages 172-543. This method is not so clearly preserved in the printed redaction.

(20) Such quaestiones can sometimes be recognized by the small number of arguments "videtur quod non" and especially by the arguments "ad oppositum" which are usually an appeal to the authority of the author expounded or the Commentator "hic".

(21) S.Gibson, Statuta Antiqua Univ. Oxon., lxxxix.

sophistae in parvigo. At Paris, according to the statutes of the English nation in 1252, undergraduates before determination had to respond for two years de sophismatibus, that is, they had to answer objections.(22) The Oxford statutes of 1268 merely state that before determination "si prius responderint in scolis, publice de sophismatibus per annum integre debent respondisse, ita quod nulla pars illius anni in quo de questione responderint in dicto anno integre computetur."(23) That is, if an undergraduate wished to undertake responsions pro forma, he must answer objections in the logical disputations for a whole year; and that year must be distinct from the period of responding de questione. At Paris in 1252 the period for answering objections de questione was one year computing from the beginning of Lent until the beginning of the following Lent.(24) It is not clear how frequently an individual would be called upon to respond during a year. These disputations were held at least once a week on a dies disputabilis. It seems that during a single disputation it was not unusual for more than one person to respond to objections raised by opposing undergraduates, bachelors, or even by the master himself. The

(22) "Item det fidem quod per duos annos diligenter disputaciones magistrorum in studio solempni frequenter averit et per idem tempus de sophismatibus in scolis requisitus responderit." Chart. U.P., I, n. 201, p.228, also II, App., p.673. It is not clear from the wording whether "per idem tempus" means that the undergraduate attended disputations and responded simultaneously, or whether the period for attending was two years, and the period of responding a further two years. This latter interpretation seems more probable. The 16th century statutes of Edward VI state that no one is to respond until he had completed his second year of Arts. (Statuta Antiqua, ed.cit., 346, 32-33)

(23) Statuta Antiqua, ed. cit., 26,10-13; the statutes of 1409 require "ad minus per annum" (ibid., 200,14)

(24) "Item per annum integrum a principio unius quadragesime ad principium alterius det fidem, quod responderit de questione." (Chart. U.P., I,n.201,p.228) A distinction must be made between responding in a disputation de questione and the obligatory responsio de quaestione prior to the vote of the four masters admitting a candidate to determination(cf. Statuta Antiqua, ed.cit., 26,14-15;33,22-23;200, 9-11; Chart.U.P.,II,App.,p.673 "ante Natale Domini.")

existing statutes of the Faculty of Arts give no hint of opponency as a special status or even as a distinct requirement for undergraduates. Apparently there was no shortage of objectors, expecially as masters themselves could pose objections (25) before giving their definitive determination to the sophisma or questio.

It is clear that an undergraduate could without difficulty abstain from responding de sophismatibus. The Oxford statutes of 1268 require that undergraduates who have not responded publicly (26) to sophismata spend a longer time in attending lectures than sophisters, and hear the Analytica Posteriora twice in addition to the other books required before determination. (27) H. Denifle noted that the obligation to respond was very frequently dispensed with at Paris, especially around the middle of of the 14th century. (28)

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(25) Cf. statute of 1407 (or before), Statuta Art., ed.cit.,194,1-13. This was very different from the custom in the Faculty of Theology where opponency was an official obligation of the bachelor. One who had been a regent Master in Arts could not oppose in disputations before his fifth year of theology or respond before his seventh year; one who had not been a regent Master in Arts could not oppose before his seventh year or respond before his ninth year. (ibid.,48 14-21) In theological disputations the Master never posed objections; he opened the disputation and presented his closing determination.

(26) To reply publice means to answer objections in a disputatio solemnis or ordinaria, which was presided over by a master. This is opposed to the private responses which could be given in the morning discussion of a pertinent question (under a master or bachelor) and to the responses in a disputatio bachilariorum (cf.ibid 32,15-21). A similar distinction is noted in the Faculty of Theology: "Statutum est, quod ad lecturam libri Sententiarum nullus de cetero sit admissus, nisi prius in disputatione solemni, non cursoria, solemniter et non furtive respondeat." Mun.Acad.Oxon.(R.S.), ed. H.Anstey, I,272.

(27) "Si autem de sophismatibus publice non responderint, omnes libros predictos iurent se audisse, hoc adiecto, quod bis audierint librum Posteriorum. Debent enim in audiendo maiorem moram fecisse quam si de sophismatibus publice responderint." (Statuta Art.,26,15-19) As the undergraduate was already obliged to hear the Posterior Analytics once, the additional hearing would not involve a delay of more than two terms.

(28) Chart.U.P.,II,p.674, note.3.

b. The Bachelor.

After four years at least of attending lectures and disputations, opposing and responding at public disputations, that is, in the fifth year of his course, the undergraduate was ready to be presented for his examination ad gradus, or ad determinandum. Before an undergraduate could determine during Lent, he had to be admitted on the vote of four masters. Every year in congregation, held the week before Ash Wednesday, the Proctors elected four Masters of Arts, two borialos and two australes. (29)

These four masters then swore that they would admit no unworthy person to determination and that they would conduct their examination de scientia et moribus within three days. During this examination, at which the master presented his scholar for licence to determine, both the presenting master and the scholar had to swear that all the necessary requirements were fulfilled regarding age, knowledge and morals, and that the candidate had responded de questions prior to the examination. Should it happen that the scholar had not heard all the books required

(29) The Oxford statutes of 1268 present certain difficulties here: "...quod singulis annis ebdomata quinta precedente diem cinerum eiusdem anni, in congregacione magistrorum quatuor magistri arcium duo scilicet borialos et duo australes vel a procuratoribus eligantur." (i) It seems highly improbable that "ebdomata quinta precedente diem cinerum" means five weeks before AshWednesday; on the other hand the fifth week of Hilary Term (which undoubtedly was on what the authors had inmind) did not always fall before Ash Wednesday, although in 1268 it happened to be the week preceding Lent. The statutes of 1409 leave no doubt: "singulis annis per octo dies ante diem cinerum, in congregacione magistrorum regentium..." Statuta Ant., 199,36-37. (ii) It would also seem that vel ought to be omitted. Grammatically the word is out of place. Anstey prints it in brackets. The Parisian statutes leave no doubt that the custom of the English nation at Paris around 1252 was for one Proctor to elect two electors who would then swear to elect three suitable masters as examiners (Chart.U.P.,I,n.201,p. 227). The Oxford statutes of 1409 clearly state "quatuor regentes in artibus, scilicet duo australes et duo borialos, a procuratoribus assignentur." Statuta Ant., 199,38-39.

pro forma determinaturi, or had not heard them the required number of times, the examining masters could still admit the scholar to determination, if they considered the non-required magisterial lectures heard by the scholar to be a sufficient substitute.(30) Any doubt in the matter of age, stature, or any other physical defect was reserved to the judgement of the majority of regent masters.(31) Furthermore the scholar had to swear that he had the use of a "school" and that he would begin his determinations between the vigil of Ash Wednesday and the first Monday of Lent, and terminate them between Tuesday and Friday of Passion Week. Thus far no evidence has been brought forth showing that the delegate masters actually examined the candidate "in the contents of his books," as Rashdall assumed.(32) If the examiners were satisfied, they, and not the Chancellor,(33) granted the licentia determinandi and admissio ad lecturam alicuius libri. By virtue of this vote of the four examining masters, it would seem, the candidate was created baccalaureus.(34)

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(30) "Et sciendum quod si aliqui determinaturi, libros, quos secundum formam suprascriptam bis tenentur audiuisse, semel rite audierint et non omnes bis, vel non omnes libros quos secundum formam predictam semel debeant audiuisse rite audierint, dummodo alios libros qui non sunt de forma ista rite audierint, qui libri secundum magistrorum electorum ad examinacionem estimacionem in sacramento suo fidelem, sufficiunt ad faciendum sufficientem recompensacionem, ad officium determinatorum admittantur, sin autem penitus repellantur." Statuta Ant., 26, 30-39.

(31) Ibid., 28, 23-27.

(32) Rashdall, op.cit., I, 453.

(33) There seems to be no evidence for the impression (S.Gibson, op. cit., xx) that the Chancellor granted this licence; the statutes for both Oxford and Paris clearly give this right to the elected examiners. Gibson gives in support of his view a reference to p.192, but this paragraph seems to refer to inception in the early 15th century: "ad honorem gradus et regencium predictorum."

(34) It is not clear whether the candidate became a "baccalaureus" by the vote of the masters or only after determination. Rashdall (op.cit., I, 441) identifies the degree of bachelor with determination; to be the "examination" for the degree (op.cit., I, lxxxv-vi); and G.C.Boyce (The English-German Nation, p.80 note) believes that in

The bachelor obtained two main privileges: that of lecturing cursorily on certain books, and that of determining during Lent. The latter was the more important, as these determinations were for the young bachelor his first taste of a master's role. The right to determine (determinare quaestionem) properly belongs to a master. But in these Lenten determinations the young bachelor shared, in a certain sense, the master's function by "determining" questions. Actually the whole proceeding was under the direction and supervision of a master, usually his own, whose task it was to intervene whenever necessary, posing objections, reprimanding unruly objectors, and helping out in difficult responses and determinations.(35) Ideally the order of a solemn disputation would be followed as much as possible, excepting, of course, the fact that here a bachelor gave his own determination to the question. But very often due to inexperience, insufficient numbers, impertinent objections, or lack of knowledge, the ideal order and dignity would be wanting.

Every afternoon of Lent on which a disputation could be held the

(34 cont'd) the 14th century and early 15th century a student 'duly admitted to determine' did not become a bachelor until he had completed the determination. However there are reasons to think that the Lenten determinations were a share in the master's function, rather than an "ordeal" leading to a degree. The word determination means to give the final solution to a problem, a function which properly belongs to a master alone. In the Lenten exercises the determiner gave such a solution, although under his master. This he could not do unless he were already a sharer in the privilege. Further, as we shall see, the determiner could give cursory lectures during the same Lenten period, but this would be impossible, unless he were already a bachelor. Then, too, it was a period of great festivity despite the season (the statute of 1322 revoked the earlier restrictions); but festivities would hardly be likely during a period of examination.

(35) Cf. Statuta Antiqua, 202-203, line 31-10.

determinatores entered the school of their master (in scolis magistri gui),[36] or at least in the school of some Master of Arts, as soon as the bell of St. Fridesuide rang after the noon meal, probably around three o'clock. All disputations had to be on logic, except on Friday, when it was on grammar. We can presume that the thesis for the afternoon's disputation was, if not suggested by the master, at least approved by him beforehand. It is quite possible that Heytesbury's Regulae solvendi sophismata and Probationes conclusionum were written to help young bachelors determine with greater facility. Normally the respondens would be another bachelor, and the objectors would be bachelors or anyone permitted to attend the determination; thus the Oxford statutes forbade the determiner to give presents.[37] The whole disputation was supposed to be completed and the bachelor's determination given by the time St. Fridesuide's bell rang for compline. The time for beginning and for terminating each day's disputations could not be altered without the consent of the Chancellor and all the regent masters; clearly such consent would not be sought without grave reason, such as the presence of great dignitaries, or relatives, wishing to arrive later or to remain longer on a special occasion.

The Oxford statutes declare that determination should end by the bell for compline, "et quod tunc scolares possint audire cursus suos sicut antiquitus fieri consuevit."[38] In other words it was customary for a determining bachelor to lecture to his undergraduates (scolares) after

(36) Statuta Antiqua, 24,24.
(37) Ibid., 28,8-20; cf. 126,23-31 regulating gifts given to promotors.
(38) Statuta Antiqua, 28, 2-3; also for 1409, ibid., 202, 18-19.

the day's determination. It would seem that the determination ended about five o'clock, or six o'clock at the latest at that time of year, and the bachelor would deliver his cursory lecture.

All the cursory lectures of a bachelor were under the direction of the master. That is to say, the masters assigned specific books to the bachelors to lecture upon for the year. At Toulouse the masters assigned bachelors to read those books of the new logic which were not being read by the masters themselves that year, and a yearly reading of Priscian and the old logic.(39) At Oxford the statutes of 1340 decreed that before inception all bachelors were obliged to lecture cursorie on at least two logical books, one from the old logic and one from the new, or else both from the new plus one of the libri naturales, namely either De celo et mundo, or De anima, or Metheora, or De generatione et corruptione, or De sensu et sensato together with De memoria et reminiscentia and De somno et vigilia, or De motuanimalium together with two books of the Parva naturalia.(40) The choice of books to be lectured upon would be made by the bachelor on the advice of his master. The above list should not be thought to represent the full extent of a bachelor's lectures; it represents only those books which were accepted pro forma inceptori.

The bachelor, as has been seen, could give his lectures at any time

(39) H.Fournier, Les Statuts, I, 465, n.542,V-VI.
(40) S.Gibson prints this statute as follows: "Vel librum De motu animalium cum duobus libris De minutis naturalibus." (Statuta Ant., 32,12-13) This implies that there was a work entitled De minutis naturalibus which contained two books. The statute merely means that a bachelor may choose any two books of the minutis naturalibus, i.e. of the Parva naturalia. Cf. p.235,2-3 where the statutes for 1431 are printed correctly: "aut aliquem de minutis libris, et hoc de textu Aristotelis."

outside the ordinaria magistrorum, i.e., the customary morning period for ordinary lectures on dies legibiles and the afternoon period for ordinary disputations on dies disputabiles. Outside of term time, i.e., before the resumptio magistorum and after the cessatio, bachelors seem to have been free in the choice of periods. By 1409 lectures were given in college as well as in the halls (41); and it is not surprising to find bachelors giving cursory lectures more frequently in college. But sometimes it happened that a master was unable to complete his ordinary course of lectures on the Metaphysics, Physics, or Ethics. If another regent master could not be found to complete the course, a bachelor could be assigned to the task and his cursoria lectura, or legens extraordinarie would fulfil the statutory requirements for his listeners. (42)

Even though a scholar could be given licence to determine and to lecture during his fifth year of study, he was expected to continue attending ordinary lectures and disputations (as well as to take part in disputations) for three years, counting the year in which he determined. (43) The 13th century statutes of Oxford note that a "noviter incepturus" had to hear at least two or three ordinary lectures each week from his own master; all others were expected to attend daily. (44)

(41) Statuta Antiqua, 200,21; 201, 6.
(42) Ibid., 193, 27-42; 235, 8-11, where this situation is refered to as "a bachalario extraordinario legente"; also Toulouse in 1309, cf. M.Fournier, Les Statuts, I, 465, n.542, III.
(43) As the determining bachelor received his licence at the beginning of Hilary Term during his fifth year of study, the rest of that year would be considered as part of his baccalaursate studies. "Consuetudo est eciam quod nullus determinans pro se incipiat in artibus ante completum finem vel terminum trium annorum post suam determinacionem." Statuta Antiqua, 34, 21-23.
(44) Before 1231, Statuta Ant., 107, 5-9

Besides having attended those lectures required pro forma determinatorum, the bachelor must have heard the following lectures before presentation to incept according to the early 14th century statute (45) : i) the Liber naturalis of Priscian, or Aristotle's Politica, or the De animalibus (including De progressu et de motu animalium), ii) the Metheorica and the other libri naturales, iii) the Ethica. Apparently these were the normal books heard during the baccalaureate years, to which we might add the Metaphysica. (46) In addition the following works were assumed as having been heard sometime during the course of study: i) six books of Euclid, ii) the Arithmetica of Boethius, iii) the Computus and Algorismus, iv) the De sphera of Sacrobosco, v) Aristotle's Rhetorica, or at least the fourth book of the Topica of Boethius. (47)

It was not necessary to have determined in order to be presented for inception. In this case a scholar was obliged to spend eight years, instead of seven, attending the necessary lectures pro forma incepturum. The early 14th century statutes of Oxford make an interesting exception in the case of those who could have determined but did not want to be limited by the forma determinatorum; if they could swear that they had heard all the required lectures long before their presentation to incept,

(45) Ibid., pp.32-33.

(46) The difficulties of Aristotle's Metaphysics and its position among the sciences would lead us to suspect that it was among the last books studied; the Paris Legatine reform for determiners in 1366 required "libr[um] Metaphisice, vel quod actu audiat eundem." cf. Rashdall, op.cit., I,443-444; Denifle, Chart.U.P., II,p.679, note.

(47) "et saltim uice rhetorice quartum Topicorum Boecii." (Statuta Ant 33,19) This implies a choice between the two. These two works were considered as belonging to the liberal art of Rhetoric, and the Oxford statutes of 1431 make this explicit: "Rethoricam per tres terminos, videlicet Rethoricam Aristotelis, seu quartum Topicorum Boecii..."

"temporis brevitas, minus videlicet triennio completo, eorum incepcioni secundum statuta pristina non obstaret.(48) That is to say, seven years of study as a scholar would be considered sufficient, notwithstanding the general rule.

Besides attending his master's ordinary lectures and delivering his own cursory lectures, the bachelor and even those who wished to incept without determining, had to take part in public disputations for about two years before presentation. In Paris this obligation is very clear in the statutes of 1252. Before being presented for the licentia he was obliged to respond publicly (publice responderit) for two years, and by this is meant exercising the office of opposing and responding in the disputations of the masters and of the determiners in the schools of the bachelors.(49) At Oxford the ancient statutes do not specify any particular length of time, but the statutes of 1340 require every incepturus to oppose (arguat) at least four times in the public disputation of the masters, to respond at least twice in such disputations of the masters which are not de quolibet, but de questione, or at least once in a disputation of the masters de quaestione and one de problemate.(50) Moreover he must oppose and respond at least

(48) Statuta Antiqua, 33,7-14.

(49) "Ad hunc articulum predictum, videlicet quod per biennium ante presentacionem publice responderit presentatus, sic intelligendum essehab omnibus decreverunt, videlicet quod presentandus in disputationibus magistrorum vel determinatorum in scolis bachellarii exercuerit officium opponendo et respondendo per duos annos, antequam ad petendum regendi licenciam presentetur." Chart.U.P.,I,n;202,p.232.

(50) "Item, ordinatum est quod arguat quilibet incepturus quater ad minus puplice in disputacionibus magistrorum, et quod semel disputet vel respondeat quilibet in disputacione generali bachilariorum facultatis predicte, et hoc pertinencia argumenta adducendo tantummodo ad questionem vel problema quam vel quod eum contigerit disputare. Item, ordinatum est quod quilibet incepturus, ante licenciam suam in artibus, respondeat bis ad minus magistris regentibus in disputacionibus solempnibus, que non fuerint de quolibet, et hec de questionibus vel semel de questione et de problemate alias." Statuta Antiqua, 32,16-27.

once in the general disputation of the bachelors held yearly at the convent of the Augustinians; in May of 1346 this was made a yearly obligation.(51)

It is clear from what has been considered that the bachelor was very much of an apprentice. All of his activities were under the direction of his master. Apart from the peculiar Lenten determinations, no bachelor determined questions in disputations; it seems that even the general disputations of the bachelors apud Augustinenses consisted only of opponents and respondents supervised by collatores.(52) If the licentia determinandi really constituted the bachelor's degree in arts, then not all those who proceeded to the Master's degree were previously bachelors, strictly speaking, although all had to fulfil the requirements pro forma inceptorum.

c. The Master.

When the master considered his bachelor to be ready for inception, he presented him to the Chancellor according to a traditional formula.(53) But before the Chancellor could grant the license to incept, he had to seek the deposition of 18 regent masters. Of these, besides the presenter, nine had to speak from actual knowledge of the inceptor's intelligence and morals, and five from belief. If this secret deposition was favourable, the Chancellor then granted the licence in a special ceremony. After the bachelor took the oath to keep the peace, incept within one year, to incept at Oxford, etc.,(54) the Chancellor solemnly conferred the licentia ineipiendi: "Ad honorem Domini nostri Iesu Christi... auctoritate mea et

(51) Ibid., 147; cf. S.Gibson, ibid., xcv.
(52) Ibid., 147
(53) Ibid., 29,13-20.
(54) Ibid., pp.34-35; for Paris, cf. Chart.U.P., I,pp.230-231,II,pp. 675-681.

tocius vniuersitatis do tibi licenciam incipiendi in tali facultate legendi, et disputandi, et omnia faciendi que ad statum magistri in eadem facultate pertinent, cum ea compleueris que ad talem pertinent solempnitatem."(55)

When the date was fixed for the solemn inception, the licentiatus visited the schools of all the masters, asking them to attend.(56)

The inception of a new master consisted of two separate ceremonies: 'vesperies' and the actual inception. The 'vesperies' could be held on any dies legibilis in the late afternoon, from which the name is derived; but the actual inception had to be held on a dies disputabilis, or at least on a day which was festine legibilis.(57) At Oxford in the 14th century 'vesperies' were held at the church of St. Mildred by a regent or non-regent master under whom the bachelor wished to incept. Sometimes bachelors wished to incept under masters other than their own. At Paris regent masters were not bound to attend 'vesperies' held by non-regent master, although all were invited.(58) 'Vesperies' began with a disputation, or a series of disputations, if more than one incepted at the same time, the question to be discussed by each inceptor having been previously announced in congregation by the presiding master. From extant 15th century evidence it seems that these questions were taken from the quadrivium or one of the philosophies, and not de sophismatibus.(59) The principal role of the inceptor was to oppose.(60) For the first disputation it was the task of

(55) Statuta Antiqua, 36,12-18; for the licentia legendi ubique terrarum at Paris, see Chart.U.P., II,App.15,p.679.
(56) Statuta Ant.,pp.36-37.
(57) Ibid., 36,30-36.
(58) Chart.U.P.,I,n.202,p.231.
(59) For example, the collection of disputations contained in Lambeth Pal. MS 221.
(60) This is different from the custom in the theological vesperies, where the role of the inceptor was to respond: "preterquam in theologia, in qua bachelarii noviter incepturi solent respondere."Statuta Ant.,37,15-16.

the most recent inceptor to respond if he had not yet responded at 'vesperies' otherwise the senior inceptor took the secondary role of responding. After all inceptors had opposed, the presiding master delivered a short address based on the subject of the disputation, usually with a pertinent text around which he developed his theme. This address was called a commendatio, because in it he commended his inceptors (filii sui) by name, often with puns on the name or allusions to peculiar characteristics of the inceptors. William Whetely in his commentary on pseudo-Boethius' De disciplina scholarium, written in 1309, remarks: "Videndum est quod magister illo die quo incipit habeat bonas et efficaces reasiones contra suum respondentem et contra quemcumque alium, et similiter quod magister suus sub quo incipit habeat verba ornata et fructuosa in sua commendacione."(61) Finally the inceptors took an oath of fidelity to the university.(62)

At the solemn inception of a master all regent masters of the faculty were obliged to be present, for which reason all lectures were suspended in that faculty. After the celebration of Mass the presiding master bestowed the insignia of office on his inceptor, the book and cap, thus creating him master. The inceptor then delivered a short lectio (his principium), followed by two questions to be disputed; it was the duty of some master, usually one who had recently incepted, to respond to the objections posed by the inceptor.(63) Out of reverence for the responding masters, the inceptor determined, quasi determinando, by repeating a single argument and declaring himself satisfied with the response of the masters. The principium

(61) Oxford, Exeter College, MS 28, quoted by S.Gibson, loc.cit, p.xxvii, note 5.
(62) Statuta Ant., 36,22-25.
(63) Ibid., 38,3-23.

together with the determination constituted the first magisterial act of the inceptor, thus signifying the twofold function of a master: Legere and disputare. Finally the incepted master took the oath to safeguard the privileges of the university, etc.

According to the university statutes a young master was bound to hold disputations for forty days after his inception on every die disputabili.(64) His very first disputation had to be on logic, unless it happened to be a Friday, in which case it was on grammar.(65) The whole purpose of inception was to start the master off on his career of teaching. Thus to fulfil his title of "Master" he had to instruct others magistraliter for at least two years after his inception.(66) At Oxford if anyone did not comply with this necessary two years of regency, he was considered a perjuror and not a member of the university until he had fulfilled his oath.(67) During this regency he could not be a scholar in one of the higher faculties, but was obliged to lecture ordinarie in the morning cum questione annexa and hold solemn disputations in the afternoon at least once a week after his customary forty disputations.

Two years regency was only a minimum requirement: he could continue to rule as regent master for as long as he liked. But ordinarily a master in arts would proceed to one of the higher faculties in spite of the expense. Sometimes a master in arts would study in one of the higher

(64) Ibid., 38,3-23.
(65) Ibid., 39,17-23: Chart.U.P., I,n.202,p.230;II,App (15),p.679.
(66) This was true of all medieval universities. But according to an early 14th century Oxford statute (op.cit., 54,11-16), if a master incepted shortly after Christmas, he had to continue for the rest of that academic year and for another full year. This would make an absolute minimum of one year and a half.
(67) Statuta Antiqua, 54,11-19.

faculties while continuing to lecture in arts and to draw payment from his scholars. One difficulty about this arrangement would be the question of time. Obviously if a master in arts enrolled under a master in one of the higher faculties, he was obliged to attend that master's ordinary lectures and disputations. But this is only an apparent difficulty, since as a master in arts he could lecture not only in the ordinaria magistrorum, but in the extraordinaria magistrorum and at any time the regent masters were not formally lecturing.(68) However it has not been shown that a great number of masters taught in arts while studying theology or while enrolled in one of the other faculties. The study of theology, medicine or law was a full time occupation and it cannot be assumed that everyone was sufficiently capable of doing both. Only those masters who had a predilection for the arts, or who were particularly capable, in one of the higher faculties. At any rate the normal practice, at least at Oxford, was to enroll in one of the higher faculties.

We have seen that the proper function of a master was to lecture (legere) and dispute (disputare). The university curriculum of arts embraced the whole of human speculative knowledge contained in the trivium, quadrivium and the three philosophies. The wisdom of the past was handled down to posterity in what was considered the best pedagogical method. The writings of the greatest known authorities were read, lectured upon in detail, and all points,

(68) The word "extraordinaria" or its variants in the content of medieval teaching is sometimes confusing, as it had various meanings. It was always opposed to "ordinaria", but this could be for different reasons, e.g., by reason of time, or person, or method. By reason of time a master would be said to lecture "extraordinarie" if he lectured at a time other than his usual time in the morning. By reason of person a bachelor would be said to lecture "extraordinarie" if he completed a course on physics, metaphysics, or ethics begun by a master. By reason of method a master would be said to lecture "extraordinarie" if he lectured cursorily on any book.

large and small, were debated in order to understand the truth. It is sometimes thought that medieval teaching was nothing more than a parroting of accepted authors, or quibbles in an elaborate and artificial form. This is a complete misunderstanding of the medieval method of teaching. It is true that there were some masters, then as today, who were incapable of anything more than a repetition of the textbook. There were masters then, as there are today, who quibbled without seeing realities and who quoted authorities without understanding the truth. But the medieval method of teaching itself aimed at presenting the student with the best authorities on the subject and at trying to inculcate in him an understanding of the reason for the truth. At least it must be admitted that Euclid, Ptolemy, Aristotle and the like were the greatest authorities at the time and that their actual writings were worth delivering to students as soon as they were capable of understanding the really difficult problems. Aristotle especially is a very difficult author to understand, even today. And it is not surprising that the medieval professors relied on the commentator such as Averroes for enlightenment in difficult passages. Today students are not even given Newton, Einstein, or Planck to read, but they are taught to repeat what someone else claims they said. In the medieval method of teaching disputations were considered a useful means of teaching the <u>reason</u> for accepting truths, as well as of solving new problems; even the disputations de sophismatibus, both the morning questions and the afternoon disputations, were considered pedagogically useful in understanding the 'why' of fallacies.

The whole of medieval teaching consisted in lecturing on some approved book and in disputing questions. In order to understand more fully the teaching of the masters and the curriculum of studies at Oxford in the early 14th century, we must consider the textbooks lectured upon and the various types of disputations held in the Faculty of arts.

A. Scholastic Textbooks.

Medieval lecturing was always based on some approved text. Certain writings were universally recognized as authoritative and worth lecturing upon. Certain basic works were required pro forma. In their courses masters would usually lecture on those books which were "commonly accepted in the schools." Already in 1277 one can see the desire for novelty in the Faculty of Arts at Paris. The famous condemnation of Stephen Tempier lists certain books which may not be read in the schools under pain of excommunication. Among these were the Liber de amore of Andreas Capellanus, a certain Liber Geomantie, (69) and any other work on necromancy. In 1339 the Parisian Faculty of Arts forbade the teaching of Ockham's works and doctrines in the schools on the grounds that his works "had not been admitted by those in authority, nor acknowledged elsewhere as customary, nor examined by us or by others to whom this might pertain." Whatever may have been the motive behind this statute, (70) the reason alleged for not reading the works of Ockham in the schools was that "we ought not to read certain books not admitted by them [i.e., by our predecessors] or in common use elsewhere." (71) At Paris textbooks seem to have been a matter

(69) Inc.: "Estimaverunt Indi..." Expl.: "...Ratiocinare ergo super eum et invenies, etc." H.Denifle found this work contained in Erfurt MS Amplon. Q. 365, fol.53-82. Cf. Chart.U.P., I, p.543 and 557.

(70) Cf. Ernest A.Moody, "Ockham, Buridan, and Nicholas of Autrecourt: The Parisian Statutes of 1339 and 1340," Franciscan Studies, VII (1947), 113-146.

(71) "Cum igitur a predecessoribus nostris non irrationabiliter motis circa libros apud nos legendos publice vel occulte certa processerit ordinatio per nos jurata observari, et quod aliquos libros per ipsos non admissos vel alias consuetos legere non debemus, et istis temporibus nonnulli doctrinam Guillelmi dicti Ockam (quamvis per ipsos ordinantes admissa non fuerit vel alias consueta, neque per nos seu alios ad quos pertineat examinata, propter quod non videtur suspiciose carere), dogmatizare presumpserint publice et occulte super hoc in locis privatis conventicula faciendo...," Chart.U.P., II, n.1023, p.485.

of customary acceptance and universal approval. There does not seem to have been any official approbation for each and every text used, otherwise objectionable texts could not have been introduced in the first place. There is no reason to think that the situation was different in Oxford.(72)

The course of arts in the early 14th century covered the whole of the trivium, quadrivium and the three philosophies. We must consider briefly the books generally in use.

The Trivium:

1) GRAMMAR. At Oxford in the early 14th century grammar seems to have lost its earlier interest and to have been largely absorbed into Logic. The way for this was prepared by the grammatica speculativa, of which there is a continuous history from the school of Chartres to Oxford. Of grammar the early 14th century statutes require only two terms of Priscian's Institutiones grammaticae.

a) Priscianus maior consisted of the first 16 books of the Institutiones. At Paris in the mid-13th century it was supposed to be covered in about two terms; at Oxford in the early 14th century it was taught at least "per sex septimanas integras, non computando dies festos." (Statuta Ant., 34,5-6)

b) Priscianus minor consisted of the last two books, also known as the De constructionibus. At Paris it was taught with the Barbarismus of Donatus over approximately two terms; at Oxford in the early 14th century one term was devoted to it.

c) Donatus' two works: the Ars minor (probably studied in the grammar school) and the three books of his Ars maior, the last book of which was known as the Barbarismus.

d) Various classical authors who were read as examples of classical Latin grammar. (On the classical authors and the curriculum, cf. E.R.Curtius, European Literature and the Latin Middle Ages, London 1953, 42-61, 436-443; L.J.Paetow, The Arts course at Medieval Universities with special reference to Grammar and Rhetoric, Champaign, Ill. 1910)

(72) A Munich MS, Clm. 4384, fol.123v-131v, written about 1340, contains an anonymous commentary on the De suppositionibus of William Sutton, "edite a magno coetu philosophorum in Anglia." If one could be certain of the authenticity of this rubric, there would be reason to think that at Oxford this anti-Ockhamist treatise was introduced by the congregation of regent Masters in Arts. But it seems more probable that this rubric is a forgery.

e) Speculative grammars such as the Doctrinale of Alexander of Villedieu (1199), the Graecismus of Eberhard of Bethune, the Grammatica Speculativa of Thomas of Erfurt, and others. (Cf. M.Grabmann, Mittelalterliches Geistesleben, I,104-146; also his "Thomas von Erfurt und die Sprachlogik des Mittelalterlichen Aristotelismus" (Sitz. d. Bay. Akad., 1943).)

2) RHETORIC. At Oxford statutory mention is made only of Aristotle and Boethius, but the statutes of 1431 mention other alternatives and give the required time as three terms. (Stat.Ant., 234, 22-24)

a) The Rhetorica of Aristotle.

b) The 4th Book of Boethius' Topica.

c) Cicero's De inventione (known as the Rhetorica vetus or prior) and (pseudo-Cicero) Rhetorica ad Herennium (Nova rhetorica).

d) Various classical authors, such as Ovid and Vergil, who were studied as examples of rhetorical style, (cf. Curtius, op.cit. 62-78, 148 ff.; Paetow, op.cit., 67-91), and manuals of the well-known ars dictaminis.

3) LOGIC. At Oxford the greatest emphasis was placed on the study of logic, which occupied about half of the actual curriculum.

a) The logica vetus consisted of the Isagoge of Porphyry, the Praedicamenta and Perihermeneias of Aristotle, and the Liber de sex principiis attributed to Gilbert de la Porrée. These books would be covered in three terms.

b) The first three books of Boethius' Topica and his Liber de divisione; this latter work seems to have been dropped during the first half of the 14th century.

c) The logica nova consisted of Aristotle's Analytica Priora and Posteriora, Topica and De sophisticis elenchis. The two analytics would each require at least two terms, while the Topica and Sophistici elenchi seem to have required one term each, although they were read in immediate succession.

d) Various texts of the parva logicalia, which will be considered later.

The Quadrivium:

1) ARITHMETIC.

a) The Arithmetica (or Arsmetrica) of Boethius was obligatory "per tres septimanas integre, non computando dies festos." These two books were adopted by Boethius from the Arithmetic of Nicomachus of Gerasa.

b) The Algorismus (or Arithmetica practica), which dealt with fractions, their addition, subtraction, multiplication, division and the extracting of roots, was taught in the brief space of eight whole days. The usual text was that ascribed to Sacrobosco, inc.: "Omnia que a primeva rerum origine processuit ratione numerorum formata...", of which there are numerous manuscripts. Paris, BN, Nouv.Acq.lat. 625, fol.51v-53v refers to it as "algorismus novus."

c) A summary of Boethius was made by Thomas Bradwardine, which seems to have been used later as a text, at least on the continent. Bradwardine's text is contained in MSS, Munich, Clm.24809, fol. 100v-106, Erfurt, Amplon. F. 375, fol.15v-17v, 88v-92v, Erfurt, Amplon. Q. 23, fol.75-81v; and a commentary is found in Vienna, NB.4953, fol.56-61v, and 4951, fol.273-304v.

d) Books VII-X of Euclid's Elements, which deals with the properties of numbers, was also considered as belonging to arithmetic. (cf. R.Bacon, Opus Math., ed. Steele, p.47). Probably for this reason Euclid is also mentioned under arithmetic by Alexander Nequam in his Sacerdos ad altare accessurus (cf. C.H.Haskins, Studies..., 2nd ed. Cambridge, Mass. 1927, 374, line 50-51).

2) MUSIC. The study of music in the middle ages still needs careful research. There is no mention of it at Oxford before 1431, when the statutes require the Musica of Boethius to be heard for one term before inception. However, there was also the De Musica of St. Augustine (PL 32, 1081-1194), and the Musica rusticorum Parisiensium of Jean de Muris belonging to the first half of the 14th century. Cf. G.Reese, Music in the Middle Ages, London 1941.

3) GEOMETRY. Geometry and astronomy were by far the most cultivated mathematical sciences in the sense that there were innumerable texts which could be used and were used for the various branches. But the only book required was Euclid I-VI, heard "per quinque septimanas integre, non computando dies festos." (Stat.Ant., 33, 31-32)

a) Euclid's Elements (or Ars geometrica), translated from the Arabic in the 12th century by Adelard of Bath, Herman of Carinthia, and Gerard of Cremona, contained the 13 authentic books plus two spurious Arabic additions. The version commonly used in the schools of Oxford was the abridgement of Adelard of Bath beginning "Punctus est cui pars non est. Linea est longitudo..." (cf. M. Clagett, "The Medieval Latin Translations from the Arabic of the Elements of Euclid, with Special Emphasis on the Versions of Adelard of Bath," Isis, XLIV (1953), 16-42; see also Isis, XLV (1954), 269-277). Only the first six books seem to have been taught as geometry in the schools.

b) Other works of speculative geometry at least used, if not expounded in the schools, were Euclid's De quantitatibus datis, and Jordanus Nemorarius' De triangulis. (cf. R.Bacon, Comm.Math., Opera hac. ined.,XVI, ed. Steele, p.42)

c) Tractatus quadrantis, usually ascribed to Robertus Anglicus, was a part of practical geometry dealing with the structure of the quadrant. Inc.prol.: "Geometrie due sunt partes, scil. theorica et practica..." Inc.text.: "Est igitur quadrans quoddam instrumentum..." (cf. P.Tannery, "Le traite du quadrant..." in Not.et Extraits..., XXXV, pt.ii (1897), 561-640; L.Thorndike, "Who Wrote Quadrans Vetus?", Isis XXXVII (1947), 150-153.)

d) Tractatus de ponderibus, a part of practical geometry dealing with statics. The text generally used was the Elementa Jordani de ponderibus, usually with some commentary such as that contained in the De ratione ponderis. (cf. A.Maier's review of The Medieval Science of Weights, ed. E.Moody and M.Clagett, 1952, in Isis XLVI (1955), 297-300)

e) Perspectiva (or Optica) was a part of practical geometry which dealt with optics. A great number of texts were available, e.g., Ptolemy's Optica, Euclid's Optica, or his De speculis (Catoptrica), Alhazen's De aspectu, Alkindi's De aspectu, Roger Bacon's Perspectiva, or Pecham's Perspectiva communis. It is not clear from the statutes or extant manuscripts which text was more commonly used at Oxford in the early 14th century.

4) ASTRONOMY. Astronomy was greatly advanced at Oxford in the early 14th century by such men as John Maudith, Richard of Wallingford, Simon Bredon, John Ashenden, and William Rede -- all Merton Fellows. (cf. R.T.Gunther, Early Science in Oxford, II,42-65). However only the De sphera and the Computus were required by statute, each "per octo dies integre." (Stat.Ant.,33, 35-38). The principal aim of this subject was to be able to understand the position of the planets and to calculate the variable feast days. The science itself covered a great variety of books, of which we mention only the more important.

a) The Almagest of Ptolemy was the basis of all speculative astronomy. Although a number of versions existed already in the 12th century both from the Greek and Arabic (cf. Haskins, op.cit.,103-112; F.Cannody, Arabic Astronomical and Astrological Sciences in Latin Translations, Berkeley, Calif., 1956, p.15-16), the common version was that made by Gerard of Cremona from the Arabic in 1175 at Toledo. To this was sometimes added the brief introductory work of Thabit ben Korah, Liber...de hiis que indigent expositione antequam legatur Almagestus (Oxford, Univ. Coll. MS 41, fol.26-28; see Cannody, op.cit., p.118)

b) For astrology Ptolemy's Quadripartitum (or Tetrabiblos) was used, translated in 1138 by Plato of Tivoli, or the abridgement by John of Seville, known as the Centiloquium or Fructus Ptolomei (cf. Haskins, op.cit.,68-69).

c) Theorica planetarum discussed the Ptolemaic system of planetary movement and was more commonly used in the schools than the Almagest. There were a number of texts by this name and various revisions (cf. P.Duhem, Le Système,III,216-326). But the most commonly used at Oxford in the early 14th century was that beginning, "Circulus eccentricus vel egressae cuspidis vel egredions centri...", ascribed to Gerard of Cremona (cf. Duhem, ibid.,219-230; F.Carmody, op.cit.,p.167-8; text edited by Carmody, Berkeley, Calif.,1942). This text was later replaced by the Theorica planetarum of Campanus of Novara.

d) The De sphera of Sacrobosco was by far the best known work of speculative astronomy in the schools of Oxford. It is a short elementary work in four chapters based on the Almagest, and the works of al-Farghani and al-Battani. It was also known as the Spera materialis. (For comparison of this text with other works of the same title, cf. L.Thorndike, The Sphere of Sacrobosco and its Commentators, Chicago 1949, 10-41).

e) The Computus was a course in practical astronomy to learn how to compute the variable feasts of the calendar, and hence the text used in this course varied considerably as efforts were made to reform the calendar (cf. C.Wordsworth, The Ancient Kalendar of the University of Oxford, (O.H.S.) 1904, 135-194). At Oxford the basic text in the 13th century seems to have been the Computus of Grosseteste, beginning, "Computus est scientia numerationis et divisionis temporum..." (ed. by R.Steele together with the Computus Fratris Rogeri in Opera hac. ined., fasc.VI, 212-267). But it would seem that the text of Sacrobosco was commonly used from the beginning of the 14th century, beginning "Computus est scientia considerans..."

f) The Tractatus quadrantis as a part of practical astronomy came into the schools at the beginning of the 14th century. This quadrans novus was composed by Profatius Hebraeus in Hebrew at Montpellier in 1288 and translated into Latin with the help of Master Hermegaud Blasii in 1299 (cf. Duhem, Le Système, III, 306-308). The rubric of Oxford, Univ.Coll. MS 41, fol.10-16 reads: "Tractatus quadrantis novi compositus a mag. Prophatio Hebreo anno dominice Incarnacionis 1288, et correctus ab eodem A.D.1301" (also in Brit.Mus. MS Harley 80, fol.94). The text begins, "Cum stellarum scientie sine instrumento congruis minime compleatur..." There is no reason to suppose that the quadrans novus supplanted the quadrans vetus of Robertus Anglicus mentioned above.

g) Astronomical tables for Oxford were abundant in the early 14th century. One based on the Alphonsine tables is contained in Oxford, Univ.Coll. MS 41, fol.52-77 entitled, "Tabula radicum planetarum super meridiem Oxonie cuius longitudo ab occidente est 51 gradus..." In the same MS, fol.35-36v there are tables of the altitude of the sun for Oxford, London and Exeter. The Mathematicos tabulae written by John Maudith in 1310 and the well known Summa iudicialis (1347-48) of John Ashenden testify to the use of astronomical tables in the schools of Oxford in the early 14th century.

h) The Tractatus de proportione was introduced some time after 1328 when Thomas Bradwardine wrote his Tractatus de proportionibus velocitatum motuum. There is reason to believe that Bradwardine's text itself was not generally used, but rather two simpler versions. One begins, "Omnis proportio vel est communiter dicta vel propria..."; the other, which is later and less common, begins, "Omnis proportio aut est communiter dicta, proprie dicta, vel magis proprie dicta..." These elementary texts will be discussed later. This course was considered a part of astronomy because it applies geometrical proportionality to variations of physical motions.

The Three Philosophies:

1) NATURAL PHILOSOPHY consisted of all the Aristotelian libri naturales, which will be discussed later. At Oxford as at Paris, most of the curriculum was devoted to logic and the natural sciences. By the beginning of the 14th century this part of the curriculum was already fully established by the traditions and translations of the 13th century. Here we will merely list the more important Aristotelian books used in the schools.

a) The eight books of the Physics were considered the foundation and general theory of natural science. Normally three terms were needed to cover all the books. Early in the 14th century the revision of James of Venice's translation seems to have been commonly used, but Averroes continued to be the common guide. It was required of determiners at Oxford.

b) The De Celo et Mundo, 4 books, dealt with locomotion in the universe, and the physical theory of the spheres, which conflicted with the Ptolemaic. At Paris in the middle of the 13th century about two and a half terms were devoted to its study; at Oxford in the early 14th century one term alone was considered sufficient, and the translatio nova of William of Moerbeke was used.

c) The Metheora, 4 books, dealt with meteorology. At Oxford this was required of inceptors, and the length of the course is given as one term. The version used seems to have been that of William of Moerbeke. In the 13th century when the translation of Gerard of Cremona was common, there was also appendix I added by Gerard, De causis proprietatum elementorum, and appendix II added by Alfredus Anglicus, De mineralibus, or De congelatis. These appendices are still mentioned in the Oxford statutes of 1431.

d) The De Generatione et Corruptione, two books, considered alterations and changes of elements and compounds. This was a required course for determiners at Oxford in the early 14th century, but no minimal time is stated; at Paris in the mid-13th century half a year is required to complete the books.

e) The De Anima in three books discussed the active principle of all living beings. This work, translated by James of Venice and revised by Moerbeke, was one of the most important treatises in the middle ages; it was required of determiners at Oxford, but no minimal time is stated.

f) The Parva Naturalia included all the small treatises of psychology, namely De sensu et sensato, De memoria et reminiscentia, De somno et vigilia, De longitudine et brevitate vite, De juventute et senectute, De respiratione, and De vita et morte.

g) The ten books De Animalibus seem sometimes to have been taught at Oxford together with the two small treatises De progressu animalium and De motu animalium (cf. Stat.Ant.,33,4-5; 34,4-6). It was one of the acceptable courses before inception, and the minimal length of the course is given as six whole weeks "non commemorando dies festos," (Ibid.). The other works of biology, namely De Generatione Animalium and De Partibus Animalium were certainly known and possibly taught cursorily. For botany the basic text was the pseudo-Aristotelian (Nicholas of Damascus) De Plantis, or De Vegetabilibus, translated by Alfredus Anglicus from the Arabic.

2) MORAL PHILOSOPHY consisted of all the Aristotelian books on Ethics, Economics, and Politics.

a) The ten books of the Ethica ad Nicomachum, in the version of Grosseteste, was a course required for inceptors, and the minimal length of the course was "quatuor menses integre, commemorando dies festos." (Stat.Ant.,33,29-30). At Toulouse the first five books were read during the first summer term and the last five during the second.

b) The Economica, translated anew from the Greek in 1295 by Durandus of Alvernia, (cf. Arist.Lat.,I,166-167) could have been used. We are certain that this course was given at Paris in the early and mid-14th century, but we have no similar certainty for Oxford.

c) The eight books of the Politica, in the version of William of Moerbeke, was an acceptable course for inceptors at Oxford; the minimal length of the course is given as "sex septimanas integre, non commemorando dies festos." (Stat.Ant.,34,5-6).

3) METAPHYSICS always meant the books of Aristotle's Metaphysica, of which only the first 12 books were read in the schools. In a marginal note to Buridan's Questiones super Metaphysicam contained in Vienna,

Dominikanerkloster cod.187/163, we read on fol.133rb: "Nota quod super 13m et 14m metaphisice non sunt questiones quia non leguntur illi libri." There is an extraordinary dearth of information concerning the teaching of metaphysics at Oxford in the early 14th century. The first statutory mention of it is made around 1407, when only ordinary, and not cursory lectures on the Metaphysics will be accepted pro forma inceptorum. The statutes of 1431 require three terms of inceptors who have not determined, and two of those who have determined (Stat.Ant., 235,5-8). The Statutes of the Faculty of Arts at Paris in 1255 give the length of these lectures as from the feast of St.Remigius (Oct.1) until the feast of St.John the Baptist (June 24). One may possibly infer from this that if ordinary lectures were given on the Metaphysics at Oxford in the early 14th century, the normal period would have been about three terms.

The university curriculum thus covered the whole of the trivium, quadrivium and the three philosophies. But exposition of a standard text was only part of the method of medieval teaching. The other essential part consisted in a discussion, or disputation of difficult questions.

B. Scholastic Disputations.

The scholastic method of debating questions arising out of the text has been called the "méthode didactique par excellence."(73) The purpose of such disputations was not only to solve new problems about which there may be a variety of views, but also to manifest more clearly the reason for accepting old truths. It was a method of teaching by which students were led to view problems more clearly, to understand truths more deeply, and to detect fallacious arguments more easily. The structure of scholastic disputations has been sufficiently discussed by

(73) G.Wallerand, Les oeuvres de Siger de Courtrai (Étude critique et textes inédits), Phil. Belges, VIII, Louvain 1913, p.(31); see also the anonymous Commentum super lib. Boetii de Scholarium Disciplina, in S.Thomae Aq. Opera Omnia, Parma 1869, vol.XXIV, exp.VI, p.208a.

Mandonnet, Grabmann, Glorieux, Landgraf and Wallerand. While the researches of the past fifty years have added greatly to our knowledge of such disputations in the Faculty of Theology, much work still needs to be done for the medieval Faculty of Arts. Our knowledge is particularly meagre concerning disputations in the Faculty of Arts at Oxford in the early 14th century. But the few facts known are most valuable in suggesting a general picture of this aspect of the arts faculty at Oxford. We are not concerned here with the morning discussion associated with the exposition of the text "cum questione pertinente cum suis argumentis pertinentibus ad materiam libri,"(74) nor with the purely academic exercises de obligationibus. We are concerned only with the solemn disputations de sophismatibus, de questione, and de quolibet.

1. Disputationes de sophismatibus.

There is considerable difficulty about the meaning of sophisma in medieval literature. This is perhaps because the word itself underwent an extension of meaning. Originally it meant a false conclusion, as in St. Augustine's use of the term,(75) or a contentious argument.(76) But, as Grabmann has shown, by the first half of the 13th century a sophisma was an enigmatic proposition of logic or grammar which could be disputed.(77)

(74) Statuta Antiqua, ed.cit., 192,29-31.

(75) De doctrina christiana, II,31 (PL 34, 58): "Sunt enim multa quae appellantur sophismata, falsae conclusiones rationum, et plerumque ita verae imitantes, ut non solum tardos, sed ingeniosos etiam minus diligenter attentos decipiant." For earlier uses of sophismata in this sense, see. C.Prantl, Geschichte der Logik im Abendlande, Leipzig 1855, I,40-58, 488-496; also G.Wallerand, op.cit., (27)-(29).

(76) Boethius, Topicorum Arist. Interpretatio, VIII,4 (PL 64, 1004): "sophisma vero syllogismus contentionis."

(77) M.Grabmann, Die Sophismataliteratur des 12. und 13. Jahrhunderts mit Textausgabe einer Sophismata des Boetius von Dacien, B.G.P.M.A., XXVI, Heft 1 (Münster 1940).

In the anonymous commentary on the De Scholarium Disciplina included among the works of Aquinas sophismata are synonymous with aenigmata and obscuritates.(78) By the end of the 13th century the term was used to signify any questio disputata in logic, even those which began with "Utrum."(79) In the 14th century there are numerous examples of the use of the term to designate ordinary questiones determined in a logical disputation or based on the logical books, questions such as "Utrum logica sit scientia," or "Utrum omnis propositio sit vera vel falsa." In Vienna, Dominikanerkloster cod.160/130, fol.96-100v, a parchment of the second half of the 14th century, there are "curialia sophismata super de suppositionibus magistri siffridi /erased/ anglici," that is, questiones on the text of William Sutton, the Mertonian logician. In the same manuscript an anonymous commentator on Sutton's De consequentiis writes:

> Nota quod hec verba propositio, questio, enunciacio, problema et sophisma sunt eadem realiter, set differunt secundum suas raciones proprias diffinibiles et formales; eadem sunt realiter, quia una et eadem propositio in numero potest esse omnia hec. Differunt aliquid /nig/ secundum suas raciones formales, ut Boecius in Ciceronis Topicis /PL 64,1049/ sic diffinit, "questio est dubitabilis propositio." Set propositionem Aristoteles primo Priorum /24a16/ sic diffinit, "propositio est oratio significans aliquid de aliquo vel negative vel affirmative." Set enunciationem sic diffinit primo Perygermenias /17a1/, "enunciacio est oratio significans id /sig/ quod est aliud verum." Set problema est propositio probabilis et improbabilis alicui. Set sophisma Wurley in abstractionibus suis circa ph^m sic describit, "sophisma est propositio probata argumento vel argumentis." (fol.100vb).

It would seem that by the beginning of the 14th century the word sophisma was used to designate at least two types of propositions in

(78) S.Thomae Aquinatis, Opera Omnia, Parma XXIV, 207b.
(79) See the list of sophismata in MS Vat.lat.3061 quoted by M.Grabmann, op.cit., 60 ff. However G.Wallerand considers sophismata to be much more restricted in meaning, cf. op.cit.,(27)-(33).

logic. Ordinarily and properly it meant an enigmatic proposition, "which from a logical viewpoint presents certain difficulties in virtue of its ambiguous or faulty formulation."(80) Such are the well known Sophismata of Heytesbury and Kilmington. But the term was also used to signify any questio disputata in logic. It is undoubtedly in this wider sense that the university statutes required disputations de sophismatibus.

C.Michalski has suggested that the novelty of the 14th century was the introduction of the sophismata physicalia.(81) It is true that the 14th century scholastics spoke of sophismata naturalia, or physicalia, and used the term to designate purely physical questions. For example Dumbleton says that his Summa contains dubia of the five great natural books "cum solucione sophismatum logicalium et naturalium."(82) The long sixth chapter of Heytesbury's Regulae solvendi sophismata is devoted exclusively to problems of physical motion; and many problems of physics are brought up in the other logical treatises.

However, it is clear that although various physical problems were raised in the logical treatises, as Michalski correctly observed, they were however discussed under the formality of logic. Further, we believe that the term "sophismata" was loosely extended to cover questiones in physics. Just as questiones in logic were called sophismata in a wide sense, so questiones in physics were sometimes called sophismata in a

(80) P.Boehner, Medieval Logic, An outline of its development from 1250-c.1400, Manchester Univ. Press. n.d.,p.6. It is in this sense that Albert of Saxony meant his definition to be understood: "Sophisma dicitur aliqua propositio que est argumentis probata et improbata."

(81) C.Michalski, "Le Criticisme et le Scepticisme dans la Philosophie du xive siècle," Cracovie 1926, p.14 ff. H.Grabmann refrains from making any comment on this suggestion, Die Sophismataliteratur ...p.9. A.Maier does not commit herself on this suggestion nor on the value of such a distinction, cf. An der Grenze von Scholastik und Naturwissenschaft, Roma 1952, 264-5.

(82) Prol., MS Vat.lat. 6750, fol.1ra.

wider sense, in the sense of "problems," or "difficulties." The dubia which Dumbleton raises in his Summa are familiar questions in the physical sciences, e.g., "numquid materia prima vel forma vel compositum ex hiis sit subiectum immediatum et primum qualitatum primarum,"(83) "utrum substantia aliqua, puta forma substantialis, magis et minus suscipiat in abstracto,"(84) "numquid una species alia imperfectior sive perfectior in infinitum excedat vel excedatur,"(85) and so forth throughout the whole of his work.(86) We believe that questions on the physical books were designated sophismata in the very wide sense of "problem" and that this designation had no special significance. One obvious reason for such an extension of the term is the fact that erroneous solutions can be given to problems, even of physics, due to logical fallacies.(87) Thus apart from the accidental consideration of physical problems in logic, the distinction between sophismata logicalia and sophismata physicalia is nothing more than the distinction between questions in logic and questions in physics. The novelty of the 14th century was not the introduction of sophismata physicalia, but the almost universal use of the tedious

(83) P.II, c.13, MS Merton College 306, fol.22ra.
(84) P.II, c.14, MS Merton College 306, fol.22vb.
(85) P.II, c.15, ibid.
(86) The same use of the term is to be found in the Calculationes of Richard Swinenhead. cf. following note.
(87) This is suggested by the Summulae in lib. Physicorum attributed to William of Ockham, P.IV, cap.11, ed. Venetiis 1506, fol.26vb: "Et ideo in isto sophismate: tempus est in terra; motus primus est tempus: ergo motus primus est in terra. Est fallacia amphibologie, quia maior improprie accipitur." This is also suggested by the use of the term in John Wyclif's Dubia super materia Physicorum contained in Venice, S.Marco Cl.VI, cod.173 (2623), fol.2ra: "unde isti termini per se et per accidens faciunt sophismata ex hoc quod antepositum vel postpositum in propositionibus..."; "alia sophismata graviora patent alibi" fol.6vb; fol.38rb: "et idem est sophisma si ponatur locum esse corpus locans..."; fol.50rb: "talia etiam sophismata possunt fieri si ponatur quod A localiter motum super pedale spacium intendat motum suum a gradu ut remissum ad gradum ut duo." See also Swinenhead, Calculationes, tr.II (ed. Venetus 1520) fol.9ra, 9rb; tr.V, fol.22ab.

argumentatio in terminis, or *calculationes*,[88] a method of argumentation common to all the disputations in the 14th century and even to commentaries on the *Sentences*.[89]

An examination of the thirty-two *Sophismata* of Heytesbury[90] shows that they are principally concerned with the distribution of terms (syncategorematic, *exponibiles* and *officiales*), and with types of propositions. The last two *sophismata*, which Michalski considers to be "sophismata physicalia" because of a colophon in MS Bibl.Nat.lat.16134,[91] are formally concerned with modal propositions involving "necesse" et "impossibile."[92]

Since every science uses terms, it is not surprising that the logical difficulties involved in those terms were considered in logic. In the Arts Faculty undergraduates and bachelors were required to dispute *de sophismatibus* during the same years they were studying the *libri naturales*, and hence it was natural to bring up difficulties of physics. Furthermore, the trend of 14th century physics, as we shall see, was to consider problems as linguistic or logical. This was principally due to the philo-

(88) Cf. A.Maier, *Studien*, III, 258, note 2.

(89) For a good discussion of the *argumentatio in terminis*, or *calculationes*, see A.Maier, *ibid.*, pp.257-288.

(90) We use the printed edition of Venice 1494, fol.77v-170v, although this does not follow the same order as the MSS. The well-ordered *Sophismata* of Kilmington show clearly how the *sophismata* followed the order of the new logical treatises: I-XXVIII, *incipit et desinit*; XXIX-XLIV, *de maximo et minimo*; XLV-XLVIII, *scire et dubitare*. MS Vat.lat.3066, fol.16-24v. These new logical treatises will be discussed in Chapter III.

(91) Fol.146: "Postremo posita sunt mag. Guilliermi Hostylibery sophismata in littera anglicana...quibus addita sunt duo alia sophismata physicalia." Cf. C.Michalski, *op.cit.*, pp.19-20. Michalski also mentions MS Bodl.Canon.Misc.376, fol.23-32, as other examples of "sophismata physicalia," but these are only fragments of Heytesbury's *De probationibus conclusionum*.

(92) In the printed edition of 1494, fol.155v: "Necesse est aliquid condensari si aliquid rarefiat"; fol.171v: "Impossibile est aliquid calefieri nisi aliquid frigefiat."

sophy of Cobham. Therefore problems of physics were discussed in logic and the works of physics abound with purely logical or verbal discussions. But properly speaking, disputations de sophismatibus were those concerned with logic; disputations de questione were those concerned with any of the "scientiae reales."

ii. Disputations de questione.

The method of solemn disputations is too well known to need elaboration here. We need only note that in the ordinary disputations of the masters the "respondens" was always a bachelor who attempted to answer the objections posed by anyone eligible to do so. The master alone could give a determination to the question; in his final response to the objections he would agree with his bachelor, distinguish, or disagree, as the case would require. In the peculiar Lenten "determinations" the bachelor shared in the Master's prerogative and had the privilege of responding and deciding questions under the guidance of his master. In the solemnities of inception the new master posed objections to older masters, and out of respect for their responses repeated a single argument quasi determinando.

A certain amount of work has been done on the disputations held in the Faculty of Arts at Bologna in the 14th century by M.Grabmann, B.Nardi, C.Piana, A.Maier and others. Unfortunately no similar work has been done on the Oxford Masters of the early 14th century, and thus far very few disputations de questione have come to light. The questiones of John Scharpe on the eight books of the Physics contained in Balliol College MS 93, fol.35v-91, end with the colophon: "Et in hoc finiunt questiones alique circa libros phisicorum superficialiter collecte modo que in scholis

physicis Oxon. disputari consueverant."(93) The structure of these questions, one on each book, suggests that they are quaestiones disputatae in the true sense of the term, which were later gathered together into a single unity, "superficialiter collectae." The structure of Swineshead's Calculationes and of certain parts of Dumbleton's Summa strongly suggest that they may have been originally disputations de quaestione, but later edited in the form we know them today.

Much more work needs to be done on this aspect of the Faculty of Arts at Oxford. But special care must be taken to distinguish an exposition of a text "per modum quaestionum" from collected "questiones disputatae" actually determined in solemn disputations. That is to say, not all quaestiones found in the manuscripts can be assumed to have been solemnly discussed in formal disputations. We have already mentioned the exposition of a text "cum questione pertinente." Such questions were frequently edited or copied independent of the exposition, or paraphrase which preceded the quaestio. Clearly these questions were not disputatae in the solemn "disputatio magistrorum."

iii. Disputations de quolibet.

Relatively little is known about the quodlibet literature in the medieval Faculty of Arts. It is not clear whether disputations de quolibet could be concerned indifferently with either logic or the real sciences. The Oxford statutes of 1340 distinguish disputations de quolibet from other disputations.(94) One basis for such a distinction is the fact that

(93) These quaestiones together with the same colophon is also found in New College MS 238, fol.53-208v.

(94) "...respondeat bis ad minus magistris regentibus in disputacionibus solempnibus, que non fuerint de quolibet, et hoc de questionibus vel semel de questione et de problemata alias." Statuta Antiqua Univ. Oxon., 32,24-27.

quodlibets were more solemn and less frequent disputations concerning any philosophical subject (de quolibet). Walter Burley's famous quodlibet held at Toulouse was concerned with a problem of physics, de primo et ultimo instanti.(95) In another Questio,(96) held at Bologna, Burley attacked Matthias of Gubbio on a doctrine of logic the day after Matthias determined a question of logic (probably a quodlibet) "in civitate Bononiensi anno domini M° ccc°xii."(97) Although it cannot definitely be ascertained at present, it would seem that disputationes de quolibet could be held on either logic or the real sciences.

Thus far no questiones quodlibetales belonging to the Arts Faculty at Oxford in the first half of the 14th century have been brought to light.(98) But from the statutes of 1340 we know that such questiones were held, at least occasionally.

A clearer picture of the Faculty of Arts at Oxford will be obtained from a consideration of the prominent Fellows of Merton College who developed logic and physics during the first half of the 14th century and from a study of their treatises of logic and physics.

(95) "Quando autem et in quibus formis est dare primum vel ultimum et in quibus non, patet in quolibet meo Tolose determinata questione..." Vienna, Dom.klos. 160/130, fol.81ra. Michalski quotes ("La physique nouvelle..." Cracow 1928, p.101) this passage with few variants from MS Vat.lat.1847, fol.215v; this is a typographical error for Vat.lat. 817. The work is very well known and was printed at Venice in 1501. MS Vat.lat. 3066, fol.54rb concludes, "Explicit questio disputata per Burley in suo quolibet Tholosse."

(96) Cf. A.Maier, Studien, I, 258.

(97) MS Vat.lat. 3066, fol.8v.

(98) Coxe (Cat. Codicum MSS qui in Collegiis Aulisque Oxon. hodie asservantur, Oxonii 1852, P.II, "Corpus Christi" p.41) erroneously entitles Corpus Christi College MS 119, fol.1-11, Quodlibeta physica. These are merely expository questions on the Physics of Aristotle.

CHAPTER II

THE MERTONIANS AND THEIR WRITINGS

In 1264 Walter de Merton, former Chancellor of the Realm, founded the "Domus Scholarium de Merton" in Maldon. In the definitive Statutes of 1274 the Bishop-elect of Rochester set forth clearly his idea of a permanent lodging at Oxford for scholars who would devote their energies to the study of the Arts and then proceed to the higher faculties of Theology or Canon Law.(1) Scholars were elected while still bachelors in Arts for one year's probation before full admission to the society. The first visitation of the college was made by Archbishop Kilwardby in 1276 during the lifetime of the founder. He imposed on the Masters in Arts a necessary regency of three full years from inception.(2) By statutes the young master in arts had to be approved by the Warden and Fellows before he could begin study in the higher faculties. Nevertheless it was the normal procedure to enroll in one of the higher faculties as soon as possible. The ordinances of Archbishop Peckham's visitation, dated 1284, forbade the admission of medical students and suspended the "arrogantes" who presumed to study Canon Law without the Warden's leave, or who spent too

(1) "Hanc igitur formam statuo (quam et inperpetuum observandum decerno), ut in ipsa Domo, quae Scholarium de Merton nuncupatur, perpetuo sint scholares litterarum studio deputati, qui artium seu philosophiae, canonum seu theologiae, studio vacare tenebuntur. Quorum pars major artium liberalium et philosophiae studio vacent, donec de sui Custodis et Sociorum arbitrio, tanquam in hiis laudabiliter provecti, ad studium se transferant theologiae. Quatuor autem vel quinque ex sui superioris providentia, quos ipse humiles et ad hoc aptos decreverit, in jure canonico licenter studeant." Merton Muniments, ed. P.S. Allen and H.W. Garrod, Oxford 1928, p.21.

(2) "Magistri queque Artium Lectiones suas habeant a tempore suae Inceptionis usque ad finem trium Annorum integre sequentium, nisi forte per corporis imbecillitatem aut alias ex causis necessariis et evidentibus impediantur." Merton College Injunctions of Archbishop Kilwardby 1276, ed. H.W. Garrod, Oxford 1929, p.15.

long a time in the study of Civil Law.[3] The founder's wish was that the majority proceed to theology when they had completed their study and regency in Arts.

Perhaps we shall never know why among all Oxford Masters the Mertonians particularly contributed so much to the development of logic and physics in the early 14th century. Nevertheless, the personalities which made the Arts Faculty of Oxford famous in the 14th century were predominantly Fellows of Merton College, at least at some period in their careers.

William of Ockham, a Franciscan, is undoubtedly the most important personality in early 14th century English thought. His influence on the Mertonians in one way or another was immense, as will become clear when we discuss the particular problems of physics. To understand the background of these problems it is necessary to say something about the life and works of Ockham.

Contrary to popular legend, Merton cannot claim Ockham as one of its Fellows.[4] William, "de civitate Occam,"[5] was born about 1284, probably in Surrey. Neither the date nor place of his entrance into the Franciscan Order are known. But according to Winchelsey's episcopal register, Gulielmus de Okam was ordained subdeacon in the conventual church of St.Mary, Southwark, in 1306.[6] He arrived at the Oxford convent some time around 1310 to pursue theological studies at the University. By August 1323 John Lutterell, Chancellor of the University from 1317 until 1322, had charged Ockham

(3) Statutes of the Colleges of Oxford, vol.I, London 1853, "Injunctions of Visitors of Merton College," cap.1-2, pp.40-41.

(4) The earliest mention of Ockham as a Fellow of Merton seems to have been made by Sir Henry Saville. Cf. G.Brodrick, Memorials of Merton College, (O.H.S.) 1885, p.194. Not only is there no contemporary record of Ockham at Merton, but unless his birth is put much earlier than 1284, it would have been impossible for Ockham to have been a Fellow before becoming a Franciscan.

(5) MS Brit.Mus., Arundel 367 (membr.xiv),fol.153 in a colophon to the first part of Ockham's Summa Logicae.

(6) Registrum Roberti Winchelsey, Pars Nona, ed. Rose Graham, Canterbury and York Society (Oxford 1940), p.981.

with heresy.(7) In 1324 Ockham was summoned to the Papal Court at Avignon by Pope John XXII. On the night of May 26, 1328, Ockham fled from Avignon in the company of Michael of Cesena and Bonagratia of Bergamo, to find refuge in Munich under the protection of Ludwig, King of Bavaria.(8) Ockham is supposed to have died in Munich about 1349, a victim, it is assumed, of the Black Death.(9)

All of Ockham's non-political works were written before his departure from Avignon in 1328. It is generally supposed that Ockham lectured upon the Sentences at Oxford during the academic year 1319-1320.(10) On this basis Miss Maier has argued that the first version of Book I was prepared during the previous year.(11) Books IV, II, III, are a reportatio(12) and thus are presumed to have been delivered during the academic year 1319-20. The second redaction of Book I, the ordinatio, found in the printed edition of Lyon, 1494, was written at the same time as his commentary on the Elenchi; thus at some time between 1320-23.(13)

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(7) On August 20, 1323, Lutterell received his permit to travel beyond the seas for two years "to prosecute an appeal." Close Rolls 18, Edw.II, 12 May 1325. Concerning the charge of heresy see A.Pelzer, "Les 51 Articles de Guillaume Occam censurés en Avignon, en 1326," Revue d'hist. eccles., XVIII (1922), 240-270, and J.Koch, "Neue Aktenstücke zu dem gegen Wilhelm Ockham in Avignon geführten Prozess," Recherches de Théol. an. et méd., VII (1935), 353-380, VIII (1936) 79-93, 168-197.

(8) Details of Ockham's life can be found in the standard biographies, especially in L.Baudry's Guillaume d'Ockam. Paris 1950. See "Ockham-Literatur 1919-1949." Franziskanische Studien. XXXII (1950).164-183.

(9) P.Boehner, The Tractatus De Successivis Attributed to William Ockham, Franciscan Institute Publications, no.1 (St.Bonaventure, N.Y. 1944), p.15.

(10) L.Baudry, op.cit., p.65, 270. A.Maier, "Zu einigen Problemen der Ockhamforschung," AFH, XLVI (1953), 163, 173-4.

(11) A copy of this redaction is contained in Florence, Bibl. Naz.,cod. A.3. 801, and an abbreviation was discovered by Maier in MS Borgh.68.

(12) C. Michalski has proved this beyond doubt, cf. "Le Criticisme et le Scepticisme dans la Philosophie du XIVe siecle," Bulletin de l' Académie Polonaise des Sciences et des Lettres, Classe d'histoire et de philosophie, 1925.

(13) Cf. A.Maier, "Zu einigen Problemen der Ockhamforschung," AFH, XLVI (1953), 161-174.

It is possible that an earlier date may have to be assigned for Ockham's lectures on the Sentences. In Mortival's Registers a Willelmus de Ocham, a Franciscan of the Reading Convent, was licensed to hear confessions on November 5, 1320; this licence was transfered to Friar John of Bledelow on August 17, 1328.(14) If this is our Ockham, he must have left Oxford by November 1320. Further, between 1320 and 1324 Ockham must have written at least five lengthy treatises besides revising his Ordinatio,(15) of which four are strictly philosophical works, namely a commentary on the logica vetus and Elenchi, an expositio on the Physics, and questiones on the Physics. It may be assumed that Ockham gave these lectures at some studium artium of the Order; certainly not at the University. His Quodlibeta could not have been disputed at the University, since Ockham was never a regent master in theology. As the Venerabilis Inceptor was for some unknown reason prevented from becoming regent master in theology, it is not likely that he would have remained at the Oxford convent. Therefore it would seem that Ockham left Oxford c.1320 having completed the course of theology short of

(14) Mortival Register (Salisbury), II,fol.186v: "Nomina fratrum minorum conventus Radynges admissorum per dominum de gracia speciali ad audiendos confessiones, etc. videlicet Willelmus de Sottesbroken, Willelmus de Ayschewelle, Ricardus de Wanetynges, Willelmus de Ocham, Willelmus de Clere, et Thomas de Stokes. Item fr. Warnerus Gardianus admissus apud Sonnyngges. Non. Novembris anno XXmo." There can be no doubt that anno XXmo is to be taken as 1320; the previous entry is dated "anno domini millesimo CCCmo xviij", and the following entry is dated "anno domini CCCmo XXmo." Fol.187r: "Item xxvi Kal. Septembris, anno domini M°CCC° xxviij, apud Sonnyngges, Dominus fratrem Johannem de Bledelawe ordinis minorum Radyngges, loco fratris Willelmi de Okam subrogavit, etc." I am indebted to Mr.C.K.Brampton for pointing this out and for loaning me his infra-red photographs of these pages of Mortival's Register. Mr.A.B.Emden has also pointed out a William of Ockham who was presented to Bishop Dalderby together with sixty-one other friars for hearing confessions in the Lincoln diocese on 12 Kal. July 1318 (Dalderby Register (Lincoln), III,fol.390v). If our conjectured date for Ockham's lectures on the Sentences is correct, namely 1317 - 18, it is not improbable that our Ockham is the one mentioned in Dalderby's register.

(15) Cf. A.Maier, Studien IV, 178; P.Boehner, The Tractatus De Successivis, ed.cit., 16-21.

inception or immediately after. But the custom at Oxford required that bachelors lecture on the Sentences and then on the Scriptures biblice seu cursorie "ad minus per biennium vel fere" before inception.(16) Thus it would seem that Ockham lectured on the Sentences about two years earlier than is generally supposed, hence during the academic year 1317-1318.(17)

Moreover the "second" of Ockham's treatises De Sacramento Altaris was certainly written after his lectures on the Sentences: "quando Sententias legi."(18) But Miss Maier has shown(19) that Francis de Marchia attacked the arguments of this treatise in his lectures on Book IV of the Sentences, given during the academic year 1319-1320. Therefore it would seem that Ockham lectured on the Sentences and wrote his "second" treatise De Sacramento Altaris before Marchia lectured at Paris.(20) This treatise, therefore,

(16) "Post lecturam insuper libri sententiarum, ad minus per biennium vel ferre studio incepturus insistat, antequam scandat cathedram magistralem." Statuta Antiqua, ed.cit.,p.50, line 16-19. Continental biographers of Ockham do not seem to have realised sufficiently that the procedure at Oxford was the reverse of Paris. At Oxford bachelors in theology lectured on the Sentences BEFORE lecturing on the Bible cursorie.

(17) The strongest argument against such an early dating of Ockham's lectures on the Sentences seems to be the mention of the "impetus theory" in Lib.IV,q.26 M (ed.Lyon 1495). See A.Maier AFH XLVI (1953), 166-168; Studien II, 154-160. But the earliest known exponent of the "impetus theory" is Francis de Marchia. However we shall see below (Chap.V,p165-8) the passage in question does not necessarily imply or presuppose any "theory of impetus" such as that proposed by Francis de Marchia.

(18) The De Sacramento Altaris of William of Ockham, ed. T.B.Birch (Iowa 1930), I Prol. (p.160) and also I, cap.10,: "Quaestiones de*dum studiosorum ingenia. Propter calumniam aliquorum praesens negotium suscepi" (p.210).

(19) A.Maier, op.cit., AFH, XLVI (1953), 164-177

(20) Authorities do not agree upon the chronological relationship between the"first"and "second"treatises De Sacramento Altaris. The question will be discussed below in Chapter IV,173-9 see especially notes 7-7 and 6767. For the present the terms are used to designate their actual position in the printed editions, and in all the known manuscripts which contain both treatises.

*Eucharistia pertractavi....et tantum recitative dixi ad exercitan-

would have been written while Ockham was still at Oxford, presumably as a cursor biblicus.

It is clear that Ockham commented on the logica vetus (Expositio Aurea) and the Elenchi between 1320-1324 at the same time as he revised his Ordinatio.(21) The Expositio Aurea is prior to the Quodlibeta and to the Expositio and Questiones on the Physics, as internal evidence indicates. The Expositio librorum Physicorum was clearly written after the logical commentaries, while the Questiones in libros Physicorum were written after the Quodlibeta, or possibly at the same time.

From his sojourn in Avignon only one of Ockham's works concern us, namely the Summa Logicae, written probably between 1324 and 1327.(22) In it Ockham not only summarized his complete logic, but also a great deal of his natural philosophy. There can be no doubt that it was written after his Expositio librorum Physicorum.(23)

One other treatise attributed to Ockham need be considered here, and that is the Summulae librorum Physicorum, an incomplete work corresponding to the first three Books of the Physics and part of the Fourth.(24) Pierre

(21) P.Boehner has shown this in his "The Text Tradition of Ockham's Ordinatio," The New Scholasticism, XVI (1942), 223, and in The Tractatus De successivis, ed.cit., 16-17. An earlier version of Ockham's Expositio Aurea was discovered by A.Maier in MS Borgh.151. Cf. "Zu einigen Problemen der Ockhamforschung," AFH, XLVI (1953), 191, and "Handschriftliches zu Wilhelm Ockham und Walter Burley," AFH, XLVIII (1955), 225-232.

(22) William Ockham, Summa Logicae (Pars Prima), ed.P.Boehner (The Franciscan Institute) 1951, p.xii.

(23) "Et quod haec sit intentio sua, declaravi per eundem 2° Physicorum ideo hic causa brevitatis omitto, " Summa Logicae, P.I,c.45 ad 6, ed.cit., p.131.

(24) Ed. Venice 1506, fol.1-32. In P.I,c.6 (fol.3ra) the author described the complete plan of the Summulae based on the order of the Aristotelian books: "Iuxta predictam distinctionem accipiende sunt partes istius tractatus: Prima pars erit de conditionibus communibus et magis notis omnium naturalium. Secunda erit de corporibus celestibus et eorum proprietatibus. Tertia erit de corporibus inanimatis et eorum passionibus. Quarta docebit de corpore animato, anima rationali et actibus eius. Quinta erit de ceteris animalibus et eorum proprietatibus. Sexta erit de plantis."

Duhem considered this treatise, "le plus parfait, peut-être, que sa plume ait produit," to be the earliest of Ockham's works on physics, because it is less profound that the Tractatus de Successivis and the Questiones.(25) Baudry also considered it to be "une oeuvre de jeunesse," but he dated it immediately after the Expositio on the Physics.(26) On the other hand, P. Boehner(27) and A.Maier(28) consider the Summulae to be the last of Ockham's treatises on physics, and perhaps his last philosophical work, because it is an unfinished summary of his position.

It would seem, however, that there are grounds for doubting the authenticity of the Summulae as a work of Ockham. The reasoning throughout the whole of the Summulae (with the exception of the appended De loco) is very loose and in places actually appalling; it is not at all comparable to the clear logic of Ockham's other works. Throughout the first Part the doctrine of the unity of substantial form is implied, while in Ockham's Commentary on the Sentences and Quodlibeta the contrary doctrine of the plurality of substantial forms is clearly defended.(29) In Part I, chapter 24 the author rejects S.Albert's inchoatio formae in substantial change, but there is no reason why Ockham should reject it; the arguments given in the Summulae all rest on the absolute unity of substantial form and the pure potentiality of first matter.(30) Moreover none of the

(25) P.Duhem, Le Système du Monde, t.VI,602-3. Duhem did not know of Ockham's Expositio in lib. Physicorum.
(26) L.Baudry, op.cit., 59. N.Abbagnano also considered the Summulae to be "un' opera giovanile di Ockham." Guglielmo di Ockham, Lanciano 1931, 34-5.
(27) P.Boehner, The Tractatus de Successivis, ed. cit., p.19.
(28) A.Maier, Studien, IV, p.194.
(29) Sent.,II.q.9ec; IV, q.7 F; Quodl.II, a.10-11.
(30) This is a peculiar chapter (ed.cit.,fol.8ra-va); it has the appearance of an excerpt from some commentary. The chapter begins: "Consequenter quia bonum est. quia bonum est. Et fuit opinio Alberti. Dubitabit aliquis an aliquid ipsius forme precedat in materia, quod potentia activa vocatur secundum aliquos vel inchoatio forme secundum

internal references, listed by Baudry,(31) necessarily refer to any of Ockham's works, nor is there any reference to a commentary on the Physics already written. Finally, it is well known that the last section of Part IV, De loco, found in the printed edition (cap.20-22) and in some manuscripts, is taken from Ockham's Expositio and is also found in the Tractatus de successivis attributed to him.(32) There can be no doubt that practically all of the doctrines expressed in the Summulae are basically Ockham's conclusions, but it may be doubted whether Ockham himself is responsible for the reasoning presented in the treatise. It seems more likely that the work was written by an unknown and less capable English disciple.

The unorthodox position and logical consistency of Ockham's doctrine was bound to produce a reaction from his contemporaries and to influence later generations. Contemporaries both at Oxford and at Paris reacted strongly not only to Ockham's nominalism, but also to his doctrine of physics. But the following generation, at least at Merton College, reveal a general acceptance of Ockham's natural philosophy together with an enthusiasm for a mathematical development of physics, which was inaugurated by Thomas Bradwardine.

(note 30 cont.) alios..." This chapter with the same beginning is present in MSS Pal.lat.1202, fol.338vb-339va, and Ghis.E.V.161, fol.13v-14 (= cap.27). However, the phrase "Et fuit opinio Alberti" is found as a marginal note in MS Pal.lat.1202.

(31) L.Baudry, op.cit., pp.54-55. Baudry admits that these references "sont conçus en des termes extrêmement vagues."

(32) A remark at the end of the Summulae contained in MS Pal.lat.1202 (15th century) states: "Hic deficiunt tria magna capitula," (fol.371rb). Boehner (op.cit., p.28) assumed that this referred to the three treatises De Successivis; but this scribal note could refer merely to the three long chapters De loco. Certainly the treatise De loco was added in the printed editions and in some MSS. Boehner has rightly shown that the Tractatus de successivis is only a compilation literally taken from Ockham's Expositio super lib. Physicorum (op.cit., 28-30, also p.22). This would suggest the work of a disciple. Boehner further remarks, "We are of the opinion that the De loco went from the Tractatus into the Summulae, because it is a natural

Important as Ockham was, we are concerned in this chapter mainly with the Fellows of Merton College and their writings. In the brief space of one chapter it is impossible to discuss all of the Mertonians who contributed to physics in the early 14th century. We can consider only the more prominent personalities. A consideration of their doctrines will arise in later chapters when we discuss certain basic problems of early 14th century physics. Here our concern is principally with the chronology of their more important writings.(33)

1. Walter Burley.

Of all the early 14th century Mertonians, perhaps the most familiar is Walter de Burley. But it is only within recent years that clear factual information has been obtained about him, principally through the efforts of Konstanty Michalski and Anneliese Maier. The many misconceptions concerning his doctrinal position can be rectified only by a complete study of his works. In this chapter we are concerned merely with establishing the

(note 32 cont.) part of the Tractatus and compiled in the same manner." In no way can the Summulae be considered "a natural part" of the De successivis, or vice versa, since they overlap. It does not even seem probable that the author of the Summulae himself appended the chapters de loco, because it is appended in the wrong place; they should have come before the discussion of time, as the Aristotelian order requires. Rather it seems that the chapters were appended later by someone who realized that the author of the Summulae neglected to discuss "place." These chapters were taken from the already compiled Tractatus de successivis.

(33) We are deeply indebted to Mr. A. B. Emden who generously made available his wealth of information concerning the Merton Fellows, gleaned from college and episcopal registers. As his volume is expected to appear soon in print, we have used his discoveries mainly as a guide to our own study.

chronology of the more important of them.(34)

From a colophon to his final version of the Ars Vetus contained in Lambeth Palace MS 143 and Vat.lat.2146, we know that Burley was born about 1275, probably in Yorkshire: "Completa est hec expositio quinta die mensis Augusti anno domini milesimo CCC° tricesimo septimo et anno etatis exponentis sexagesimo secundo."(35) The first mention of Burley in the Merton Records is dated 1305 where he is not designated "magister," whereas eight other Fellows in that list are so designated.(36) But we cannot infer from this that Burley was not a regent Master in Arts at this time, because two known works of "Magister" Walterus de Burley bear earlier dates. Gonville and Caius College, Cambridge, cod.668°/645, fol.60-76, contain "questiones date a m. Waltero de Burley super libros peryarmenias a.d. M.CCC primo," and the British Museum MS, Royal 12.F.XIX, fol.138-148, contains an "optimus tractatus de obligacionibus datus a mag. Waltero de Burleye anno domini Millesimo trecentesimo secundo." Thus Walter Burley was already a Master in Arts by 1301. It would seem that during his long regency in arts(37) he expounded practically all of the Aristotelian books before taking up residence in Paris, although these early versions are not those generally known.

(34) A more complete list of Burley's works will be found in the Repertorium appended to the thesis. Prof.S.Harrison Thomson is preparing a complete list of extant Burley MSS.

(35) MS Lambeth Pal.70, fol.84rb has an unintelligible abbreviation for "septimo," which M.R.James omitted; cf. A Descriptive Catalogue of the Manuscripts in the Library of Lambeth Palace, Cambridge 1930-32, p.113.

(36) Mert. Rec. 3634. Mr.Emden has observed that these records are by no means a complete list of resident Fellows and that the mere absence of a name or title does not of itself prove anything.

(37) In Lambeth Pal. MS 70 (membr.xiv), fol.109vb, we read: "Explicit tractatus de puritate artis logice mag. Walteri Burley Anglici, optimi logici, famosi naturalis philosophi, et subtilis theologi, utpote qui in universitate Oxon. quamultis annis rexit in artibus et tandem Parisius in theologica facultate." At least part of this colophon is verified by our reckoning Burley's regency at Oxford from about 1300 until 1310.

In 1310 Walter Burley was the companion of Baldwin of St.Albans, nephew of Archbishop Greenfield, at the University of Paris.(38) Most probably Burley began his theological studies at this time. He is listed according to Feret as a member of the Sorbonne in 1324,(39) and he seems to have remained in Paris until his appointment on February 28, 1327, as envoy of Edward III to the Papal Court for the promotion of the canonization of Thomas, Earl of Lancaster.(40) It seems that Burley was still at the Papal Court on March 7, 1330.(41) During Richard de Bury's episcopacy at Durham (1333-1345), Burley, "inter ceteros minimus clericos eius,"(42) received constant encouragement and numerous benefactions from his friend.(43) We do not know how often Burley travelled abroad, but besides his stay in Paris (1310-1327) and his mission to Avignon (Feb.1327-c.1330), we know that he held a disputatio de quolibet at Toulouse before 1327, was overseas on the King's business from September 7, 1338, until Easter of 1339,(44) held a disputation at Bologna in 1341, as Maier has pointed out, and that he was present in Avignon on November 23, 1343.(45) The date of Burley's death

(38) Reg. Greenfield, York, (Sert.Soc.), IV, 100,319,325,335-6.

(39) P.Feret, La Faculté de Théologie de Paris et ses docteurs les plus célèbres, t.III, Paris 1896, p.243. MS Bibl.Nat.,lat.16130, fol. 110vb, also refers to Burley as a member of the Sorbonne: "Explicit tractatus de puritate artis logice Magistri Gualteri Burley socii domus de Sorbona parisius." Among Burley's licences to study,Mr. Emden has discovered two, one dated 25 July, 1317 (for one year), the other dated 5 November 1321 (for two years). We shall show in our discussion of Burley's Comm. in Phys. that he was still in Paris in 1326.

(40) T.Rymer, Foedera, ed. London 1821, II, P.II, p.695.

(41) Ibid., p.782.

(42) Prol. in lib. Physicorum, MS All Souls College 86, fol.1r.

(43) This can be judged from the complete list of Burley's many benefices to be published in the forthcoming volume by Mr.Emden.

(44) Cal. Pat. Rolls, Edw.III, 1338-40, p.123.

(45) A.Maier, "Zu Walter Burley's Politik-Kommentar," Recherches de Theologie ancienne et médiévale, XIV (1947), 332-336. Burley's "Epistola manucpatoria," presenting Pope Clement VI with a copy of his Expositio lib. Politicorum is dated: "Scriptum Avinioni in die sancti Clementis pape et martyris, pontificatus Vestri felicis anno secundo...." MS Bergh. 129, fol.2r.

is not known, but we know that he was alive on January 12, 1344, when he made a petition to the Holy See on behalf of his nephew, Nicholas de Borbach, "whom he regards as the light of his eyes and the staff of his old age."(46)

With regard to Burley's numerous works we can reserve the bulk of them for our Repertorium, considering here only the chronology of his principal works of philosophy, and the question of his mastership in theology.

A. ON LOGIC. Concerning logic Burley wrote extensively at least from 1301 until 1337. These writings may be grouped into three categories; commentaries on the Aristotelian books, notabilia and treatises on the Parva Logicalia, and independent works.

a) Expositions of Aristotelian Books. Burley's expositions are of three kinds; detailed commentaries, often with special questions raised in the course of the exposition, questiones on the various books, and brief summaries of the text.

On the Ars Vetus there are at least two complete redactions by Burley. One of the earliest of Burley's works is contained in St.John's College, Cambridge, MS 100, fol.47-54v, an exposition of Porphyry, the Predicamenta and the Peryermenias, beginning, "Primo querende sunt cause huius libri quia secundum Aristotelem 1° Phisicorum tunc arbitramus..." The same codex contains another redaction of his exposition on the Predicamenta (fol.55-66v, inc.: "Impossibile est cognoscere totum partibus ignotis...") and the Peryermenias (fol.67-73rb, inc.: "Cum cognicio sillogismi sit finis logice et cognicio partis precedit cognicionem tocius..."). At the end of

(46) Cal. Pap. Pet., I, p.34.

this second commentary on the Predicamenta Burley notes that the species of relation "in libro de sex principiis planius apparebit." But there are at least three versions of Burley's commentary on the Liber de sex Principiis prior to the printed text. Lambeth Palace MS 70 contains two of Burley's commentaries on this work, both of which antecede the printed version. An "Expositio Vetus" is found on fol.35-43;(47) it depends heavily on St. Albert and always speaks of the "auctor 6 principiorum." Another exposition "que communiter dicitur expositio nova," is found on fol.43v-55v;(48) this seems to be a revision of the earlier version, still with a heavy reliance on St.Albert and no mention of Ockham's doctrines. The version discovered by Miss Maier in MS Vat.lat.2147, fol.80v-102v,(49) is not identical with either of those contained in Lambeth MS 70. The version contained in Vat. lat.2147 was certainly written after Burley had left Paris.(50) There seem to be at least two other versions of Burley's commentary on the Liber de sex Principiis not identical with those already noted.(51) Concerning

(47) Inc.: "Iste liber intitulatur de sex principiis. Cum tamen sit de sex predicamentis; genera enim generalissima et sunt principia..." (expl.:)...et cum aer generatur ex igne est generacio secundum quid respectiva. Ista satis patent ex 1° De Gen. Et [in] hoc finitur liber 6 principiorum. Explicit expositio Burley super librum sex principiorum, que dicitur expositio vetus." This is also found in Lambeth Pal. MS 143, fol.141-150.

(48) Inc.: "Quamvis Aristoteles in libro Predicamentorum sufficienter..." (Expl.:)...Et cum aer generatur ex igne est generacio secundum quid respectiva. Ista satis patent ex 1° De Gen. Explicit expositio Burley super librum sex principiorum." In this later redaction Burley acknowledges that "Gilbertus Porretanus hunc librum composuit."

(49) A.Maier, AFH, XLVI (1953), 189-191.

(50) Vat.lat.2147, vol.102r: "Et istam opinionem tenui Parisius et eam declaravi in primo tractatu de formis accidentalibus."

(51) MS Caius 448/409, fol.57-87v and Peterhouse MS 184, fol.156v-171, inc.: "Quamvis Aristoteles in libro... generatur minus nobile sive in substantiis sive in accidentibus. Et opposito modo est de corruptione. In hac completur intencio Porretani in sex principiis." MS Caius 139/79, fol.131-153, inc.: "Iste liber intitulatur... fit minus nobile sive in substantiis sive in accidentibus. Et opposito modo est de corrupcione. Et in hoc /completur/ liber 6 principiorum." The commentary super sex principia ascribed to "Wilhelmo burley" in Florence,

the Perycrmenias we have already noted that the five "Questiones date a m. Waltero de Burley super librum Peryarmenias," bear the date 1301 in Caius College MS 668*/645, fol.60-76. The final version of the complete Expositio super Artem Veterem was written by Burley in 1337 and was directed against Ockham's Expositio Aurea. This is the version found in all the printed editions.

On the Analytica Posteriora Burley wrote a detailed commentary based on Albert and Lincolniensis,(52) Questiones super librum Posteriora contained in Caius MS 668*/645, fol.117v-132v, and possibly the summary attributed to him in the edition of Venice 1497. None of these indicate the slightest awareness of Ockham, and thus may be dated before 1319.

The detailed expositio of Aristotle's Topica must also be dated early. For although Lambeth Palace MS 70, fol.170-268, has two marginal notes "contra Ockham," the internal evidence does not bear this out.

Of early date also are a summary of the Elenchi, known as the Tractatus de modo arguendi,(53) and seventeen questiones on the text, contained in St.John's College, Cambridge, MS 100, fol.153-162v.

b) Sophismata and treatises on the Parva Logicalia.

The earliest of these is perhaps the "optimus tractatus de obligationibus datus a mag. Waltero de Burleye anno domini Millesimo trecentesimo secundo," contained in MS Royal 12.F.XIX, fol.138-148.(54) Burley's better

(note 51 cont.) Laurenziana, Plut.71,cod.25, fol.74-105v, should be attributed to William Mulverly as in MSS Oriel Col.35, fol.134v-152, Magdalen Col.47, fol.67v-85v, Royal 12.B.XIX, fol.96-123.

(52) We have used MSS Royal 12.B.XIX, fol.244-301, Lambeth Pal.70, fol. 149-169, and Caius 448/409, fol.117-171v (mem.).

(53) Inc.: "Modi arguendi sunt duo, ut ait Phil. 1° Elenchorum... et sunt apta nata videre, sunt oculi." We have used the text contained in Lambeth Pal. 70 and Caius 448/409.

(54) Inc.: "In disputacione dialectica due sunt partes, scilicet opponens et respondens... non fit una obligacio tantum sed plures et diverse." We have also used MS Venice, S.Marco, Z.lat.301 (1576), fol.47-57v.

known treatise bearing the same title (inc.: "Obligaciones secundum quod nos utimur...") seems to be a later treatise. No date can yet be ascribed to Burley's Insolubilia,(55) but as this work does not mention the positions of Ockham or Bradwardine, it may be safe to put this work some time before 1320. Burley's treatise De consequentiis appears to antecede the early version of his De Puritate Artis Logicae, which was written before the advent of Ockham's logic. The short notabilia(56) have not yet been traced to any particular text of which they are observations, but the logical notabilia are conspicuously free of Ockham's opinions. The best known of Burley's treatises on the Parva Logicalia is his De Suppositionibus, of which Burley said in later years (between 1326-1329), "Plurimas divisiones suppositionis in juventute mea memini me scripsisse."(57)

c) Independent Works on Logic.

In his edition of the two redactions of Burley's De Puritate Artis Logicae Boehner pointed out with convincing arguments the most probable relationship between them. The shorter version seems to be the earlier, begun and left incomplete before Ockham wrote his Summa Logicae. For the longer treatise Burley revised his plan in view of Ockham's treatise, and wrote the unfinished De Puritate Artis Logicae some time after Ockham's Summa and before 1329.(58) Boehner has suggested that the longer redaction

(55) Inc.: "Circa insolubilia quaeruntur duo, primo circa insolubile simplex..." The best MS we found is that of Royal 12.F. XII, fol.133v-138.

(56) A.Maier has given a description of those contained in Vat.lat.2146. Cf. AFH. XLVIII (1955), 247-249. These notabilia are also found in Lambeth Pal. 70 and All Souls College 85.

(57) De Puritate Artis Logicae, ed. Boehner (St.Bonaventure, N.Y. 1955) p.2, line 14-15.

(58) This is clear from a scribal note contained in Erfurt, MS Amplon. O.67, fol.123v. Cf. Burleigh, De Puritate Artis Logicae, ed.cit., p.vii-viii.

was probably written between 1325 and 1328.(59)

Burley's Tractatus De Universalibus Realibus, as it is found in the printed edition and in many manuscripts,(60) was probably written after the second version of Ockham's ordinatio. The basic elements of this treatise are to be found in Burley's early commentaries on Porphyry, and only at the end of the treatise does Burley attack the opinion which postulates universals as having no "esse in rerum natura," but only "esse objectivum in intellectu." The lack of a detailed refutation of Ockham's arguments may, however, suggest that it was written before Burley actually saw Ockham's ordinatio.

B. ON NATURAL SCIENCE. Burley wrote a wealth of material on all the libri naturales: detailed expositions, collected questiones, summaries, questiones disputatae, and distinct treatises.

Burley produced at least two distinct redactions of his Expositio librorum Physicorum. The earliest version known to us is that contained in Gaius College, Cambridge, cod.448/409, pages 172-543v, a parchment manuscript of the 14th century. It is a detailed exposition of all eight Books "cum questionibus optime disputatis."(61) A fragment of this commentary, which we have identified, is to be found in St.John's College,

(59) Boehner, ibid., p.viii.

(60) Mi. Venetiis 1492-93 /GW 5770/. We have used Lambeth Pal.70, fol. 110-113v and Vienna, Dom.klos. 14/14, fol.40-46; this latter MS has the name of "Ockham" in the margin of fol.40 referring to the text "alia tamen est opinio seu potest esse, quod nullum universale realiter (?) existit in rerum natura, sed solum habet esse fictum in intellectu."

(61) Inc.: "Quoniam autem intelligere, etc. Iste liber habet duas partes..." (Expl.:)...nam ille motor est actualiter infinite. Sed probatum est prius quod in magnitudine finita non est virtus infinita. Primus igitur motor nec est corpus nec in corpore, sed etiam indivisibilis et impartibilis, nullam habens magnitudinem. Explicit expositio omnium librorum phisicorum edita a magistro Waltero de Burley cum questionibus optime disputatis."

Cambridge, cod.100, fol.76-85v.[62] On the top margin of fol.80v is written out in full "anno domini Millesimo CCC° XVI^mo" in what appears to be a different hand. Therefore, the early redaction of Burley's Expositio omnium librorum Physicorum was edited before 1316. The principal sources of this exposition are Averroes, Avicenna, Albert, and Grosseteste's commentary on the Posterior Analytics.[63]

The printed version of Burley's commentary on the Physics was written at two different periods. The first six Books were written while Burley was teaching at Paris.[64] From the scribal rubric in Basel Universitäts-bibliothek cod. F.II.30, an early 14th century manuscript containing Burley's commentary on the first six Books, we can infer that Burley began his final version not later than 1324: "Scriptum magistri Galteri de Burley doctoris sacre theologie super librum phisicorum Aristotelis editum parisius anno domini M°CCC°xxiiii."[65] It is not clear what is intended by the term "editum," but it may refer to the first Book alone. In certain manuscripts at the end of Book IV there is a colophon which reads: "et

(62) In a late table of contents this fragment is entitled "Quedam questiones de motu," without author. It is Burley's commentary on Phys., V, text.9, agreeing with Caius MS 448/409, pp.361a-376b.

(63) At this date Burley does not yet seem to have known Grosseteste's Notulae in lib. Physicorum, which he used so extensively in his later exposition. Cf. D.A.Callus, "The Oxford Career of Robert Grosseteste," Oxoniensia, X (1945), 45-46.

(64) Florence, Bibl.Naz. MS conv.soppr. D.I.1362, fol.147rb: "Et in hoc finitur expositio super toto libro phisicorum secundum extollendum doc. mag. Gualterium de burlee Parisius compilata... [completur] anno domini M°364, die Febr. 3a hora noctis ab incarnacione." Burley himself confirms the Parisian composition of the first six Books in his prologue to Books VII-VIII dedicated to the Masters and Scholars in Philosophy at the University of Paris.

(65) S.Harrison Thomson reads this date as 1314, but there can be no doubt that the manuscript has M°CCC°xxiiii (cf. "Unnoticed questions of Walter Burley on the Physics," Mitteilungen des Instituts für Österreichische Geschichtsforschung, LXII (1954), 391. I am indebted to Dr.Max Burckhart, keeper of manuscripts at the Öffentliche Bibliothek der Universität Basel, for procuring microfilms of the first Book and for giving me a detailed description of the manuscript.

completus est iste liber quartus anno domini M°CCC° vicesimo quinto, secunda die mensis Marcii, dominica qua cantatur in ecclesia catholica Letare Jerusalem." Originally Miss Maier was inclined to believe that this colophon in MS Vat.lat.5934 referred to the date when the scribe finished copying the first four Books.(66) But in a recent study she agreed that the date most probably stems from the author himself, and not from the copyist.(67) We have found this same colophon in five additional manuscripts(68) and there can be no doubt that Burley himself finished this commentary on Book IV on Laetare Sunday, March 2, 1326. Even the Basel manuscript, "editum parisius anno domini M°CCC°xxiiii," contains this identical colophon.(69) There is no reason to suppose, however, that Burley did not continue his commentary with Book V immediately after March 2, 1326. Many years later Burley referred to this work of his "youth"(70) and he

(66) A.Maier, AFH, XLVI (1953), 183-4, and Studien, IV, 199 note 1.
(67) A.Maier, AFH, XLVIII (1955), 243.
(68) Oxford, All Souls College MS 86, fol.119rb; Paris Bibl.Nat.lat.6528, fol.187v; Florence, Bibl.Naz.Cent., Conv.Soppr.D.I, 1362, fol.78ra; Naples, Bibl.Naz. VIII.E.47, fol.172; and Basel, Universitatsbibliothek, cod.F.II.30, fol.156vb. The Paris manuscript has also been noted by S.H.Thomson (ibid.). Prof.Thomson further states that "an almost identical colophon appears in Perugia MS H.65," and that he believes these dates to be that of the particular codex (cf. ibid.). The Perugia manuscript however, does not contain the Physics, and the only date found in the entire codex is a scribal one on fol.60v, after the Questio de universalibus: "Scripta per me fratrem Franciscum de Monte Sancto M°CCCC°L°2, die xvii mensis Julii." I am indebted to Miss Olga Marinelli for this information and for the photograph.
(69) Fol.156vb. I am indebted to Dr. Max Burckhart for transcribing the colophon.
(70) "...qui quondam iuvenis scripseram super sex libros Phisicorum, super duos reliquos scribam iam senex." Burley, Epistola Dedicatoria, MS All Souls College 86, fol.1. C.Michalski already noted that Burley wrote his commentary on the first six Books of the Physics some years before commenting on Books VII-VIII; he also pointed out that the dedication of Books VII-VIII preserved in Venice MS S.Marco Z. LCCV.B, fol.243, is addressed directly to Richard de Bury (cf. La Physique Nouvelle (1928), p.5-6). However Michalski did not notice the second dedication of the complete eight Books to the Masters and Scholars of Paris contained in MS Oxford, All Souls College 86, fol.1.

observed, "ut cum dudum Parisius studens sex primos libros phisicorum Aristotelis exposuerim, compleren super duos residuos opus illud, factus sum timidus et perplexus."(71) These first six Books of Burley's commentary are a direct attack on Ockham's doctrine contained principally in the Expositio in libros Physicorum, as Maier has shown.(72) When Burley was "iam senex" he was encouraged by his friend, Richard de Bury, then Bishop of Durham (1333-1345), to complete his commentary with an exposition of the last two Books, as "dudum modo meo textus logicales Aristotelis exposuerem."(73) This he did by merely revising his early version of the Physics, immediately after he had completed his commentary on the Ethics at the request of the same Bishop,(74) dedicating one copy to Richard de Bury and another to "carissimis amicis suis et dominis magistris et scholaribus Parisius in philosophia studentibus." Since Burley speaks of his logical commentaries as something in the distant past, it is clear that he had not yet written his large commentary on the Ars Vetus. Therefore the revision of the last two Books of the Physics and the two dedications to the University of Paris, as well as the dedication to Bury, were written before 1337 and immediately after his revision of the Ethics, thus some time between 1334-1337.

(71) All Souls College 86, fol.159v. We have controlled this text with Florence, Bibl.Nas.Cent., Conv.Soppr. D.I.1362, fol.106; this MS is the direct source of the MS Conv.Soppr. A.I.1361. The two dedications to the University of Paris are to be found in the Appendix.

(72) A.Maier, AFH, XLVI (1953),84-88.

(73) Epistola Dedicatoria of Burley's commentary on the Physics, MS All Souls College 86, fol.1.

(74) "Eundem modum et ordinem observando in septimo et octavo quos tenui in sex libris phisicorum supradictis et etiam in expositione libri Ethicorum quam nuper ad preceptum dicti Patris aliter qualiter compilavi." Epist. Dedicatoria Prior, MS All Souls College 86, fol.1. "...tenendo modum et ordinem quos tenui in sex libris supra dictis et in expositione libri Ethicorum quam nuper ad preceptum dicti Patris venerabilis compilavi." Epist. Ded. Altera, ibid., fol.159v.

S.H.Thomson has discovered Questiones on the Physics by Burley contained in MS Basel Universitätsbibliothek F.v.12.(75) This manuscript, although incomplete,(76) seems to contain an early commentary in the form of "questiones annexae." These questiones are quite distinct from the questions found in the two versions, and hence constitute a separate commentary on the Physics. A number of extant manuscripts contain "Questiones Burlei in VIII Physicorum," but these are merely questions extracted from the final version of Burley's Expositio in lib. Physicorum.(77)

Except for the Expositio super lib. de Anima, all the other expositions of the natural books attributed to Burley seem to be summaries or paraphrases of the Aristotelian text with occasional dubia. Possibly all of them could be dated before 1320, but further study would be required to ascertain this.

Perhaps the earliest reaction of Burley to Ockham's philosophy of nature is found in his Tractatus de formis.(78) In it Burley answers each of Ockham's arguments concerning the identification of substance and quantity, and he defends the doctrine, "quod quantitas est alia res a substantia et a qualitate, et quod corpus de genere substantie est alia res a corpore de genere quantitatis." This treatise, it would appear, antecedes Burley's Expositio in libros Physicorum.

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(75) S.H.Thomson, "Unnoticed questions of Walter Burley on the Physics, Mitteilungen d. Inst. f. Österreichische Geschichtsforschung, LXII (1954), 390-405.

(76) The codex is incomplete, according to Thomson, ending on fol.169v in question 43. But the complete list of questions found on fol. 108 was published by him.

(77) For example, Lambeth Pal. MS 70 fol.1-53v.

(78) Inc.: "Notandum quod materia prima est materia remotissima..." Tanner (Bibl. Brit.-Hib., London 1748, p.141) erroneously identified this treatise with the De intensione et remissione formarum. We have used the text contained in MS Lambeth Pal. 70, fol.125-134v.

Burley's Quodlibet at Toulouse was the object of much discussion in the schools of Bologna. This Quodlibet, De primo et ultimo instanti,(79) has not yet been dated, but it was certainly given before Burley's Tractatus Primus, in which he explicitly refers to it.(80) Thus it was delivered before 1327.

The Tractatus Primus, already discussed by Maier,(81) is a reply to "quidam reverendus socius et magister" who objected to four points in Burley's commentary on the Sentences, namely, (1) that a quality can produce a substantial form virtute propria, (2) that in the instant in which a substantial form is effected there is no need for an agent to be acting upon the composite, (3) that celestial, elementary, and animal heat all belong to the same atomic species, (4) that contrary forms, such as white and black, are of the same ultimate species.(82) It is not clear who is meant by "quidam reverendus socius et magister" with whom Burley carried on this polemic, but certain clues are significant.(83) The text contained in Vienna, Dominikanerkloster, cod. 160/130, clearly reveals the

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(79) This was printed at Venice in 1501. A very good text is contained in Bodl. Canon.Misc.177, fol.11-14.

(80) "Quando autem et in quibus formis est dare primum vel ultimum et in quibus non, patet in quolibet meo Tolose determinata questione." MS Vienna, Dom.klos. 160/130, fol.81ra.

(81) A.Maier, AFH, XLVIII (1955), 235-243. This treatise was copied under a great variety of titles, cf. Repertorium in Appendix.

(82) "Dixi quatuor conclusiones que videbantur quibusdam dubie vel false. Prima quod qualitas in virtute propria potest producere formam substantialem vel in virtute propria esse principium totale productivum forme substantialis, v.g. calor ignis potest virtute propria producere ignem, et calor qui est in semine potest in virtute propria producere animam sensitivam. Secunda conclusio que etiam videtur dubia, fuit ista, quod in instanti inductionis subite forme substantialis in materia non requiritur agens pro tunc inducens formam. Tercia conclusio quod isti tres calores quos Philosophus distinguit in 2° De Gen. Animalium, scilicet calor celestis, elementaris et animalis sunt eiusdem speciei athome. Quarta conclusio quod forme contrarie, vis. calor et frigus, albedo et nigredo sunt eiusdem speciei specialissime." Vienna, Dom.klos. cod.160/130, fol.83rb.

(83) Vienna, Dom.klos. cod.160/130, fol.89v-91v, contains a Tractatus

Tractatus Primus to be a collection of three successive replies to three successive rebuttals.(84) The first reply (fol.83-86ra) was to certain objections raised against the four propositions held by Burley in his commentary on the Sentences. This opponent, certainly to the first proposition, was Thomas Wilton, "reverendus magister noster dominus Cancellarius London,"(85) and former Fellow of Merton. Burley's defense of the fourth and most peculiar conclusion was answered ("respondet") by "quidam reverendus socius" in "prima replicatione sua,"(86) to which Burley replied with eight new propositions (fol.86ra-86vb). After a "replicatio secunda" Burley replied with a third "reprobatio replicationis" (fol.86vb-89va), adding new arguments in favour of his theory of intension and remission of forms. It is not absolutely certain that Thomas Wilton, who objected to the first proposition,(87) is the same socius who attacked the other con-

(note 83 cont.) mag. Chunradi de Monte Puellarum qui probat oppositum quarte conclusionis principalis ipsius Burley. Also noted by A. Maier, AFH, XLVIII (1955),240. This Conrad of Megenberg, "rector universitatis Parisiensis" (MS cit.,fol.91v), or more accurately, proctor of the English Nation at the University of Paris, cannot have been Burley's opponent. Conrad's treatise is clearly posterior to the entire polemic. Moreover, Conrad, born on February 2, 1309, would have been 18 years old or less at the time of the controversy. Cf. "L'Oeconomica de Conrad de Megenberg Retrouvee," by A.Pelzer and T.Kaeppeli, O.P., Revue d'histoire ecclésiastique, XLV (1950),559-616.

(84) In MS Vat.lat.2148, fol.46-56, this work is called a quodlibet. "Questio prima nostri quolibet est utrum in virtute propria..." (fol. 46). A fifth questio is also added, "Utrum contradictio sit maxima oppositio," and ends, "Explicunt quinque questiones determinate a magistro Gualterio dicto burleo de quolibet..." The Tractatus Primus, however, does not at all reveal the technique of a quodlibet and the fifth question is an entirely distinct work.

(85) Vienna, Dom.klos. cod.160/130, fol.83rb. MS Vat.lat.2148, fol.46, has the peculiar reading "huic rationi respondent Canchelarius et Iandunum."

(86) "contra istam responsionem arguo sic: primo quia illa sunt dicta in ipsa responsione dictis suis in prima replicacione sua." Vienna, Dom.klos.160/130, fol.86vb.

(87) "Huic rationi respondet reverendus magister noster, dominus Cancellarius London /sic/, quod calor in virtute propria non potest in aliquam dispositionem necessitantem ad formam ignis, quia nulla dispositio precedens dispositionem forme ignis necessitat ad formam ignis." ibid., fol.83rb.

clusions and continued his rebuttals in succeeding treatises. But Burley's text does not imply any change of opponents, and the theory of intension and remission of forms against which Burley argued is known to be that defended by Thomas Wilton.(88) Thus the polemic of the Tractatus Primus may have been with Thomas Wilton, his own Master in Theology and former Fellow of Merton College.(89)

The Tractatus Primus must be dated between August 1320 and 1327, while Wilton was Chancellor of St.Paul's Cathedral, London. It was certainly written after Burley's commentary on the Sentences; and the last set of replies, at least, were written after his Quodlibet at Toulouse.

Burley's Tractatus Secundus, as Maier has shown,(90) is his famous treatise De Causa intrinseca intencionis et remissionis formarum.(91)

C. THEOLOGICAL CAREER. There can be no doubt that Burley became a Master in Theology of Paris. From Basel, Universitätsbibliothek cod. F. II.30, fol.3ra we can infer that Burley was already a Master in Sacred Theology by 1324: "Scriptum magistri Galteri de Burley doctoris sacre theologie super librum phisicorum Aristotelis editum parisius anno domini M°CCC°xxiiii." The earliest official document known to us, which designates

(88) Questio de susceptione magis et minus qualitatis. Inc.: "Utrum qualitas suscipiat magis et minus. Quod non probo, quia tunc aliqua qualitas foret infinita... Explicit questio de susceptione magis et minus qualitatis disputata per magistrum Thomam de Anglia." MS Oxford, Canon.Misc.226, fol.38-43.

(89) Thomas de Wilton was a Fellow of Merton College from about 1288 until about 1301. On April 26, 1304, he was granted license by his bishop to study at a University in England or abroad (Reg. Gainsborough, Worc. (Worcs. Hist. Soc.), 134). In a papal provision of March 2, 1311, he is mentioned as having studied at Paris (Cal.Pap.Let., II, 82). By May 1314, Wilton was a Master in Theology of Paris. Cf. Denifle, Chart. U.P., II,171; Glorieux, Repertoire des Maîtres en Theologie de Paris, I,460-462.

(90) A.Maier, AFH, XLVIII (1955),235-236.

(91) Inc.: "In hoc tractatu secundo intendo perscrutari de causa intrinseca susceptionis magis et minus..." Ed. Venice 1496, fol.2-15v.

him as "sacrae paginae professor," is dated February 1327, appointing Burley and two companions as envoys of Edward III to the Papal Court.(92) It is clear from the Tractatus Primus that Burley wrote a commentary on the Sentences, now lost,(93) and that his Master at Paris was Thomas Wilton.(94) It seems that Wilton may have left Paris around November of 1322.(95) If this was indeed the case, then Burley's lectures on the Sentences and his inception would have taken place before 1322. In spite of his mastership in theology, Burley's predilections were for logic and natural philosophy, and practically nothing is known of his theological writings.(96)

D. ON MORAL PHILOSOPHY.

Late in life Burley completed his Expositio librorum Ethicorum and dedicated the complete work to Richard de Bury, Bishop of Durham.(97) In his letter of dedication Burley mentioned that he remembers having com-

(92) Rymer, Foedera, London 1821, II,P.II, p.695. Mr.A.B.Emden has observed that Burley is called Master in Sacred Theology in all later official documents.

(93) "In prima questione quarti Sententiarum dixi quedam que aliquibus dubia et aliquibus sophistica videbantur." Tractatus Primus, MS Vienna, Dom.Klos. 160/130, fol.83rb. Tanner notes that Bale and Pits ascribe to Burley a commentary on the Sentences, beginning "Cupiens aliquid, etc. In hac pro /lege/..." Cf. Tanner, op.cit., p.142. This work does not appear in Stegmüller's Repertorium Commentariorum, Wurzburg 1947, nor in V.Doucet's Supplement, AFH, XLVII (1954), 88-170.

(94) Not only does Burley speak of the Chancellor of London as "reverendus magister noster," but in one place he says, "quod dicit magister meus." MS Vienna, Dom.Klos. 160/130, fol.83rb.

(95) According to Mr.Emden, the last known Papal dispensation granted to Wilton for absence expired on November 1, 1322. Cf. Cal.Pap.Let., II,225. It is possible, however, that Wilton obtained a further dispensation to be absent from his benefice.

(96) The fragment published by S.H.Thomson may well be part of a theological question, but it is of little value, since it embodies only the objections to the question. Cf. S.H.Thomson, "An unnoticed Quaestio Theologica of Walter Burley," Mediaevalia et Humanistica, VI (1950), 84-88.

(97) Ed. Venice 1481, 1500.

mented on the first six Books a long time ago, and that he returns to the work in order to complete it.(98) This seems to be the first work completed under Richard de Bury's patronage. We know that the final redaction of the Ethics was completed immediately before Burley revised Books VII and VIII of the Physics. Therefore it would be safe to say that Burley's Expositio librorum Ethicorum was completed between 1333-1335.

We know that Burley wrote a long commentary on Aristotle's Politics and dedicated it twice to Richard de Bury,(99) and once to Pope Clement VI, whom he had known as Peter Rogier at the University of Paris.(100) Burley dedicated his commentary to Clement VI on November 23, 1343.(101) From the formal dedication to Bury we learn that Richard Bentworth, Bishop of London, asked Burley to publish a commentary on the Politics. But because of Bentworth's untimely death on December 8, 1339,(102) hardly a year and a half since his consecration, the work was dedicated to Richard de Bury. S.H.Thomson has dated Burley's Expositio librorum Politicorum between 1340

(98) "Inde quum super sex primos libros Ethicorum diffusius alias memini me scripsisse, nec completo opere super quatuor ultimis libris, revertor ad scribendum." Ed. Venetiis 1481, fol.1.

(99) Conor Martin has pointed this out in his unpublished thesis, The Commentaries on the Politics of Aristotle in the late Thirteenth and early Fourteenth Centuries, with reference to the Thought and Political Life of the Time, (D.Phil. Thesis, Oxford, Hilary Term 1949), pp. 153-162.

(100) A.Maier, "Zu Walter Burleys Politik-Kommentar," Recherches de Théol. anc. et méd., XIV (1947), 332-336. In his dedication to Clement VI Burley wrote: "Nomini igitur vestrae sanctitatis, a qua dudum est in studio Parisiensi clarum, artificiosum multumque ordinatum modum loquendi ac etiam exponendi, temporibus quibus ibi legeram sacras scripturas ceteroquin actus scholasticos exercebatis tanquam doctor in theologia excellentissimus et veritatis perscrutator subtilissimus, expositionem praedictorum librorum merito dedicavi." Ibid., 334.

(101) A.Maier, ibid., 336. "Scriptum Avinioni in die sancti Clementis papae et martyris, pontificatus vestri felicis anno secundo...."

(102) John Le Neve, Fasti Ecclesiae Anglicanae, Oxford 1854, II, 290.

and the date of Richard de Bury's death, April 14, 1345.(103) But the work must have been completed by March, 1343, as we know from the dedication to Clement VI.

An early 14th century manuscript in the University Library, Cambridge, Ii.2.8, contains two items written in the same hand, Burley's commentary on the Politics(104) and the De Regimine Principum of Giles of Rome. At the end of the last item (fol.128v) the scribe adds, "scriptus per manum magistri Ricardi Bury." The text of Burley's commentary is beautifully written and richly illuminated at the beginning of each book, but full of blanks indicating that the scribe could not read his exemplar. The text of this manuscript is not noticeably different from the text eventually dedicated to Bury when he was Bishop of Durham. This would lead us to suspect that the work was actually written when Bury was a young Master in Arts.(105) There are early questiones of Burley on the Politica contained in Gaius College MS 505/383, fol.1-101.(106) It would seem that Bentworth asked Burley to publish his commentary on the Politica, or possibly to write one; but Burley did nothing about it until Bury mentioned it again after Bentworth's death. But since the text contained in University Library,

(103) S.H.Thomson, "Walter Burley's Commentary on the Politica of Aristotle," Mélanges Auguste Pelzer, Louvain 1947, 563.

(104) Inc.: "Subiectum libri Politicorum est civitas in qua pro materia... ad virtutem et per consequens operabuntur secundum rationem et per consequens facilius attingent ad felicitatem. Et in hoc finitur intencio Aristotelis super totum quod translatum est de greco in latinum super librum Politicorum, et Deo qui dedit intelligere sint gracie infinite. Explicit liber octavus Politicorum."

(105) Richard was born on January 24, 1287, near Bury St.Edmunds. He studied at Oxford c.1302-1312, although he probably did not graduate. From 1312 onwards he was a clerk in the King's service. On October 24, 1333, he was appointed Bishop of Durham by John XXII, and consecrated on December 19, 1333. Bury died at his home in Auckland, April 14, 1345.

(106) Inc.Prol.: "Ut dicit Philosophus Ethicorum quinto...in hoc libro primo sunt noven. Explicit prohemium." Inc. quest.: "Prima questio est quid est servus..."

Cambridge, represents Burley's early exposition,[107] he did nothing more than polish up an old commentary, dedicating it twice to his patron, and finally dedicating the same version to Pope Clement VI.

I have not made a study of Burley's popular De vita et moribus philosophorum,[108] and I cannot suggest a date for its composition.

2. Thomas Bradwardine.

Among the early 14th century Fellows of Merton the one who most influenced the thought of the College toward a mathematical approach to nature was undoubtedly Thomas Bradwardine. He not only had a penchant for mathematical studies, but he had what might be called a 'mathematical mind.' His writings both in philosophy and in theology are modelled on the procedure of Euclid, and his mind is most facile when considering clear, distinct and univocal ideas. Maier acutely observes, "One might almost say that Bradwardine would have wanted to write the Principia mathematica philosophiae naturalis of his century."[109] With his important treatise De proportionibus velocitatum motuum he renewed interest in the application of mathematics to problems of natural science. Bradwardine has rightly been called the "founder of the Merton School," even though he was promulgating and developing the scientific ideals defended by Grosseteste, Kilwardby and Roger Bacon.

Thomas de Bradwardine was born about 1295, probably in the diocese of

(107) Richard de Bury would not have copied the text with his own hand after he became Bishop in 1333; he would have had the work done by a scribe. Further Bury had two copies dedicated to himself. And finally, he would not have described himself as "magister."
(108) Cf. S.H.Thomson, op.cit., Mélanges Auguste Pelzer, Louvain 1947, 561.
(109) A.Maier, Studien, I, 86, note 10.

Chichester.[110] He is first noted as a Fellow of Balliol College in August 1321, but by 1323 Bradwardine had become at least a probationary Fellow at Merton, most probably after his inception in arts.[111] While Bradwardine was a student in the Faculty of Theology he was twice elected proctor[112] of the University, November 1325-26, 1326-27.[113] We do not know the date of his inception in theology. One would have thought that he had incepted and completed his two years regency before vacating his Fellowship at Merton in 1335. But as late as February 1336 Bradwardine is still called "bachelor of theology and Canon of Lincoln."[114] The earliest known reference to Bradwardine as "Master in Theology" dates from November, 1348,[115] but we do not know when he fulfilled his obligatory regency. In 1335 Bradwardine relinquished his fellowship at Merton and joined the household of Richard de Bury,[116] who had already been consecrated Bishop of Durham.

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(110) Cf. D.N.B. article by W.R.W.Stephens. The date usually given for Bradwardine's birth, following Saville, is c.1290, but there is no evidence for this. However it would seem probable that Bradwardine was born some time between 1290-1300. Saville, and many biographers after him, believed that Bradwardine himself claimed Chichester as his birthplace. But Bradwardine merely said, "Per similem etiam rationem, quicquid nunc scribo Cantiae, scriberet pater meus Cicestriae, quia genuit me scribentem, immo avus et proavus, et ceteri genitores, ipsi quoque primi parentes nunc facerent omnia facta nostra." (De causa Dei, III, cap.22, ed.Saville, London 1618, p.559). This merely states that his father was then living at Chichester.

(111) Mert.Reg.3652-3. For these dates and the end of Bradwardine's Fellowship at Merton we rely on information given by A.B.Emden.

(112) On the office of proctor, see S.Gibson, Statuta, ed.cit., lxxiv-lxxvii. Michalski misunderstood the role of proctor when he claimed that Bradwardine was at the Papal Curia in this official capacity; furthermore there is no evidence that he was proctor in 1322. Cf. "Le problème de la volonté à Oxford et à Paris au xive siècle." Commentarium Societatis Philosophicae Polonorum. Studia Philosophica, (Lemberg 1937), t.II, 239.

(113) Snappe's Formulary, ed. H.E.Salter, (O.H.S.) 1924, p.326.

(114) Cal.Pap.Let., II, 529.

(115) Cal.Pap.Pet., I, 145: "Master in Theology and Canon of Lincoln." Cal.Pap.Let., III, 273: "Sacrae Theologiae Professor."

(116) Royal Historical Society Transactions, 4th series, XX, 160-1, 165.

From September 1337 until 1349 Bradwardine was Chancellor of St.Paul's Cathedral, London,[117] where as Chancellor he was expected to lecture on Sacred Theology.[117a] After being elected "for a second time"[118] to the archbishopric of Canterbury, he was appointed on June 19, 1349, by Pope Clement VI, and consecrated at Avignon on July 10, 1349.[119] Shortly after his return to England he died of the Plague at the residence of the Bishop of Rochester in Lambeth, August 26, 1349.

During his regency in Arts, most probably between 1321-1324, Bradwardine produced his treatise De insolubilibus in 12 chapters.[120] A codex now lost of the Bibl. del Noviciado de la Universidad Central ascribed the

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(117) Registrum Stephani Gravesend, London, (Cant. & York Soc.), 315.

(117a) See "Statutes. Baldock. P.I, cap.56-57" in Registrum Statutorum et Consuetudinum Ecclesiae Cathedralis S.Pauli, Londini, ed. W. Sparrow Simpson, London 1873, p.83. See also the "Ordinatio domini pro lectura in theologia" from the Register of Bishop Fitz-James (fol.137b): "...fuerit ab antiquo salubriter statutum, provisum, et ordinatum, quod Cancellarius Ecclesie Cathedralis predicte quicumque pro tempore existens, lecturam in sacra theologia per se vel per alium continue legeret et observaret..." (ed. W.S.Simpson, ibid., p.413). The teaching obligation of the Chancellor is discussed by Kathleen Edwards, The English Secular Cathedrals in the Middle Ages, Manchester 1949, pp.200-208.

(118) Cf. William de Dene's Historia Roffensis, in Anglia Sacra, I, 375.

(119) C.Eubel, Hierarchia Catholica Medii Aevi, I,169; Cal.Pap.Let., III, 387, 389.

(120) Inc.Prol.: "Solvere non est ignorantis vinculum, ut habetur 5° Metaph., cap.1°. Qui vero insolubilium vincula..." We have used the text contained in Bodl. Canon.Misc. 219, fol.53-57v (incomplete).

De insolubilibus to "mag. Thomae de Bradvardinus, de Anglia, Regentis Oxonie."(121) In this early treatise Bradwardine rejected the opinion, not uncommon in his day,(122) that predicates of propositions cannot represent (suppomere) the whole proposition of which they are a part. The opinion, rejected by Bradwardine, implied that if no other statement is uttered besides "Socrates dicit falsum," this proposition cannot be objectively true or false. Bradwardine, however, maintained that "qualibet propositio est vera vel falsa."(123) But every such proposition claiming to signify itself as false, while in reality it is true, must be considered false.(124) This position was later developed by Swineshead in his famous treatise in which he held that all such propositions "falsify themselves."

It is also probable that during his regency in Arts Bradwardine wrote the Arithmetica speculativa(125) and Geometria speculativa(126) attributed

(121) Cod.105. Cf. Catalogo de los manuscritos existentes en la Biblioteca del Noviciado de la Universidad Central (procedentes de la antigua de Alcala), ed. J.Villa-Amil y Castro, Pt.I: Codices, Madrid 1878, p.57.

(122) For example Walter Segrave in his De insolubilibus, MS Erfurt, Amplon. Q.76, fol.21v-34 (we have used the incomplete copy contained in MS Bodl. Canon.Misc.219, fol.1-3v), the Insolubilia magistri henrici anglici, MS Canon.Misc.219, fol.9v-11v (also found in MS Canon.Lat. 311, fol.33v), and the Insolubilia more exacte compilata edita ab eximio doctore magistro Johanne Manatore, MS Canon.Misc.219, fol.7-9, esp. fol.7v-8. This position was later made famous by Ockham's Summa Logicae, P.III, cap.43.

(123) Bradwardine, De insolubilibus, suppositio prima, MS Canon.Misc.219, fol.55ra.

(124) "Si aliqua propositio significat se non esse veram vel se esse falsam, postea significat se esse veram, est falsa." Ibid., fol.55rb; see also cap.9, fol.57ra.

(125) There is some difficulty in identifying Bradwardine's Arithmetica speculativa. Farmer refers to the text of the printed editions of Paris 1502 and 1512 (first printed in Paris 1495), beginning, "Quantitatum alia est continua que magnitudo dicitur, alia discreta..." But the Latinity and puerility of this treatise cast certain suspicions on the authenticity of this text. Another text contained in Clm 24809, fol.100v-106, begins "Numerus est duplex: mathematicus qui dicitur numerus numerans..." and is ascribed to Bradwardine; commentaries on this version are found in Vienna, Nat.Bibl.lat. 4953, fol.36-61v and 4951, fol.273-304. We do not know how these two

to him. Both of these works are summaries of Euclid and Boethius, but the sections on proportions and proportionality reveal a familiarity with the De proportionibus of Thabit and the De proportione et proportionalitate epistola of Ahmad ibn Yusuf (Abu Ja'far).

This doctrine of proportionality was applied to the specific problem of varying velocities of locomotion in the Tractatus de proportione velocitatum in motibus,(127) "editus a mag. Thoma de Bradwardin a.d. 1328."(128) This treatise will be discussed in Chapter V. For the present we wish only to observe that this treatise, which stimulated the Mertonians into discovering similar functional dependencies in all types of motion, was written in 1328 while Bradwardine was a student of theology at Oxford. Bradwardine's treatise quickly dominated the whole mathematical discussion of motion in the 14th century, and at least two simpler versions were arranged,

(note 125 cont.) versions compare with that ascribed to Bradwardine in MSS Erfurt, Amplon. F. 375, fol.15v-17, 88v-92, and Q. 23, fol.75-81v, beginning "Horum que sunt aliud est continuum aliud discretum..."

(126) Ed. Paris 1530, fol.1-20. In his discussion of proportionality (Tr.III, c.1) he says, "et hec omnia sunt dicta in arithmetica" (fol.11).

(127) This treatise is more commonly known as De proportionibus velocitatum motuum, it has been recently edited by E.Lamar Crosby, Jr., The University of Wisconsin Press, Madison 1955. If, however, the Tractatus de continuo is an authentic work of Bradwardine, then the original title of the treatise is De proportione velocitatum in motibus, as found in Rome, Angelica MS 1017, fol.50-56v and in several other manuscripts. Cf. Tractatus de continuo, MS Erfurt, Amplon Q.395, fol.24v, fol.32v, fol.41r, fol.45v-46r.

(128) MS Paris, Bibl.Nat.nouv.acq. 625 (a.d.,1348), fol.62-70v; this date is also preserved in Bibl.Nat.lat. 14576, fol.261v, and lat. 16621, fol.212r. The Questiones de velocitate motuum in MS Erfurt, Amplon. F. 313, fol.166-190, are not by Bradwardine as Schum believed (Beschreibendes Verzeichnis der Amplonianischen Handschriften-Sammlung zu Erfurt, Berlin 1887, p.217). These are questiones by an anonymous master on the Tractatus de proportionibus of Bradwardine, as an examination of the text clearly shows. Fol.177ra gives some indication of this anonymous master: "Ad oppositum illius videtur esse quidam Reverendus magister meus Doren /sic/ in tractatu suo de proportionibus in capitulo primo ubi sic dicit: Omnes proportiones equales..."

as we shall point out, to help beginners acquire the fundamentals of "Bradwardine's function." ~~Cf. Chapter V, pp.~~

It is well known that Bradwardine was highly skilled in the science of geometry. More concrete proof of this may be found in the Tractatus de continuo, ascribed to him in Torun (Poland) MS 4°. 2., of the late 14th century, pages 153-192; the same text is found anonymously in Erfurt, Amplon. Q.385, fol.17-48.(129) There is no internal evidence for the authenticity of this work. From the impersonal references to the well known De proportions velocitatum in motibus, it is clear that the De continuo is a later composition. However, we have found in Paris, Bibl.Nat., Nouv.Acq.lat.625, a fragment of the Tractatus de continuo on fol.71v.(130) This fragment is explicitly ascribed to "bradwardin" in the margin and it is written by the same scribe who penned the Tractatus de proportionibus (fol.62-70va), "scriptum Parisius anno eiusdem 1348," and Dumbleton's Compendium sex conclusionum quarti capituli tractatus proportionum mag. Thome Bradwardin (fol.70v-71v). Thus the earliest known ascription of the Tractatus de continuo to Bradwardine is found in the Paris fragment, which can be dated about 1348.

Bradwardine's fame as a theologian rests chiefly on his De causa Dei contra Pelagium, et de virtute causarum ad suos Mertonenses libri tres.(131)

(129) Inc.: "Continuum est quantum cuius partes ad invicem copulantur. Continuum permanens est continuum cuius partes simule manent simul..." See the study of this work by Edward Stamm, "Tractatus de Continuo von Thomas Bradwardina," Isis, XXVI (1936-7), 13-32. Mr.John Murdoch is preparing a text and a study of this work for the University of Wisconsin. I am grateful to Mr.Murdoch for the use of his text.

(130) This fragment is not noted in Omont's catalogue, Nouvelles acquisitions..., 1898, p.9.

(131) This was edited by Sir Henry Saville in 1618 on the basis of six good manuscripts and published in London.

Although Michalski attempted to prove that this work must have been written around 1322-25,[132] it seems more probable that the work was completed at London in 1344 while Bradwardine was Chancellor of St.Paul's,[133]. As Chancellor of a Cathedral Chapter Bradwardine would be obliged to provide lectures in theology,[134] and the De causa Dei may very well have been the result of those lectures, at least in part. The fragments of a questio on future contingent events, edited by B.M.Xiberta,[135] would seem to

(132) "Le Problème de la volonté à Oxford et à Paris au xive siècle," ed.cit., 235-9, 302. Basically Michalski's arguments rest on his belief that Bradwardine's work influenced Nicolas de Autrecourt (summoned to Avignon in 1340), Jean de Mirecourt (lectured on the Sentences 1344/45 or 1345/46) and Gregory of Rimini (lectured on the Sentences in 1344).

(133) While it is true, as Michalski observed, that "perscriptum London. 1344" does not necessarily indicate the date of publication, it would seem that in this case 1344 is the date of publication and not merely of the particular codices. This date is given in at least three MSS and there are none earlier. MS Lambeth Pal.32 ends "perscriptum Cantebrigie a.d. Mill.CCC° octogesimo quinto, editum ab eodem Thoma London. A.d. Mill.CCC° quadragesimo quarto." There is not sufficient proof that Bradwardine influenced Nicolas of Autrecourt, as has been pointed out by S.Hahn, "Thomas Bradwardinus und seine Lehre von der menschlichen Willensfreiheit," B.G.P.M.A., Band V, Heft 2 (Münster 1905), 53, and J.R.Weinberg, Nicolaus of Autrecourt, Princeton 1948, 66-67. Gregory of Rimini, as far as we can judge, shows no awareness of Bradwardine's doctrines in those questions where he would be most likely to note them; the two editorial references in the margin of II Sent., d.29, q.1, a.1 and d.38. q.1, a.2 (ed. Venetiis 1522, fol.105va and fol.125vb) are too vague to prove that Gregory read Bradwardine's De causa Dei. This is also the opinion of J.F.Laun, "Thomas von Bradwardina, der Schüler Augustins und Lehrer Wiclifs," Imago Dei (Vortrag, gehalten am 17 August 1928 auf dem Internationalen Historikerkongress in Oslo), pp.51-93. Bradwardine's influence on Jean de Mirecourt is better established, cf. Michalski, op.cit., Denifle, Chart.U.P., II, p.613 note.

(134) W.A.Pantin, The English Church in the Fourteenth Century, Cambridge 1955, p.111.

(135) "Fragments d'una questió inèdita de Tomàs Bradwardine," in Festschrift M.Grabmann (B.G.P.M.A.,suppl.III,2), Münster 1935, 1169-1180. Bradwardine refers to an earlier question in this collection, now missing: "...ut praedictum est in quaestione de peccato, scilicet utrum Deus sit causa peccati." ibid., p.1172.

antecede at least Book III of De causa Dei.(136)

In the preface Bradwardine mentioned that he had heard certain "advocates of Pelagius" affirm that Pelagius could never have been convicted of error by purely natural and philosophical arguments, but only by the authority of the Church. To disprove this contention Bradwardine attacked the Pelagiani of his day "per rationes et auctoritates philosophicas." There can be little doubt that among those who "hodie cum Pelagio pro libero arbitrio contra gratuitam gratiam tuam pugnant," Bradwardine intended to include Ockham and his followers. The principal charge of heresy brought against Ockham by Lutterell was one of Pelagianism.(137) By reducing "grace" to a word which signified the divine acceptance of a human act or person,(138) even though that person may be separated from God by sin,(139) Ockham denied the reality of grace as an intrinsic entity and the reality of God's activity within creatures. But it is also clear that Bradwardine intended to attack more than Ockhamist nominalism, for he developed a doctrine which denied that the human will could perform any

(136) After a brief discussion of human free will Bradwardine says, "Sed hoc non dico asserendo, quia istam materiam non bene studui adhuc." Ibid., p.1176. But he does deal with this question in great detail in Lib.III, especially in chapter 12.

(137) See A.Pelzer, "Les 51 articles de Guillaume Occam censurés en Avignon," Revue d'hist. eccles., XVIII (1922), 230-254. J.Koch, "Neue Abhandlungen zu dem gegen Wilhelm Ockham," Recha de Théol. anc. et. méd., VII (1935), 375-380, esp. art. 14,16,18,20 and 35.

(138) Ockham, Sent., III,q.V, ed.cit., G-O.

(139) Ibid. The extremes to which this view was carried can be seen from the opinions contained in the anonymous commentary on the Sentences found in MS Vat.lat. 986, especially fol.83v-93. This seems to be a Parisian commentary dating about 1370, delivered under "magister Amandus" (fol.55vb), but the author was very well acquainted with such English writers as Bradwardine, Ockham, Kilmington, Billingham, Rogeth, Aston, Chaton, Halifax (Kilphat), and Grantham.

good act[140] or overcome any temptation without God's auxilium speciale,[141] and maintained that in a certain sense God necessitates even the free acts of creatures[142] in His way of operating through all creatures.

Although we are not particularly concerned with Bradwardine's theological works, his De Causa Dei is important not only in revealing the intellectual climate of the mid-fourteenth century, but also to illuminate his view of physical problems.[143] Bradwardine deals with "metaphysical" problems only in the De causa Dei.[144]

3. William Heytesbury.

P.Duhem has indicated something of Heytesbury's great influence on the Italian schools of the 15th and 16th centuries,[145] but he failed to place Heytesbury correctly in his Oxford milieu. Although Duhem knew the work of R.L.Poole in the D.N.B., he insisted on dating Heytesbury's works after the Summa of John Dumbleton and half a century after Bradwardine's Tractatus.[146]

(140) Bradwardine, De causa Dei, I, cap.41, ed.cit., p.373-4.
(141) Ibid., II, cap.4-7, ed.cit., p.472-491.
(142) Ibid., III, cap.1-2, ed.cit., p.637-649. Bradwardine's view is accurately expressed, although not explained, in Chaucer's "The Nun's Priest's Tale."
(143) Cf. A.Koyré, "Le vide et l'espace infini au XIVe siècle," Archives d'Hist. Doctr. et Litt. du M.-A., XVII (1949), 80-91.
(144) The Quaestiones Bradwardin super XII libros Metaphysice described by Schum, Amplon. Fol. 326 (Beschreibendes Verzeichnis..., ed.cit. p.225) cannot be a work by Bradwardine, as the colophon clearly indicates: "Explicuit determinaciones super libros metaphisice determinate per magistrum Stephridum prolem matris Beharie... huius exercicium vigerit in Uxonia... complete a.d. M°CCC°XLIII° in vigilia assumptionis Marie."
(145) P.Duhem, Etudes, III, 493-510.
(146) Ibid., 406, 420, 469.

A.Maier seems to be more correct in accepting the works of Heytesbury and Dumbleton as more or less contemporary.(147)

William of Heytesbury must have been born by 1313, and it seems most likely that he came from Wiltshire in the Salisbury diocese. He is first mentioned in the Merton records as a Fellow in 1330.(148) In February, 1340, he was named one of the foundation Fellows of Queen's College.(149) Since the statutes of Queen's required that a candidate for Fellowship should have completed his necessary regency in arts and be well fitted to study theology,(150) we may assume that Heytesbury was already a theological student in 1340. But it appears that Heytesbury did not remain long at Queen's, for he is again mentioned among the Fellows of Merton.(151) There can be no doubt that Heytesbury became a Master in Theology, but the date of his inception is not known. The earliest known document to give him the title of "Doctor in Theology" is dated July 1348.(152) In a University roll for papal graces compiled before February 1363 he is called "late Chancellor of the University."(153) If this statement is correct, Heytesbury must have held office from 1353-54, the only period for

(147) A.Maier, Studien, III, 265-281.
(148) Mert. Reg. 3660. Heytesbury was first bursar of the College in 1338-39. A fragmentary record of three college scrutinies held during 1338-39, containing Heytesbury's comments, was published by Allen and Gerred, Merton Muniments, (O.H.S.) 1928, 32-35.
(149) Statutes of the Colleges of Oxford, London 1853, vol.I, Statutes of Queen's College, Oxford, p.7. Cf. J.R.Magrath, The Queen's College, Oxford 1921, I,91-94.
(150) Statutes of Queen's College, ed.cit., p.12.
(151) Mert. Reg. 3673, 3679.
(152) When he was a witness to an indenture together with William de Hunkesworth, who was then acting on behalf of the Chancellor. Mun. Acad.Oxon., (.R.S.), I,167. Two documents of early 1349 testify to his doctorate in theology, Cal.Pap.Pet., I,146, and Cal.Pap.Let., III,298, dated March 7.
(153) Cal.Pap.Pet., II,402; this petition was granted at Avignon on February 15.

which no chancellor is known,[154] or else he merely filled the office temporarily between two chancellorships. According to another document he was again Chancellor on November 9, 1371;[155] hence Salter surmised that Heytesbury held office from Pentecost 1370 until Pentecost 1372.[156] It appears that Heytesbury died in December of 1372 or in January of 1373.[157]

It would seem that all of Heytesbury's known works date from his regency in arts, which may be placed approximately between 1331-1339. According to an Erfurt MS, Amplon. F.135, fol.17rb, the Regulae solvendi sophismata was "datus Oxonie a mag. Wilhelmo de Hytthisbyri a.D. M°CCC° XXXV°." This particular codex, begun on July 22, 1537,[158] was purchased by Amplonius in Prague on March 12, 1399.[159] Although the treatise bears no title in the codex, Amplonius added the note, "et vocatur communi nomine Leyca Hesburi." The treatise in this codex is without prologue and begins, "Secundum Philosophum in Predicamentis quarto capitulo, quadratura circuli..." The printed edition of 1494 claims to be a "corrected" version, but apart from the prologue and the opening of the first chapter, the Erfurt text is practically identical with that of the printed edition.[160] It would seem, however, that the prohemium was added by Heytesbury after he

(154) Snappe's Formulary, ed. H.E.Salter (O.H.S.), 328.
(155) Mun.Civ.Oxon., ed. H.E.Salter (O.H.S.), 149.
(156) Snappe's Formulary, ed.cit., 330.
(157) A.B.Emden has found in Whittlesey's Registers Heytesbury's will dated 17 December, 1372, and proved 5 February, 1373 (fol.126v).
(158) Fol.1 in upper margin: "Inceptum est hoc opus in festo Magdalene a.d. 1337 littera dominicale e."
(159) Amplonius' note is added at the end of the treatise, fol.17rb. Cf. A.Maier, Studien, III,266, note 26.
(160) We have carefully compared photographs of the Erfurt text with the printed edition of Venice 1494 and with MS Canon.Misc.221, fol.60-85. Generally the reading of the Erfurt MS is superior and we have used this text wherever it was advisable.

had completed the original text of his "summula," as he called it, that is, shortly after 1335.

In the prohemium Heytesbury seems to address the "juvenes studio logicalium agentes primum annum," and says he would like to have written a short summa of rules for solving sophismata, but this was rendered impossible by the inflated words of the old sophists and the indignation of promotors seeking higher things.(161) Although Heytesbury addressed students of first year logic, the treatise itself would certainly have surpassed their capacities. The real purpose of the treatise was to help sophistae respond in disputations.(162) It presupposes a certain amount of knowledge of physical problems and covers all the new treatises of logic. The Leyes or Regulae solvendi sophismata is divided into six chapters: (1) De insolubilibus, (2) De scire et dubitare, (3) De relativis, (4) De incipit et desinit, (5) De maximo et minimo, (6) De tribus predicamentis. Many questions of physics arise in the fourth and fifth chapters, and the last chapter is devoted entirely to questions of physical motion. The five chapters of the De probationibus conclusionum,(163) undoubtedly written in conjunction with or shortly after the Regulae, correspond

(161) Here the reading of the printed edition is better than MS Canon. Misc. 221.

(162) "atque responsalem oportet nosse evellere," "...responsalem efficit certiorem," etc. MS Canon.Misc.221, fol.60ra.

(163) Ed. Venice 1494, fol.188v-203. MS Canon.Misc. 376, fol.23-32, contains only chapters three to five, but chapters 3 and 5 are themselves incomplete. The authenticity of the De probationibus conclusionum is not beyond dispute. The usual phrase in the manuscripts "probationes conclusionum hentisberi" could be interpreted as meaning an anonymous commentator's proofs of the conclusions in Heytesbury's Regulae. The clearest ascription is found in Florence, Laurens. Ashburn.171, fol.13-31ra: "Explicium conclusiones Tisberi super suis regulis." But this manuscript is dated 1440.

perfectly to the Regulae, with the exception of the treatise on insolubilia. Thus, although many problems of physical science arise in these works of Heytesbury, they are primarily works of logic.

Besides these works and De sensu composito et diviso, Sophismata XXXII, and De veritate et falsitate propositionis found in the printed edition of 1494, certain other works of Heytesbury should be noted. A Tractatus consequentiarum was printed in the Venice edition of 1517 (fol. 108v-115v), but this text differs somewhat from the manuscripts which have been examined.(164) A unique Tractatus Hentisberi de propositionum multiplicium significatione valde raro inventus is contained in Venice, S.Marco, lat.Cl.VI,cod.160 (2816), fol.252-253v; the codex is dated 1443, but the work is clearly ascribed to Heytesbury and internal evidence does not contradict this. It begins, "Qui autem nominum virtutis sunt ignari et ipsi disputantes et alios audientes paralogizant de facili, primo elenchorum. Cum igitur in disputatione cuiuslibet..." Further there are a series of Casus obligatorii ascribed to him in certain manuscripts, beginning, "Primo ponitur talis casus quod heri videmus: Sortes et nullus alius..."(165) Finally, the well known Termini naturales, beginning, "Natura est principium motus et quietis...." is ascribed to Heytesbury in Clm 8997, fol.167. This treatise, as we have pointed out, is a beginner's text of definitions and

(164) Cambridge, Caius College MS 182/215, pp.102-116, Corpus Christi College MS 244, fol.39r-58, Venice, S.Marco, Z.lat.277 (1728), fol.23-33.

(165) Oxford, Bodl.Canon.Lat.278, fol.70-72 and Venice, S.Marco, Z.lat. 310 (1577), fol.96va-b. There are also two different treatises De insolubilibus ascribed to Heytesbury, besides the printed version, but as we have not made a sufficient study of them, they will be noted in the Repertorium.

divisions in natural philosophy, and may very well have been "compilata a magistro Wilhelmo Hesbri," but it is of little speculative importance. However, as this treatise was very widely used, "secundum usum Oxonii," we will give a transcription of this work in the appendix as an example of a beginner's text in physics. Heytesbury's Sophismata were frequently copied and commented upon. MS Vat.lat.3056, fol.1-41, contains an epitome of these sophismata, complete "anno domini M°CCC° octogesimo octavo in nostro collegio de Mertone."(166)

Thus far no theological works ascribed to Heytesbury have been discovered.(167)

Although Heytesbury was never outspoken in his defence of Ockham's doctrines, he clearly did accept the fundamental ideas of Ockham's logic and natural philosophy. In logic Heytesbury implies an acceptance of Ockham's view of suppositio simplex in his complicated rules of distribution, requiring that a complete enumeration of singulars be made before a word can truely represent a singular.(168) In natural philosophy Heytesbury tacitly accepts Ockham's doctrine of substance and quantity, motion, and time, as we shall see in the following chapters. Heytesbury represents a curious combination of a logician who accepted most of Ockham's philosophy

(166) Inc.: "Adspiciens a longe conditionem iuvenum elegancium suis ingeniis tanquam viribus aquilinis..." Venice, S.Marco, Z.lat.310 (1577), fol.54-78v, contains "Sex sophismata principalia edita et compilata per mag. Guillelmum Hentisberum, doctorem anglicum, regem sophistarum."

(167) The theological Repertorium argumentorum of Stephen Patrington includes arguments taken from Heytesbury, but all of these are from his logical works. MS Cambridge, St.John's College 103, fol.1-109; another copy is to be found in Venice, S.Marco, Z.lat.280, fol.21-131.

(168) "Nam ad hoc quod universalis aliqua per inductionem probetur, requiritur quod pro tot singularibus fiat inductio, pro quot in universali fit distributio, ut in tali universali, ut pretactum est, pro qualibet quod de necessitate erit, et etiam pro qualibet quod erit, fiat distributio requiritur, quod pro illis singularibus fiat inductio, et tunc habebit universalis ista aliquas singulares falsas." MS Venice, S.Marco, lat.VI,160 (2816), fol.252va.

and at the same time had an interest in developing Bradwardine's mathematical approach to physical problems. Nevertheless, in spite of Heytesbury's contributions to the mathematical development of physical problems, he was formally a logician. He always approached physical problems through a logical analysis of terms which in his day involved mathematical proportions. Intellectually Heytesbury belonged to the generation after Ockham, Burley, and Bradwardine. Instead of reacting to Ockham's doctrines, as Bradwardine had done, he became a disciple of both Ockham and Bradwardine. However it is very doubtful whether Heytesbury ever met Ockham or was ever a student under Bradwardine.

4. John Dumbleton.

Dumbleton was much more open in his adherence to Ockham's doctrines than Heytesbury, although he never quoted Ockham once by name. Very little is known about John de Dumbleton. Undoubtedly he was a native of the village of Dumbleton in Gloucestershire within the diocese of Worcester. We know that he was a Fellow of Merton College in 1338[169] and that he was still there in 1347-8.[170] The Merton scrutinies of 1338-39 mention him in the company of William Heytesbury, John Ashindon, William Sutton, Simon Bredon, and Thomas Buckingham. However it would seem that Dumbleton was somewhat younger than Heytesbury, who is first mentioned at Merton in 1330.[171] We

(169) Merton Muniments, ed. P.S.Allen and H.W.Garrod, Oxford 1928, p.34, 35. Merton Records 3673, 3676-7.

(170) Mert. Rec. 3680.

(171) R.L.Poole in the D.N.B. rightly distinguished the Merton Fellow from John of Dumbleton, a monk of Worcester, who in November 1299 was appointed prior of Little Malvern (Annales Wigorn. Monast (R.S.), ed. H.R.Luard, IV,548). See also Little and Pelster, Oxford Theology and Theologians (O.H.S.), 1934, 236-8. But he must also be distinguished from Thomas de Dumbelton, M.A., to whom Pope John XXII on July 6, 1330, reserved a benefice in the gift of the abbot and convent of Abingdon (Cal.Pap.Let., II,321); Cf. also Merton Rec. 3660 "magister Thome Dumbelton" 1330.

also know that Master "Johannes de Dumbelton" was named as a Fellow of Queen's College in the founder's statutes of February 10, 1340.(172) This means that Dumbleton had completed his regency in Arts by that date, and that he at least intended to study theology and to take Holy Orders.(173) Clearly he did not remain at Queen's, for he is again mentioned in the Merton records for 1344-45.(174) Nothing more is known about him, except that he wrote a large Summa logicae et philosophiae naturalis.(175) It is assumed that Dumbleton died of the plague around 1349, since nothing more is heard of him.

Further details of his life can be obtained from a study of the manuscripts of his works. A late 14th or early 15th century manuscript of Dumbleton's Summa in the Antoniana Library, Padua, Scaff. XVII, n.375, notes at the end of the first part (fol.21rb): "Explicit prima pars Summe magistri Johannis de dulmenton anglici baccalarii sacre theologie." The first two folios are missing in this codex and Part IX is unfinished. This is the only evidence known of Dumbleton having been a bachelor in theology, but there is no reason to doubt this testimony. If the scribe were merely giving Dumbleton titles gratuitously, he surely would have made him a Master. Furthermore if Dumbleton began his theological studies around 1340,

(172) Statutes of the Colleges of Oxford, London 1853, vol.I, "Statutes of Queen's College, Oxford," p.7.

(173) See "Statutes of Queen's College, Oxford," ed.cit., pp.6, 12-14.

(174) Mert. Rec. 3676-7. Cf. J.R.Magrath, The Queen's College, Oxford 1921, pp.92-93.

(175) This work has been variously called "Summa Theologiae Maior," "Summa Philosophiae," "In Philosophiam Moralem libri X," etc. Cf. Tanner, Bibl. Brit.-Hib., ed.cit., 257. But these are all one and the same work. It is difficult to know what Tanner meant by "Summam theol. minorem, lib.i" and "Summam artium, lib.i," as he gives no initium or reference to where he saw these works.

as he apparently intended, he would have been a bachelor in theology by 1349, the assumed date of his death, and not a Master.

The Summa logicae et philosophiae naturalis is a huge work divided into ten parts. The first part, or the Summa logicae, is not a summary of the traditional Aristotelian books. Rather it has a peculiar unity of its own centred around the new logical treatises and deals particularly with the intension and remission of certitude. It is divided into four "articles":(176) (1) on the signification of terms and the insolubilia, (2) the treatise de scire et dubitare(177) and the intension and remission of knowledge and doubt, (3) questions of more or less in knowledge, (4) on the principles of knowledge and the increase of credulity and science. Unlike Heytesbury, Dumbleton does not concern himself with questions of pure physics in his logic; but he is concerned with the psychology of logic more than with the Aristotelian books.

Part II-X of Dumbleton's Summa, the only one produced by the early Mertonians on natural philosophy, is really a collection of certain dubia

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(176) The manuscript readings are faulty on this division: "Prima pars quatuor pertractat articulos: 1° significationis termini et eius impositionis ad placitum cum aliis incidentibus, eorum si qua sint naturalem extendit. 2° /big/, quid est prius esse alio, ac magis scire nature et nobis, quibus confusa magis distinctionis universalia plus particularibus cognoscimus, et de cognitione diffinitionis respectu diffiniti, et eius partium investigat. 3° /big/ de principiis doctrine nostre primarie ac de intensione credulitatis et scientie quandam assertit conclusionem." We quote the reading in MS Vat.lat. 6750, fol.1ra, which basically corresponds with MSS Pal. lat.1056, Worcester Cath. F.6 and F.23, Venice, S.Marco, lat.VI,79, and Magdalen College 195. The enumeration in MS Magdalen College 32 is clearly wrong, and the forced distribution into four found in MS Merton College 306 does not agree with the actual division.

(177) Dumbleton himself refers to this "article" in this way: "Hec responsio improbatur tractatu de scire et dubitare diffusius." MS Vat.lat.6750,fol.1vb; the reference is to cap.20, according to the chapter divisions given in Vat.lat. 6750.

"magnorum librorum naturalium quinque."(178) Part II and III correspond to the first six books of the Physica:

> Secunda pars de primis principiis, scilicet materia et forma, et de opinionibus multipliciter formarum substantialium primarum qualitatum ac secundarum intensionem ponentibus, et de intensione qualitatis uniformis et difformis latitudinis secundum rem seu secundum nomen dicte, cum descriptione intensionis mixtorum quedam sustinenda demonstrat.
> Tertia pars causam veri motus in tribus predicamentis et quam proportionem motus sequitur consignificat distantiam et penes quam velocitates motus alterationis et augmentationis, et de latitudine raritatis et densitatis vere habent attendi concludit; ultimo de motu et tempore quid et qualia sint rationibus inquirit et in eadem, motum uniformiter acquisitum medio gradui equivalere cum conclusionibus aliis demonstratur.

Parts IV, V, and VI basically correspond to the De Coelo et Mundo, the Meteora, and to part of the Eighth Book of the Physica:

> Quarta pars de natura elementorum inquirens; 1° si summa elementa utrumque qualitatis summe habeant, et qualiter prime qualitates sunt active ostendere insistit. 2° de reactione inter easdem et qualiter qualitates prime formas primas, et densitas et raritas summa et remissa corpora naturaliter consequantur diffinit, et si eadem ab aliis qualitatibus sunt distincte. 3° item qualiter potencie corporum magnitudines eorum sequantur, et si iuxta sese alterent, et qualia sint pura hec eadem quarta demonstrat.
> Quinta pars agens de actione spirituali, si iux alicui elemento competat, qualiter simplex vel resultans existat enarrat. Item eadem de differencia formarum superiorum et inferiorum, lumen agnoscum, et de sectione earum uniformi et difformi respectu agentis et passi dubia edisserit.
> Sexta pars de finibus potencialarum tractans; 1° potencias activas difficultate terminare docet. 2° de sectione naturali et fine formarum, ut sunt motus et quies, deducendo si forma sit proprie mobilis, et si forma et locus attribuuntur equaliter generato iuxta ceteras partes hec sexta pars exprimit. Insuper eadem iurta processum Philosophi circa motores et motus celestes dubia commovens, qucmodo corpora naturalia quantitate terminantur, et si ad primum motorem sit deveniendum attendendo que corpora ex se moventur, et de aliis que in eodem deficiunt determinat.

(178) Here we quote the text contained in MS Vat.lat. 6750, but in the Appendix a collated text will be found with the variant readings. Throughout the thesis we shall refer to this MS of the Summa, of which we have transcribed the first three parts in full; but wherever necessary, corrections will be made from other reliable MSS of the work.

Part VII corresponds to the two Books of the De Generatione et Corruptione, the Seventh Book of the Physica and to the remaining part of the Eighth:

> Septima pars causam individuorum et specierum generabilium et corruptibilium quantum ad numerum et ordinem potenciarum materie et agentis persuadet, et numquid primam motorem infinite virtutis existere, et mundum et motum non incepisse racione philosophica comprobantur.

The last three Parts of the Summa are devoted to the generation of living creatures, the operation of the senses and the intellect. Hence they correspond to the problems of the De Anima together with the other books of biology and botany:

> In Octava parte primo de generacione substancie a simili et animalium perfectorum et putrefactibilium pertractatur. Item de unitate anime numerali respectu anime sensibilis et intellectualis, et de operacionibus anime intellective tractatum suum consummat.
> Nona pars iuxta seriem processus 2° De Anima de quinque sensibus dubia et plurima pertinencia eidem materie et plurimas questiones decidit.
> Decima et ultima pars de universalibus que idee apud Platonem dicuntur et de passivitate intellectus humani quantum ad susceptionem intentionum alicuius eiusdem operacione simplici atque complexa quamdam sentenciam concludens huinc summe finem imponit. Cuius prima parte et decima intellectus propositionum significancium pro complexis qualiterumque nobis naturalis solucio intimatur.

Among the 19 known MSS of Dumbleton's Summa not one contains the tenth, and perhaps most interesting part. All the "complete" manuscripts end in Part IX with the words "...asserunt sic, rem visualem in se continere activitatem, naturalium enim ex^m sepe stat procul respicit et a longe." It is not clear whether this is all Dumbleton intended to include among the "plurima pertinentia" of the ninth Part. It is possible that Dumbleton died around 1349 without completing his Summa. Further considerations tend to confirm this view.

A noticeable difference of procedure can be detected from about the middle of Part VI onward. The earlier portion discusses dubia with

lengthy discussions "contra," "respondetur" and "contra responsionem," the structure of which gives the impression of material drawn from actual class room disputations. The second portion, on the other hand, deals rather with certain difficult passages in Aristotle, Avicenna, or in the Commentator, giving the impression that Dumbleton never actually lectured on those questions of embryology, botany, or the physiology of sensation, but wished to complete his Summa according to plan, even though he was then studying theology. In this case it is not at all unlikely that Dumbleton was overtaken by death before he could complete his Summa.

The date post quem of the Summa's composition can be fixed with some certainty. First, it must be noted that Cajetan de Thienis is misleading on this point. In his commentary on Heytesbury's Regulae solvendi sophismata, Cajetan ascribes the first erroneous opinion listed concerning insolubilia to Swineshead, the second to Dumbleton, and the third to Richard Kilmington.(179) At first sight one would assume that Heytesbury's work was posterior to those of the others mentioned by Cajetan. In actual fact Heytesbury's Regulae was prior to the first Part of Dumbleton's Summa. Although the second opinion which Heytesbury rejected was defended by Dumbleton, neither the actual phrasing of this opinion in Heytesbury nor the arguments are to be found anywhere in Dumbleton's work.(180) But

(179) "Prima harum posicionum est suissaet; secunda ponitur a dulmentone; et tercia est ricardi Ollentonis in sophismatibus suis." MS Venice, S.Marco, lat.VI,160 (2816), fol.122rb.

(180) Heytesbury phrases the opinion thus: "Est autem et alia opinio circa idem, que alicuri iuramento fundata que efficaci et recta racione affirmat, quod in insolubilibus non est verum aliquod contradictorium nec falsum, eo quod nullum insolubile est propositio apud eum. Quamvis enim quodlibet insolubile sit oracio indicativa significans sicud est aut sicud non est, eius significacio tamen ad hoc non sufficit ut propositio ipsum nominare." MS Erfurt, Amplon. F.135, fol.1ra. The reason for Dumbleton's position is that "solum propositionem esse extra et in anima dum est actualis comprehensio per animam." Summa P.I,cap.13, MS Vat.lat.6750, fol.4vb.

Heytesbury's opinion (the fourth listed by Dumbleton) is rejected and answered verbatim by Dumbleton, as a comparison of the two texts will indicate:

Heytesbury, Regulae, cap.1
MS Amplon. F.135, fol.2va

Una /suppositio/ est: casus de insolubili est in quo fit mencio de aliqua proposicione que si cum eodem casu significaret precise sicut verba illius communiter pretendunt, sequeretur eam esse veram et etiam esse falsam. Alia est quod proposicio est insolubilis de qua fit mencio in casu de insolubili, que si cum eodem casu significaret precise sicut verba communiter pretendunt, sequeretur eam esse veram et etiam esse falsam; v.g. si ponatur quod nem "Sortes dicit falsum" et nullam aliam, vel talem "Sortes non dicit verum," vel talem "Sortes dicit aliter quam est," aut quod talis proposicio "Falsum est" sit quelibet proposicio, aut quod hec sit quelibet proposicio "nulla proposicio est vera"; et sic de talibus quibus talis casus dicitur insolubilis. Et ista proposicio "Sortes dicit falsum" in tali casu dicitur proposicio insolubilis, quia si ista in tali casu significaret precise quod Sortes dicit falsum, sequitur eam esse veram et etiam eam esse falsam...
/Secunda regula/ Secundo est advertendum quod si ponatur casus de insolubili et cum hoc supponatur quod illud insolubile significat precise sicut termini illius pretendunt communiter, casus ille nullatenus admittatur, sicut cum supponatur quod falsum ista proposicio "falsum est," sic quelibet proposicio; et quod ista proposicio significat precise "Falsum est" statim reiciendus est ille casus et qualibet convertibilis cum eodem.

Dumbleton, Summa, P.I, c.6, a.10
MS Vat.lat. 6750, fol.3rb, 4ra

Tertia /opinio/ dicit seipsum insolubile falsificatur, non obstante quod significat precise sicut est, quam quarta /opinio/ redarguens ponit pro principio quod nullum insolubile significat sicut verba pretendunt, in quo convenit cum secunda nominata. Tamen discrepat in hoc quod negat causam falsitatis insolubilis assignatam ab eadem, nec dicit aliquam significacionem quare insolubile est negandum.

Quarta opinio scribit quod nullum insolubile significat precise sicut verba pretendunt; et quia non dicit qualiter precise significat, nec que sit significacio propter quam insolubile est negandum, ideo hec positio prius attemptat solvere quam sciat precisam significacionem proposicionis solvende. Quare non ordine competenti procedit, cum prius requiritur cognicio totalis significacionis proposicionis antequam ab aliquo ipsa solvatur.
Secundo: licet hec positio dicit hanc "falsum est" non solum sic significare, non tamen exponit utrum sit impossibile vel possibile. Et per consequence non solvit, cum solucio sit manifestacio falsitatis secundum quam proposicio solvenda falsa est.
Tercio: si hec "falsum est" ipsa sola existente significat aliter quam quod "falsum est," vel igitur eo ipso quod significat quod "falsum est" significat aliter, vel ex hoc quod ita est omnis proposicio, quorum neutrum hec posicio dicit nec manifestat.

* Sortes dicat talem proposicio-

In the second and third parts of the Summa certain opinions concerning the velocity of alteration and augmentation are rejected. As we shall see, these opinions were proposed verbatim by Heytesbury in Chapter V of his Regulae. Therefore it seems clear that Dumbleton began his Summa some time after 1335. The composition would require a considerable number of years, and may very well have been left unfinished by Dumbleton's death in 1349.

Besides the Summa certain other works have been attributed to Dumbleton.(181) Merton College MS 306, fol.3-7, contains a logical work on insolubilia, the signification and supposition of terms, and de arte obligatoria, beginning, "De sophismatibus, que non re sed nomine insolubilia extant, superest pertractare...." This treatise is anonymous and without title.(182) A late table of contents ascribes this to Dumbleton, whose Summa fills the rest of the codex. On the basis of this table of contents Tanner,(183) Coxe,(184) and R.L.Poole(185) have attributed this work to Dumbleton. This treatise is in reality a commentary on an unidentified logical "summule" dealing with insolubilia and obligatoria.(186) It seems more probable, however, that this commentary should not be attributed to Dumbleton. Concerning the first type of insoluble propositions, the anonymous author maintains that

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(181) We make no mention of the Commentary on the Canticles ascribed to Dumbley, which Leland listed together with Dumbleton because of the proximity of the name (cf. Tanner, loc.cit.). Nor do we mention the verses contained in Merton College MS 306, fol.8, noted by Wood (cf. R.L.Poole, article in D.N.B.).

(182) At the end of the treatise there is written "Explicium tractatus de diversis insolubilibus, et de significacione et suppositione terminorum et confusione et distribucione eorundem et de modis...signis universalibus, et de arte obligatoria cum aliis incidentibus." (fol.7rb).

(183) Bibl. Brit.-Hib., ed.cit., 237.

(184) Catalogus Codicum Manuscriptorum qui in Collegiis Aulisque Oxon. hodie asservantur, Oxonii 1852, t.I, Mertonenses p.121.

(185) R.L.Poole, article in D.N.B.

(186) "Disciplinarum logicalium tria inter ceteras ut utiles exercentur. Prima de termini significacione, que non in principio illius summule distinguitur. Set secunda et tercia aliqualiter possunt

"intentiones in anima non ad placitum, sed naturaliter significant."(187) But it is precisely this notion which Dumbleton rejects so vehemently in the first part of his Summa, maintaining that "nullus terminus aliquam rem significat naturaliter,"(188) but "quilibet terminus cuiuscumque rei est significativus ad placitum,"(189) and then only when there is "actualis comprehensio per eundem."(190)

P.Duhem believed he discovered a sophisma of Dumbleton in Paris, Bibl.Nat. lat.16621.(191) This "Miscellanea Philosophica" is a paper codex of the second half of the 14th century, formerly belonging to the Sorbonne. It seems to be a student's notebook containing various works of Burley, Bradwardine, Dumbleton, Swineshead, Oresme and others.(192) But the fragmentary selections from Dumbleton and Swineshead are badly ordered, since the scribe copied the sexterni and quaterni as they became available, and it is difficult to determine the beginning and end of distinct treatises. Duhem believed that this notebook contains not only extracts from the Summa of Dumbleton, but also a fragment not derived from the Summa. This fragment Duhem believed to be composed of three parts: De motu locali demonstrata per Dumenton (fol.114v-116v), a sophisma "Uniformiter continue variabitur alteratio uniformis..." (fol.124r-130r), and an alia questio "de maximo spacio lineari pertransito" (fol.130v-139r). Duhem attributed these three

(note 186 cont.) ulterius et sumarie indicari (?), ut que in eis obscure et superflue consuetudinem expeni liceat et restringi. Quarum prima est de suppositione termini; secunda ars obligatoria." fol.2r.

(187) "Quarum primus casus sit ille quod quilibet homo intelligens verum sedeat et solum talis, habente Sorte in anima sua solum hanc "Sortes non sedet," que sit A, de qua non oportet supponere illam solum se significare, quia intentiones in anima non ad placitum, sed naturaliter significant." ibid., fol.1r.

(188) Summa, P.I,c.1, MS Vat.lat. 6750, fol.1rb.

(189) Summa, P.I,c.2, MS cit., fol.1vb.

(190) Summa, P.I,c.13, MS cit., fol.5ra.

(191) P.Duhem, Etudes, III, 426.

(192) L.Delisle already noted that the same hand wrote MSS lat.16533-5. Cf. Inventaire des manuscrits latins..., XXXI (1870),71.

"parts," as though they were one work, to Dumbleton because of two tables of contents, which appear to group them together.(193) On further examination these "parts" prove to be distinct works. The first of these is undoubtedly by Dumbleton, but it belongs to his Summa, P.III, cap.7-8, Inc.: "Sequitur dicere qualiter motus sequitur proportionem..." This is a very poor text and actually continues on fol.117r, where part of the following chapter is repeated and cancelled, and immediately precedes the subsequent text contained on folios 117v-123v. The "part" noticed by Duhem is really based on Bradwardine's Tractatus de proportionibus motuum, and for this reason the scribe called it "Dulmenton de proportionibus motuum." The second work is not actually ascribed to Dumbleton in the codex, either in the two tables of contents or in the text. But on the top margin of fol.130 there is inscribed the name "Dulmenton." The authenticity of this attribution is not at all clear. Bale attributes a sophisma beginning "Uniformiter continue variari...." to a certain John of Tewkesbury, who is said to have flourished around 1350.(194) But Bale gave no source for this information, and no work with this beginning ascribed to John of Tewkesbury has yet been found.(195) The third work, or "part" of a fragment, contained in Bibl.Nat.lat.16621 is not explicitly ascribed to Dumbleton at all. Duhem merely assumed that it belonged to the first "part" and attributed it to

(193) "Item de Dulmenton de uniformiter difformi varia cum quodam sophismate forti de uniformiter difformi in sequenti cisterno. Item de maximo spacio lineari pertransito questio, una cum articulis notabilibus. Hec in duobus cisternis." (fol.13v). "Dulmenton de proportionibus motuum, gradu medio et similibus; unum sophisma de alteratione uniformiter difformi; questio una de maximo spacio lineari cum quibusdam similis materie." (fol.64v).

(194) Belæe, Script. Illustr., V, 86. Cf. Tanner, op.cit., 706.

(195) An anonymous sophisma beginning, "Uniformiter continue variabitur alteratio uniformis. Ad quod sophisma arguitur sic..." is contained in Venice, S.Marco, lat.VIII,19, fol.193-211. Cf. A.Maier Studien, III, 365, note 16. We have not compared this text with Bibl.Nat. lat.16621, fol.124-130.

Dumbleton. But this *questio* is clearly a distinct work and remains anonymous.

A hitherto unnoticed work explicitly ascribed to Dumbleton is found in Paris, Bibl.Nat. Nouv.Acq.lat. 625, fol.70v-71v.(196) It is a revision of the six conclusions on rotational motion given by Bradwardine in his *Tractatus*. Dumbleton's treatise begins, "In hoc compendio intellectum sex conclusionum quarti capituli tractatus proportionum mag. Thome Bradwardin intendo brevissime declarare..." The ascription is clearly stated on fol.71va, "Explicit Dunmulton." This treatise is preceded by Bradwardine's *Tractatus*, "scriptus Parisiis Anno eiusdem 1348," and followed by a fragment of Bradwardine's *De Continuo* beginning, "Continuum est quantum cuius partes adinvicem copulantur..." These three works are written in the same hand, which is distinct from that of the other treatises in the codex. Thus Dumbleton's *Compendium sex conclusionum* was apparently composed before 1348, but it is impossible as yet to give a more precise date.

There can be no doubt that Dumbleton accepted the nominalist logic and natural philosophy of Ockham. In many ways he could justly be described as a precursor of John Locke or David Hume. Nevertheless he, like his contemporary, Heytesbury, was a disciple of Thomas Bradwardine in the sense that he sought to explain physical phenomena through mathematical proportionality. A Vatican manuscript of Dumbleton's *Summa* P.II-IX (lat.954) is ascribed by a later hand to William of Ockham and is called "super tribus principiis rerum naturalium." Although both Heytesbury and Dumbleton were intensely interested in the proportions of velocities and did much to develop the

(196) Formerly Phillipps MS 3122. This item is listed in Omont's catalogue without author as "Declaratio super sex conclusiones predicti magistri Thome de proporcionibus." *Nouvelles acquisitions...*, 1898, p.9.

mathematics of physical motion, Dumbleton's approach to these problems is quite different from that of Heytesbury. Dumbleton was not so much interested in a verbal analysis of terms as he was in the psychology of meaning, especially of intension and remission. His own philosophy is a curious combination developed from Ockham, Bradwardine, and Plato — all within an Aristotelian framework. A study of the Platonic influences on Dumbleton would prove most illuminating, but it is outside the scope of the present thesis. The mathematical approach to nature, developed by Dumbleton and Heytesbury, was brought to completion in the Merton school by Swineshead.

5. Richard Swineshead.

One of the great difficulties in obtaining accurate biographical information concerning the author of the Calculationes is due to the multiplicity of persons bearing the name Swineshead and the great confusion of names in the various manuscripts. Our concern is principally with Richard Swineshead, author of various works on physics, and Fellow of Merton College.

Toward the middle of the 14th century there were two Fellows at Merton College bearing the name "Swineshead," one called Richard, the other John. John's career is much clearer, at least after the middle of the century. He was certainly a Fellow of Merton by July 2, 1343, when "John de Swynesheved, M.A., of the diocese of Lincoln" was included in an Oxford University roll for a benefice in the gift of Bardney Abbey, Lincolnshire.(197) He is still mentioned at Merton in 1346-7, but by 1353 he was a "scholar of Canon Law."(198) John Swineshead must have transferred to Cambridge University,

(197) Cal.Pap.Pet., I,62; Cal.Pap.Let., III,104.
(198) Cal.Pap.Pet., I,252.

because by 1363 "John de Swinesheved, M.A., Bachelor of Canon and Civil Law, priest of the diocese of Lincoln," was included in a Cambridge University roll for Papal graces for a canonry of Exeter with expectation of a prebend.(199) It is clear from Mr.A.B.Emden's research that John Swineshead devoted his life to Canon Law from about 1350 until his death in October 1372.

The earliest entry in the Bursar's rolls of "Swynsheued" is that for 1340-1, Mert. Rec.36, 73. It is not certain whether this entry refers to John or to Richard. The earliest mention of Richard as a Fellow of the College is found in the rolls for 1344-5,(200) and he is still listed in 1355. We know that together with Richard de Bylyngham and others, Richard de Swyneheved was a supporter of Mag. John Wylyot in his tumultuous election to the Chancellorship in 1349.(201) In the Lincoln registers A.B.Emden has found that Richard Swineshead was ordained deacon to the title of Fellowship on March 29, 1354. Thus we know that Richard was at Merton at least between 1344-1355, and possibly the entry for 1340-41 refers to Richard as well.

In the manuscripts and printed editions Swineshead is variously called John, Roger, Richard, Raymond or William; but more often he is called Roger or Richard. In the Merton records there is no mention whatever of a "Roger" Swineshead. The only known Roger Swynyshed of the period was a Benedictine monk of Glastonbury, a Master in Sacred Theology, who borrowed two volumes from the library of Malmesbury Abbey, which were returned on

(199) Cal.Pap.Pet., I,407.
(200) Mert. Rec. 3676. See also 3677-9, 3683, 3685-9.
(201) Calendar of Close Rolls, Edw.III, 1349-1354, p.74 (letter dated April 2, 1349). Cf. Knappe's Formulary (O.H.S.), 305.

May 12, 1365.(202) Since the work of James Brucker(203) and George Brodrick(204) most authorities have agreed that the true name of the Merton Calculator was Richard. And since the work of Bale, confirmed by Tanner, most of the authorities have attributed all the known works of Swineshead to the same person, the Mertonian Calculator.

However, on the basis of one manuscript (Bibl.Nat.lat. 14715, fol.90vb) P.Duhem(205) has suggested an ingenious theory, that all the logical treatises should be attributed to John, while De primo motore should be attributed to Roger (or Richard). Although such a distribution of the known works is not impossible, this theory has not been sufficiently proved, especially as earlier manuscripts explicitly attribute the De obligatoriis to Roger.(206)

The surname of this author also presents certain difficulties in the manuscripts. In English manuscripts the surname is usually written "Swynyshed." But as this would have been pronounced "Swinised," as it is actually written in one of the Paris manuscripts,(207) the corruption of this name into "Suisset" on the continent is not hard to imagine. Before long the Calculator became confused with the Franciscan, Roger Rogerth, or Rossetus, as we shall see, and by the end of the 14th century a work of this Franciscan was ascribed to "Rogerio Suisceptio sive Roseto in studio

(202) Brit.Mus., Arundel MS 2, fol.80v. This information was given by Mr. A.B.Emden, who further suggests that since the volumes were returned by the Abbot of Glastenbury to the Abbot of Malmesbury, Roger Swineshead may have been dead at that date.

(203) Jacobi Bruckeri, Historia Critica Philosophiae, t.III, Lipsiae 1743, p.849; cf. P.Duhem, Études, III,417.

(204) G.Brodrick, Memorials of Merton College, (O.H.S.), 213, who utilised the unpublished material of Anthony Wood.

(205) P.Duhem, Études, III,414.

(206) Vienna, Dom.Klos., cod.160/130, fol.125v: "Explicit textus de obligatoriis mag. Rudegeri dicti Swineshaupt Anglici." Fol.122v: "Explicit expositio mag. Rudegerii Sweineshaupt Anglici super de obligatoriis." This last is an anonymous commentary on Swineshead's text.

(207) Bibl.Nat.lat.14715, fol.90vb; Duhem's "Swiinsed" (Études, III,415) is undoubtedly a typographical error. However the colophon in B.N. lat. 16621, fol.84v. has been rendered by Duhem (ibid.,414) as

Anglicano."(208)

Although Duhem's attribution of the logical works to John must be rejected, it is not at all improbable that the works of Roger Swineshead must be distinguished from those of Richard. We know that by May, 1365, Roger was or had been a Benedictine monk of Glastonbury, a Master in Sacred Theology. Undoubtedly it is this Swineshead who is mentioned by Richard Tryvytlam, O.F.M., in his poem De laude Universitatis Oxoniae as:

> Subtilis Swynyshed, prolea Glastoniae,
> Revera monachus bonae memoriae,
> Cuius non periit fama industriae,
> Sinebat pauperes in pace vivere.
>
> Iste, vix aliquem habens scientiam
> Respectu Swynyshed, ut verum exprimam,
> Indignus solvere eius corrigiam,
> Minatur fratribus mortis sententiam.(209)

Two known works are explicitly ascribed to Roger in early manuscripts and not to Richard. The well known logical text, De insolubilibus et obligationibus, is twice ascribed to Roger in a Vienna manuscript, Dominikanerkloster 160/130, once after the text itself, and again after an anonymous exposition of the text.(210) In Heytesbury's Regulae of 1335 the second erroneous opinion listed concerning insolubilia is verbatim that of Swineshead's text. Although this does not necessarily prove that Heytesbury had Swineshead in mind when he wrote the treatise, a hand contemporary, if not

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(note 207 cont.) "Explicit tractatus M. Rogero Suinset datus eximio." This should read: "Explicit tractatus M. Rogeri Suisset datus Oxonie."

(208) Bodl. MS Canon.Misc. 177, fol.182, dated "1395 die 12 Februarii in studio Paduano." Vatican MS Chigi, E.V.161, written about 1401 describes the treatise "sec. Rogerium Swynset" (fol.63V).

(209) Collectanea, III, ed. M.Burrows (O.H.S.), 204. Burrows observed that Bale, Pits, and Tanner may be wrong in stating that he was a Fellow of Merton (ibid., note to line 321). However, the Elucubrationes in P.Lombardum, noted by Tanner and Burrows is not to be attributed to any Swineshead, as we shall see, and Ludovicus Vives objected to the Calculationes of Richard and not to the works of Roger.

(210) Cf. supra p.96, note 206

identical, with the Erfurt manuscript dated 1337, wrote in the margin next to this opinion the name "Swynyshp." If Heytesbury did have Swineshead's famous treatise in mind, then Roger Swineshead must have written his work before 1335.

The second work ascribed to Roger Swineshead is a work on physics. Duhem called it De primo motore from the opening words, "Motore primo primitus invocato..."; but in Erfurt MS Amplon F. 135, it is correctly called De motibus naturalibus. The Erfurt text seems to be the only complete copy known.(211) The rubric of this manuscript (fol.25va) describes the work as "tractatus magistri Willelmi Swineshep datus Oxonie ad utilitatem studencium," while the colophon (fol.47rb) states, "Explicit tractatus de motibus naturalibus datus a magistro Rogero Swyneshede."(212) This is the work of a young, but ambitious Master in Arts. After a short introduction, similar to that of Heytesbury and Dumbleton, Roger Swineshead presents the division of his treatise:

> Tocius autem operis substanciam octo distincciombus sive differencciis assignabo. Quarum prima prohemii vicem habet. Secunda motum et tempus diffinet /sic/. Tercia quedam insueta quamvis non nova de generacione declarat. Quarta de alteracione determinat. Quinta circa augmentum et diminucionem versatur. Sexta de motu locali perscrutatur. Septima proporcionales possibiles in motibus manifestat. Octava maximum a minimo dividit et limitat." (MS Amplon. F. 135, fol.25vb).

In the treatise the fundamental Ockhamist doctrines of natural philosophy seem to be rejected, for Roger maintained that there are three distinct

(211) The text which Duhem used, Bibl.Nat.lat.16621, seems to be fragmentary. Only a detailed comparison of the scattered quaterni with the Erfurt text could determine whether this be so. Tanner mentions "Descriptiones motuum, lib.1. 'Motore primo primitus invocato.' MS. Cantabr. in coll. Caii inscribitur, De motu oculi et similibus, lib.1" I have not been able to find this work in Caius College Library.

(212) This treatise is also ascribed to Roger in Bibl.Nat.lat. 16621, fol.84r: "Explicit tractatus m. rogeri suisset datus Oxonie."

res, namely substance, quality and quantity,(213) and that motion and time are modi rei distinct from the body in motion and time.(214) He hurried over questions of generation(215) in order to consider the more important questions of physical motion and intensity of forms. Since Roger utilized the "Bradwardine function," the treatise must have been written after 1328. The Erfurt text is written in the same hand which wrote Heytesbury's Regulae, "inceptum...in festo Magdalene a.d. 1337." Therefore Roger's De motibus naturalibus must have been "datus Oxonie ad utilitatem studencium" some time before 1338, or at the latest before 1339.(216)

Duhem rightly pointed out the vast difference between De motibus naturalibus (or De primo motore) and the Calculationes,(217) but he drew an untenable conclusion. Instead of attributing the former to Swineshead, the Mertonian, and the latter to a mythical "magistro Riccardo de Ghlymi Eshedi," we ought perhaps to attribute De motibus naturalibus to Roger Swineshead, and the Calculationes to Richard Swineshead, Fellow of Merton. It is not impossible that Roger Swineshead lectured in arts at Oxford around 1350 and produced his logical and physical treatises before becoming a Benedictine and Master in Theology some time before 1365. This would explain more

(213) "Harum autem propositionum hec est prima; secundum differencias rerum generalissimas tantum tria sunt predicamenta...substancia, qualitas et quantitas." MS cit., fol.25rb. The other predicaments he called modi rerum.

(214) "Quinta /propositio/ est hec; motus non res, sed modus rei positive /sic/ existit." ibid., fol.26va. Roger explicitly rejected the "erroneous opinion" which identifies motion with the body in motion, cf. fol.25vb. "...igitur tempus modus rei positivus existit." fol.26ra.

(215) "Inter singulas siquidem questiones generaciones concernentes duas materie presenti maxime spectantes sufficiet ad presens pertractare circa varias nature curiositates, quoniam altioris est negocii, nec parvitas experiencie nec ista poterit attingere, sed principia quedam communia ad cognicionem generacionis mixtorum introductoria manifestare temptabo." ibid., fol.31vb.

(216) Roger's De motibus naturalibus seems to reveal no awareness of Dumbleton's Summa, nor even of Heytesbury's Regulae. Hence it may have been "datus Oxonie" well before 1335.

(217) "D'ailleurs, la comparaison de cet ouvrage au traité De primo motore

easily the confusion in names between Roger and Richard.

There can be no doubt that Richard Swineshead, Fellow of Merton, wrote the well known Liber calculationum; it is explicitly ascribed to "mag. Ricardo de Swyinshede" in MS Chis.R.IV.120.(218) Duhem's erroneous attribution of this work to a certain Riccardus de Ghlymi Eshedi has been pointed out sufficiently by Lynn Thorndike and others.(219) One point, however, which has not been studied is the fact that tractatus VII (De reactione) of the printed edition of Venice 1520 is not found in a considerable number of manuscripts. As we have not studied this fact sufficiently, we cannot make any further observations. Swineshead's Calculationes corresponds in general to Dumbleton's Summa, Parts II-VI, discussing those novel questions of the early 14th century, rather than expounding the traditional Aristotelian books. But there can be little doubt that it was composed after Heytesbury's Regulae and Dumbleton's Summa, P.VI. Miss Maier is undoubtedly correct when she dates the Calculationes before 1355 and around 1350.(220)

The Calculationes had an enormous influence on the thought of the following centuries. Humanists denounced the abominations of such types of argumentation, and Luis Vives accused Swineshead of having contributed to

(note 217 cont.) qui, lui, est incontestablement de Swineshead, montre, au premier coup d'oeil, que ces deux ouvrages ne sauraient être du même auteur." P.Duhem, Etudes, III,419.

(218) Also MS Vat.lat. 3095: "Explicitant calculationes...D. Magistri Ricardi Suisset Anglici." Cf.A.Maier, Studien,III,269-270,n.35.

(219) L.Thorndike, A History of Magic and Experimental Science, 1934, III,573-4; A.Maier, loc.cit.

(220) A.Maier, Studien, III,361.

the development of the calculus of which he always had a horror.(221) But Leibniz was sufficiently impressed with Swineshead's work to think that he was the first to introduce mathematics into scholastic philosophy.(222) And such mathematicians as Wallis and Fermat began with the problems posed by the Calculator.

Besides the Calculationes others works have been attributed to Richard Swineshead. Some of these must be considered briefly. In Cambridge, Caius College MS 499/268, two short treatises on motion are ascribed to Swineshead. The first (fol.204-211v) is a treatise beginning, "In primo de celo Philosophus com.35 arguit corpus infinitum circumvolvi non posse..." It is a treatise in six chapters treating of intensity of forms.(223) The second (fol.213rb-215rb) is a "tractatus de Swineshede de motu locali," beginning, "Multe possint elici conclusiones sive regule super variationem proporcionum et motus..." Between these two items there is an anonymous Tractatus de motu locali difformi, beginning, "Cum omnis effectus naturalis per motum ad esse producitur, inquisicionem naturalium volenti insistere..." The mere fact that this work is between two ascribed works and together with the Calculationes is not sufficient grounds for attributing it to Swineshead.(224) The other two works are without doubt by the Calculator, and seem to antecede his larger treatise.

(221) J.L.Vivis, De causis corruptarum artium liber V, Opera, Basilae 1555, t.I, 412-413.

(222) Letter to Thomas Smith (1696): "Vellem etiam edi scripta Suissseti vulgo dicti Calculatoris, qui mathesin in philosophiam scholasticam introduxit." (Quoted by Thorndike, op.cit., III,370). See also his letter to Wallis, J.Wallisii Opera, t.III,673.

(223) This work is listed by Tanner as De coelo et mundo, lib.ii, because of the opening words, op.cit., 701.

(224) Some peculiarities of this work will be considered in Chapter V, p.232-3. Another anonymous copy of this work is found in Seville, Bibl. Colombina 7-7-29, fol.27va ff.

The four Questiones on the Sentences ascribed to "Rogero Swynissed" in Oriel College MS 15 have been shown by V.Doucet to be part of a commentary by Roger Roseth, O.F.M., given at Norwich before 1337.(225) The first article of the first question was frequently copied separately as a Tractatus de maximo et minimo, and the author was sometimes confused with Swineshead.(226) If Roger or Richard did write a commentary on the Sentences, that work is still not identified.

Miss Maier has already noticed the "quatuor questiones compilate a Rev. viro mag. Ricardo super libro Phisicorum," contained in Venice, S.Marco, lat.Cl.VI, cod.72 (2810), fol.81-112. She believes that these questions might belong to Richard Swineshead.(227) Other works listed by Tanner have either not been located, or are not explicitly ascribed in the manuscripts examined.(228)

On the whole Richard Swineshead was more successful than Heytesbury or Dumbleton in separating a mathematical analysis of physical problems from an Ockhamist natural philosophy. In many ways Swineshead can be considered the bridge between the Merton school and the beginnings of modern

(225) "Le Studium Franciscain de Norwich en 1337 d'après le MS Chigi B. V.66 de la Bibliothèque Vaticane," AFH, XLVI (1953), 89-93. A.De Poorter, relying on C.Michalski's identification of Rosserius and Swineshead, attributed MS 192 of the Library of Bruges, fol.1-44 to Swineshead (cf. "Un Recueil peu connu de questions sur les Sentences" Revue Néo-Scholastique, 2me series, XXXII (1931), 487-9; Michalski, "Le Criticisme et le Scepticisme..." Cracovie 1926, p.7; La Physique nouvelle (1928) p.14-17). For this reason F.Stegmüller assigned the work of Rogeth to Richard Swineshead in his Repertorium, ed.cit., I, n.330, p.357.

(226) To Doucet's list of MSS may be added: Bodl.Canon.Misc.177, fol.174-185, and Seville, Colombina 7-7-29, fol.145-165; Vatican, MS Chigi, E.V. 161, fol.50-63^{v}.

(227) A.Maier, Studien, III, 269, note 34.

(228) Tanner lists De divisionibus lib.i, beginning "Quatuor sunt divisiones propositionum/..." An anonymous work with this beginning is found in Bodl. MS 676 (SC 2593), fol.126-131 and also in Cambridge, Corpus Christi College MS 378, fol.77-80, and MS 244, fol.59-77, where it is called Insolubilia. The beginning which Tanner gives for De

physics in the seventeenth century. But for our period he is rather the culmination of the intense interest shown in problems of physical science in the early 14th century. At least he completed the work of Thomas Bradwardine, profiting much from his own contemporaries and predecessors.

(note 228 cont.) intensione et remissione, lib.ii, is identical with the Calculationes, which he apparently listed separately, giving the printed editions. For a lost work De Consequentiis, see below, Chapter XII, pp.[illegible].

CHAPTER III

DEVELOPMENT OF THE MEDIEVAL IDEA OF SCIENCE

Since the seventeenth century the word 'science' has acquired a rather vague meaning, and it has come to represent those branches of human knowledge which imitate the observational and mathematical method of modern physics. The nature of physical science since the seventeenth century can best be described as the reduction of the whole range of observable phenomena to mathematical measurement and the attempt to explain these phenomena in terms of functional dependencies, rather than of causal relationships. When a modern physicist gives a scientific "explanation" of a problem, he not only gives an explanation different from that of the 13th and 14th century, but even what he means by an explanation is different. This change of meaning did not come about suddenly with Galileo or Newton, but can be traced back to certain movements in the 13th and 14th century.

In the 14th century, as well as throughout the whole of the middle ages and classical antiquity, the word 'science' was not restricted to investigations of the physical world, but was applied in a general way to every intellectual discipline which sought to give explanations about a particular group of problems. As a particular kind of intellectual knowledge, it was distinguished from opinion and error; as a body of truths it was distinguished from art and prudence.

The Scholastics divided the sciences into theoretical, practical, mechanical, and logical. Theoretical sciences such as arithmetic, geometry, astronomy, natural philosophy, and metaphysics, sought to give intelligible explanations of certain facts and phenomena. The practical science of moral philosophy explained how man should live on this earth in order to be

happy. Hugh of St.Victor brings in the seven mechanical arts to parallel with the seven liberal arts, and considers them to be sciences, although not in the strict sense (scientiae adulterinae), because they explain how certain tasks are to be accomplished.(1) The logical sciences (sermocinales) taught the fundamental method of using words in thought and speech.

The medieval idea of science was a development and clarification of elements already expressed by Aristotle. The Aristotelian notion of scientific knowledge involved two essential factors, both of which are important for an understanding of the 14th century changes in physical theory. For Aristotle scientific knowledge is essentially knowledge through causes; more specifically, perfect knowledge of a phenomenon, that is, knowledge propter quid, is knowledge through the proper, per se causes of the effect. The second factor is the basis for distinguishing the various sciences one from the other.

A. The Nature of Scientific Knowledge

1. Aristotelian Doctrine

In the Posterior Analytics Aristotle attempted to answer the problem posed by Plato in the Meno concerning the possibility of new knowledge: "either a man will learn nothing or what he already knows,"(2) because in a certain sense a man must already know the answer before he can learn it. Rejecting Plato's solution of learning as a process of mere remembering,

(1) Hugonis de S.Victore, Eruditionis Didascalicae Libri Septem, Lib.II, cap.2, PL 176,752. "Mechanica septem scientias continet: lanificium, armaturam, navigationem, agriculturam, venationem, medicinam, theatricam." Ibid.,760. Of these mechanical arts, or sciences, only medicine became part of the university curriculum in the middle ages. By the beginning of the 13th century medicine constituted a separate Faculty. Cf. Chart.U.P.,I,68 note.

(2) Aristotle, Post.Anal.,I,c.1, 71a29.

Aristotle insisted that, what a man knows before he learns, is not the same thing as what he learns. That is to say, although a man must have some pre-existent knowledge, sometimes of the fact, sometimes comprehension of the meaning of the terms, and sometimes of both,[3] new knowledge, or science, implies the realization of one factor as the cause of another, i.e., the explanation of why the fact is such. For example, a man may know long beforehand that an opaque body placed in the path of light rays casts a shadow, and he also knows that the moon is eclipsed at certain times. But only when he knows that the earth is such an opaque body sometimes intervening between the sun and moon does he know why the moon is eclipsed.[4] Scientific knowledge for Aristotle meant the knowledge of the cause on which the fact depends, as the cause of that fact.[5] Searching for the cause of a phenomenon could be expressed in logical terms as "a search for a 'middle'."[6] "In all our inquiries we are asking either whether there is a 'middle' or what the 'middle' is; for the 'middle' here is precisely the cause, and it is the cause that we seek in all our inquiries."[7] Whether we know the fact (which later turns out to be the cause) at the beginning of our research, or whether that fact turns up in our research, is not the important point. The important point is that scientific knowledge is the awareness of such a real causal relationship.

By the end of the second Book of the Posterior Analytics Aristotle is

(3) Ibid., I, c.1, 71a11-12.
(4) Ibid., II, c.16, 98b16-24; c.2, 90a1-35.
(5) Ibid., I, c.2, 71b9-12.
(6) Ibid., II, c.3, 90a35.
(7) Ibid., II, c.2, 90a6-7.

in a position to reject Plato's theory of innate knowledge, and of learning as a process of remembering what was clearly known in a separate and previous existence. Aristotle insists that all knowledge originates in sense experience; the memory of a number of experiences constitutes an experimentum,(8) a quasi-universal judgment which is the source of science and art.(9)

Aristotle's method of scientific procedure is often misunderstood. It is too often conceived as a deductive process of drawing conclusions out of given premises, much as the conclusions of geometry are drawn out of postulates, axioms and theorems. The whole procedure of the Posterior Analytics is contrary to such a conception of scientific method. Almost the whole of the second Book is taken up with how to find correct definitions, which can constitute the middle terms of propter quid demonstrations. The Scholastic philosophers of the 13th century were careful to distinguish the via inventionis (or inquisitionis, or acquisitionis) from the via iudicii. The former is the arduous process of finding the cause of a phenomenon, a resolution to causes; the latter, on the other hand, is the syllogistic presentation of the discovery so that one may judge its veracity according to the laws of formal logic.(10) For the Scholastics the syllogism was not an instrument of scientific discovery, but of scientific exposition.(11)

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(8) "Et est experimentum accepcio alicuius unius a multis presentatis et memoriter retentis, quod quidem unum in illis omnibus est et in quo illa omnia similia sunt; et est hec communis unius de multis accepcio, opere racionis facta que singularia sensata et memoriter retenta ad invicem confert considerans quid in eis idem, quid non idem." Robert Kilwardby, De Ortu Scientiarum, cap.4, Merton College, Oxford, MS 261, fol.19va.

(9) Aristotle, Metaphysics I, c.1, 981a1-8; Post.Anal.II, c.17, 99b31-100b17.

(10) For a full discussion of "resolution" and "composition" see A.C. Crombie, Robert Grosseteste and the Origins of Experimental Science, Oxford 1953, 24-35, 51-81. See also J.Isaac, "La Notion de Dialectique chez saint Thomas," Revue des Sciences Phil. et Théol., XXXIV (1950) 481-506.

(11) That this was still the understanding in the early 17th century is clear from Galileo's letter to Carcavi in 1637, Opere (ed.Naz.) t.17, p.90.

In the Second Book of the Physics Aristotle entered into a long discussion of causes, because, he says, "knowledge is the object of our inquiry, and men do not think they know a thing till they have grasped the 'why', which is to grasp its primary cause."(12) He discussed the four types of causes, material, formal, efficient and final, because the philosopher of nature must find all of them before he can claim to understand any natural phenomenon. Briefly, for Aristotle and the Scholastics a cause is "that from which anything proceeds with dependence in esse," or that which is responsible for anything coming into being or remaining in existence. Thus matter and form are intrinsic causes, because the generation of a composite reality and its preservation in existence depend upon them. Among efficient causes some are responsible only for the coming into being; others are responsible for the continuation in being. The final cause is responsible for the agent's activity. Aristotle's notion of causality involves not mere succession, but real existential dependence of one reality upon another. Aristotle's view of scientific knowledge, therefore, is based not only on the reality of causation, but on the conviction that such causes can be known so as to give real explanations for physical events.

One further point must be mentioned. For Aristotle perfect knowledge, that is, propter quid knowledge of an event lies in the discovery of the immediate proper cause. Demonstration through some remote, even though proper cause, or through effects, produces knowledge of the fact (quia est), but not of the real reason why it is so (propter quid est).(13) Demonstration through some accidentally conjoined medium produces knowledge of the

(12) Aristotle, Physics, II, c.3, 194b18-21.
(13) Aristotle, Post.Anal., I, c.13 78a22-b31.

fact "in the accidental way in which the sophist knows."(14) The proper immediate cause, or causes, must account for the whole effect as it really is. That is to say, the problems of one science cannot properly be solved by another science, for the other science could only present remote explanations.(15) Expressed in logical terms this means that the medium of demonstration must belong essentially to the major and minor terms, and must be of the same character: "The conclusion must be homogeneous with the basic facts of the science."(16) The only exception Aristotle made to this rule concerns the case of subalternate sciences, where the lower science actually borrows some of its principles from the subalternating science. Such is the case with the science of harmonics which borrows laws of proportionality from arithmetic, and of mechanics, optics and astronomy which borrow theorems from geometry. Regarding the type of knowledge obtained in the subalternate sciences, Aristotle merely stated that a subalternate science, such as optics, knows only the fact (quia), while it belongs to the higher science, geometry in this case, to know the reason why (propter quid).(17) "As optics is related to geometry, so another science is related to optics, namely the theory of the rainbow. Here knowledge of the fact is within the province of the natural philosopher, knowledge of the reasoned fact within that of the optician, either qua optician or qua mathematical optician."(18) The question here is the logical value of mathematical explanations for physical events.

(14) Ibid., I,c.2, 71b9-10.
(15) Ibid., I,c.7.
(16) Ibid., I,c.9, 76a28-30; also 76a7-8.
(17) Ibid., I,c.8, 76a12-13.
(18) Ibid., I,c.13, 79a10-13.

Aristotle's rather incomplete explanation of subalternate sciences was taken over literally by Averroes, who applied it to all the scientiae mediae, that is, sciences which use mathematics to explain physical phenomena. Averroes considered each of these sciences to consist of a theoretical part and an experimental part.(19) He admitted that the observer or practitioner knows only the facts without being able to give any real explanations for them. For example the practical astronomer knows the position of the various planets. But he insisted that the mathematical astronomer knows the propter quid, the real cause of their position.(20) Averroes was convinced that mathematical explanations give the real cause of physical events, and that the applied mathematician has propter quid knowledge of the event.(21)

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(19) Actually Averroes considered these two parts as distinct sciences. In this Averroes followed Alfarabi. (cf. De Scientiis cap.3, trans. Gerard of Cremona, ed. A.G.Palencia, Madrid 1932, 145-156). "Et videtur propter hoc dixit /Aristoteles/; Haec autem scientiae sunt univocae, seu nomine conveniunt, idest, quod existimatur, quod sint una scientia, ut se habet ars medica practica, seu experimentativa, cum ipsa rationali, cum tamen revera sint duae scientiae; similiterque ars quae considerat Astra apparentia se habet cum ipsa Perspectiva." Averroes, I Post.Resol. (Comm. Magna), comm.100, Opera Omnia, ed. Venetiis apud Juntas 1574, vol.I, pars II, fol.229v.

(20) "Deinde dicit /Aristoteles/, et ut se habet scientia earum, quae apparent ad Scientiam Astronomicam, hoc est, et ut artes experimentativae, seu practicae, se habent ad artes Theoricas seu speculatrices, quae praestant causas rei, quam ipsa experientia verificavit in illa arte experimentative, ut est habere cognitionem de stellis quae nullo tempore occultantur. Nam Astrologi practici cognoscunt illas stellas perspectivas per artem practicam; ars vero Mathematica astronomica, idest Theorica, cognoscit causam ob quam semper apparent in illa arte practica. Et universaliter ita se habent artes, quae dividuntur in practicam et theoricam." ibid., fol.229r-v.

(21) "Artes theoricae...praestant causas rei" (ibid., fol.229r); "Ars vero astronomica theorica tradet huius rei causas, nempe causas ob quas apparentia variis temporibus..." (ibid., fol.229v); "Ars superior praestat inferiori causas quas quaerit." (ibid., comm.60, ed.cit., fol.140r B).

ii. In 13th Century Paris.

In Paris Albertus Magnus, writing about the middle of the 13th century, was not willing to accept this view of subalternate sciences without qualification. Quantitative properties of a subject can be considered in two ways: either as belonging to quantity in itself, or as depending upon a determined kind of nature or matter.(22) Material events are quantified, and it belongs to the mathematician to discuss quantitative relationships as such. To the extent that the mathematician and the subalternate science are talking about the same thing, mathematics can give a propter quid explanation. But there are other quantitative properties which are caused by the particular physical subject considered, and for these the subalternate science itself gives the proper explanation. "Si autem passiones aliquae sunt, quae causantur ab hoc vel illo secundum quod hoc vel illud, in illis non dicit propter quid scientia superior, sed inferior."(23) Applying this to the consideration of light rays, Albert says that geometry can explain certain things about rays inasmuch as deflected lines form angles of different degrees. But geometry cannot give any explanation why light rays should be reflected in smooth polished surfaces, or why they should be reflected to the middle in concave mirrors. These properties do not arise from linear characteristics, but from visual. Thus it belongs to the science of perspective to search for the propter quid explanation. "If one

(22) "Attendendum autem quod passiones subiecti possunt considerari dupliciter, scilicet in quantum sunt subiecti quod est per se et secundum ipsum, vel in quantum sunt huius subiecti determinati ad hanc naturam vel materiam." Albert, In I Post.Anal., tr.III, cap.7 (ed. Borgnet), II, 85b.

(23) In I Post.Anal., tr.III, cap.7, ed.cit., II, 85b-86a.

considers this carefully, it is not under this aspect that Perspective is subalternate to geometry; moreover a science is supposed to consider the properties of its own subject."(24)

Thomas Aquinas also accepted the Aristotelian conclusion that in subalternate sciences the lower science can give a quia explanation, while it remains to the higher science to give the proper and immediate (propter quid) explanation. But he makes two important clarifications.

First of all, Aquinas agrees with Albert that the higher science gives a proper explanation only to the extent that it is applicable to the lower science. Sciences which apply mathematical principles to sensible phenomena present true and proper explanations because sensible phenomena are quantified and to that extent can be explained in mathematical terms. However those peculiarities which arise from the "material" aspect of the subject(25) — what St.Albert called "in quantum sunt huius subiecti determinati ad hanc naturam vel materiam" — or those which are not quantified, cannot be explained properly by mathematics. This is especially clear in the case of an independent science which seeks a particular solution in mathematics. For example, if the physician wishes to know why a circular wound heals more slowly, he can find a propter quid explanation in the science of geometry which defines a circle.(26) The circular figure found in the wound is studied abstractly by geometry. Because of this common element,

(24) "Nec etiam in hoc, si quis subtiliter inspiciat, subalternatur perspectiva geometriae; quinimo scientia est per se considerative passionum sui subiecti." ibid., p.86a.

(25) Cf. Aquinas, In Lib. Post. Anal., I, lect.25, ed.Leo., n.2-4.

(26) "Sicut quod vulnera circularia tardius sanetur, medici est scire quia, qui hoc experitur, sed propter quid scire est geometrae, ad quem pertinet cognoscere quod circulus est figura sine angulo. Unde partes circularis vulneris non appropinquant sibi, ut possint de facili coniungi." ibid., n.6.

namely quantity, some truths of geometry can be applied to medicine. But there are a number of other reasons, non-quantitative reasons, to explain the slow healing of a circular wound.

The second important clarification made by Aquinas was his explanation of the formal character of such propter quid demonstrations. The Scholastics unanimously held that mathematics does not demonstrate through efficient or final causes. That is to say, mathematics abstracts quantities (a kind of formal cause) and is not concerned with efficient or final causality; even though a mathematician may turn his attention to natural agents, motion or time.(27) Aquinas pointed out that in sciences subalternated to mathematics, the explanations offered by mathematics are exclusively through the formal cause. Although mathematics considers those quantities modo abstracto et separato a materia, mathematical truths can sometimes explain sensible phenomena, because those phenomena are quantified. "Unde patet quod geometra dicit propter quid in istis scientiis secundum causam formalem."(28) The formal cause of which Aquinas speaks has nothing to do with substantial form, but only with that accidental formality of quantity, which can be abstracted and compared to other quantities according to various mathematical functions. The "formal cause" expressed by a mathematical explanation of a sensible phenomenon is really a description of how that event takes place quantitatively. This is precisely what the 17th century physicists were to insist upon: they were not interested in the cause of events (efficient,

(27) "Mathematicus autem considerat res abstractas secundum considerationem tantum, et ideo illae res prout cadunt in considerationem mathematici, non convenit esse principium et finis motus, et ideo mathematicus non demonstrat per causas efficientem et finalem." Aquinas, In Boeth. de Trin., q.5, a.4 ad 7. Cf. Aristotle, Metaph., III, c.2, 996a29-32.

(28) In Post.Anal., I, lect.25, ed.cit., n.4.

final, or substantial formal causes), but only in a correct mathematical expression of how certain phenomena occur.

iii. In 13th Century Oxford.

In Oxford Robert Grosseteste (c.1168-1253) was to exercise the greatest influence on the theory of physical science. His remarkable commentary on the Posterior Analytics was accepted as the opus classicum in the Schools during the second half of the 13th century and throughout the 14th century. It is an especially remarkable work when one considers that it was written before Averroes was translated into Latin. According to Trivet[29] Grosseteste commented on the Posterior Analytics while he was master in arts; therefore, sometime during the first decade of the 13th century.[30]

A.C.Crombie has already analyzed Grosseteste's theory of physical science in his Robert Grosseteste and the Origins of Experimental Science.[31] On the point which concerns us at present it is interesting to note that Grosseteste's work is probably the origin of St.Albert's view. Commenting on Chapter 12, Grosseteste paraphrases Aristotle 78b31-79a3 (text.30) ending with the general conclusion: "Therefore, with such sciences of which one is under the other, the superior science provides the reason (propter quid) for that thing of which the inferior science provides the fact (quia)."[32] "But," he continues, "it must be observed that a lower science always has an added condition by which it appropriates to itself the subject and predi-

(29) Nicholai Triveti, Annales Sex Regum Angliae, ed. T.Hog, London 1845, p.243.
(30) D.A.Callus, "The Oxford Career of Robert Grosseteste," Oxoniensia, X (1945),45; Robert Grosseteste, Oxford 1955, p.12.
(31) Especially in Chapter 3 and 5.
(32) Comm.Post.Anal., I, c.12, ed. Venetiis 1494, fol.11vb.

cate of the higher sciences; and they are in the conclusion of the subordinate science like two natures, namely the nature which it receives from the higher and its own nature which it superadds of itself. And so the higher science does not speak of the causes of this [latter] addition..., but the higher science does speak of the causes of that condition which the lower science receives from the higher."(33) In other words, Grosseteste says there are two aspects to a subordinate science: one aspect which it has from the fact that it borrows mathematical principles, the other which it has of itself.

Earlier in his commentary Grosseteste discussed the relationship between optics and geometry. By means of a geometrical proof, namely Theorem I of Euclid's Catoptrica,(34) he demonstrated the optical conclusion, that every two angles, of which the ray incident with the mirror makes one and the reflected ray the other, are two equal radiant angles. He points out that the middle term of geometry unites the subject of the lower science with the predicate of the higher. This propter quid syllogism of the higher science differs from the syllogism quia of the lower science. "For," he says, "the cause of the equality of the two angles made on a mirror... is not the middle term taken from geometry, but is the nature of the radiant energy generating itself according to rectilinear progress."(35)

(33) "Sciendum autem quod scientia inferior semper addit conditionem per quam appropriat sibi subiectum et passiones superioris scientie et sunt in conclusione scientie subalternate sicut nature due, natura scilicet quam accipit a superiori et natura propria quam superaddit proprii. Itaque superadiecti causas non dicit scientia superior; et [sic] quandoque dicit eas causas scientia inferior et quandoque non; illius vero quod accipit scientia inferior a superiori causas dicit scientia superior." Comm. in Lib.Post., I,c.12, ed. Venetiis 1494, fol.11vb-12ra.

(34) Cf. A.C.Crombie, op.cit., 95.

(35) "Causa namque equalitatis duorum angulorum...non est medium sumptum ex geometria, sed eius causa est natura radiositatis sese generantis ..." Comm. in Post., I,c.8, ed.cit., fol.8r. Crombie translates namque as yet (op.cit., 95); this alters considerably the sense of the passage. (cf. ibid., 96).

The significant point here is that although he makes the distinction which St.Albert was later to follow, Grosseteste does not come to the same conclusion. For Grosseteste, explanations derived from the nature of the subject of subordinated sciences are not explanations propter quid. Not even his theory of the nature of light(36) provided him with a propter quid explanation in optics; this ability is accorded only to mathematics, at least in such scientiae mediae as optics. Even though a lower science discusses causes which arise out of the subject matter which it has of itself (natura propria quam superaddit proprii), these are demonstrations quia.

Grosseteste's view on this point is basically similar to that of Averroes. It adheres to the literal conclusion of Aristotle: with such sciences of which one is under the other, the superior science provides the reason (propter quid) for that thing of which the inferior science provides the fact (quia).(37) And it is compatible with Grosseteste's well-known predilection for mathematical demonstration. This penchant for mathematical demonstration was to remain in the Schools of Oxford for many centuries, even though not all of its advocates were mathematicians.

B. The Division of the Sciences

1. In General.

For our present purpose it is not necessary to deal with the intricate problem of the division of the sciences, or its complicated and obscure

(36) In Grosseteste's view, light is the first corporeal form, which although simple and indivisible in itself is the cause of "tridimensional" corporeity by multiplying itself instantaneously in straight lines. Cf. De Luce, ed. L.Baur 51-59; Crombie, op.cit., 104-134.

(37) Grosseteste, Comm. in Lib.Post., I,c.12, ed.cit., fol.11vb. Aristotle, Post.Anal., I,13, 79a2-3.

history. We are primarily interested in the distinction between mathematics (geometry and arithmetic), natural philosophy and the scientiae mediae.

Aristotle had already suggested the tripartite division of speculative knowledge into physica, mathematica and divina (First Philosophy, or Metaphysics).(38) For him logic was an instrument (organon) of all the sciences, and therefore introductory to the speculative sciences. He divided mathematics into arithmetic and geometry. But it does not seem that he would have admitted a similar subdivision of either physics or metaphysics. Although this tripartite division does not embrace optics, mechanics, music, astronomy, and a host of other "sciences" mentioned by Aristotle, it is a convenient division and it was accepted by all the Scholastics. As we have seen it was incorporated into the medieval curriculum of arts.

Before the introduction of Aristotle's libri naturales and Metaphysica into the Schools of the early 13th century, knowledge was conveniently divided into the seven liberal arts.(39) The trivium and quadrivium made up the course of arts introductory to theology. The introduction of the Aristotelian works into the arts curriculum presented no practical problem. They were merely added on to form the course in natural philosophy and metaphysics. There was ample justification for separating mathematics from natural philosophy and metaphysics. The Moslem falâsifa had insisted on

(38) Cf. Metaph., VI, c.1, 1026a18.

(39) For example by Cassiodorus, Isidore and others. Even before the new Aristotelian books were translated into Latin, 12th century thinkers took into account physics, metaphysics and ethics and included these branches of knowledge into their division of philosophy. Cf. M. Grabmann, Die Geschichte der Scholastischen Methode, II, 28-54; G.Paré, A.Brunet, P.Tremblay, La Renaissance du XIIe Siècle; Les Ecoles et l'Enseignement, Ottawa 1933, 98-108.

treating mathematics together with logic as a propædeutic to philosophy, or science strictly so called.(40) For them logic and mathematics were sciences of instruction or exercise, rather than true philosophy. Even Averroes was inclined to follow this view.(41) Moreover, Aristotle wrote no works on pure mathematics; and geometry and arithmetic were already taught in the quadrivium.

Albert the Great and Thomas Aquinas considered the natural order of learning to be logic, mathematics, natural science, moral philosophy (a practical science), and metaphysics.(42) Following Boethius they considered logic to be an instrumentum scientiae, rather than a part of philosophy.(43) Following Aristotle's observation(44) they noted that young boys

(40) Cf. L.Gauthier, Ibn Rochd (Averroès), Paris 1948, pp.49-50.

(41) "Unus [modus scientiae speculativae] est propter exercitium, sicut mathematica, aliud propter perfectionem, propter quam ipsum exercitium est; et est scientia Naturalis et Divina." Averroes, Procem. in Phys., ed. Venetiis 1574, t.VI,fol.4r A; cf. also II Phys., comm.35, VI Metaph., comm.1, "res exercitabiles." At least as early as Boethius the Latins understood μάθημα in a technical sense of discipline as distinct from philosophical knowledge; cf. Boethius, De Trinitate Liber, "in mathematicis disciplinabiliter" (PL 64,1250); Gilbert de la Porrée, Comm. in Boeth. de Trin., "Graece quidem μαθηματική, Latine vero disciplinalis vocatur" (PL 64,1267).

(42) "Erit ergo congruus ordo addiscendi, ut primo quidem pueri logicalibus instruantur, quia logica docet modum totius philosophiae. Secundo autem instruendi sunt in mathematicis quae nec experientia indigent, nec imaginationem transcendunt. Tertio autem in naturalibus, quae etsi non excedunt sensum et imaginationem, requirunt tamen experientiam. Quarto in moralibus, quae requirunt experientiam et animum a passionibus liberum, ut in primo habitum est. Quinto autem in sapientibus et divinis, quae transcendunt imaginationem et requirunt validum intellectum." Aquinas, In VI Ethic.,lect.7,n.1211; also In Librum de Causis, lect.1. S.Albert, In VI Ethic.,tr.II,cap.2, ed. cit., t.VII, 442-443; In Lib.I Metaph.,tr.I,cap.1, ed.cit.,t.VI,2-4a. Roger Bacon also considered this to be the natural order of learning, except that he puts ethics after metaphysics (Communium Naturalium, ed. R.Steele, Opera hactenus inedita, fasc.II,p.1-3) as does Robert Kilwardby (cf. De Ortu Scientiarum, cap.63-64, MS Merton College, Oxford, 261, fol.62rb-64rb).

(43) Boethius, In Isagogen Porphyrii Comm., ed. secunda, lib.I,cap.3: Manifestum est non eam esse philosophiae partem, sed potius instrumentum." Thomas Aquinas, In Boeth. De Trin.,q.5,a.1 ad 2. Albertus Magnus, In I Post.Anal.,tr.I,cap.1, ed.cit., t.II,2b. Cf. Averroes,

can easily grasp the imaginable objects of mathematics, while time and experience are needed to understand the principles of natural science.(45) "Aristotle also says in the Sixth Book of the Ethics that mathematics can be understood by boys, but not physics, which requires experience. And by this one must understand that after logic the pupil should study mathematics, which is embraced in the quadrivium; and so by this way his intellect is prepared for philosophical studies."(46) Natural science should next be studied, because although it requires experience, it does not transcend sense experience and imagination. Moral philosophy, "cuius iuvenis esse convenienus auditor non potest,"(47) should be studied in the fourth place, because both experience and freedom from unruly passions are required. Metaphysics, or scientia divina should be the last science studied, because knowledge of the ultimate causes of all things is the goal of human pursuits. "Unde scientiam de primis causis ultimo ordinabant [philosophi], cuius considerationi ultimum tempus vitae suae deputarent."

If the ideal number of years could not be devoted to the acquisition of knowledge in the proper order, Albert and Aquinas believed that the order of learning was fittingly observed in the arts curriculum, already considered in Chapter I.

(note 43 cont.) II Metaph., comm.15 (ed.Venetiis 1574, t.I, fol.35r); "Dedit [Aristoteles] praeceptum valde utile, et est, ut homo non addiscat illam [i.e., artem logicam] cum admixtione aliarum scientiarum, quoniam tunc neque addiscent hanc neque istam, sicut dixit 'Quoniam malum est quaerere aliquam scientiam et modum,' secundum quem declaratur."

(44) Ethic.Nicom., VI, c.9, 1142a11-19.

(45) Aquinas, In Lib. Ethic., VI, lect.7, n.1209-10. Albertus Magnus, In VI Ethic., tr.II, cap.25, ed.cit., t.VII,445; In I Metaph., tr.I, cap.8, ed.cit., t.VI,15.

(46) "Dicit etiam in VI Ethic. quod mathematica potest sciri a pueris, non autem physica, quae experimentum requirit. Et sic datur intelligi, quod post logicam consequenter debet mathematica addisci, ad quam pertinet quadrivium; et ita his quasi quibusdam viis praeparatur anima ad alias philosophicas disciplinas." Aquinas, In Boeth.De Trin., q.5, a.1 ad 3.

(47) Aquinas, In Lib. De Causis, lect.1.

Nevertheless the introduction of the new Aristotelian corpus did bring into focus the speculative problem of the division and relationship of the various sciences. This problem is more pertinent to the 13th century than to the 14th, but its clarification will help in understanding better the scientific developments which took place in the early 14th century.

Even before the translation of the libri naturales and the Metaphysics, the Scholastics were familiar with Aristotle's tripartite division of speculative knowledge. Through the De Trinitate of Boethius, the Institutiones (II, iii, 5) of Cassiodorus, and the Etymologia (II, xxiii, 3) of Isidore they knew that mathematics was more abstract than natural science, and therefore somehow intermediate between natural science and metaphysics. They also knew that among the "mathematical sciences" one must consider astronomy, music, and optics. But the precise relationship between these sciences does not seem to have been much discussed until the Posteriora Analytica, libri naturales, and the Metaphysics reached the schools.

In his De Trinitate Liber Boethius gave the general outline of what was to become the common medieval view. Natural science is about inabstracta in motu, for it considers the forms of bodies actually existing in matter and capable of motion, such as that of heavy bodies downward and of light bodies upward. Mathematics is about inabstracta sine motu; that is, it considers forms, although actually existing in matter, as separate from matter and motion. Metaphysics or natural theology considers abstracta atque separabilia sine motu, for it considers things actually separate from matter and motion, as God and separate substances, or things separable from matter and motion, such as substance, cause, etc.(48)

(48) De Trinitate Liber, cap. ii, PL 64, 1250.

From Boethius' description of the three speculative sciences it is not clear whether or not this should be considered an ascending order of abstraction, that is, whether by relinquishing matter and motion one arrives at mathematical being, and by relinquishing quantitative form one arrives at the pure form of substance. Very often this is the view implied, if not expressed, by certain Scholastic authors.

ii. The View of Robert Kilwardby.

The De Ortu Scientiarum of Robert Kilwardby is a monumental treatise on the nature, division and relation of the speculative and practical sciences, composed not earlier than 1246-7, probably about 1250, while he was a Dominican student of theology at Oxford.(49) Kilwardby's treatise contains 67 chapters.(50) After a brief discussion of the nature and division of scientific knowledge in general (cap.1-4), he discusses the speculative sciences (cap.5-33): natural science, the four mathematical sciences, and metaphysics; under the practical sciences he discusses the three moral sciences, the seven mechanical arts, and the three scientie sermocinales (grammar, logic and rhetoric). In Chapter 25 Kilwardby raises four questions, the responses to which clearly present his view of the division of the sciences. First he asks how can abstracted knowledge be true? Second why is the term 'abstraction' applied especially to the mathematical sciences? Third, what is the difference and the order of abstraction in

(49) D.A.Callus, "The 'Tabulae super Originalia Patrum' of Robert Kilwardby, O.P.," Studia Mediaevalia R.J.Martin O.P., Bruges 1948, 247-249.

(50) I am indebted to Father Bernard Delany, O.P., for allowing me to use his text of Kilwardby's De Ortu Scientiarum, prepared from four MSS and submitted for the degree of B.Litt. at the University. Certain obvious corrections have been made without noting the variants, and references given below are to Merton College MS 261, fol.19r-66r.

the three speculative sciences? Fourth, what is the difference and the order of abstraction in the four mathematical sciences?

Answering the first question, Kilwardby says that the veracity of abstractions is based upon the priority and posteriority of different forms in nature. What is prior in nature can be conceived by the intellect without that which is posterior. There is no error in such conceptions, for when the intellect conceives the prior without the latter, it does not affirm that the prior actually exists in nature without that latter addition.(51) In nature one finds this priority of forms between substance and accident, number and magnitude, quantity and sensible qualities, and universally between a form absolute considerata and a form here and now existing in materia signata.(52)

In his answer to the second question Kilwardby admits that mathematics is more abstract than natural science, and that metaphysics is more abstract than mathematics.(53) However it is mathematics which is primarily said to be de abstractis, even in preference to metaphysics, "because everything which the mathematician considers, he considers per abstractionem." Almost all the objects considered in mathematics are concretely realised in sensible reality. Kilwardby inserted the word "almost", because, regardless of what the philosophers think, one can speak of the 'number' of angels,

(51) "Quod enim est prius per naturam potest ab intellectu concipi per se sine posteriori. Quando ergo illud prius ab intellectu concipitur cum suis proprietatibus preter posterius et eius proprietates, non est in hoc conceptu nec in hac consideracione falsitas, quia intellectus non dicit quod illud prius est in re per se sine omni posteriori ei concreto..." ibid., cap.25 ad 1. MS cit., fol.31rb.

(52) "Eodem modo se habent ad invicem substancia et accidens, similiter numerus et magnitudo, ut patet, et quantitas ad qualitates activas et passivas, et omnino forma absolute considerata preter materiam signatam ad formam in materia signata hic et nunc, que forte eadem est per essencialem solo esse differens." ibid., fol.31va.

(53) Also cap.24 ad 1, fol.29rb.

even though this is not the concern of the mathematician.(54) But as metaphysics considers not only material substances in as much as they are substances, but substances which are actually apart from matter, it is said to be de separatis, rather than de abstractis.(55)

In his reply to the third question Kilwardby presents a clear and simple picture of ascending "grades of abstraction." The first and lowest grade of abstraction is from concrete matter (a sensibili signato), and that belongs to the physicist. The second and higher grade abstracts from qualitative motion and changeable matter, and this belongs to the mathematician.(56) Kilwardby excludes qualitative motion in this grade of abstraction, but he allows for change of place in order to account for astronomy and the other mathematical sciences which deal with locomotion. The third and last grade abstracts from all accidents and considers substance in all its purity, and this belongs to the metaphysician.(57)

The basis for Kilwardby's conception of the tripartite division of science is Aristotle's doctrine of the order of accidents in a substance.

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(54) Cap.25, fol.32ra; also cap.24 ad 1, fol.29rb.

(55) "Ad secundum dicendum quod verum est quod phisica et omnis sciencia abstrahit, et metaphisica plus quam mathematica. Et tamen mathematica pocius dicitur esse de abstractis quam phisica, quia maioris abstraccionis est quam illa, sicut dicit Aristoteles in 2° Phisicorum quod minus abstrahunt phisica mathematicis. Item pocius quam metaphisica; quia omnia que mathematica considerat per abstraccionem considerat, quia aut omnino omnia aut fere sunt concreta cum rebus phisicis. Et dixi fere propter numerum qui in spiritibus separatis est, quicquid super hoc sentirent philosophi. Verumptamen de numeris illorum non est cura arismetico secundum quod talis est; set metaphisica non solum considerat substanciam que est in rebus phisicis abstrahendo ipsam ut in se consideret secundum quod substancia est, set substancias omnino separatas a motu et a materia secundum esse; et quia illa est potissima pars metaphisice que huiusmodi substancias considerat, ideo magis dicitur esse de separatis quam de abstractis." ibid., fol.31va-b.

(56) See also cap.29, fol.34r-v; cap.30 ad 3, fol.34vb-35ra.

(57) "Ad 3um dicendum quod omnis sciencia abstrahit, et maxime speculativa. Et primus et minimus gradus abstraccionis est a sensibili signato, et iste competit phisico. Secundus et ulterior gradus est omnino a

For Aristotle the first accident of a substance is quantity, by which a material substance is quantified numerically and extensively.(58) Following quantity is quality, by which a quantified material substance possesses various sensible characteristics. According to Kilwardby one proceeds by abstraction in the reverse order: consideration of the qualified substance, apart from individuality as such, belongs to physics; consideration of the quantified substance apart from qualities belongs to the mathematical sciences; consideration of substance as such apart from quantity and qualities belongs to metaphysics. Kilwardby uses the example of flesh to show that the natural scientist studies it with all of its qualitative characteristics, but a mathematician will consider only its dimensions (que sunt corporis); take away quantitative dimensions and there remains only the nuda substantia, which concerns the metaphysician.(59) Lest there be any doubt of his position, Kilwardby further notes that whatever there is of substance in the metaphysician's consideration is also in mathematics and physics, and whatever quantity there is in the mathematician's consideration is also in physics.(60)

Thus both natural science and mathematics consider quantity, but in different ways.(61) One can consider quantity as a property of natural

(note 57 cont) motu alterativo et materia transmutabili, non tamen omnino a motu et omnino a materia, et iste competit mathematico. Tercius et ultimus est omnino ab accidente, ut consideretur substancia in sua puritate, et iste competit metaphisico." ibid., fol.31vb.

(58) See below, Chapter IV.

(59) "Tercio, tolle dimensiones quantitatiuas et restat nuda substancia, et hec est ultima abstraccio et pertinet ad metaphisicum." ibid., fol.31vb. See also cap.24 ad 1, fol.29ra.

(60) Ibid., fol.31vb-32ra.

(61) Cap.14 ad 1, fol.21r-v.

bodies, varying according to their natures, or one can consider quantity abstracted from all natural bodies and antecedent to natural forms. The first way belongs to natural science; the second way belongs properly to mathematics, and accidentally to natural science in such discussions, for example, as the divisibility of the continuum and the nature of infinity. To understand the quantitative relations which lie behind the sensible forms, the natural scientist must have recourse to the mathematical sciences, ultimately to arithmetical proportionality. The fundamental difference between mathematics and natural science is that natural science considers materia transmutabilis and motion; therefore it must consider all the four causes. The mathematical sciences consider only dimensional matter and the quantitative characteristics of locomotion; therefore it does not have to consider the efficient cause nor the final.(62)

Mathematics and metaphysics both consider substance, but mathematics considers corporeal substance which is quantified, while metaphysics deals only with substantia corporea nuda and separated substances. However Kilwardby believed that even the pure corporeal substance of metaphysics and the separated substance have all the characteristics of unity and multiplicity similar to mathematics. Therefore he said that it also belongs to the metaphysician to explain the cause of plurality in mathematics.(63) The difference between metaphysics and the mathematical sciences can best be understood through Kilwardby's difficult doctrine of the plurality of forms. For him both material and spiritual beings possess some kind of

(62) Ibid., cap.14 ad 2, fol.24v.
(63) Ibid., cap.29 ad 1, fol.33vb; also cap.14 ad 2, fol.24vb.

materia by which each is individualised; this matter is the cause of number. The first form is that of substance. This form united to spiritual matter constitutes a separated substance; united to corporeal matter it constitutes a body capable of dimensions. The second form (received only in corporeal substances) is that of dimensionality, which is studied in mathematics. The third is a natural form, which gives the body its physical characteristics and differences, all of which are studied in physics. It was because of his inability to distinguish between the use of numbers in mathematics (predicamental number) and their use in metaphysics (number as identical with being), that Kilwardby found difficulty in explaining the difference between mathematics and metaphysics.(64) This also explains why, for Kilwardby, arithmetic was so important a science. Even though metaphysics is the highest of all the speculative sciences, the lower sciences are at no time subordinated to it.(65) But all sciences are subordinated to arithmetic to the extent that they use numbers and arithmetical proportionality; arithmetic, claimed Kilwardby, quasi mater est aliarum.(66)

In his response to the fourth question Kilwardby summarised his view of the four mathematical sciences. The lowest of all the mathematical sciences is astronomy, because it considers the celestial movements through the principles of geometry. In this astronomy is prior and more abstract

(64) This is apparent throughout the whole of cap.29-31, fol.33vb-38ra.
(65) "Ex his patet quod hec non subalternat sibi alias, quamvis quodammodo considerent omnia, sicut neque logica subalternat eas cum sit de omnibus secundum opinionem sicut metaphisica de omnibus secundum veritatem." Ibid., cap.32, fol.38rb. It must be observed that for Kilwardby metaphysics, since it is the highest science, must explain the cause of number.
(66) Ibid., cap.22, fol.28vb; cf. whole of cap.22.

than natural science, but subordinate to geometry.(67) Strictly speaking discrete quantity is simpler and prior to extension, therefore the sciences which deal with number are prior to geometry. "Thus it seems that harmony naturally precedes geometry, because harmonic number, which it considers, seems to be prior to magnitude, and this is in fact true."(68) By this Kilwardby did not mean the audible harmony of music, but the pure harmony of numerical proportions.(69) The highest and most abstract of all the mathematical sciences is arithmetic, "quia ipsa, ut sic, nulla aliarum indiget."(70)

Kilwardby believed that the speculative sciences were discovered in the order in which he discussed them: physics, geometry, astronomy, music, arithmetic, and finally metaphysics.(71) Underlying his discussion of these speculative sciences is the conviction that the science of numerical proportions (arithmetic) is the key to understanding all the other sciences, even metaphysics, because numerical proportions are, as it were, the ultimate principles of being.

Although Roger Bacon's view differs from Kilwardby's in detail, he followed the same tradition which saw in mathematics a key to understanding

(67) Ibid., cap.16 ad 1, fol.25v.
(68) "Deinde armonica adhuc naturaliter precedere videtur geometriam, quia numerus armonicus de quo considerat, prior videtur esse magnitudine, et est secundum veritatem." cap.24 ad 4, fol.32ra.
(69) "Hinc igitur triplicem musicam statuerunt seu armonicam, scilicet mundanam, humanam et instrumentalem. Unde non omnis musica sonora est, sicut nec omnis armonia, set omnis armonia sonorum est sonora." cap.18, fol.27rb.
(70) Cap.19, fol.27va.
(71) "De ipsis autem speculativis estimatur congrue illo ordo invencionis qui superius servatus est de illis tractando." cap.63, fol.62va. For the discovery of mathematics after physics, cf. cap.11, fol. 22vb-23ra.

all the other sciences: "Sine mathematica non possunt sciri scientiae istae."(72) Bacon's praise of mathematics is too well known to need repetition. But it should be noted that for him metaphysics is the highest science because the suppositions and principles of the lower sciences are proved and clarified in metaphysics. Such principles as 'every whole is greater than its part' and 'between two points there is one straight line' must be assumed by geometry, but can be proved in metaphysics.(73) Bacon does not seem to have gone so far as to say that numbers are the principles of metaphysics. When he said that mathematics is necessary for metaphysics, he meant only that the proofs of metaphysics should be cast in mathematical form and should have the same rigour.(74)

iii. The View of Albertus Magnus and Thomas Aquinas.

At the very beginning of his paraphrase of the Metaphysics Albertus Magnus directed his attack on the error Platonis "who said that natural things are founded on mathematical, and mathematical being is founded on divine, just as the third cause is based on the second, and the second on the first; and so he said that the principles of natural being are mathematical, which is completely false."(75) Albert said he had already

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(72) Opus Majus, cap.2, ed. Jebb, p.59. "Ostendi autem in Metaphysicis per modos utiles quod nulla scientia potest haberi sine hac scientia, nec quod aliquis potest suam ignorantiam in aliis percipere scientiis nisi fuerit in hac peroptime informatus" Communia Mathematica, P.I, cap.3, p.1, ed. Steele, Opera hac. ined., fasc. xvi, 6-7.

(73) "sed petitiones et suppositiones simpliciter credibiles nulla scientia particularis habet ex sua proprietate virtutem probandi, quia illa sunt fundamenta omnium que probantur in scientia et considerantur, et per que omnia probantur..., et tunc patet particularis scientia hoc facere ex beneficio Metaphysice in quantum communicat cum ea et ostenditur ex ea, nam Metaphysica influit suam virtutem in omnes scientias et dat potestatem singulis et vigorem." Communia Mathematica, P.I, dist.5, cap.4, ed.cit., p.66.

(74) Cf. Communia Mathematica, P.I, dist.1, cap.3, ed.cit., p.7.

(75) In Lib. I Metaph., tr.I, cap.1, ed.cit., t.VI, 2b.

rejected this error in his work on the Physics. Actually in his paraphrase of the Physics Albert rejected the Platonic position only in passing, discussing it infrequently and very briefly. But in the Metaphysics it is a central theme running throughout the whole of his paraphrase. Albert had in mind not so much the historical Plato, but the amici Platonis,(76) who seem to be contemporaries. Albert rejects the view that lines and dimensions generate corporeal substance. This view was defended by Grosseteste. For Albert lines and dimensions are the properties of bodies and not their cause. He rejects the view that corpus mathematicum, or quantum, is antecedent to the characteristics of natural bodies. This, as we have seen, was defended by Kilwardby. For Albert there are no dimensions separate from the concrete physical bodies which can be measured and enumerated.(77) The numbers considered by the mathematician are not physical things enumerated (numerus numeratus). The lines and surfaces studied in geometry are not dimensions of a physical body, but the measure of that body. Therefore Albert considered the demonstrations of mathematics to be concerned with the physical bodies of the sensible world, non inquantum sunt sensibilia, sed inquantum sunt talia, hoc est, mensurae et numeri.(78) In other words, for Albert the object of the mathematical sciences are measures and numbers, which do not exist antecedent to physical bodies, but are abstracted from them and have separate existence only in the imagination. Mathematics is concerned with real being, but only in the sense that such

(76) In I Metaph., tr.I, cap.8, ed.cit., t.VI, 15b.
(77) Ibid., lib.XII, tr.I, cap.3, pp.696b-697b.
(78) Ibid., p.697a.

measures and numbers exist potentially in sensible reality.(79)

Albertus Magnus was inclined to defend the autonomy of each science in its own field, for he considered each science to have its own principles (principia illuminantia) by which it could investigate the problems pertaining to its proper subject.(80) He was especially concerned with defending the autonomy of natural science against the 'Platonic' reduction of natural science to mathematics, and basing mathematical number on metaphysical unity and plurality.

Already in his early work In Boethium de Trinitate, which D.M.Chenu has shown can be placed in 1256,(81) Thomas Aquinas revealed his opposition to classifying the speculative sciences according to ascending degrees of abstraction. L.B.Geiger's study of the first and second versions shows Aquinas decided to restrict the term abstractio to the first act of the mind, applying it primarily to that by which we conceive mathematical being.(82) Of the three speculative sciences only mathematics properly abstracts a form of a part (forma partis); by this abstraction mathematics leaves out everything except extension and number. But since number and extension cannot be conceived as pure accidents, that which is imagined to be a line, point, circle or any given number is said to have materia intelligibilis.

(79) "Et ideo geometrae recte dicunt, et de his quae sunt vere entia disputant: haec enim quae considerant, vere sunt entia. Sicut enim in ente habitis determinatum est, ens dicitur dupliciter, de ente endelechia sive actu, et de ente potestate. Et ideo talia qualia mathematici considerant, sunt potestate in entibus sensibilibus." ibid., p.298b-299a.

(80) Cf. In I Post.Anal., tr.I, cap.3, ed.cit., II, 8b-9; cap.5, p.19b; tr.II, cap.6, p.34a.

(81) M.-D.Chenu, "La date du commentaire de S.Thomas sur le De Trinitate de Boèce," in Les Sciences Philos. et Théol., II (1941-2), 432-434.

(82) L.-B.Geiger, "Abstraction et séparation d'après s.Thomas." Revue des Sciences Phil. et Théol., XXXI (1947), 3-40.

from which neither mathematics nor metaphysics can abstract.(83) For Aquinas metaphysics considers even singular things, not secundum proprias rationes, but according to the common aspect of being, that is, to that extent to which they have anything in common with separated substances.(84)

Aquinas' view is more clearly expressed in his commentary on the Metaphysics, when he says that if there were no other substances besides those of which natural science treats, then natural science would be the highest knowledge; but if there is some substance which is immaterial and immovable, then the science which studies that being is prima philosophia.(85) Thus mathematics for Aquinas does not present a deeper explanation of natural phenomena, nor does it offer the principles of natural philosophy; on the contrary, it looks to natural philosophy for its justification. Mathematical principles can be applied to motion and time, just as they can be applied to physical quantities.(86) But such an application is concerned only with the quantitative aspects of physical phenomena, and not with their sensible, or natural aspects.

Thus in the 13th century there were at least two distinct views of the division of the speculative sciences. According to one view the tripartite division is based upon ascending degrees of abstraction; problems of natural science can be and should be reduced to mathematics,

(83) See below, Chapter IV.

(84) "Metaphysicus considerat etiam de singularibus entibus non secundum proprias rationes, per quas sunt tale vel tale ens, sed secundum quod participant communem rationem entis, et sic etiam pertinet ad eius considerationem materia et motus." In Boeth. de Trin., q.5, a.4 ad 6; cf. ad 5.

(85) "Si non est aliqua alia substantia praeter eas que consistunt secundum naturam, de quibus est physica, physica erit prima scientia. Sed si est aliqua substantia immobilis, ista erit prior substantia naturali; et per consequens philosophia considerans huiusmodi substantiam, erit philosophia prima." In VI Metaph., lect.1, n.1170; cf. I Metaph., lect.12, n.181; IV Metaph., lect.5, n.593.

(86) In Boeth. de Trin., q.5, a.3 ad 5, also ad 6-8.

for mathematics, especially arithmetic, offers a key to understanding all physical reality; metaphysics is considered the highest science either because it proves the principles of mathematics, or because it explains the cause of number by metaphysical unity and diversity. According to the other view mathematics alone really abstracts, leaving out of consideration physical substance as well as sensible qualities; problems of natural science can be reduced to mathematics, but at the expense of leaving out important and autonomous considerations; metaphysics is considered the highest science because immaterial substances exist and all things can be considered in the common analogy of being.

The writings of the 14th century which have been preserved reveal very little concern about the division of the sciences or the polemic of the 13th century. Nevertheless the two tendencies remain: one to reduce physical problems to mathematics, the other to insist upon the autonomy of the physical sciences. But in the first half of the 14th century two new movements developed under the inspiration of William of Ockham and of Thomas Bradwardine. One movement was the tendency to reduce all problems, physical or metaphysical, to problems of linguistics and logic. The other was really a new development of the tendency to reduce problems of natural philosophy to mathematics, and to see in mathematics, especially in mathematical proportionality, a key to understanding _cuno secretum absconditum_ -- the _revelatrix omnis veritatis ningere_.(87)

(87) Bradwardine, _Tractatus de Continuo_, MS Erfurt, Amplon.Q.385, fol.31v.

C. Early 14th Century Developments at Oxford.

The university curriculum, as we have seen in the First Chapter covered the whole of the trivium, quadrivium, and the three philosophies. But the two main pillars of Oxford education in the early 14th century were logic and natural philosophy. Already in the School of Chartres, especially in William of Conches, we find the division of knowledge into philosophy (physica, mathematica, and theologia), which dealt with real things, and "eloquentia" (trivium), which dealt with the expression of knowledge. This latter branch of knowledge became commonly known as the "scientiae sermocinales" in the 13th century. And by the early 14th century at Oxford the "scientiae sermocinales" are represented basically by the libri logicales. Among the "real sciences" it was physics and mathematics which predominated, with mathematics subordinated to the libri naturales.

By Canon Law religious were excluded from the Faculty of Arts at the universities.(88) Religious orders therefore had to establish studia artium in which their members could acquire the necessary knowledge before embarking on the study of theology. By the middle of the 13th century the Order of Friars Preachers had established studia artium in each province. The General Chapter of 1325, held in Venice, made a distinction between the teaching of logicalia and naturalia; those destined to become lectors were obliged to hear logic for three years and natural science for at least two years before they could be sent to a studium theologiae.(89)

(88) Cf. Decretum, dist.21, c.2, and dist.68, c.6.
(89) Acta Cap. Gen. I (MOPH IV), 157-8.

About four years later the General Chapter of the Austin Friars ordained that every province of the Order, if possible, was to have two *studia*, one for natural philosophy, the other for logic; the whole of logic was to be covered in three years, and the whole of natural philosophy in three years.(90) At present our knowledge of these *studia* is too meagre to make further comparison with the Faculty of Arts at the University of Oxford.(91) But at least it is clear that the two principal courses consisted of the *libri logicales* and the *libri naturales*.

i. The Libri Logicales.

The division of the logical books into *Ars vetus* and *Ars nova* was merely an accidental one due to the chronological order in which the Aristotelian books reached the West.(92) But by a happy coincidence this chronological order harmonized perfectly with the logical order as seen by the scholastics of the 13th and 14th centuries, and the terminology persisted in statutes and commentaries throughout the rest of the middle ages.

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(90) "...diffinimus et ordinamus quod in qualibet provincia nostri Ordinis ordinentur duo loca, si ad hoc sint ibi duo apta, in quorum uno sit studium naturalis philosophiae, et in alio studium logicae, ita quod lector qui legit philosophiam teneatur infra triennium naturalem philosophiam perficere. Lector vero qui leget logicam teneatur similiter infra triennium perficere totam logicam... Si vero sit aliqua provincia in qua non sint duo loca que ad huius studia sint apta, saltem ordinetur ibidem unus locus ubi sint duo lectores, quorum unus per triennium leget philosophiam, alter logicam eo modo quo superius dictum est." *Chart.E.P.*, II, 328-9. A.Gwynn does not advert to this ordination and hence omits the *studium naturalis philosophiae* from the organisation of studies (*The English Austin Friars in the Time of Wyclif*, Chapter III, Oxford 1940).

(91) For studies on the *studia* in religious orders see H.Denifle, *Die Entstehung der Universitäten des Mittelalters*, Berlin 1885, 710-723; A.G.Little, "Educational Organization," *Trans. Roy. Hist. Soc.*, n.s. VIII, 49-70; W.A.Hinnebusch, *The Early English Friars Preachers*, Rome 1951, 332-342; A.Gwynn, *op.cit.*, 26-34.

(92) One of the earliest uses of the terms is to be found in the statutes

As a science concerning correct reasoning, logic was divided essentially "secundum diversitatem actuum rationis,"(93) that is, according to the three acts of the mind: simple apprehension, judgment and reasoning. By the first act of the mind was meant the apprehension of things (incomplexa) without affirming or denying anything about them. To this part of logic was assigned the Predicamenta of Aristotle together with the Isagoge of Porphyry and the Liber de sex principiis of Gilbert of la Porree. By the second act of the mind was meant the enunciation of a proposition affirming or denying the predicate of the subject. The basic elements of this part of logic were contained in the Perihermeneias of Aristotle, from which were developed specialized treatises on modal propositions, future contingent propositions and the conversion of propositions. The third act of the mind, scientific reasoning, was considered as a resolution to first principles; hence this part of logic, which discussed the proper subject of the whole of logic,(94) was called analytica. But this resolution was of two kinds: resolution to the formal principles of syllogistic reasoning and resolution to the matter contained in the premises. Formal resolution was the object of Aristotle's Analytica Priora. Resolution to the matter or nature of the propositions involved was subdivided according to the

(note 92 cont.) of Robert Curzon for Paris (1215): "Et quod legant libros Aristotelis de dialectica tam de veteri quam de nova in scolis ordinarie et non ad cursum." (Chart.U.P., I, 78, n.20). But this terminology must have already been commonly accepted. Haskins places the reception of the logica nova between ca.1121 and 1158, (Studies..., 225-6).

(93) S.Thomas, Procemium in Post. Anal., n.3.

(94) "Est autem haec scientia, ut de subiecto de syllogismo demonstrativo; de hoc enim inquirit differentias et passiones et modos quibus fiat." S.Alberti, In I Post.Anal., tr.I, cap.1 (ed.cit., II, 2b). "Subiectum autem in ista est syllogismus, partes vero ipsius sunt propositio et oratio." Robertus Anglicus, Expositio in Introductiones Petri Hispani, MS Vat.lat. 3049, fol.1vb.

certitude of the premises. Necessary and per se propositions yielding certain knowledge were discussed in Aristotle's Analytica Posteriora. Probable propositions yielding dialectical knowledge were discussed in his Topica; this part of logic was often called logica inventiva because probable reasons are useful in the discovery of truth and sometimes this is the only kind of certitude possible.(95) False and sophistical propositions were discussed in Aristotle's De Sophisticis Elenchis and in other treatises entitled De Falsidis.

Throughout the 13th and 14th centuries the basic texts of logic were those of Aristotle. But from about the middle of the 13th century onwards certain introductory and supplementary texts were introduced, at least for private use. A certain Magister Robertus Anglicus, commenting on the Introductiones(96) of Peter of Spain, explains that "because the dialectica transmitted in the books of Aristotle is very difficult, various authors of recent date for the sake of a fuller understanding have laboured to compile certain books or treatises introductory to this art, which treatises being mastered, the sciences of Aristotle shines forth more clearly."(97) Among

(95) S.Thomas, Prooemium in Lib. Post.Anal., n.6; cf. S.Albert, Prooemium in Lib. I Topicorum, cap.1 (ed.cit., II, 233a-235b).

(96) This work is commonly known as the Summulae Logicales, but at least in the commentary of Robertus Anglicus the title is Introductiones Magistri Petri Yspani (MS Vat.lat. 3049, fol.2rb). This conveys better the original idea of the treatise.

(97) "Verum quia in libris Aristotelis est dyalectica tradita difficiliter, ideo rationes intelligendi amplioris studuerunt diversi auctores temporis retroanissis quosdam libros seu tractatus introductores in arte loquendi compilare, quibus cognitis sciencia Aristotelis limpidius elucescat." MS Vat.lat. 3049, fol.2ra. This unique manuscript of the 13th century has been discussed by M.Grabmann in his "Handschriftliche Forschungen und Funde zu den philosophischen Schriften des Petrus Hispanus, des späteren Papstes Johannes XXI (+1277)," in Sitzungsberichte der Bayerischen Akademie der Wissenschaften, 1936, Heft 9 (München, 1937), pp.65-67; however we do not follow his transcription, which is faulty in places. Unfortunately the colophon is completely unintelligible: "Finita ista compilacio super tractatus a magistro Roberto Anglico in qua comuti potest

the best known Introductiones of this period are those of Peter of Spain (d.1277), William of Shyreswood (d. after 1267), and Lambert of Auxerre.(98) These introductions are brief summaries of logic for beginners. There were others in the second half of the 13th century, such as the anonymous "Cum sit nostra presens intentio..."(99) By the 15th century there were even more elementary introductions consisting of definitions, divisions and rules, which the beginner was expected to memorise.(100)

Among the supplementary texts the best known today is the Syncategoremata of William of Shyreswood.(101) Syncategoremata are terms such as "omnis," "nullus," "aliquis," "solus" and the like which qualify the supposition of terms to which they are attached. By themselves they do not properly signify anything, but as quantifiers of other terms they are

(note 97 cont.) materiam explanandi dacio magistri Petri Yspani anno domini M° ducentesimo septimo mense maii tercia decima, die sole existente in vire (fol.81v) octavo gradu thauri." Grabmann assumes that Robertus Anglicus is Robert Kilwardby and so he places the commentary between 1248 and 1261, at which time Kilwardby became Prior Provincial of the Dominican Order in England. But there is no reason to suppose that this Robertus Anglicus is Kilwardby, whose regency in Arts at Paris was "probably from 1237 to 1245 or thereabouts" (D.A.Callus, "The 'Tabulae super Originalia Patrum' of Robert Kilwardby," Studia Mediaevalia R.J.Martin, Bruges 1948,p.247).

(98) These have all been discussed in detail by Grabmann, especially in the above-mentioned paper and in his "Die Introductiones in logicam des Wilhelm von Shyreswood" in Sitzungsberichte der Bay. Akad. d. Wissen., 1937, Heft 10 (München 1937).

(99) There are numerous copies of this text together with various commentaries; some of these manuscripts have been noted by Grabmann in "Handschriftliche Forschungen..." ed.cit.,p.41.

(100) For example the text of magister Berlingarius contained in Bodl. MS lat. Misc. c. 100, fol.44-62, beginning: "Ad /h/abendum bonam notitiam terminorum sequens tractatus suppositionum memorie debet commendari..."

(101) Edited by Reginald O'Donnell, "The Syncategoremata of William of Sherwood," in Mediaeval Studies, III (1941),46-93. But Grabmann has also discovered Syncategoremata ascribed to Peter of Spain, Nicholas of Paris, and Johannes Pagus (cf. "Handschriftliche Forschungen..." ed.cit., p.129).

said to "co-signify."(102) Many of the 13th century sophismata involve the use of syncategorematic terms. By the middle of the 14th century the syncategoremata were not considered in a special treatise exclusively devoted to such terms, but seem to have been absorbed into treatises on supposition.(103)

There is no evidence that any of these Introductiones or Summulae were ever used as text books at Oxford in the early 14th century.(104) Instead separate and fuller treatises seem to have been in use, four in particular: Textus de suppositionibus, Textus de consequentiis, Textus de obligatoriis, and the Textus de insolubilibus.

a. Textus de Suppositionibus.

The question of the supposition of terms in statements necessarily arises in a discussion of the Perihermeneias (I,7), although it may have originated separately in discussions of grammar. Supposition (distinct from signification) may be defined as "that which a term represents in a

(102) Peter of Spain, Summulae Logicales, ed. I.M.Bochénski, (Marietti 1947), n. 1.05, pp.2-3. "Et dicitur syncategorema consignificativum, id est, cum aliis significativum, scilicet cum categorematicis, ... quia non habet significationem finitam et determinatam." Burley, De Puritate Artis Logicae (tract. brevior), ed. P.Boehner, The Franciscan Institute, 1955, p.220, lines 8-11.

(103) We know that Burley wrote certain questions on syncategorematic terms (Erfurt, MS Amplon. Q.276, fol.19v-21v, beginning: "Queritur de obliquis utrum possit fieri syllogismus..."), and in his earlier version of the De Puritate Artis Logicae he says, "Et hanc particulam secundum 'Tractatum syncategorematum' volumus appellare." ed.cit., 220, 6-7. But by the middle of the 14th century these ideas are contained in the other short treatises. Perhaps this was unfortunate, because it led to a confusion of the essential difference between terms properly so called and syncategorematic words. Cf. P.T.Geach, "The Doctrine of Distribution," Mind, LXV (1956), esp. p.72-73.

(104) However it is possible that the many minor works of Burley on logic, e.g., de relativis, de abstractis, de toto et parte, etc., may be related to some common text which is not that of Aristotle.

particular statement." Thus in the statement "Man is a rational animal," if the term "man" is taken to represent a mental concept or a three lettered word, the statement is false. Strictly speaking only subject terms can have supposition, but Peter of Spain had already extended supposition to predicates.(105)

In the early 14th century Walter Burley wrote a youthful work on Suppositions, a highly exhaustive and complex treatise in which he generally follows William of Shyreswood, although attributing supposition to both subject and predicate in a proposition.(106) Burley's treatise is the most exhaustive treatment of suppositions as such, but it is difficult to judge the influence of Burley's treatise on later treatises De suppositionibus.

Perhaps the greatest impact upon the study of suppositions was made by William of Ockham, for the basic tenet of nominalism, namely that universal natures are in no way to be found apart from the intentio animae, is embodied in Ockham's doctrine of supposition.(107) Ockham rejected the traditional understanding of suppositio simplex ("quando dictio supponit significatum pro significato"),(108) because he rejected the objective reality of universal natures in every form. Already in his Commentary on

(105) Peter of Spain, Summulae, tr.VI, ed.cit., n. 1.06-07, pp.58-59.

(106) "Suppositio est proprietas extremi secundum quod unum extremum ordinatur ad aliud in propositione, et sic suppositio non debetur extremo extra propositionem, sed solum in propositione." Burley, Suppositiones, MS Royal 12 F.XIX, fol.130rb.

(107) Ockham's doctrine will be discussed more fully in Chapter IV. See also C.Michalski, "Le criticisme et le scepticisme..." (1926 reprint) 14-30; "La physique nouvelle..." (1928 reprint), 29-30; P.Vignaux, article "Nominalisme" in D.T.C., t.XI, p.I, 733-754. C.Prantl, Geschichte der Logik im Abendlande, III, 331-396.

(108) William of Shyreswood, Introductiones in logicam, ed. Grabmann, op.cit., p.75,15. Cf. Peter of Spain, Summulae Logicales, ed.cit., n. 6.05, p.56; Roger Bacon, Summa Dialectica, ed. Steele (Opera hac. incd., fasc.XV), Oxford 1940, p.269,4.

the Sentences he declared, "Falsa est opinio que dicit quod suppositio simplex est quando terminus supponit pro suo significato."(109) For Ockham "suppositio simplex est quando terminus supponit pro intentione animae."(110) It was after Ockham's systematic Summa Logicae that Burley wrote his longer De Puritate Artis Logicae, the first tractatus of which is designed as an attack on Ockham's position concerning suppositions. But because of the prolixity of both Ockham and Burley ("nimis esse prolixa")(111) some simple treatise had to be established for beginners in the Oxford schools of logic.

One anti-Ockhamist text was written by William Sutton, a Fellow of Merton College. This Textus de suppositionibus begins, "Ut iuvenes habeant faciliorem cognicionem in suppositionibus terminorum, breves regule atque generales sunt ponende..." It is a short text consisting of basic definitions and divisions of suppositions, including that of relative terms, together with eleven rules governing their distribution.(112) Sutton's treatise is based largely on William of Shyreswood, and it explicitly rejects Ockham's doctrine of suppositio simplex;

(109) Ockham, Comm. in Sent.,I,dist.IV,q.1 F, ed. Lyon 1495. Also Summa Logicae, P.I,c.64, ed. Boehner, p.178, 27-38.

(110) Comm. in Sent.,I,dist.IV,q.1 E. Summa Logicae, P.I,c.64.

(111) "Sed causa efficiens /tractatus suppositionum/ fuit Wilhelmus Okham et Walterus Werley, ambo anglici qui sententias prolixe tradiderunt (fol.92ra) scientiam de suppositionibus terminorum, et hoc quantum ad causam principalem. Sed alteri modernorum videntur dicta sua nimis esse prolixa et viris anglicis qui collegit illum librum de suppositionibus ex libris aliorum de quo nomine nichil curretur." Scriptum magistri Sifridi anglici super textum de suppositionibus Suttonis Anglici, MS Vienna, Dominikanerkloster 160/130, fol.91vb-92ra.

(112) Sutton's text is to be found in Vienna, Dominikanerkloster cod. 160/130, fol.123ra-rb, Munich, Clm.4397, fol.198; a commentary on this text is found in Munich, Clm.4384, fol.123v-131v; and sophismata curialia on the text are contained in the above mentioned Vienna MS, fol.96r-100v.

> Ex quo patet illorum error qui credunt cum dicitur 'homo est substantia' predicatum huius propositionis supponere pro intentionibus animae simplicibus /sic/, quoniam si intentio animae nec possit esse de pluribus predicari, constat quod terminus pro ea supponere non potest. (MS Vienna, Dom.Klos. 160/130, fol.123ra).

A Munich MS, Clm.4384, fol.123v-131v, written about 1340,[113] contains an anonymous commentary on Sutton's text, which is said to have been "edite a magno cetu philosopharum in Anglia."[114] William Sutton was admitted to Fellowship at Merton in 1330.[115] Thus it would seem that his treatise De suppositionibus was written some time between 1330-1340. Whether this text was in use for any considerable time in Oxford cannot be ascertained at present.

The scope of this part of logic rapidly grew in extent during the second quarter of the 14th century, and in some cases subordinate treatises grew out of it. Burley, Ockham and Sutton had discussed the supposition of relative terms; out of this grew the treatises, such as Heytesbury's, De relativis. Ockham furthermore discussed the supposition of such terms as "incipit" and "desinit;" out of this grew the various treatises De incipit et desinit. Heytesbury himself discussed the supposition of comparative and superlative adverbs and adjectives in the fifth chapter of his Regulae solvendi sophismata, "De maximo et minimo," written in 1335.

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(113) The previous item, a repertatio on the De Falacijs, is dated "finitus est liber iste per me indocum anno domini 1340 proxima die veneris ante festum sancti Thome." (fol.123v).

(114) Inc.: "Primo elenchorum dicitur, Qui virtutes vocabulorum ignari sunt de facili paralogizantur. In ista propositione duo tanguntur...." Cf. above Chapter I, p.28, note 72.

(115) Mert.Reg. 417. Sutton was first Bursar 1338-9, third Bursar 1340-1, 1342-3; and subwarden from 1344-45. He seems to have died by December 1349. (Ex informatione A.B.Emden).

To these may be added the problems of *scire* and *dubitare* when the object of a term is unknown, such as in the treatises of Heytesbury (chap.2 of his *Regulae* and chap.1 of the *Probationes*),[116] in the *Sophismata* of Kilmington[117] and the *Conclusiones* of Billingham.[118] But many of these became confused, or rather involved with *insolubilia*, so that the real extent of supposition was lost. Once the scholastics lost the original and real role of suppositions as functions of subject-terms and of no other part of speech, the place of this treatise became intermingled with other questions of logic and philosophy.

When Sutton's text became insufficient to embrace the supposition of all the terms then discussed, Richard Billingham, another Fellow of Merton (fl.1344-1361), wrote his famous *Speculum Juvenum*, or *De probatione propositionum*, some time after Heytesbury's *De sensu composito et diviso*.[119] This *textus Billingham*, which became a required book in many of the continental universities during the 15th century,[120] is a good example of the extent of this part of logic by the middle of the 14th century. The treatise may be divided as follows on the basis of terms:[121]

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(116) This chapter, which begins "A est scitum a te et idem A est tibi dubium..." is found in various manuscripts as the first or third chapter (as in the printed edition of Venice 1494).

(117) The last four *sophismata*, MS Vat.lat.3066, fol.23vb-24vb.

(118) Inc.: "Si credis aliquam propositionem..." MS Vat.lat.3065, fol.21-25v. Other MSS are listed in the Appendix *Repertorium*.

(119) "Sed ubi duo essent mediati, bene differet, ut A scis, et scis A, ut patet in alio compendio de sensu composito et diviso." *Speculum Juvenum*, MS Florence, Nas.Cent., Magl.V.43, fol.11r. Billingham may here be referring to his own treatise *De sensu composito et diviso*, contained in Paris, Bibl.Nat.lat.14715, fol.79-82 (inc.: "Pro sensu composito et diviso est sciendum et primo..."), but this clearly depends upon Heytesbury's work.

(120) Cf. C.Michalski, "La physique nouvelle..." (1928), p.19-20.

(121) Inc.: "Terminus est in quem resolvitur propositio..." Passages quoted are taken from the text contained in Florence, Nas.Cent. MS Magl. V.43, fol.1-12. In Cambridge, Corpus Christi College MS 378, of the 15th century, Billingham's treatise is called the *Tractatus Aureus*.

1. Immediate terms, e.g., ego, tu, iste, huc iste, sum, etc. Propositions involving these terms cannot be proved, for their supposition is obvious.

2. Mediate terms are subdivided:

   a. resolubiles, i.e., any word in a sentence; propositions can be proved by reduction to an immediate term, its inferior.

   b. exponibiles are those which are convertible with their exponentes, e.g., "dictio exclusiva, dictio exceptiva, signum universale affirmativum, differt, aliud, non idem, incipit, desinit, comparativus gradus et superlativus, primum, ultimum, maximum, minimum, immediate, primo, fine, etc." Propositions involving such terms are proved by a conversion to the exponent of those terms.

   c. officiales are those which imply some positive or privative function, e.g., "scire, percipere, credere, dubitare, intelligere, imaginare, et similia" or "appeto, desidero, debeo, possum promittere tibi pauma;" likewise such terms as "possibile," "impossibile," "contingens," "necesse," the verb "est" when it is used impersonally, and "non." Billingham gives a series of rules for proving propositions which involve such terms.

Although Billingham's purpose in this treatise was to teach the correct method of argumentation, the proving of propositions, he believed that the main fallacies arise from ignorance of the proper supposition of terms and the rules governing the verification of these terms.(122)

Thus the part of logic which discussed supposition was extended to embrace the following new treatises: (i) De relativis, (ii) De incipit et desinit, (iii) De maxime et minime, (iv) De scire et dubitare. To these may be added the treatise De insolubilibus, because the solution of

(122) "Et credo quod maior pars deficiencium ex defectu aliminus istarum regularum, deficit tam arguendo quam respondendo in diversis facultatibus. Ex quo sequitur ex predictis quod omnis huiusmodi defectus est penes aliquam fallaciam, sed fallacie communiter ad has reducuntur que per illas regulas cognoscuntur." ibid., fol.11r.

insolubilia depended upon one's doctrine of supposition. But these treatises De insolubilibus seem to have had another origin, and so can be considered separately. An examination of Heytesbury's Regulae solvendi sophismata readily shows that these five new treatises constitute the first five chapters of Heytesbury's work.(123)

From what has been briefly indicated we can see the vast extent of that part of logic devoted to supposition during the first half of the 14th century. For the historian of English medieval thought this development of suppositions is perhaps the most important element in the early 14th century.

b. Textus de consequentiis.

The most practical treatise for the undergraduate was that dealing with inferences, or De consequentiis. P.Boehner has claimed that, "This is, perhaps, the most important new element of scholastic logic, for it deals with inferences from one simple or compound proposition to another simple or compound proposition."(124) Whatever may be the truth of this claim, it must be noted that the whole of Aristotelian logic was directed to knowing the nature and the necessary rules of correct inferences. The purpose of these elementary treatises was to give the undergraduate a list

(123) See above, Chapter II, pp. 81-2. Heytesbury's treatises De incipit et desinit and De maximo et minimo have been discussed in detail by Dr.Curtis Wilson in his William Heytesbury: Medieval Logic and the Rise of Mathematical Physics, Madison (Univ. of Wis. Press) 1956, pp.29-114.

(124) P.Boehner, Medieval Logic, an outline of its development from 1250-c.1400, Manchester University Press, 1952, pp.15-16.

of practical rules of inference to help him in scholastic disputations.(125) These treatises presented the general rules of inference from propositions containing exclusive (only, alone), excepting, disjunctive or conditional clauses as well as propositions containing those terms which were later called exponibiles, such as incipit and desinit.

Treatises De consequentiis are very numerous for the first half of the 14th century, and a great many are merely commentaries on standard texts. An early treatise of Walter Burley (beginning, "Quia in sophismatibus probandis et improbandis consequentiis utimur, et ideo circa naturam consequentiarum multa oportet scire..."), considers rules of inference involving exclusive, or excepting terms in conditional and categorical propositions.(126) This text seems to have been the source of the better known Textus de consequentiis of William Sutton beginning, "Quia in sophismatibus probandis et improbandis utimur consequentiis, que circa ut iuniores materia dyalectica collatione animus anime... Est autem consequentia antecedens et consequens cum consequentie nota..."(127) Sutton added a section on incipit and desinit, which he did not discuss in his De suppositionibus; thus it would seem that the De consequentiis is a later work.

(125) "Sed causa finalis tangitur in littera ubi dicitur 'ut iuniorum probitas in collacione dyalectica,' i.e., ut iuvenes promptius possint disputare in diversis facultatibus hoc opus fuit compilatum." Anon. Exposicio super textum de consequenciis /Sutonis Anglici/. MS Vienna, Dominikanerkloster, cod.160/130, fol.100vb.

(126) We have used the text preserved in Florence, Laurenz. Plut.XII, sin.cod.2, fol.203v-212 and Gains College MS 434/434, fol.1-6, (fol.6va-10 contain part of Burley's Tractatus Obligacionum, and this is a distinct work).

(127) MS Vienna, Dominikanerkloster 160/130, fol.123rb-124rb.

From an anonymous commentator on Sutton's text we learn that Swineshead also wrote a treatise on consequences in which he defines inference: "Consequentia est totum aggregatum ex antecedente et consequente cum nota consequentie."(128) Swineshead's work has not been discovered; at least no known treatise De consequentiis is ascribed to Roger or Richard Swineshead.(129) But the treatises of both Swineshead and Sutton were known to the Parisian master, John Buridan, when he wrote his treatise of the same title.(130) One other standard text on consequences was known to the anonymous commentator of William Sutton: "Nota alius videtur consequentiam sic diffinire et malins: consequentia est habitudo antecedentis ad consequentiam per notam consequentie denotata."(131) This treatise has not been identified, but may very well be the basis for the numerous treatises which define inference as habitudo.

The rules of inference depend intimately on the doctrine of suppositio; thus as suppositio was extended to include more and more terms, the treatises De consequentiis proportionally included a greater number of rules.(132) But basically these treatises were intended to be practical guides to solemn disputations.

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(128) "Nota Swinsheit Anglicus in suo tractatu de consequentiis consequentiam sic diffinivit: consequentia est totum aggregatum ex antecedente et consequente cum nota consequentie." Expositio super textum de consequentiis, MS Vienna, Dom.klos. cod.160/130, fol.101ra.

(129) There are numerous works beginning with this definition, but as far as I know, none are ascribed to Swineshead. See also G.E.Mohan, O.F.M., "Incipits of Logical Writings of the XIIIth-XVth Centuries," in Franciscan Studies, XII (1952), 380-381.

(130) "Consequentia est antecedens et consequens cum nota consequentie vel est aggregatum ex antecedente et consequente cum nota consequentie." Consequentie mag. Jo. Buridani, MS Florence, Nas.Cent. Magl. V,43, fol.55r.

(131) MS Vienna, Dom.klos. cod.160/130, fol.101ra.

(132) In the same Vienna MS there is a Logica segeri or Rogerii (sic in colophon), beginning: "Logicam Boecius in libro de disciplina scolarium magnis extolleris laudibus..." in which 520 rules are given for the whole of logic (fol.25ra-56va).

c. Textus de obligatoriis.

This treatise of logic was designed to give the beginner rules of inferences in purely logical exercises. These sophistic exercises of positio and impositio should not be confused with the disputations de sophismatibus or de quaestione. The ars obligatoria, or exercitativa, was not concerned with the truth or falsity of any doctrine or question, but only with the formal consistency (non-contradiction) of inferences. The original positio may be false in itself, although not impossible. The role of the opponent was to force (oblige) the respondent to admit an impossible conclusion apparently following from the original premise posited. The role of the respondent was to uphold the original premise so that nothing impossible could be drawn from it.(133) These were strictly ingenious exercises among school boys and had little objective value, although Father Boehner sees in them the nucleus of rules for an axiomatic method somewhat similar, though in a rather crude form to that of modern axiomatics.(134)

Already in the 13th century there were treatises instructing beginners on the procedure of scholastic disputations. H.Grabmann has pointed out a rather famous 13th century treatise, De arte opponendi et respondendi,

(133) "Opus opponentis est sic inducere oracionem ut faciat respondentem concedere impossibilia que propter positum non sunt necessaria concedere. Opus autem respondentis est sic sustinere positum ut propter ipsum non videatur aliquod impossibile sequi, set magis propter positum. Igitur intencio opponentis et respondentis circa enunciabile versatur ad quod respondens est obligatus." Burley, Obligaciones, MS Royal 12 F.XIX, fol.138rb.

(134) P.Boehner, Medieval Logic, ed.cit., p.14-15.

contained in Bibl.Nat.lat.16617, fol.131-161v, between the works of Shyreswood and Lambert of Auxerre.(135) This anonymous treatise is divided into four parts dealing with (i) the art of opposing, (ii) the manner of responding, (iii) sophismata together with their solutions and explanation of distinctions, (iv) the art of opposing and solving obligationes.(136)

A number of treatises De obligationibus are attributed to Walter Burley alone. The earliest is perhaps that contained in British Museum MS Royal 12 F.XIX, fol.138-148, beginning "In disputacione dyalectica due sunt partes, scilicet opponens et respondens..." From the colophon we learn that Burley wrote this treatise in 1302: "Explicit optimus tractatus de obligacionibus datus a mag. Waltero de Burleye anno domini Millesimo trecentesimo secundo."(137)

There are extant numerous treatises De obligationibus emanating from the early 14th century, and a great many by Oxford logicians; but the most important, judging from its extensive use, was that of Roger Swineshead beginning "Cum in singulis sciencciis secundum materiam subiectam sit certitudo querenda..." It is a comparatively short treatise containing two

(135) Inc.: "Ut scribitur in libro primo elenchorum, duo sunt opera sapientis, scilicet non mentiri de quibus novit, et mentientem posse manifestare..." This work was printed four times in the 15th century under the name of Albertus Magnus. Cf. M.Grabmann, "Handschriftliche Forschungen...," Sitzungsber. d. Bay. Akad., 1936, Heft 9, p.40.

(136) "In prima trademus artem opponendi in generali. In secunda modum respondendi. In tertia de sophismatibus et eorum solutionibus et intellectu distinctionum in his accidentibus disputabimus aliqua. In quarta autem opponendi obligationes solvendi." MS cit., fol. 131v, quoted by Grabmann, op.cit., p.39.

(137) This text is also found in Venice, Marc.Z.lat.301 (1576), fol.47-57v and in Bruges de la ville 500, fol.72-81. A shorter version is found in the above mentioned Venice MS, fol.57rb-41rb it is anonymous and called brevia insolubilia et utilia secundum usum Esonie. At least two other treatises De obligationibus are also attributed to Burley: a very short one beginning "Cum ars obligatoria sit..." (MS Erfurt, Amplon.O.76, fol.34v-36), and another beginning "Obligatio secundum quod nos utimur hoc nomine in sophis-

parts, the first De obligationibus, the second De insolubilibus. The first part contains five particule: (i) proœmium, (ii) a series of definitions, divisions, suppositions and conclusions concerning the solution of obligationes, (iii) de impositione, (iv) de propositione, (v) de positione. All of these chapters contain rules for admitting or denying inferences in logical exercises, rules which clearly depend on the doctrine of supposition.

Although Swineshead's treatise was a required text at certain continental universities in the late 14th century and the 15th, it is much too long and complicated to have been used by beginners. There must have been a shorter text in use for beginners, which would be of more practical value. Perhaps this is the short treatise known on the continent as Obligationes secundum unum Oxonie, beginning "Obligacio est quedam are qua opponens potest ligare respondentem ut ad placitum suum respondeat ad propositionem sibi positam affirmative vel negative..."(138) There are numerous copies of this treatise still extant, some together with commentaries, which accounts for its being attributed to different authors in the catalogues.

d. Tractatus de insolubilibus.

Insolubilia are propositions in a certain qualified case, from which

(note 137 cont.) natibus est prefixio enumerabilis..." (MSS Erfurt, Amplon.Q.259 (a.d.1340), fol.209-214, Paris, BN, lat.16130, fol.110v-114, and Venice Marc.Z.lat.302 (1873), fol.151 ff).

(138) The work has this title in three MSS examined, Vat.lat.3065 (15th cent.), fol.95v-98v, Padua, Univ.1123 (membr. 14th cent.), fol.3vb-5va, and Bibl.Anton. XIX.407, (a.d.1469), fol.34v-36. The slight verbal differences in these manuscripts are insignificant, although cataloguers of initia would separate them.

one can infer that the proposition contradicts itself. For example, if Socrates utters this statement and no other, "Socrates is telling a lie," then if the statement is taken to be true it follows that it is false; and if the statement is taken at face value, namely that he is telling a lie, it follows that the statement is not a lie. The treatise on insoluble propositions arose out of the logical exercises in the schools,(139) and in later compendia such propositions are invariably discussed after the nature and rules of inference. Swineshead published his De insolubilibus as the second part of his De obligationibus. But it is ultimately a question of supposition. The sentence "Sortes dicit falsum" was thought to be an insoluble proposition because the predicate "falsum" seems to refer to the proposition itself, otherwise it would have no supposition.

There were almost as many solutions of these difficult cases as there were Oxford logicians. Ockham held that a part of a proposition, e.g., "falsum," could not refer to the whole of which it is a part. Swineshead, denying this, held that the proposition is not true, because it "falsifies" itself. Dumbleton held that, although such sentences signify something, they cannot be called propositions, and so were neither true nor false. Kilmington held that every proposition must be either true or false, and insolubilia are propositions which are true in a certain sense and false in another. Heytesbury held that some statements cannot be taken to mean what they say.

(139) G.Wallerand, it would seem, has not made a sufficient distinction between purely scholastic exercises (de obligationibus et insolubilibus) and sophismata and quaestiones. (Cf. G.Wallerand, Les Oeuvres de Siger de Courtrai, (Les Philosophes Belges, t.VIII) Louvain 1913, 24-33). It is true that all obligationes and insolubilia were sophismata, but not vice versa.

Because of the lively discussion among the Oxford masters, clearly no one text-book De insolubilibus was in common use in the logic schools at Oxford in the early 14th century. However, the subject was of particular concern to all masters in arts; it was even discussed in commentaries on the Sentences.(140)

From what has been said concerning the new books of logic it is clear that logic was one of the most important developments in the Faculty of Arts at Oxford. The "English subtleties which [the Parisians] denounce in public" and which were "the subject of their furtive vigils"(141) centred around the doctrine of supposition. Ockham and his followers denied that terms could represent universal natures in some way existing in reality; terms had to be reduced to individual existing things and the manner of signifying. Further, since every term was supposed to have some supposition, the treatise on supposition was extended to embrace every part of speech and included many terms which involve a doctrine of physics, such as incipit, desinit, maximum, minimum, and relative terms. When the scholastics of the 14th century extended the notion of supposition to every term in the sentence, they necessarily embraced a whole range of problems which properly belong to physics.

ii. The Libri Naturales.

The study of natural science was not augmented in the same way as

(140) See for example the commentary of Roger Roseth, O.F.M., given at Norwich before 1337, q.1, art.2, and the lengthy discussion by the anonymous commentator on the Sentences preserved in MS Vat.lat.896, fol.113 ff. (= Lib.III, q.1, art.1-3), in which the opinion of Ockham, Roseth and Kilvington are rejected.

(141) Richard de Bury, Philobiblon, chap.9, trans. E.C.Thomas, London 1888, p.212.

logic in the early 14th century. It was not so much an introduction of new treatises into the curriculum as a new approach to Aristotelian physics.

The whole of natural science was considered a single unity in which Aristotle's Physica de auditu presented the general principles, or theory of physical science. In the Physica Aristotle discussed the principles and causes of change, the nature of motion and time, the different kinds of real motion and their causes. Every physical theory must give some explanation of these phenomena in nature. In the early 14th century the sharpest controversies ranged around these theoretical problems. While the books of the Physica dealt with the general problems of nature, the other physical books considered more particular aspects. The De Coelo et Mundo considered the problems of locomotion in the universe, both rectilinear and circular; the Meteora considered more particular cases of locomotion. The De Generatione et Corruptione considered the problems of alteration, especially those leading to substantial change; this aspect of science was later to be represented by chemistry. The De Anima and subsequent books considered the problems of living beings; this part of natural science was later to be developed into the various branches of psychology and biology.

Thirteenth century commentaries on the libri naturales were limited to a close exposition or paraphrase of the Aristotelian text. The questions discussed by Albertus Magnus, Thomas Aquinas, Roger Bacon, Siger of Brabant, John of Jandun, and Walter Burley are conspicuous for their fidelity to the Aristotelian text in the sense that the type of question asked was governed by the text and the commentary of Averroes.

Treatises and questiones originating from Oxford during the second quarter of the 14th century reveal a striking characteristic, vastly

different from earlier commentaries. A new type of question was being asked in the schools of physics, and the manner of discussing it would have been strange to philosophers of the 13th century. This is partly revealed in the Summa Philosophiae Naturalis of John Dumbleton. An analytical division of the chapters in Part II and III of the Summa, corresponding to the first Six Books of Aristotle's Physica, will help to compare Dumbleton's work with the better known printed treatises of Heytesbury and Swineshead.

Pars Secunda[142]

I. De Primis Principiis

A. De significatione horum nominum, scilicet principium, causa et elementum (cap.1-2)

B. De principiis intrinsecis rerum naturalium.
1. Opiniones antiquorum: Parmenides, Melissus, etc. (cap.3)
2. Opinio Platonis (cap.4-5)
3. Opinio Aristotelis (cap.6)

/Dub.I/: Numquid tantum tria sint prima principia rerum naturalium. (cap.7)

/Dub.II/: Utrum principia sint contraria. (cap.8)

/Dub.III/ De numero principiorum restant dubia solvenda: 1° si tria principia sufficiant ad generationem rei naturalis; 2° si plura tribus essent superflua. (cap.9)

/Dub.IV/: Ium restat inquirere numquid materia prima habeat ex se longitudinem et latitudinem. (cap.10)

/Dub.V/: Cum materia prima sit in potentia ad omnes formas elementares quaeritur numquid potentia in ipsa sit qualitas aliqua vel sit ipsa materia. (cap.11)

/Dub.VI/: Cum materia prima dicatur ens in potentia inquirendum est qualiter est in potentia et numquid magis habeat esse et perfectior sit in sua natura quam forma vel compositum. (cap.12)

(142) The chapter divisions given here follow those found in MS Vat.lat. 6750, which in general has proved more satisfactory and logical than the divisions found in other MSS of Dumbleton's Summa.

/Dub.VII/ Sequitur inquirere numquid materia prima vel forma vel compositum ex hiis sit subiectum immediatum et primum qualitatum primarum. (cap.13)

II. Postquam sit determinatum de materia et forma sequitur investigare qualiter aliquid magis et minus suscipiat.

A. De formis substantialibus in abstracto:

/Dub.I/ Utrum substantia naturalis, puta forma substantialis, magis et minus suscipiat in abstracto. (cap.14)

/Dub.II/ Numquid una species alia imperfectior sive perfectior in infinitum excedat vel excedatur, ut corpus excedat lineam, et linea excediter a corpore in infinitum. (cap.15)

/Dub.III/ Numquid corpus habeat infinitam longitudinem et latitudinem. (cap.16)

/Dub.IV/ Dubitatur qualiter aliquid alio est magis substantia, dum nihil sit magis homo alio homine. (cap.17)

/Dub.V/ Numquid illa que sunt naturaliter priora sunt perfectiora posterioribus. (cap.18)

B. De intensione qualitatum simplicium:

/Dub.I/ Sequitur inquirere qualiter qualitates intenduntur et remittuntur. Circa quam materiam multe sunt opiniones. Quatuor tamen sunt circa quas disputatio moderna maxime versatur.

1. Contra primam opinionem. (cap.19)
2. Contra secundam opinionem. (cap.20)
3. Contra tertiam opinionem. (cap.21)
4. Contra aliam opinionem. (cap.22)
5. Quarta opinio que tenenda est, ponit quod nulla qualitas intenditur vel remittitur, sed subiectum qualitatis intenditur et remittitur per acquisitionem et remissionem realem qualitatum, sicut quantum maioratur vel minoratur per appositionem partium et amotionem earundem. (cap.23)

/Dub.II/ Istis positis restat inquirere qualiter qualitates difformes remisse sunt et intense, et quomodo latitudo in sua natura per se et proprie est intensa,* respondeo. Circa istud tres sunt opiniones.

1. Contra primam opinionem. (cap.24)
2. Contra secundam opinionem. (cap.25)
3. Post hec tertiam opinionem, que vera est, exprimamus. (cap.26)

/Dub.III/ Ultimo determinetur utrum omnis qualitas intensibilis divisibilis sit in infinitum sicut omnis quantitas in infinitum est divisibilis quantitative, vel, quod cuiuscumque latitudinis in infinitum remisse sit aliquis gradus. (cap.27 - 28).

C. De qualitatibus secundis:

* et numquid alicui gradui intrinseco sui ipsius cor-

/Dub.I/ Sequitur inquirere qualiter qualitates secunde intensionem et remissionem suscipiunt. (cap.29)

/Dub.II/ Sequitur qualiter mixta qualitatibus sunt talia et qualia.

1. Et primo improbande sunt quedam opiniones, scilicet tres. (cap.30)
2. Quarta opinio que tenenda est, est hec: quod omne mixtum est ita intensum precise sicut excessus per se acceptus per quod intensior qualitas excedit suum contrarium, non tamen proportionaliter, sed quod una excedit aliam intensive, ut si sit A mixtum habens tres quartas caliditatis et unam quartam frigiditatis. (cap.31)

D. De intensione forme substantialis:

/Dub.I/ Sequitur inquirere numquid forma substantialis aliqua intenditur et remittitur. (cap.32-33)

Pars Tertia

I. De Motu.

A. In quibus predicamentis sit verus motus:

1. Quod sola substantia vere movetur per susceptionem aliarum rerum in aliis predicamentis. (cap.1)
2. Sequitur causam assignare quare tantum in tribus predicamentis, scilicet qualitate, quantitate et ubi, sit verus motus, in substantia vero et in aliis motus improprie dictus. (cap.2)
   /Dub.I/ Propterea dubitatur qualiter probatur quod in substantia non est motus per hoc medium quod substantie nihil est contrarium. (cap.3)
3. Post hoc instat assignare causam quare non in habitibus nec in figuris nec in finibus, ut asserunt Aristoteles et Commentator, est verus motus. (cap.4)

B. Qualiter velocitas in motibus veris et successivis producitur et causatur:

1. Et primo de motu locali:

   /Dubium I/ Penes quid sequitur velocitas motus. Tres possunt esse opiniones.
   a. Contra primam opinionem. (cap.5)
   b. Contra secundam opinionem. (cap.6)
   c. Opinio propria:
      1. Sequitur dicere qualiter motus sequitur proportionem et primo modo exemplariter exprimemus, ut qui in Geometria non sunt experti, exemplis grossis et sensibilibus veritatem ingrediantur et eius causam videant. (cap.7)

ii. Sequitur solvere argumentum quod est alterius positionis, scilicet secunde, fundamentum. (cap.8)

/Dub.II/ Numquid latitudo motus suo medio gradui correspondeat.
1. Probationes. (cap.9-11)
2. Quedam conclusiones ex hoc. (cap.12)

/Dub.III/ Cum motus fit secundum proportionem maioris inequalitatis, numquid finitum posset agere in infinitum dubitatur. (cap.13)

/Dub.IV/ Ulterius est dubitandum quantum est in divisione corporis quod eum agens applicatur parti super quam ducatur, quare eam non dividit et cessat a motu, ut gravum iacens super terram super aliam partem illius dominatur et tamen eam non dividit. (Ibid).

2. De motu alterationis:

/Dub.I/ Penes quid attenditur velocitas alterationis. Tres sunt opiniones veritatem in tota vel in parte negantes.
1. Contra istas opiniones. (cap.14-15)
2. Quarta opinio que tenenda est talis est, quod omnis motus et eiusdem velocitas alicuius predicamenti respectu distantie unite istius predicamenti attenditur, non ita quod motus localis attenditur penes quantitatem et quod motus alterationis vel velociter alterari penes qualitatem et quantitatem, cum mulla predicamenta naturaliter faciunt ad aliquam distantiam /continuam/ alicuius unius predicamenti. (cap.16)

/Dub.II/ Sequitur dicere qualiter mixta alterantur et quomodo attenditur in eis velocitas alterationis, cum non proprie et primo alterantur prinis qualitatibus, sed ex consequenti mediantibus elementis existentibus in illis. (cap.17)

3. De motu augmentationis.

/Dub.I/ Penes quid attenditur velocitas augmentationis. (cap.18)

4. De motu condensationis et rarefactionis.

/Dub.I/ Numquid tam latitudo densitatis quam raritatis latitudo sit infinita. (cap.19)

/Dub.II/ Utrum rarefactio est augmentatio, condensatio et diminutio corporibus proportionaliter et equevelociter acquirantur. (cap.20)

C. Quid sit motus. (cap.21-25)

D. Qualiter motus et quies se habent respectu mobilis. (cap.26)

II. De Tempore.

A. Dicto de motu, naturam temporis inquiramus. Quatuor sunt opiniones.
1. Contra primam opinionem. (cap.27)
2. Contra secundam opinionem. (cap.28)
3. Contra tertiam opinionem. (cap.29)
4. Quarta positio tenenda est, scilicet quod motus et tempus idem sunt secundum rem, diversa tamen secundum rationem. (cap.30)

B. Quaedam dubia:
1. Quid significat 'numerus' qui positus est in diffinitione. (cap.31)
2. Numquid tempus sit sine anima. (cap.32)
3. Numquid motus et tempus sunt alia et alia, quia illa non sunt res permanentes. (cap.33-35)
4. Ulterius dubitatur qualiter tempus est per se causa corruptionis et causa per accidens generationis. (cap.36)

III. Restat dubia communia quaedam de motu et tempore solvere.

/Dub.I/ Primo arguitur quod si tempus est motus et mobile, igitur annus est equalis diei, et menses horae, et tempus instanti, quod videtur falsum. (cap.37)

/Dub.II/ Qualiter non sunt duo instantia immediata in tempore, ut arguit Philosophus in 4° probando quod nullum continuum ex indivisibilibus componitur et per consequens nec tempus ex instantibus componitur. (cap.38)

/Dub.III/ Qualiter ex motu alterationis tempus et duratio habent esse. (cap.39)

From this outline it is clear that the principal interest of the Second Part of the Summa surrounds intension and remission of forms, while that of the Third Part concerns velocities of motion. The question of intension and remission of forms was already discussed in the 13th century by theologians, while in the 14th century it predominated in all discussions of physics. The absorbing interest in velocities, on the other hand, is one of the novel characteristics of early 14th century physics in Oxford, as can be seen in the writings of Heytesbury, Roger Swineshead, Richard Swineshead, John of Holland, and the large anonymous treatise De Motu contained in MS Digby 190. Discussed through the tedious form of argumentation known as the calculationes, or "letter-calculus," it was a develop-

ment characteristic of Oxford. This development was due not to William of Ockham, but to the genius and influence of Thomas Bradwardine.

The Tractatus de proportione velocitatum in motibus, "editus a mag. Thoma de Bradwardin a.D. 1328,"(143) was an attempt to express variations of velocity in a mathematical law, universally valid for all cases. Bradwardine's treatise was widely used in the schools, judging from the number of extant commentaries and quaestiones on the text. But undergraduates were introduced to Bradwardine's doctrine more often through shorter and simpler treatises, De proportionibus. Besides Albert of Saxony's well-known treatise produced at Paris, two in particular were commonly used in the schools. The earlier and shorter "proportiones breves"(144) "extractus ex proportionibus longis mag. Thome Bragwardin"(145) consisted of three chapters dealing with proportions and proportionality in general, the erroneous opinions concerning kinematics, and the solution of Bradwardine.(146) The second covered the same matter together with conclusions pertaining to rotational motion in five chapters, but in greater detail.(147) Bradwardine's solution, as we shall see, and his mathematical interest directly influenced Heytesbury, Dumbleton, Swineshead and a host of other Oxford Masters.

In his little-known treatise De continuo Bradwardine clearly professed his belief in the power of mathematics to reveal the secrets of nature. After rejecting the opinion of "Plato ac Waltherus modernus," who believe the continuum to be composed of a finite number of indivisible points, he

(143) MS Paris, BN lat. nouv.acq.625, fol.70v; this date is also to be found in BN lat.14576, fol.261v, and BN lat.16621, fol.212v. Bradwardine's treatise will be discussed in detail in Chapter V.
(144) MS Vienna, Nat.Bibl. lat. 4764, fol.231.
(145) MS Vienna, Nat.Bibl. lat. 4953, fol.19.
(146) The text of this treatise will be found in the Appendix.
(147) Inc.: "Omnis proportio aut est communiter dicta, proprie dicta, vel magis proprie dicta..."

gave credit to mathematics for first seeing the error.

> Ipsa enim suis ceteris sororibus acutius contemplatur, inflexibilius telum iacit, et se protegit clypeo tutori. Nullius enim physice certamine se speret gavisurum triumpho nisi mathematice utatur consilio, et auxilio confortetur. Ipsa enim revelatrix omnis veritatis sincere, et novit omne secretum absconditum, se /7 et/ omnium litterarum subtilium clavem gerit. Quicumque igitur ipsa neglecta physicari presumpserit, sapientie ianuam se nunquam ingressurum agnoscat. Arismetica igitur, prima totius mathematice mater et ianua, sic ordinatur certamine.(148)

With the success of Bradwardine's kinematic law interest in the mathematical aspects of physical motion was revived and later Mertonians at least tried to find mathematical proportionality in all physical changes, and thus follow the ideal set by Bradwardine.

For the beginner there also came into use at Oxford an introductory treatise of definitions and divisions known as the Termini Naturales, beginning, "Natura est principium motus et quietis..." According to a Munich manuscript of the 14th century, Clm 8997, this list of definitions was "compilata a mag. Wilhelmo Heabri" (fol.167r); other manuscripts describe it as "secundum usum Oxonii." The number of extant commentaries, including that of John Garisdale,(149) on this elementary treatise testify to its popularity.(150) Variations of this treatise came into use later on the continent. Although this is not a work of mathematics, it does summarise the Oxford teaching and show the influence of mathematics on concepts of natural philosophy.(151)

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(148) Tractatus de continuo, MS Erfurt, Amplon. Q.385, fol.31v also MS Torun, 4° .2, page 171. I am deeply indebted to Mr. John E. Murdoch, of Wisconsin University, for allowing me to read and to quote from his transcription of these two manuscripts.

(149) MS Oxford, New College 289, fol.38-50v.

(150) See also A.Pelzer, Codices Vaticani Latini, II, (1) (Vat.lat.1062 fol.88-92), p.617. Heytesbury's Termini Naturales is quite different from the summary of the Aristotelian books, the Parvulus Philosophiae Naturalis of Peter of Dresden, discussed by M.Grabmann in his "Die Philosophia Pauperum u. ihr Verfasser Albert von Orlamünde," Beiträge z. Gesch.d.Phil.d. M.-A., XX, Heft 2, Münster i.W.1918, pp.29-33.

(151) See text included in the Appendix.

CHAPTER IV

PROBLEMS OF QUANTIFIED SUBSTANCE

One of the most important problems in physical theory concerns the nature and function of quantity. All material substances, with which physics is concerned, are quantified. Change of quantity, as in the phenomena of augmentation, diminution, condensation and rarefaction, has presented physicists of all generations with problems of the greatest difficulty. Further the mathematical sciences are all concerned with quantities abstracted from material substances; certain difficulties arise concerning the nature and origin of such abstract quantities. But greater problems arise in the 'mathematical physical' sciences regarding the precise relation of these abstracted quantities to the physical realities measured. This is particularly important in a Platonic tradition, which sees in mathematics the ultimate explanation of physical phenomena.

For the historian of physical science, however, the problem of quantity is extremely difficult to discuss. The nature of quantity itself is obscure, even though the fact is evident to the senses. And especially in medieval physics, various philosophers viewed the intricate problems of quantity in diverse ways, so that there is scarcely any unanimity of doctrine among 'Aristotelian' Scholastics.

In the early 14th century two relatively new theories of quantity became prominent. One was that of William of Ockham which tended to treat problems of quantity as problems relating to the use of words in statements of fact; this tendency may be called logicalism or terminism. The other was conspicuous among the Mertonian Masters who tended to consider problems of quantity as mathematical ratios and who sought to formulate universal

laws of physical science in terms of mathematical proportionality; this tendency may be called the mathematization of physics. Although these two tendencies in themselves are distinct, in the early 14th century they were not mutually exclusive, especially as John Dumbleton and, to a lesser degree, William Heytesbury represent both tendencies. These 14th century developments, though profoundly different from the earlier scholastic notion of quantity, have their origins in the more ancient problem of the individuality of material substances.

In this chapter we will consider first the early scholastic notion of quantity, principally as exemplified in the problem of individuality. Second we will examine Ockham's 'identification' of matter with extension and its repercussions in the Merton 'school.' Finally we will consider the Mertonian contribution to the mathematizing of quantitas materiae.

I. The Early Scholastic Notion of Quantity.

The scholastic notion of dimensive quantity was based on two fundamental Aristotelian principles, namely its accidental character and its essential divisibility. Quantities, for Aristotle, are not themselves substances, as Plato and the Pythagoreans thought, but are attributes of substances.(1) Although physical quantity is radiated in the same "matter out of which corporeal substance itself comes to be,"(2) that is, 'first matter,' changes in quantitative characteristics such as growth and diminution are accidental changes, because they presuppose a material substance already constituted and quantified.(3)

(1) Metaph., VII, c.2, 1028b16-21.
(2) De Gen. et Corrup., I, c.5, 320b22-23.
(3) Ibid., 320b26-35.

One of the great problems for the scholastic philosophers was this Aristotelian conception of 'first matter' as pure potentiality, formless, without any act, and unextended. The imagination tempted more than one scholastic commentator to conceive this material principle with some kind of act prior to substantial form and with some quantitative characteristics prior to quantity. This is clearly manifest in the scholastic discussion of the problem of individuality.

By definition an individuum was considered to be in itself undivided (numerically one) and divided (numerically distinct) from all others. Such terms as unity, multiplicity, division, undivided, properly belong to the notion of quantity, and not to substance, which for Aristotle was of itself neither one nor many, neither divided nor undivided except through dimensions.(4) For Plato, space had been subsistent dimensionality,(5) conceived as a kind of matter "in quo gignitur."(6) The various positions or dimensions occupied in this "eternal and indestructible" space distinguished one body from another, so that, although the dimensions of occupied space and the dimensions of the physical body were coexistent,(7) no two

(4) Phys., I,c.3, 186a.
(5) Timaeus, 52A-D. Cf. J.A.Weisheipl, "Space and Gravitation," TMS, XXIX (1955), 179-180.
(6) Trans. of Calcidius, n.24. Fragmenta Philosophorum Graecorum, ed. Mullach, Paris 1867, II,178. There can be no doubt that at least scholastic philosophers believed that Plato identified matter with place (cf. J.A.Weisheipl, op.cit., p.180 note 11). "Silva demum ex nativa specie sumit substantiam. At vero locum vocat eam, velut regionem quandam susciplentem speciorum incorporearum intelligibilium que simulacra." Calcidii, Comm. in Timaeum, n.342, ed. Mullach, ibid., II,255. Plato's doctrine of matter and its similarity to occupied space is explained in great detail by John Dumbleton, Summa, P.II,cc.4-5, MS Vat.lat.6750, fol.19rb-20va.
(7) Arist., Phys., IV,c.4, 211b13-29.

bodies could occupy the same dimensions of space without ceasing to be 'two.' Aristotle, however, made a clear distinction between matter and dimensionality. Matter is that potential principle "ex quo compositum generatur," while dimensions are accidental attributes belonging to each individual body.(8) Thus for Aristotle individuality strictly belongs to a concrete material substance, hoc aliquid,(9) arising from the 'division of matter';(10) but bodies manifest numerical distinction one from the other by a spatial distinction of quantity.(11)

One of the strongest influences toward a Platonic theory in scholastic philosophy was exercised by Avicenna. He was aware of Aristotle's doctrine that the individual body is constituted by 'yle,' that is, materia signata, or designata.(12) But under the influence of Alfarabi and the neo-Platonic tradition, he thought that form itself must somehow be individuated by reception into individual matter. In Avicenna's view substantial form receives an intrinsic 'thisness,' a substantial modality derived from quantity, quality, place and position,(13) when form is actually present

(8) Ibid., 211b15-16. Cf. Metaph., VII, c.3, 1029a11-19; De Gen. et Corrup., I, c.5, 320b20-25.

(9) Metaph., VII, c.8, 1033a23-1034a8; also cc.13-15.

(10) The commonly accepted scholastic phrase, "Divisio materiae causa numeri est" (St. Albert, Phys., III, tr.II, c.12, ed.cit., III, 229a), or "numerus sequitur divisionem" (St. Thomas, Summa Theol., III, q.76, a.3 ad 1; I, q.50, a.3 ad 1) is not found verbatim in Aristotle's works, but is based on such passages as Phys., III, c.7, 207b13-14. St. Thomas attributes the phrase "divisio est causa numeri" to John Damascene (In Boeth. de Trin., q.4, a.1, Sed contra, ed. B. Decker, Leiden 1955, 133-4), but Decker was unable to locate the passage (cf. ibid., n.6).

(11) De Gen. et Corrup., I, c.5, 320b21-25.

(12) M.-D. Roland-Gosselin has shown very clearly that the scholastic terms used to designate the principle of individuation, such as signatum, materia signata, designata, etc., are derived from Avicenna's Sufficientia and Metaphysica. Cf. Le "De Ente et Essentia" de S. Thomas d'Aquin (Bibl. Thomiste VIII), Paris 1948, 59-66.

(13) "Accidunt autem ei alia praeterquam haec accidentia, scilicet quia cum fuerit in materia acquiritur ei aliquis modus quanti, et qualis, et ubi, et situs; quae omnia sunt extranea a natura ipsius, quia si hoc

in matter. In other words, Avicenna realised that matter can be designated 'this' only in relation to quantitative accidents, "que comparatio cum remota fuerit destruetur apprehensio ipsa."(14) But by conceding an additional modality to form, rendering it individual, he yielded to the Platonic tradition.(15)

This tendency to seek some kind of formal principle of individuality was continued in the Christian schools from William of Auvergne to Francis Suarez, but it was defended particularly in the Franciscan school, as Roland-Gosselin has shown.(16) Avicenna's view of an intrinsic modality individualising form was developed by Duns Scotus,(17) who conceived it as

(note 13 cont.) quod est humanitas, esset ex hoc predicto modo, vel alio modo quanti et qualis et ubi et situs, tunc ex hoc quod est humanitas, ~~esset ex hoc predicto modo, vel alio modo quanti et qualis et ubi et situs, tunc ex hoc quod est humanitas~~, oporteret unumquemque hominem convenire cum alio in his intentionibus... Ergo forma humana ex sui essentia non debet habere accidentia hec, que solent ei accidere, sed propter materiam habetur cum illis accidentibus, et propter accidentia comparationis que est inter eam et materiam; que comparatio cum remota fuerit destruetur apprehensio ipsa." Avicenna, De Anima, II, c.2, ed. Venetiis 1508, fol.6vb. The whole of this passage is quoted almost verbatim by John of Rochelle, Summa de Anima, P.II, c.35, ed. T.Domenichelli, Prato 1882, 286-7. John of Rochelle followed Avicenna's view more fully than did Alexander of Hales, Bonaventure or Scotus. Cf. ibid., P.I, c.12, ed.cit., pp.116-118.

(14) Ibid.

(15) Algazel's Maqâsid el-falâcifa (a summary of Avicenna's views) presents an inaccurate paraphrase of Avicenna's opinion on this point: "Sed non pervenit hec divisio nisi ex diversitate accidendi esse a dextris, vel a sinistris, vel appropinquandi ad superficiem, vel ad medium vasis; et hoc totum facit debere esse divisionem." Algazel's Metaphysics, P.I, tr.I, div.1, cap.3, ed. J.T.Muckle, Toronto 1933, pp.15-16.

(16) Op.cit., pp.71-81. Roger Bacon, however, as a secular Master manifested his contempt for the whole discussion: "Ista questio est stulta... Et ideo stultitia magna est in huiusmodi questione quam faciunt de individuatione." (Opera hac. ined., fasc.II, Communium Naturalium, ed. R.Steele, p.100, 33; p.101, 18-19). His own view is that, "Creator hanc materiam primam fecit singularem, quia sua proprietas hoc exigit, et hanc formam primam fecit individuam, quia eius natura hoc requirit." (ibid., p.101, 11-14).

(17) E.Gilson has shown Scotus' dependence on Avicenna in other points of his teaching; see his "Avicenne et le Point de Départ de Duns Scot," AHDLMA, II (1927), 89-149.

a certain positive entity, an entitas individualis, or haecceitas.(18) The Platonic problem of how to render common specific nature concretely individual was solved for Scotus by an "ultima actualitas formae," which was neither matter, nor form, nor an accident, but an ultimate modality of form. However, in Scotus' development of Avicenna's view there is no trace of quantity as a determining factor, not even in understanding 'this' substance or 'this' matter.(19)

In his earlier writing Averroes accepted and developed the Avicennian doctrine of individuality through form, and more particularly through forma singularitatis.(20) But Averroes gradually conceived the division of matter to be the only principle of individuation. Faced with the problem of how matter is so divided without quantity and how it is really designata, Averroes developed his significant and influential doctrine of dimensiones interminatae, but such quantity cannot cause individuality: (i) because this quantity is merely an accident and no accident can individualise a substance; (ii) because actual quantity can change, as in augmentation, condensation and rarefaction, without changing the individuality of the body. Therefore, some kind of quantification must belong to 'this' first matter, by which it can become corporeal and quantified.(21) Although the individual body will actually have a given terminated quantity,

(18) II Sent., dist. 3, q. 6, ed. Venetiis 1598, fol. 36r-v; see also E. Gilson, Jean Duns Scot, Paris 1952, pp. 451-466, 676-677.

(19) Scotus rejected the view of Giles of Rome, which sought to explain individuality by quantity alone (Quodl. I, q. 11) and the view of Godfrey of Fontaine (Quodl. VII, q. 5), Henry of Ghent (Quodl. II, q. 8), and Peter of Auvergne (Quodl. II, q. 5), which gave quantity a secondary role of "accidental unity."

(20) Metaph., I, comm. 17; De Anima, II, comm. 8, comm. 9; De Anima, III, comm. 5.

(21) De substantia Orbis, cap. 1, ed. Venetiis 1489 (no foliation). A concise presentation of this doctrine is found in the pseudo-Thomistic treatise, De Natura Materiae, cap. 2, ed. J.M. Wyss, Fribourg 1953, pp. 94-95. Averroes undoubtedly influenced the view of William of Rothwell, OP, who strongly defended the divisibility of matter prior to the accident of quantity (De principiis rerum naturalium, MS Vat. lat. 11585, fol. 192r-v).

the potentiality for actual, variable quantity is unchangeable dimensiones interminatae, which divide 'this' body from every other. The purpose, therefore, of dimensiones interminatae in the philosophy of Averroes is to give meaning to 'this' first matter, since such a designation is necessarily quantitative, and to explain the persistent individuality of matter in all changes, both substantial and quantitative. This will be discussed more fully when we consider the problem of quantitas materiae.

Albertus Magnus was very much preoccupied with the meaning of materia designata seu signata. Repeatedly he insisted that concrete realities are composed of 'this' matter and of 'this' form.(22) At least in his more mature philosophical discussions of the subject, Albert clearly held that a singular matter is the only source of substantial individuality: "hic homo est ab individuatione materiae huius."(23) However, Albert refused to see in first matter any forma completa antecedent to substantial form,(24) or any dimensionality antecedent to forma corporeitatis.(25) But he pointed out that "materia quidem si secundum seipsam accipiatur,

(22) Lib. VII Metaph., tr.III, cap.5 (ed. Borgnet, VI, 458b); cf. ibid., cap.3 (ibid., 454b-456a); Lib.III Phys., tr.II, cap.12 (ed.cit., III, 228a-229b); cap.15 (ibid., 233b); cap.18 (ibid., 236b-237a). It would seem that Roland-Gosselin (op.cit., 94-99) has relied too much on Albert's commentary on the De Anima for his interpretation of Albert's doctrine. Not only was the individuality of the human soul a special difficulty for Albert and for other Schoolmen, but it is well known that in this commentary of 1256 Albert still had not fully realized the implications of Averroes' teaching on the relation between the human intellect and matter. See E.Miller, "An Aspect of Averroes' Influence on St.Albert," Mediaeval Studies, XVI (1954), 57-71.

(23) Lib. VII Metaph., tr.III, cap.5 (ed.cit., VI, 458b).

(24) Lib. I Phys., tr.III, cap.13 (ed.cit., III, 75b-79a); Lib. VIII Metaph., tr.II, cap.6 (ed.cit., VI, 517b-518b).

(25) Lib.I de Coelo et Mundo, tr.III, cap.4 (B.IV, 72b-74a).

ignota est, nec est etiam principium cognoscendi aliquid, nec noscitur et scitur nisi per analogiam ad formam."(26) This material principle cannot be grasped by "aliqua predicatione secundum se, sed potius denominative,"(27) from accidents which, as far as knowledge is concerned, give meaning to 'this' matter as distinct from 'that.'(28) For Albert the principal source of such a designation are quantitative accidents, e.g., dimensive quantity, position in place and time.(29) Quantity is thus not a principle of individuality and plurality, but only of our knowing and designating individuals as one or many.

In his early works St.Thomas Aquinas utilized the terminology of Averroes with some hesitancy,(30) but he never thought of quantitates interminatae as any kind of actuality antecedent to substantial form. Even in his early works 'this' first matter is the ultimate source of individuality "prout subest dimensionibus interminatis,"(31) or "quae sub determinatis dimensionibus consideratur."(32) In the more mature works, when Aquinas abandoned the terminology of Averroes, materia determinata alone and in itself was considered the root of individuality, while quantity became only a means of such a designation, precisely as in the

(26) Lib.VII Metaph., tr.III, cap.5 (B.VI,459a).
(27) Ibid., cap.2 (B.VI,453b).
(28) "Quamvis enim haec materia sit formae particularis et individuationis principium et individui pars substantialis, tamen haec accidentia quamvis non componant substantiam singularem, sunt facientia ad notitiam suae discretionis, ... discrete nomen designetur." Lib. de Praedicabilibus, tr.IV, cap.7 (B.I, 77b-78a).
(29) Lib.XI Metaph., tr.I, cap.7 (B.VI,590b-591b). For Albert just as sensible matter designated by quantitative accidents constitutes individuality in the physical world, so materia intelligibilis designated by different positions in imagined space, constitutes individuality of entia mathematica, cf. Lib.VII Metaph., tr.III, cap.5 (pp.458a-459a), cap.10 (pp.463a-464b) Lib.VIII Metaph., tr.II, cap.4 (pp.513b-514a).
(30) II Sent., d.3, q.1, a.4; d.30, q.2, a.1; IV Sent., d.12, q.1, a.1 sol. 3 ad 3; a.2, sol.4; sol.6 ad 5; a.3, sol. ad 3; dist.44, q.44, q.1, a.1, sol.1 ad 3; In Boeth. de Trin., q.4, a.2.
(31) In Boeth. de Trin., q.4, a.2, ed. B.Decker, p.143, 25-26.
(32) De ente et essentia, cap.2, ed. M.-D.Roland-Gosselin, p.11, 25-6.

doctrine of St.Albert.(33) In other words, dimensive quantity, implying otherness of position and divisibility, has in itself all the intelligibility of individuality and plurality. But since for Aquinas first matter is the source of quantity, quantitative characteristics are thought of (praeintellecta)(34) as designating a purely potential principle called matter, indescribably individual in itself. Hence first matter is a purely potential principle, having no quantity in itself, but necessarily understood as though it were quantified.(35)

Among the propositions condemned at Paris in 1277, three in particular condemned the view of Albert and Aquinas concerning matter as the ultimate source of individuality.(36) Not only did Franciscans follow the "positio sobria et catholica"(37) which explained individuality by a singular form created or produced individually by God, but secular masters as well sought

(33) Roland-Gosselin may be correct in seeing in the early works of Aquinas a twofold principle of individuality, matter and quantity; but it may be doubted whether this represents accurately the teaching of St.Thomas. Father Roland-Gosselin believes (op.cit.,115-126) that in the definitive position of Aquinas matter and quantity constitute a dual principle of individuality; matter conferring ontological unity, and quantity conferring numerical unity. This, however assumes that for Aquinas concrete first matter has an intelligiblity apart from quantitative designations; but potentia pura for Aquinas is completely unintelligible, except in reference to actuality (Sum.Theol.,I,q.86, a.2 ad 1; In I Phys.,lect.13,n.9; lect.15,n.10; In VIII Metaph.,lect.1, n.1687). When St.Thomas speaks of dimensive quantity as "quoddam individuationis principium" (Sum.Theol.,III,q.77,a.2), he means, it would seem, that intelligibility and manifestation of individuality depend upon quantity; in the case of the Eucharist, where there is no first matter, the function of quantity is maintained, but this does not mean that quantity is an independent source of individuality (cf. Quodl.I,q.10,a.1-2; Quodl. VII,q.4,a.3.

(34) "...consideretur cum determinatione dimensionum, harum scilicet vel illarum." Quest.Disp. De Veritate, q.2,a.6 ad 1.

(35) "Dimensiones quantitativae sunt accidentia consequentia corporeitatem, quae toti materiae convenit. Unde materia iam intellecta sub corporeitate et dimensionibus, potest intelligi ut distincta in diversas partes." Sum.Theol.,I,q.76,a.6 ad.2.

(36) Chart.U.P., I,n.473, propositions 96, 81 and 191.

(37) St.Bonaventure, II Sent.,dist.3,P.I,a.2,q.1 (ed. Quaracchi II,103b); see also Roger Marston, Quaestiones Disputatae de Anima, q.2 (ed.

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such an explanation in form. Henry of Ghent was willing to grant that matter and quantity together individualise material substances, but in spiritual substances individual subsistere must be the explanation.(38) Godfrey of Fontaine(39) and Peter of Auverne(40) sought to explain individuality of quantified substances by a dual principle; individual form and quantity. For them essential, or ontological unity is due to individual form, and accidental unity due to the accident of quantity.(41) Even the Averroist, John of Jandun, was more Avicennian in defending forma individua as the source of numerical unity in material substances.(42)

Peter John Olivi OFM phrased the problem in the traditional Platonic way when he asked, "An individuatio aliquid addat ad essentiam individui specifice acceptam."(43) In the final version(44) of his question on the Second Book of the Sentences, written after 1283, Olivi lists the great variety of opinions concerning the principle of individuation, but he is primarily concerned with whether or not individuality adds anything real to the specific essence. He argues at great length to show that nothing

(note 37 cont.) Quaracchi 1932, pp. 231-35); William de la Mare, Declarationes Magistri Guilelmi de la Marre OFM de variis sentiis S. Thomae Aquinatis, ed. F. Pelster (Opuscula et Textus, fasc. XXI, Münster 1956), nn. 10, 12, 13, 22, 53; William de la Mare, Correctorium, ed. P. Glorieux, Le Correctorium Corruptorii 'Quare', (Bibl. Thom. IX), nn. 8, 10, 11, 27-30, 87; Peter John Olivi, Quaestiones in II Sent., q. 33, ed. B. Jansen (Quaracchi 1922) I, 597.

(38) Henricl a Gandavo, Quodlibeta XI, q. 8, Paris n.d., fol. 32-33.

(39) Godefroid de Fontaines, Quodlibetum VII, q. 5 (Les Philosophes Belges III), ed. M. De Wulf et J. Hoffmans, 320-336.

(40) Quodlibetum II, q. 5, ed. E. Hocedez, Revue Néo-scholastique, XXXVI (1934), 370-379.

(41) Cf. E. Hocedez, "Une Question inédite de Pierre d'Auvergne sur l'individuation," Revue Néo-scholastique, XXXVI (1934), 335-365.

(42) Ioannis de Ianduno, Super Octo Libros Arist. de Physico Auditu Subtilissimae Quaestiones, Lib. I, q. 24, ed. Venetiis 1522, fol. 20va-21rb.

(43) Quaestiones in Secundum Librum Sententiarum, q. 12, ed. cit., I, 210-231.

(44) Ibid., Introd. vii.

real can be added, but verbally he defends the conclusion: "Alia autem opinio est praedicta multo communior et solemnior, prout credo, quod individuatio aliquid addat ad essentiam individui."(45) Olivi ends his discussion by saying, "Quid autem de istis opinionibus verius sit, sapientiorum iudicio derelinquo."(46) There can be no doubt that although Olivi verbally accepted the common view that there is some difference between individuality and the essential nature, "quia solemnior et communior est," he himself was inclined to believe that there is no difference. But for Olivi this meant an absence of distinction, not between the universal nature and the individual, but "inter individuans et individuatum,"(47) as his arguments clearly show. This means nothing more than that in Olivi's personal view individual material substances are in seipsis individual. This doctrine was, in fact, later explicity defended by Ockham.

In his Quaestiones super libros Physicorum, written between 1321-1323,(48) John Marbres (Johannes Canonicus), Master in Arts of Toulouse and Canon of

(45) Ibid., p.226.
(46) Ibid., p.231.
(47) Ibid., p.226.
(48) Against E.Longpré's contention that Johannes Canonicus belonged to the early 15th century, Miss A.Maier has proved beyond any doubt that the Quaestiones were written between 1321-1323. Cf. A.Maier "Verschollene Aristoteleskommentare des 14. Jahrhunderts," Autour d'Aristote (offert à Mon. A. Mansion), Louvain 1955, 517-518; see also Studien, III, 86 note 66. L.Baudry was led to date the composition of the Quaestiones between 1329 and 1342 because the printed editions refer to Gerard Odonis as "generalis minister minorum" (e.g., Lib.I, q.9; Lib.II, q.1). See L.Baudry, "En Lisant Jean le Chanoine," AHDLMA, IX (1934), 188. But this designation is not found in MSS Peterhouse 188, Balliol College 96, Vat.lat.303, or in any others examined.

Tortosa,[49] followed Duns Scotus in explaining individuality by haecceitas, or a determined grade of entitative singularity.[50] But against Thomas Wilton, Marbres maintained that matter has its own existential act, so that by divine omnipotence first matter can exist without any form.[51] Further against Wilton, Marbres maintained that Matter has its own quantitative parts (quantitates indeterminatae) independent of the plurality of parts conferred by the accident of quantity.[52] According to the view preserved by John Marbres, Wilton rejected the Averroist doctrine of

(49) P.Duhem has shown that Johannes Canonicus was a Catalonian master in arts of Toulouse, and not an Oxford master, from internal evidence patent in the printed edition of Venice 1492 (cf. Le Système du Monde, VI,386-396). The phrase, however, opinio quinadam solennis baccalaurei cathalani (Lib.I,q.1, ed. Venetiis 1492, fol.2va), noted by Bendry (ibid) and others, directly proves nothing. An English manuscript of the 15th century, Balliol College 96, has a corrupted colophon (fol.102) which reads: "Explicitunt questiones super 8 libros phisicorum compilate a denino Marlo[is] mag. in artibus Tolose ac canonico de Timsey." An English scribe may very well have read Marlo[is] for Mard[ns], and de Timsey for dertusensis. But there is no evidence that he, under the name of John Canon, was an immediate disciple of Scotus at Oxford, as Wadding asserts (Scriptores Ord.Min., Romae 1906,p.132), or that he was a Franciscan, as all authorities seem to assume. He could not have been a Franciscan while he was Canon of Tortosa, nor while he was lecturing in Arts at Toulouse.

(50) Joannis Canonici, Super octo libros Physicorum Quaestiones, ed. Venetiis 1492, Lib.I,q.VI, fol.18rb.

(51) "...pono istam conclusionem: quod materia dicit aliquam entitatem actualem et aliquam entitatem determinatam et distinctam a forma." (ibid.,Lib.I,q.II, fol.23rb) "Et sciendum quod fuit una opinio et est adhuc Thomas /Anglici/ et omnium sequentium eum, qui ponit partem negativam, scilicet quod per nullam potentiam materia est separabilis ab omni forma... Ista opinio non placet. Pono ergo istam conclusionem: quod materia est separabilis ab omni forma sive substantiali sive accidentali." (ibid.,fol.23rb-23va). I have collated these passages of the printed text with MS Peterhouse 186.

(52) "Sequendo ergo opinionem Geraldi Odonis, dico quod quantitas indeterminata est pars seu pluralitas partium materiae; quantitas vero terminata est ordo seu ratio partium." (ibid.,fol.24vb).

quantitates interminatae, and held that matter has no plurality of parts except through quantity.(53) If this indeed was Wilton's position, then Marbres was more "Averroist" than Wilton, who is generally taken to have been an "Averroist."

A survey of the problem of individuality in material substances before the time of William of Ockham clearly shows the variety of views concerning the nature of quantity. Even apart from the Platonic influences on Scholastic thinkers, the impossibility of conceiving a purely potential principle except in reference to some actuality led many Schoolmen to think of 'first matter' as having some kind of act, or form in its own right. And the impossibility of imagining the potentiality of matter apart from such quantitative characteristics as unity, amount, position in space and time, led certain thinkers to attribute to 'first matter' a kind of quantity antecedent to the Aristotelian accident of quantity. This multiplication of quantities prepared the way for Ockham's denial of any distinction between quantity and material substance. The opinions "secretly approved" by Peter John Olivi were systematically developed by Ockham. The pseudo-problem of the platonic tradition was denied and the individuality of material substances ceased to be a problem for Ockham and his successors.

(53) "Tertium dubium est, si materia habet partes preter quantitatem, ita quod habeat partes distinctas a partibus quantitatis. ... Una opinio est Thomae Anglici, in qua Aureolus et multi alii videntur concordare, qui ponit quod ipsa materia non habeat partes distinctas a partibus quantitatis, ita quod imaginatur quod substantia est causa subiectiva quantitatis; quantitas autem est causa formalis per quam substantia est divisibilis ut habeat partes, ita quod preter quantitatem non est illa partibilitas.... Ista opinio non placet. Et ideo dico aliter quod ipsa materia habet partium pluralitatem preter quantitatem et ante quantitatem..." Ibid., fol.24va. P.Glorieux (Répertoire..., I,461) lists a commentary on the Physics as a doubtful work of Wilton, MS Cesena, Bibl.Malatestiana, Plut.VIII sin.cod.2. I have not seen this work, but the Quaestiones of John Marbres would prove a useful guide to judging the authenticity of this commentary as a work of Thomas Wilton.

II. The Notion of Quantity According to Ockham and His Successors.

The basic principle of Ockham's natural philosophy is that only individual *res absolutae* are existing realities; everything else is merely a name, a term. But for Ockham there are only two *res absolutae*: substance and qualities. "Praeter res absolutas, scilicet substantias et qualitates, nulla res est imaginabilis, nec in actu nec in potentia."(54) Since for Ockham quantity is not a *res absoluta* distinct from substance or quality, quantity is identified in part with substance and in part with quality.(55) Matter and form, the components of material substances, cannot be imagined except as extended, nor can they naturally exist except as essentially quantified and extended in space; they need no distinct *res* called 'quantity' to render them extended. Sensible qualities, such as colour, heat, shape, and weight, are likewise quantified in their own right, and not by some 'quantity' in which they inhere.(56) Similarly, numbers, points, lines and

(54) *Summa Logicae*, P.I, cap.49, *ed.cit.*, p.141, 21-22. This fundamental Ockhamist doctrine was clearly recognized by Francis de Meyronnes in his *Quodlibet* disputed about 1322: "Et istis adiungitur avaritia mira quorundam quod nullum ens reale volunt ponere nisi cogantur, et dicunt quod non possunt cogi nisi ad substantiam et qualitatem, omnibus aliis predicamentis positis tantum secundum rationem." Q.6, ed. Venetiis 1520, fol.235, where the editors have noted in the margin, "Contra Ockam et sequaces."

(55) "Ideo dico... quod quantitas non est res distincta realiter a substantia et qualitate, sed aliqua quantitas est realiter eadem cum substantia, et aliqua quantitas est realiter eadem cum qualitate." *De Sac. Altaris* I, q.3, ed. Birch, p.114, 23-27. Also II, cap.17, ed. Birch, pp.246-250; *Sent.*, IV, q.4 G.

(56) *Summa Logicae*, P.I, cap.44, *ed.cit.*, p.124, 94-107. It would seem that Ockham was led to this position principally by Peter Lombard's quotation from Hugh of St.Victor (*Sum.Sent.*, tr.6, cap.4, PL 176, 141) that the qualities of taste and weight in the Blessed Sacrament remain "per se subsistentia" (*Sent.*, IV, dist.12, cap.1, ed. Quaracchi 1916, p.906) and by the gloss on *Decretum Gratiani*, dist.2, cap.27 (ed. Lugduni 1609, p.1928): "ponderositas remanet ibi cum aliis accidentibus, tamen nihil est ibi ponderosum." (cf. *Summa Logicae*, *ibid.*, *De Sac.Altaris* II, cap.21, ed. Birch, pp.266-276).

surfaces are terms expressing an aspect of quantity, and not realities distinct from material substances and quantified qualities.(57)

Miss Maier has shown(58) that the source of Ockham's doctrine of quantity is Peter John Olivi. Although he did not openly disapprove the common opinion, it seems that he secretly upheld the view that "quantitas non dicit rem absolutam aliam a substantia."(59) The opinions which Olivi presented without refutation concerning substance, quantity, motion and time were adopted without hesitation by Ockham in his systematic philosophy of nature.

The reportatio of Book IV of the Sentences, q.IV, "Utrum corpus Christi realiter sub speciebus panis contineatur," is perhaps the earliest ex professo defence by Ockham of the identification of quantity with substance and quality:(60)

> Ideo primo videndum est quid sit quantitas. Dico hic tenendo quod quantitas nullam aliam rem absolutam vel respectivam a substantia et a qualitate dicit. Dico tunc quod quantitas non est aliud nisi extensio rei habentis partes a quarum una ad aliam potest esse motus localis, ita quod sicut in 2° dictum est de durationc, quod duratio nihil positivum dicit ultra rem durantem, sed est quedam vox vel conceptus significans principaliter

(57) Summa Logicae P.I, cap.44, ed.cit., p.124, 108-133; De Sac.Altaris I, qq.1-2 (per totum).
(58) A.Maier, Studien, IV, 153-175.
(59) "Quoniam autem ex quadam opinione, quam de quantitate inter ceteras aliquando recitavi, absque tamen assertione aliqua, imponitur michi ab isto [Fratre Arnaldo] et ab eius consentaneis, quod ego opiniones aliquas ridiculosas et periculosas recito dimittendo rationes earum insolutas, ex quo videor occulte eas approbare..." (quoted by Maier, ibid., 160). Cf. Olivi, II Sent., q.58, ed.cit., II, 440-449; Tractatus de quantitate, in edition of Quodlibeta, Venetiis n.d., fol.49v-53.
(60) Sent., IV, q.IV C. The text of the printed edition has been collated with MSS Oxford, Balliol College 299, fol.180va (= IV, q.1) and Merton College 100, fol.186va (= IV, q.6). In all of my quotations from Ockham's Sentences I have generally given preference to the reading found in Balliol College MS 299, a very good text written before 1368.

> ipsam rem durantem et connotat successionem actualem vel potentialem, ita quod significat rem coexistentem successioni actualiter vel que coexisteret successioni si esset, ita extensio vel quantitas non dicit aliquam rem absolutam vel respectivam ultra substantiam et qualitatem, sed est quedam vox vel conceptus, significans principaliter substantiam, puta materiam vel formam vel qualitatem corporalem, et connotans multas alias res inter quas potest esse motus localis, si talia essent, ita tamen quod tota substantia vel qualitas coexistit toti corpori extrinseco vel toti loco et pars una substantie uni parti loci et alia alteri et sic deinceps, ita quod posset esse motus localis inter unam partem substantie sic coexistentem loco et aliam existentem alteri parti loci.

Ockham presents two arguments to prove that quantity is not a forma absoluta distinct from substance and quality. First, Ockham argues, if quantity were a distinct form, it would have to inhere in some subject; but this subject cannot be matter or form, since there is no more reason for inherence in one than in the other, nor can that subject be the composite of both, since the immediate subject of every accident must be as simple as the accident itself. "Hoc nunc suppono, post probabitur et prius fuit probatum in tertio."(61) Second, Ockham adds, matter, form and quality are themselves quantum et extensum sine omni extrinseco, and therefore do not need to be extended by a distinct accident called quantity. He defends this contention with regard to matter for two reasons: (i) Matter existing under substantial form is already extended in place and position, since any part of matter can be annihilated without affecting the other parts; thus "circumscripta quacumque forma de mundo, adhuc una pars materie distinguitur ab alia, quia seipsa et per aliquid sibi intrinsecum." (ii) By

(61) These references are not necessarily part of the original text; certainly not if, as Maier suggests, the reportatio of Book IV is chronologically prior to Books II and III. The references may have been inserted later by Ockham or by a scribe. In any case they are not clear. In Sent.III,q.6 G, Ockham rejects the view (held by Wilton) that accidents are composed like substances, but Ockham merely says, "quod suppono esse falsum ad presens." (See also De Sac. Altaris I,q.3, ed.cit., 112,15-26, where no reason is given.) The explanation given in the Tractatus de principiis theologie attributed to Ockham (ed.cit., pp.142-3) has not been located in the Sentences.

His absolute power God can preserve in existence "omne absolutum prius alio per se, nulla facta mutatione circa primum absolutum;" thus even if God annihilated all quantity posterior to a certain matter existing in Oxford or in Rome, that matter would still be "circumscriptive in loco," i.e., it would still be where it was before the quantity was annihilated.(62) Therefore matter is of itself extended in place and position. Since quantity, strictly speaking, is that which has part outside part in place and position, in such a way that the whole corresponds to the whole place and part to part, matter is of itself naturally extended, "sine omni alio absoluto." Ockham adds that the same arguments can be applied to substantial form and to quality.(63)

Ockham is careful to insist that extension naturally belongs to the nature of matter, substantial form and qualities, for God can by His absolute power preserve the distinct parts of matter, form and qualities without extension in space,(64) as He does in the case of Christ's Body and Blood in the Eucharist.(65) God could by His power make all the parts of the material universe exist simul, as in a point, in such a way that the distinct parts would be without extension, without quantity.(66) In condensation and rarefaction the area of space occupied changes, and by God's absolute power could be eliminated altogether.

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(62) This is the famous "argumentum theologicum" of Ockham.
(63) "Et sicut argutum est de materia, ita eodem modo dicendum est per omnia de forma substantiali et qualitate." Sent.,IV, q.4 G.
(64) "Deus potest conservare materiam et formam sine quantitate et omni extensione, et tamen tunc habent partes realiter distinctas, licet non extensas; igitur eodem modo potest qualitas habere plures partes sine omni extensione." Sent.III,q.6 E.
(65) Sent.IV,q.4 N. Cf. De Sac.Altaris II,cap.VI.
(66) Sent.IV,q.4 H; also q.6 J.

The two treatises De Sacramento Altaris,(67) written, at the earliest, after the reportatio of the Fourth Book of the Sentences, are directed principally to answering certain objections of a quidam doctor modernus who held that the identification of quantity with substance and quality was "contra Philosophum...contra communem opinionem doctorum...contra experientiam...etiam contra rationem."(68) This quidam doctor, as Miss Maier has shown,(69) is none other than Richard of Mediavilla OFM, who raised these objections in his commentary on the Sentences (revised c.1295) against the doctrine of Peter John Olivi.(70) To the six objections of Richard of Mediavilla quoted in the first Tractatus de Sacramento Altaris, Ockham added three more; these last became objections i to iii of the second Tractatus, while the original six became objections vi to xi, the remaining two being theological arguments from authority. In the second Tractatus each of these objections receives detailed consideration in Chapters 31 to 40.(71) Apart from the arguments drawn from authority, Richard of Mediavilla

(67) It is difficult to determine the chronological relation between these two treatises. The treatise found in second place in the printed editions (and which I call the "second" treatise) is much longer and more detailed than that found in first place. For this reason and the fact that Francis de Marchia attacked the longer treatise in his commentary on the Sentences (1319-1320), A.Maier believes that the longer treatise is earlier in composition (cf. Studien IV, 182 and 203). But one might equally argue that the shorter treatise is an early version which was not widely circulated (4 MSS known) until the printed editions; the internal structure of the longer treatise would seem to suggest that this is a revision and amplification of the "first" treatise. See below note 7197.

(68) De Sac. Altaris I, q.3, ed.cit., pp.116-120; II, cap.30, ibid., pp.354-358. The passage is also quoted by A.Maier, AFH, XLVI (1953), 178-179.

(69) A.Maier, ibid., 178-181.

(70) Richardi de Mediavilla, Comm.in Lib.Sent., IV, dist.12, a.1, q.1. The passage is quoted by Maier (ibid) from the printed edition of 1591, Brescia.

(71) The new edition of the two treatises De Sacramento Altaris by T.B. Birch offers little help in following Ockham's reasoning. A schematised arrangement of the objections raised in the two treatises may be an aid in reading the text and in showing the dependence of the two treatises:

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raised three salient objections to the doctrine of Olivi: (i) in a condensed body there is less quantity, but no loss of material parts; (ii) there is no difference between the length, width and depth of a measure of air and the same measure of water, even though their subjects are different; (iii) if matter, form and qualities each had their own dimensions, then many solids would exist simultaneously in the same place.(72)

Defending his own doctrine in the two treatises, Ockham elaborates the arguments already given in his commentary on the Sentences; his arguments rest ultimately on the principle, "Deus potest conservare rem priorem sine mutatione locali ipsius et destruere rem posteriorem."(73) That is to say, even if God divested a given quantified substance of everything but matter,

(note 71 cont.)

Tract.I,q.3,ed.cit.	Tract.II,c.30,ed.cit.	Resp.Tr.II
Add. obj.1 (p.118, 22-26)	= obj.1 (p.354,6-10)	
Confirmatur (p.118, 27-p.120,4)	= obj.2 (p.354,11-17)	Cap.31
Add. obj.2 (p.120, 4-7)	= obj.3 (p.354,18-20)	
	obj.4 (p.354,21-356,9)	Cap.34
	obj.5 (p.356,10-16)	
obj.1-6 quidam doctorin (p.116,22-118,21)	= obj.6-11 (p.356,17-358,29)	Cap.35-40

(72) Tractatus de Sac. Altaris II,cap.30: "/Obj.8/ Item est contra experientiam, quia cum substantia corporea denatur /not: dividatur/ absque conversione alicuius rei in ipsam, efficitur minoris quantitatis absque alicuius suae partis amissione... /Obj.9/ Item in diversis substantiis differentibus specie est eadem quantitas specie; non enim est alia longitudo seu latitudo /vel profunditas/ specie in pugillo aeris et ignis... /Obj.11/ Item impossibile est naturaliter unum corpus, quod est quantitas, esse simul cum alio corpore quod est quantitas, quia dimensiones mutuo se expellunt. Sed qualitas simul est cum substantia..." ed.cit.,pp.356-9. These objections of Richard of Mediavilla are also raised and answered in Ockham's Quodlibeta IV,q.25, ed. Paris 1487.

(73) De Sac.Altaris I,q.3, ed.cit.,96,19-21; De Sac.Altaris II,cap.12, ed.cit.,pp.218-220; Sent.IV,q.4 G; Quodl.IV,q.25; Summa Logicae P.I, cap.44.

that matter would still exist in the same place as before; therefore extension in place belongs to the nature of matter. But on this basis it would seem that condensation and rarefaction present a difficulty. In the first Tractatus, however, Ockham proposed the phenomena of condensation and rarefaction as an additional argument, holding that since no parts of matter are lost or acquired, "eadem quantitas numero" remains, but now occupying a larger or a smaller place; and this is the same difficulty which concerns substance.(74) In his reply to Richard of Mediavilla's objection Ockham claimed that nothing "absolute" is generated or corrupted in condensation and rarefaction; therefore condensation means nothing more than that "the parts are moved locally so as to occupy a smaller place now than before and one part now is less distant from another than before."(75) In the second Tractatus he referred to the phenomena only in his answer to the objection raised by Richard, arguing that since no parts are acquired or lost, there is no generation or corruption of any res absoluta (quantity); therefore "without corruption of any absolute reality, the identical thing, which first was of greater quantity, is afterwards of less quantity, because the parts of that thing were at first more distant one from the other than now."(76) But this is no longer the "eadem quantitas numero" defended in the first Tractatus.

(74) "Sexto arguitur sic: quando ex denso fit rarum, quaero aut est ibi nova alia quantitas aut non; sed praecise est eadem quantitas numero; ... Si sit eadem quantitas, tunc sine variatione absoluti coexistit maiori loco nunc quam prius; sed hoc inconveniens ponitur de substantia; igitur frustra ponitur talis quantitas distincta a qualitate et a substantia." De Sac.Altaris I,q.3, ed.cit.,p.114.

(75) "Unde per hoc solum, quod omnes partes sic moventur localiter ut occupent minorem locum nunc quam prius et una pars minus distet ab alia nunc quam prius, condensatur tota substantia, nec aliud est substantiam condensari." Ibid.,p.130,6-10; cf. p.136,13-19.

(76) "sine omni corruptione rei absolutae eadem res, quae primo erat maioris quantitatis, est postea minoris quantitatis per hoc, quod partes eiusdem rei magis distabant situaliter prius quam nunc." De Sac.Altaris II,cap.37, ed.cit.,p.454,19-22.

Ockham, thus, never appreciated the difficulties involved in the problem of condensation and rarefaction. He was more anxious to show that if bodies by natural condensation could retain distinction of parts under less quantity, the Body of Christ in the Eucharist could have distinct parts without any quantity.(77) Thus 'quantity' was conceived as nothing more than a name, a term, signifying matter itself (or form or qualities) and its relation to place, even though that matter be unextended, i.e., without dimensions. Condensation and rarefaction, therefore, are terms signifying statements of actual fact, that is, statements of whether more or less space is occupied now than before. But if quantity is identical with matter, how can that matter exist without quantity, without extension? Ockham appealed to the absolute power of God to reconcile the apparent contradiction, but this evades the scientific problem.

Ockham's doctrine of quantity was immediately attacked by his contemporaries. In his lectures on the Sentences, given at Paris during the academic year 1319-20, Francis de Marchia OFM attacked Ockham's doctrine in his discussion of the Eucharist.(78) It would seem that Marchia had in mind Ockham's second treatise De Sacramento Altaris.(79)

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(77) In Ockham's theology the quantified substance of bread is annihilated in consecration, the qualities of bread remain per se subsistentia without any 'subject' (cf. above note 56), and the distinct parts of Christ's Body are present without extension in space. Cf. Sent.IV, q.4 G; IV, q.6 J; De Sac. Altaris I, q.3, ed.cit., pp.142-154; De Sac. Altaris II, cap.37, p.456; cap.41, pp.482-506.

(78) Cf. A.Maier, AFH, XLVI (1953), 174-178; Studien, IV, 200-209.

(79) This is the view of Miss Maier (Ibid., p.177; Studien, IV, 203). She also considers Ockham's "first" treatise to be a reply to Francis de Marchia; thus she interprets aliqui moderni, mentioned by Ockham, as including Francis de Marchia. The evidence, however, for this chronology is not sufficiently conclusive.

In his commentary on the Physica, lib.I, text.15, written about 1324, Walter Burley presents Ockham's arguments, drawn mainly from the two treatises De Sacramento Altaris and the Expositio in lib. Physicorum, and refutes them at great length.(80) Burley repeats the objections of Richard of Mediavilla,(81) but he also attacks the fundamental weakness of Ockham's "theological argument." He points out that it is impossible to conceive a body in place except through quantity.(82) Therefore, if God by His absolute power removed quantity and all consequent attributes, that body could not be said to exist in any place, either in Oxford or in Rome. Furthermore, Burley insisted that extension in space belongs to the very notion of quantity, even mathematical quantity (and not to the notion of substance); a quantified substance which is not extended in place would cease to be quantified.(83) Burley considered Ockham's view to be hostile to mathematics as well as to natural philosophy.(84)

Among the 56 articles submitted to the Holy See by John Luttrell in 1324 three involved Ockham's doctrine concerning the Eucharist, but only one directly expressed his view of quantity: "Duodecimus articulus: Quod tam quantitas continua quam discreta sunt ipsa substantia."(85) The

(80) Burlaei, Expositio in libros Physicorum, Lib.I, text.15, ed. Venetiis 1501, fol.13rb-15va.
(81) Ibid., fol.14vb.
(82) "Et eodem modo dico ad aliam rationem, quando dicitur quod contingit intelligere substantiam quiescentem in eodem loco, illa circumscripta per intellectum, etc., dico per interemptionem quia non contingit intelligere substantiam occupantem locum nisi intelligatur quantitas et etiam locus, que sunt tamen res posteriores in esse." Ibid., fol.15rb.
(83) "...ut dicit Commentator 1° De Gen. cap. de tacto, quod forme mathematice non abstrahunt a loco sicut aliis accidentibus, quia si essent separate adhuc occuparent locum. Propter ista et multa alia videtur mihi quod quantitas de se habeat partem extra partem." ibid., fol.15va.
(84) Cf. ibid., fol.15rb-va.
(85) Ed. J.Koch, MTAM, VII (1935), 375, 26-27. Luttrell's reason for listing the article as erroneous (ibid., 379, 13) is peculiar and was not followed by the Magistri.

commission of theologians appointed by John XXII retained this article in their list of 51, but altered its phrasing twice.(86) The response of the masters, however, was basically the same in both processes, namely that it was contrary to the common opinion of philosophers and contrary to the teaching of the Church which declares that in the Eucharist only the substance is changed.(87)

Miss Maier has already pointed out that Ockham's identification of substance and quantity was rejected by Francis de Marchia in his commentary on the Sentences (1319-20) and by Jean Buridan in his commentary on the Physics (c.1328) precisely because of the difficulties in explaining condensation and rarefaction.(88) In presenting Ockham's opinion Buridan notes, "ponunt enim multi, specialiter moderni, quod omnis res extensa est magnitudo propter auctoritates et rationes factas prius," but in defending his own position Buridan always speaks of quantity as distinct from substantia or from materia et forma and from qualities. Nicole Oresme also rejected Ockham's identification because he considered locomotion to be insufficient to explain condensation and rarefaction.(89) However, at Paris Ockham's doctrine was accepted by Albert of Saxony, and probably by Marsilius of Inghen. Later Parisian masters usually discussed the question under the form, "Utrum omnis res extensa sit quantitas seu magnitudo." This formulation of the question often facilitated an Ockhamist answer.

At Oxford the reaction to Ockham's doctrine of quantity is not so clear.

(86) Ed. J.Koch, RTAM, VIII (1936), 177, 28-34. It is listed as article 9 in the first list, and as article 21 in the second.
(87) Ibid., p.178, 1-12.
(88) A.Maier, AFH, XLVI (1951), 174-177; Studien IV, 209-216.
(89) Cf. A.Maier, Studien IV, 218.

Walter Burley's short treatise De formis[90] was probably written at Paris, as was his Expositio in libros Physicorum.[91]

Richard Fitzralph, a Fellow of Balliol during his course in Arts, raises the question in his lectures on the Sentences delivered at Oxford during the academic year 1328-29.[92] He notes that there are two opinions concerning quantity.[93] One view is that of Aquinas, namely that quantity

(90) "Modo restat dicere ad rationem fundamentalem opinionis contrarie. Cum dicitur Deus potest facere substanciam corpoream sine quantitate corporea, ipsa substancia manente in eodem loco remanentibus omnibus partibus... dicendum quod Deus potest destruere omne accidens in substantia et conservare illam substantiam cum omnibus partibus suis, sed non in eodem loco, quia destructa quantitate per quam substantia est in loco, non remanebit substantia in loco circumscriptive, cum non habeat partem extra partem." Tractatus de formis, MS London, Lambeth Palace 70, fol.132va.

(91) See above, Chap.II, pp.59-63

(92) Cf. A.Gwynn, The English Austin Friars in the Time of Wyclif, Oxford U. Press 1940, p.80.

(93) Richardi Radulphi Armachani, Questiones in P.Lombardi Sententias, Lib. IV, q.2: "In isto articulo igitur, ut videtur, est duplex opinio. Una opinio est opinio Thome, scilicet quod quantitas est alia res a substantia et a qualitatibus, et est communiter omnium doctorum. Et secundum hoc ponunt quod omnia accidentia in sacramento altaris preter quantitatem sunt subiective in quantitate, et quod ipsa est sine subiecto et habet virtutem per potentiam Dei; et secundum istam opinionem vacuantur argumenta multa et plures difficultates que non ita salventur ponendo quod quantitas non est aliud a substantia et a qualitate; et hec opinio dicit Doctor Communis 4 lib., dist.12, a.1, q.1. Alia est opinio modernorum ponentium qualitatem esse quantum per se et similiter (?) quamlibet rem naturalem, nec ponit aliam quantitatem preter substantiam et qualitatem. Et secundum istam opinionem oportet dicere accidentia omnia in sacramento altaris manere sine subiecto proprie dicto, sicut dicit Doctor Subtilis... non videtur mihi nunc esse sustinendam, quia hic /sic/ magis pertinet ad alias scolas." MS Oxford, Oriel College 15, fol.111rb. The Eucharistic controversy between the time of Ockham and Wyclif involved two essentially distinct questions, not always distinguished by historians: (i) the nature of "transubstantiation," (ii) whether quantity is the "subject" of the other accidents. It is this second question to which Fitzralph refers (cf. above note 50; H.B.Workman, John Wyclif, Oxford 1926, II,31-41). However Aquinas himself never considered quantity to be a "subject" proprie dictum; the other accidents inhere in quantity sicut or tanquam in subiecto (cf. IV Sent., dist.12, q.1, a.1; Sum.Theol., III, q.77, a.1-2; Sum.Contra Gent., IV, c.63).

is a distinct reality from substance and qualities, and that in the Eucharist accidents subsequent to quantity inhere subiective in quantitate, which by divine power exists without any subject. The other opinion is that of the moderni who consider quality and every natural thing to be quantum per se, and who reject every quantity distinct from substance and quality; according to this view one must say that the accidents in the Eucharist remain without any subject properly so called. Fitzralph did not discuss the problem in any detail in his lectures on the Sentences, but he was inclined to reject the Ockhamist view: "non videtur mihi nunc esse sustinendam, quia hec magis pertinet ad alias scolas." Obviously in his view this question pertains to the Faculty of Arts, but whether he ever discussed this problem in his philosophical writings, we do not know.

The Mertonian writings on physics known to us are rarely concerned with an explicit discussion of this question; they are concerned rather with a different sort of question, namely with the type of proportionality found in all physical motions, including condensation and rarefaction.

John Dumbleton, however, discusses the question explicitly in his Summa, Part II, chapter 10, where he asks, "numquid materia prima habeat ex se longitudinem et latitudinem."(94) After a series of arguments drawn from the authority of Aristotle and Averroes to show that first matter is pure potentiality, having no determination of form or quantity, Dumbleton presents only one, though significant, argument sed contra:

(94) MS Vat.lat. 6750, fol.22vb-23vb. The text has been checked with MSS Cambridge, Peterhouse 272, Oxford, Merton College 306 and 279, Magdalen College 195, and Vatican, Pal.lat.1056. The chapter divisions vary considerably in the MSS, but it will be practical to use that found in Vat.lat.6750 throughout our study; only significant variations from this text will be noted.

> Si materia prima in se sit indivisibilis in sua natura, tunc ipsa non posset fieri divisibilis. Consequens falsum, quia tunc non pateretur naturaliter ab aliqua potentia naturali immediate, nisi ponendo quod reciperet formam indivisibilem, ut dicitur de intellectu hominis quod recipit intentiones indivisibiles.

To this argument some have said that the indivisibility of first matter is due to the absence of quantity, but one might reply that the quantification imposed upon matter would then be violent and unnatural, "quia illud quod est indivisibile naturaliter non est subiectum naturale alicuius divisibilis."

In his answer to the original question Dumbleton first examines "utrum quantitas realiter distinguitur a rebus quantis, ut caliditas a re calida, puta a subiecto calido." In a series of arguments designed to show that "quantitas non distinguitur a re quanta"(95) Dumbleton consistently returns to the principle that it is impossible for an indivisible thing to become divisible.(96) Briefly, for Dumbleton all bodies are naturally divisible;

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(95) "Quia si sic sit, sit A una longitudo que sit linea, et sit B una superficies. Tunc A et B sunt duo accidentia diverse speciei. Vel igitur est idem subiectum naturaliter A et B, vel diversum. Quod idem patet, quia forma elementaris et corpus sunt naturaliter longa et lata. Igitur idem est subiectum A linee et B superficiei; igitur corpus per se consideratum est indivisibile. Consequens falsum; et consequentia tenet ex hoc quod corpus intelligitur sine aliqua dimensione in eo. Et ideo intelligitur indivisibile iuxta istam positionem sicut aer intellectus per se non intelligitur luminosum... Item sequitur quod profunditas esset subiectum cuiuscumque forme substantialis et accidentalis existense, quia nulla forma materialis potest induci nisi mediante et preexistente profunditate, sicut iam non potest forma ignis induci nisi preexistente materia prima. Igitur sicut materia prima est subiectum forme ignis, ita patet profunditatem esse subiectum cuiuscumque forme materialis." (ibid., fol. 23ra).

(96) "Sit igitur quod subiectum longitudinis, latitudinis, et profunditatis sit D corpus. Tunc sic: D corpus est prius quam in illo sunt iste dimensiones, que sunt ille tres quantitates. Igitur prius est D quam sit longum, latum vel profundum. Igitur D corpus prius est quam ipsum sit divisibile; et ita omne corpus prius esset indivisibile quam divisibile — quod est impossibile. ... Igitur subiectum indivisibile est per se subiectum et naturaliter divisibilitatis. Sed cum omne subiectum per se et naturaliter respectu quantitatis potest esse tale vere quod per talem quantitatem susceptum, sequitur quod hec denominatio est possibilis iuxta naturam 'indivisibile est longum et latum et profundum' sicut hec denominatio est vera 'homo est albus'. Item si nihil sit extensum nisi per tales dimensiones que sunt

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since there is no infinite regress in essences or causes, one must say that every quantified thing is itself quantity.(97) First matter, therefore, cannot acquire or lose any quantity of itself,(98) nevertheless it can receive and be coextensive with such accidental quantities as sensible qualities.(99) When Aristotle and Grosseteste speak of quantity as a distinct entity, they are speaking as geometers and not as natural scientists.(100) "Et ideo quantitas est solum res rationis vel ipsum quantum."(101)

Compared to Ockham, Dumbleton's arguments are very superficial. He has already accepted Ockham's identification of quantity with matter and qualities, but his reasons for doing so are considerably weaker than those of Ockham. The fundamental reason given by Dumbleton for rejecting quantity as a distinct reality is that no indivisible can ever become divisible by the addition of an accident called 'quantity.'

Ockham's identification of quantity with material substance and sensible qualities seems to have been universally accepted by his junior contemporaries at Oxford. Present research has revealed no dissenting

(note 96 cont.) accidentia, ut /fol.23va/ dicit positio, igitur aliqua res que per se est indivisibilis potest fieri divisibilis per tales dimensiones. Sed cum non sit ratio quare una res que est indivisibilis in sua natura potest fieri divisibilis et quanta per inductionem quantitatis, sequitur quod qualibet res indivisibilis potest fieri divisibilis per inductionem quantitatis. Consequens falsum et impossibile; igitur et hec positio ex qua sequitur." (ibid., fol.23rb-va).

(97) "Ad istud dubium est dicendum iuxta probationem argumentorum quod quantitas non distinguitur a re quanta, sed quelibet res quanta est quantitas, ut essentia materie prime est ipsa materia prima, quia non est procedendum infinitum in essentiis nec extra nec intra rem." (ibid., fol.23va).

(98) "Quantitatem nullam tamen acquirit materia prima nec deperdit ex se, sicut elementa ex suis formis /fol.23vb/ faciunt iuxta hoc quod quedam sunt aliis naturaliter rariora."

(99) "Sed quia quantitas et eius subiectum non sunt res distincte, ideo non obstante quod materia prima sit quanta, est tamen susceptiva rei quante." (ibid., fol.23vb).

(100) "Et ideo loquitur /Aristoteles/ ut geometer vel exponit nomen ayud geometricum et non loquitur ut naturalis... Et ita loquitur Lincolniensis, intelligendo lineam et quantitatem ut geometer, ac si quantitates essent res distincte a quantibus, quod non est negandum simpliciter." (ibid., fol.23va).

(101) Ibid., fol.23vb.

voice in the Oxford schools between the early thirties and the early sixties. Ockham's doctrine seems to have been at least tacitly accepted by those Masters more interested in a different sort of question than those raised by Aristotle or Ockham.

The earliest known dissenting voice at Oxford, after an apparently common acceptance of Ockham's teaching on quantity, is that of John Wyclif, a Master in Arts of Oxford and one time Master of Balliol College.(102) In the Dubia super materia librorum Phisicorum ascribed to him,(103) Wyclif adduced(104) eight "communia argumenta continentia logicam, que adduxi libro Predicamentorum" to show that quantity is identical with substance. In his response to the question Wyclif maintained that "de necessitate omnis quantitas differt a substantia et qualitate." Although the text is not clear at this point, it would seem that he upheld this view largely because it saves the appearances more conveniently. He believes that it is impossible to demonstrate absolute the existence of anything, even the existence of quantity. However, there is no cogent reason for denying that quantity is a reality distinct from substances and quality, especially as

(102) Cf. H.B.Workman, John Wyclif, Oxford 1926, I,63-81.

(103) MS Venice, San Marco Cl.VI, cod.173 (2625), fol.1-85v. This manuscript of the early 15th century, acquired by Giovanni Marchanova in 1442 as volume LI, was discovered by S.Harrison Thomson (cf. Journal of Theological Studies, 1937, pp.145-8). This is the only known copy of Wyclif's Questiones on the Physics, but there seems to be no reason to doubt the ascription: "Et patent dubia super materia librorum Phisicorum Aristotelis secundum sentenciam mag. Jo. Wycliff" (fol.85v). The mention of Lombardy on fol.19va ("...set quod est materia omnium istorum corruptibilium in sensu composito, sicut iste, omnes divisie in lombardia simul sumpte sunt omnium istorum, set nullius istorum sunt iste divisie...") may be a scribal substitution. Wyclif took his degree as Master in Arts in the Spring of 1361 (cf. Workman, op.cit., I,xxxvii); these questions on the Physics may have been written during his necessary regency, 1361-1363.

(104) Lib.I,q.4, MS cit., fol.4rb-7rb.

this is the opinion of the authorities on the subject.(105) Although all bodies are necessarily quantified, this quantification is per accidens.(106) In answer to Ockham's "theological argument," Wyclif maintains that it is not possible for a material substance to exist (stat esse) without the posterior accident of quantity.(107) Perhaps this latter insistence prepared the way for Wyclif's later Eucharistic teaching in which he maintained that the substance of bread remains after consecration, as well as quantity.(108)

(105) "Quantum ad illud dubium respondeo et dico quod de necessitate omnis quantitas differt a substantia et qualitate etceteris. Illud tamen dico [non] propter argumentum cogens ad hoc ponendum, set gratia auctorum philosophorum et mathematicorum difficultatem evitando in modo loquendi, quia puto quod sit impossibile absolute demonstrare aliquam rem esse, cum propositiones immediate que sunt prime in demonstratione sunt capte a sensu, sicut docet Aristoteles in 2° Posteriorum in fine, quod ex multis sensibus generatur memoria, et ex multis memoriis generatur experimentum, et ex experimento generatur intellectus, ita tamen (?) quod neganti sensui nullo modo potest probari nisi a posteriori; et ita impossibile vel difficile est habere demonstrationem a priori probantem formas substantiales vel accidentales esse, quia ego nunquam audivi argumentum propinquum quin cedebat ad talem: tales effectus nos sentimus et illi non possunt salvari nisi ponatur talia accidencia vel tales forme, igitur sunt talia entia. Set si perquirimus intueri ordines essentiales rerum et necessitatem unius rei de altera sicut realiter sunt in suis essentiis, multa entia poneremus forte que nunc negamus, et multas consequencias concederemus quibus nunc dissentimus... Dico tunc quod nullum est argumentum cogens ad negandum quantitatem esse rem distinctam a substantia et qualitate." (ibid., fol.5va).

(106) "...concedo quod per accidens est homo quantus et non per se homo est quantus, tamen de necessitate homo est quantus. Et dico ultima quod iste terminus 'per accidens' aliquando privat necessitatem et aliquando perseitatem et non necessitatem, ut per accidens homo habet cor et tamen de necessitate homo habet cor." (ibid., ad 4, fol.6vb).

(107) "Ad argumentum illud theologicum [fol.7ra] negando [sig] assumptum, set concedo quod omnem rem priorem sine suo posteriori stat Deum producere et stat esse. Set ex isto non sequitur quod omnem substantiam stat esse sine accidente. Set sequitur quod omnem substantiam habentem accidens sine suo accidente stat esse; nec est veram quod omne prius stat esse sine suo posteriori, set super suo posteriori stat ipsum esse; et non sequitur hoc est prius quam aliquod accidens in hoc..." Ad 6m et 7m argumenta patet ibidem quod accidens tale quod est res quantitatis sine subiecto cui inexistit potest esse, sed non potest esse sine subiecto." (ibid., fol.7rb).

(108) De Eucharistia, ed. J.Loserth (Wyclif Soc., 1892). Cf. H.B.Workman, op.cit., II,53-39; Fasciculi Zizaniorum, ed. W.W.Shirley (R.S) 1858, pp.105-6.

However, in spite of his rejection of Ockham's "theological argument," he considered it probable that first matter had an infinite number of coextensive intensive parts in order to explain condensation and rarefaction.(109)

From what we have seen, the primary significance of Ockham's 'identification' of quantity with substance and qualities is that it fundamentally overthrows the whole of Aristotelian physics. Secondarily, and with the help of the Mertonian calculatores, it helped to direct attention to the measure of quantified realities in the physical world, rather than to potency and act.

III. The Mathematizing of 'Quantitas Materiae'

Newtonian physics has three fundamental concepts of quantity: spatial extension, temporal duration and mass (quantitas materiae). The first two have always been known in natural science, although the means of measuring those quantities have developed. The concept of mass, however, seems to have been explicitly formulated first by Newton when he defined the "quantity of matter" as the "measure of the same, arising from its density and bulk conjointly" and considered it to be "proportional to the weight."(110) But,

(109) "Ad 2am reductionem de coexistentibus materie dico ad presens, credens sensui et experimentis, etiam quia plus consequitur responsionem ponentem formas elementares intendi et alias materias calulatorias, quibus adhuc insisto, teneo tanquem probabile quod materia prima habet infinitas partes intensivas coextensas." Lib.I,q.9,a.3, MS cit., fol.20 rb. Also Lib.I,q.4 ad 3, fol.5vb.

(110) "Quantitas materiae est mensura eiusdem orta ex illius densitate et magnitudine conjunctim... Innotescit ea per corporis cuiusdem pondus. Nam ponderi proportionalem esse reperi per experimenta pendulorum accuratissime instituta." I.Newton, Principia, def.I., Londini 1687. Cf. F.Cajori's notes in his edition of the Principia (Berkeley 1947), pp.638-9. A full historical study of Newton's concept of mass, particularly its immediate sources, is still needed.

as Miss Maier has found,(111) the concept of mass can be traced back to its rudimentary formulation by Giles of Rome in the late 13th century. The notion of quantitas materiae as constant in physical changes, distinct from volume, and mathematically determinable was developed even more clearly in the early 14th century by the Mertonian calculatores.

In Aristotle's physics there were two distinct problems which led to the late scholastic notion of quantitas materiae. (i) In substantial changes, as when air is produced from water, the same amount of matter becomes something different and occupies a greater volume without acquiring additional parts of matter. (ii) In rarefaction, as when air expands, the same amount of matter occupies a larger volume, "not by the matter's acquiring anything new, but because the matter is in potency to both states";(112) in condensation the same matter occupies a smaller volume without loss of parts. What is the meaning of the 'same amount of matter,' if matter is a pure potency, quantified only by a variable accident?

The earliest important attempt to give meaning to the 'same amount of matter' (eadem materia numero) was made by Averroes in his De Substantia Orbis. The primary purpose of dimensiones interminatae, inseparable from matter, as already pointed out, was to explain the individuality of any

(111) A.Maier, Studien I, 26-48.

(112) "Est igitur et corporis materia et magni et parvi eadem. Manifestum est autem hoc. Cum enim ex aqua aer fiat, eadem materia non accipiens aliud aliquid facta est; sed quod erat potentia actu facta est. Et iterum aqua ex aere similiter; aliquando quidem in magnitudinem ex parvitate, aliquando in parvitatem ex magnitudine. Similiter igitur et cum multus aer, existens in minori fit mole, et ex minori maior, potentia cum sit, fit materia utraque... Quare et magnitudo et parvitas sensibilis corporis, non accipiente aliquid materia, extenditur, sed quia potentia est materia utriusque. Itaque idem est densum et rarum et una materia ipsorum." Phys., IV, 9, 217a26-b10 (trans. of William of Moerbeke); see also De Coelo et Mundo, III, 1, 299b8.

given matter in all substantial change: "divisio autem non est huic subiecto nisi inquantum habet quantitatem."(113) Averroes reprimanded Avicenna for not postulating such dimensiones interminatae in first matter antecedent to form, for how then could dimensions arise from no dimensions, or contrary forms from one potentiality, or how could matter receive greater or less quantity. For Averroes dimensiones interminatae not only divided a given amount of matter from all other, but they could be terminated in a variable quantity. By this distinction of two kinds of quantity Averroes could not only explain condensation and rarefaction, but also how the same amount of matter under the form of water can occupy a smaller volume than it did under the form of air.

Thomas Aquinas gives essentially the same explanation of condensation and rarefaction as did Aristotle.(114) He seems to distinguish alterations in the qualities of rarity and density, as such, from alterations in the volume, which properly constitute the accident of dimensive quantity. Rarity and density are qualities of bodies arising from the ratio between a certain amount of matter and its volume.(115) Rarefaction and condensation, therefore, are alterations by which the same amount of matter receives greater or less dimensions through reduction of potentiality to actuality.

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(113) De Substantia Orbis, c.1, ed. Venetiis 1489 (no foliation).

(114) "Ergo et cum aer multus existens reducitur ad minorem quantitatem per condensationem, vel ex minori in maiorem per rarefactionem, eadem materia est quae fit utrumque in actu, scilicet magnum et parvum, prius existens ad haec in potentia." In IV Phys., lect.14, n.11; see also In I De Gen., lect.14, n.5; II Sent., dist.30, q.2, a.1; Sum.Theol., III, q.77, a.2. The same explanation is given by Albert in his paraphrase of Phys. IV, text.83-86, (tr.II, cap.10, ed.nit., III, 301a-304b).

(115) "Rarum est ex hoc, quod materia recipit maiores dimensiones; densum autem ex hoc, quod materia recipit minores dimensiones; et sic si accipiantur diversa corpora aequalis quantitatis, unum rarum et aliud densum, densum habet plus de materia." In IV Phys., lect.14, n.13.

"sic rarefieri nihil aliud sit, quam materiam recipere maiores dimensiones per reductionem de potentia in actum; condensari autem e converso."(116) But Aquinas notes that there are limitations to the condensation and rarefaction of natural bodies; these limitations arise not only from the form, such as water or air, but from the potentiality of matter itself.(117) However, since for Aquinas first matter has no actuality whatever of its own, such designations as 'plus de materia,' 'quantitas materiae' and 'limitations' have to be understood as preintellecta in matter and derived from actual quantity. Thus Aquinas' explanation remains somewhat incomplete and obscure.

Giles of Rome returned to the suggestion of Averroes, which he developed in great detail, as Miss Maier has pointed out.(118) In his early(119) Metaphysicales Quaestiones, a reportatio, Giles seems to have misunderstood the doctrine of Averroes.(120) In discussing how dimensiones indeterminatae precede substantial form, Giles replies that there are two such dimensions prior to form: those prior to all form, and those prior to the specific form. The first type, as dimensiones, make matter to be "multum et paucum"; as indeterminatae they allow matter to occupy a greater or less volume of space, "quia eadem multitudo materiae aliquando occupat minorem locum, ut in uno pugillo terrae, aliquando maiorem, ut quando ex illo uno pugillo fiunt decem aeris." Concerning this first type Giles remarks, "et hunc modum dimensionum

(116) Ibid., n.11. Later Thomists, notably John of St.Thomas, restricted condensation and rarefaction to alterations in quality (volume), identifying quantity with "quantitas materiae." Cf. Cursus Philosophicus Thomisticus, Phil.Nat.III, q.VII, art.1, ed. B.Reiser, Taurini 1933, II, 707b-717a.

(117) "Sicut autem materia est in potentia ad determinatas formas, ita etiam est in potentia ad determinatam quantitatem. Unde rarefactio et condensatio non procedit in rebus naturalibus in infinitum." Ibid., n.11.

(118) A.Maier, Studien I, 29-43.

(119) Ibid., p.36, note 12.

(120) Lib.VIII, q.5. The text of the Venice edition of 1552 is quoted at length by Maier, op.cit., pp.36-38, note 13.

indeterminatarum non videtur venari Averroes in De substantia orbis." The second type, "et hunc magis venatur Averroes," makes matter to be a body in place, but without specific dimensions. The "Aegidian dimensiones indeterminatae," as Maier calls the first type, precede all form, are radicated in first matter itself, are really distinct from substantial form and terminated quantity, and are compared to terminated quantity as matter to form. The "Averroist" dimensiones indeterminatae, on the other hand, precede only the specific form of a concrete body, are radicated in the composite of matter and forma corporis, only logically distinct from substantial form and terminated quantity, and are compared to terminated quantity as a "forma confusa magis ad formam particularem."

While it is true that Averroes never designated matter as "multum et paucum," the primary purpose of his dimensiones interminatae was to divide this first matter from all other, hence "so much matter" from all other. Further, the objection which Averroes raised against Avicenna was that in the Avicennian view the first form precedes dimensions, and therefore that form is not divided by the division of matter.(121) Thus it would appear that for Averroes such dimensions are really distinct from substantial form and from terminated quantity,(122) and that Giles of Rome independently arrived at a deeper understanding of the same doctrine.

In any case Giles of Rome abandoned this complicated presentation in

(121) "Unde putavit Avicenna quod dispositio trium dimensionum existentium in materia simpliciter, scilicet non terminatarum, est dispositio dimensionum terminatarum in ea; qua propter dicit necesse est primam formam existere in prima materia antequam dimensiones existant in ea, ex quo accidunt ei multa impossibilia quorum unum est formam non dividi per divisionem materia." De Sub.Orbis, cap.1.

(122) See above, Chapter IV, ~~note 36.~~ pp. 166-7.

his later works in favour of a simpler development of the Averroist doctrine. In his Theoremata de corpore Christi (1276) and in his Commentary on the Physics (1277) he expounded his doctrine of the duplex quantitas: one is an indetermined quantity by which matter is "tanta et tanta, ut quod sit multa vel pauca," the other is a determined quantity by which matter occupies "tantum et tantum locum, ut magnum vel parvum."(123) These two quantities are not the same, for if air is generated from water, there is as much matter in one measure of water as there will be in ten measures of air. There are three important points to notice in the doctrine of Giles of Rome. (i) The two types of quantity (inspired by Averroes, although developed independently) are presented as really distinct quantities.(124) (ii) The quantity by which matter occupies a given volume varies in condensation, rarefaction, and in elementary changes without loss or addition of material parts — and without atoms or pores. (iii) The quantity by which matter is "so much," the quantitas materiae,(125) remains constant in condensation, rarefaction, and in all substantial changes so that when water becomes air, the same amount of matter (materia tanta) remains, and no natural agent can alter this quantity.(126) Giles of Rome thus developed a clear distinction between a constant "quantity of matter"

(123) See Maier's study, op.cit., 29-36.

(124) This is the precise point of Thomas Sutton's objection to Giles' teaching, for Sutton maintained that the two quantities are "eadem secundum essentiam" since all change is merely a reduction of potency to act (cf. Maier, ibid.,43-44). This position seems to have been inspired by Aquinas (cf. above, pp.168-9.), and may explain the "Averroist" view presented by Giles in his Metaphysicales Quaestiones.

(125) The term is used frequently by Giles of Rome in his Quodlibet IV,q.1, held in 1289.

(126) "Naturaliter enim fieri potest quod materia occupans parvum locum postea occupet maiorem locum, quia naturaliter ex aqua fit aer et ex aere ignis; sed nulla virtus naturalis agentis potest immutare quantitatem illam per quam materia est tanta et tanta..." Theoremata de corpore Christi, prop.44 (quoted by Maier, op.cit.,33).

and the variable volume occupied by matter.(127) In common with other Schoolmen, Giles taught that the actual volume of a body depends not only upon the substantial form, e.g., of earth, water, air, or fire, but also upon such qualities as heat, cold, dry and moist.

Because William of Ockham rejected the notion of quantity as a physical reality, he was unable to give a satisfactory explanation of condensation and rarefaction, as we have seen.(128) For him condensation means that the parts of matter exist, or rather coexist, in a smaller volume of space, and rarefaction means that the parts of matter occupy a larger space.

This teaching seems to have influenced the De motibus naturalibus of Roger Swineshead "datus Oxonie ad utilitatem studencium." For Swineshead rarity and density are not res, but modi positivi rerum, signifying the "situs partium in toto," and hence pertain to the category of 'positio.'(129) After distinguishing natural and violent condensation and rarefaction, Swineshead explains that the compression of porous bodies may be called condensation in the wide sense; strictly speaking, condensation is the "accessus partium alicuius continui per mutuos earundem ingressus," so that the parts of matter are really coexistent.(130) However in discussing

(127) The doctrine of Giles was rejected at Paris by his confrère, Gregory of Rimini, in his Sentence commentary of 1344: "Dico igitur quod non est in materia duplex quantitas, sed unus tantum, que potest terminari maiori et minori extensione, seu potest esse plus et minus extensa, et rarior et minus rara." Sent.II,dist.12,q.2,a.1, ed. Venetiis 1522, fol.78vb.

(128) See above, Chapter IV, pp.180-1.

(129) "Pro quibus est sciendum quod densitas et raritas non res, sed modi rerum consistunt; sub predicamentis enim positionis colliguntur, cum sint situs partium in toto." De motibus naturalibus, Diff.3,cap.2, pars 2, q.3. MS Erfurt, Amplon. F.135, fol.31rb.

(130) "Dupliciter igitur condensari, dupliciterque rarefieri, naturaliter scilicet et violente corpora contingunt. Rarefactionum aut condensationum violentarum utraque communiter et proprie poterit assumi... Corpus naturaliter condensari est per intensionem alicuius qualitatis per solam compressionem ipsum densius fieri. Corpus vero naturaliter rarefieri est per intensionem alicuius qualitatis ipsum rarius fieri.

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whether the four elements belong to the same ultimate species, Swineshead maintains that the elements are really incorruptible; all that changes is a certain kind of "form" and the "name" of the whole composite.(131) Swineshead admits that he is not able to overcome entirely the apparent contradiction between his teaching and that of Aristotle, but he reminds his readers that in natural philosophy it is reason which distinguishes the darkness of error from the light of truth, and not the authority of Aristotle or Plato.(132) The important point is that this MASSA ELEMENTARIS, as Swineshead calls it, remains constant in all "changes," even though diversely dense and rare due to alterations in primary and secondary qualities,(133) effectively produced by the "ethereal region."(134) For Swineshead the

(note 130 cont.) Corpus autem violente condensari vel rarefieri est preter intensionem alicuius qualitatis per solam compressionem ipsam densius vel rarius fieri. Condensatio propria sumpta est accessus parcium alicuius continui per mutuos earundem ingressus. Condensatio vero dicta communiter est alicuius quantitatis continue vel discrete, aut alicuius quanti continui vel discreti parcium accessus absque ingressu..." ibid., Diff.3,cap.2,pars 3. MS cit., fol.33ra.

(131) "Secundo nunquid quatuor elementa, scilicet ignis, aqua, aer, terra, sub eadem specie specialissima reponentur dubitatur..." ibid., Diff.3,cap.2, pars 2. MS cit., fol.31ra-b. The full text of this question is given in Appendix II, n.3.

(132) "Quia tamen inter dicta Aristotelis et predicta repugnanciam apparentem penitus evadere non potero, instanciis peterer compellor quatenus inferius dicta superiusque dicenda, quia non Aristotelis aut Platonis nemo condempnet nec dictis eorum singulis, quia Aristotelis aut Platonis fidem statim adhibere quis presumat; in philosophia enim naturali fidem sine ratione tenebras erroris a lumine veritatis non distinguente ubi ratio naturalis pocius habundat quietem cum fide naturali ibidem appenat." ibid.

(133) The distinction between primary and secondary qualities in late medieval physics should not be identified with the 17th century classification. Aristotle distinguished the four tangible qualities, which combine to differentiate the four elements, from qualities perceived by the other senses, e.g., black and white, sweet and bitter (cf. De Gen. et Cor., II,2). These two groups were commonly called primary and secondary qualities in the early 14th century. See text of the Tenuini Naturales in Appendix II, n.4.

(134) "Cum igitur mediantibus qualitatibus primis ab etheria regione primo causatur, partem elementorum propinquius aut remocius iacentem, sequitur veritas partis affirmative dubitacionis. Maior autem prime

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massa elementaris, or inanimalis signifies the inanimate bulk of matter which remains constant in all changes, even in substantial changes; it is contrasted with massa humoralis only in that the latter is animated and depends upon the humors in a living body. Contrary to Ockham, Roger Swineshead believes quantity to be a res distinct from substance and quality,(135) and the position of the parts of matter in space (volume) to be a modus rei, a mode of quantity. Thus for Swineshead, rarity and density depend upon the proportion between volume and massa elementaris; the greater the proportion of volume to mass, the greater the rarity; the smaller the proportion, the greater the density. The lack of uniformity in rare and dense bodies depends largely upon the primary qualities, which, if eliminated completely, would allow a body to be uniformly rare or dense, and limited only by the containing body of the heavens.(136) Rarity and density, therefore, depend directly upon the volume produced by the intensity of primary qualities, and not upon the amount of matter. Thus in Roger Swineshead's position there is no means of determining the quantity of matter, the massa elementaris.

A less explicit position is taught in the begimners' text, Termini naturales, attributed to William Heytesbury. Rarefaction is the separation of the parts of matter so as to occupy a greater volume without the addition

(note 134 cont.) rationis non debet admitti, cum massa elementaris rationem qualitatum primarum in densitate et raritate maximam habet difformitatem." Diff.3, cap.2, para 2. MS cit., fol.31rb. The term Massa occurs frequently throughout this work of Roger Swineshead. Miss Maier refers to a more precise use of the term in the Physica (lib.I, q.6) of Albert of Saxony (cf. Studien I,49 note 26). But the earliest known use of the term to designate a constant amount of matter seems to be in this work of Roger Swineshead (cf. above, Chapter II, pp. 98-101.).

(135) MS cit., fol.26rb.

(136) "Qualitatibus primis tamen plene circumscriptis, raritatem penitus uniformem ibi non habitam elementaris massa poterit habere. Nec tunc illa raritas per formam foret terminata, cum concavitate cuili duplicata vel subduplicata massa elementaris totum spacium naturaliter poterit occupare." ibid., fol.31rb.

of a new body; condensation is the constriction or compression of the parts without the loss of any body.(137) After discussing the various combinations of the primary qualities, the text notes that fire is ten times larger in volume than air and ten times as rare. "Unde elementum in quanto est maioris quantitatis in tanto est rarius, et in quanto minoris quantitatis tanto densius."(138) In other words, rarity and density depend directly upon volume somehow related to a given elementary mass.

In the Logica, or Regulae solvendi sophismata Heytesbury is concerned only with determining the proportional velocity of condensations and rarefactions. He discusses it under De velocitate motus augmentationis communiter dicta, quae dicitur rarefactio.(139) The question is to determine a universal law by which one can describe the relative velocities of rarefactions. After rejecting two opinions which hold that the greater velocity of rarefaction depends upon the greater degree (latitudo) of quantity acquired, Heytesbury presents his own opinion, namely that the velocity depends upon the proportion of quantity acquired to the original volume in equal time.(140)

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(137) "Rarefactio est parcium inter se remocio sine aliqua novi corporis acquisicione. Nam rarum est tale cuius partes remote iacent, ut ponit Philosophus in Predicamentis, cap. de quantitate. Condensacio est parcium adinvicem constriccio vel compressio sine alicuius novi corporis depposicione. Nam densum est tale cuius partes propinque iacent, ut patet ibidem." Termini Naturales. MS Vienna, Dom.klos., cod.93/57, fol.99va.

(138) Ibid., fol.101rb.

(139) Ed. Venetiis 1494, fol.45ra-49va. We have checked the text with MS Erfurt, Amplon. F.135, fol.14vb-16ra.

(140) "...Ideo sequitur tercia posicio quam inter alias in hac materia reputo veriorem, scilicet quod universaliter omnis velocitas talis motus attenditur penes proportionem quantitatis de novo uniformiter adquirende in tanto tempore vel in tanto ad quantitatem prius habitam, sic videlicet quod quibuscumque quantis seu quantitatibus signatis quarum utrumque uniformiter in equali tempore augmentabatur ad equalitatem sui dupli quantumcumque sunt illa duo inequalia quod illan equevelociter augmentabuntur." MS Erfurt, Amplon. F.135, fol. 15ra; this reading is better than the printed edition.

That is to say, if two bodies of unequal volume acquire equal quantities in equal time, then that body which acquired proportionally the greater quantity would have rarefied more quickly. For Heytesbury motion consists essentially in a proportion; thus as the proportion acquired is greater, so is its velocity. In his consideration of the problem Heytesbury neglects both the amount of matter and the degree of density in the original bodies considered.

John Dumbleton discusses condensation and rarefaction under augmentation and diminution "because growth and decrease come about by rarefaction."(141) For Dumbleton rarefaction and growth are governed by the same laws of velocity. In his discussion of the velocity of augmentation Dumbleton lists two opinions. The first is in fact that of Heytesbury, though not mentioned by name:

> Quidam dicunt quod velocitas motus augmentationis attenditur penes proportionalem acquisitionem respectu illius cui acquiritur quantitas, ut Sortes existens bipedalis quantitatis acquirat duas pedales in hora, et Plato existens quadrupedalis quantitatis acquirat duas in eadem, /tunc/ Sortes velocius augmentabitur in quantitate quam Plato, quia plus proportionale sibi acquirit in eodem tempore. Et ideo dicit, quod illud quod incipit a non quanto augmentari infinitum velociter incipit augmentari. (142)

The second opinion is his own, "quod velocitas augmentationis attenditur penes distantiam acquisitam, ut in aliis motibus." That is to say, the

(141) Dumbleton, Summa, P.III, cap.19. MS Vat.lat.6750, fol.47vb.

(142) Ibid., cap.19. MS cit., fol.46va. This same opinion is listed first and rejected by Richard Swineshead: "Quarum una ponit quod velocitas augmentationis attenditur penes proportionalem acquisitionem quantitatis, ut si /a/ inaequalia equevelociter augmentabuntur, si unum augmentabitur ad duplum reliquum etiam ad duplum... et si duplum augmentabitur cum suo subduplo equevelociter, requiritur quod in duplo velocius acquirat de quantitate quam illud subduplum, quia aliter non equo proportionabiliter augmentaretur, ut constat." Calculationes, Tract.VI (De augmentatione), ed. Venetiis 1520, fol. 22rb. The editors of the Venice edition also noted in the margin: "prima positio que est Hesberi."

velocity of growth depends entirely upon the precise amount of quantity which is acquired in a given time, "penes hoc quod precise acquirunt,"(143) without any reference to the subjects which are growing, whether they be equals or unequals.(144)

Analyzing the text of Averroes, Phys., VII, comm.38 and 39, Dumbleton insists on three points, which underlie his discussion of velocities.(145) The first is that all velocities, of whatever kind of motion, vary and are proportioned to other velocities according to geometrical proportionality; that is, all velocities are proportionate according to the Bradwardine function. The second is that uniform motions can be called equal or unequal depending upon the equality or inequality of the spatia acquisita in the various kinds of motion; that is, uniform motions can be compared according to the degree of form (latitudo formae) acquired. The third is

(143) Dumbleton, Summa, P.III, cap.19. MS cit., fol.47ra.

(144) This opinion is listed second by Swineshead: "Alia positio ponit, quod velocitas augmentationis attenditur penes quantitatem acquisitam, non habendo respectu quovismodo ad prehabita, ita quod sive equalia sive inequalia equevelociter acquirat de quantitate equevelociter augmentabuntur." (Calculationes, loc.cit., fol.24va). Swineshead himself modifies Dumbleton's opinion: "Pro ista materia potest corrigi positio; et dicitur quod velocitas augmentationis attenditur penes acquisitionem excessus supra quantitatem prehabitam. Vel sub aliis verbis: velocitas augmentationis attenditur penes recessum a quo incipit illa res maiorari versus terminum ad quem supra." (ibid., fol.24vb).

(145) "Ex ista auctoritate /Commentatoris/ patent tria. Primum quod omnis velocitas motus cuiuscumque predicamenti penes proportionem geometricam attenditur. Secundum quod ex hoc quod sunt spatia acquisita equalia vel inequalia proportionaliter in predicamento in quo fiunt motus, sunt motus uniformes dicendi equales vel inequales inter se. Tertium, quia Aristoteles dicit omnia eodem modo esse in alteratione et in augmentatione sicut est in motu locali, ex intentione Philosophi est quod si omnia que moventur equaliter equali latitudine motus, qualitercumque extendatur latitudo motus, equaliter movetur, ita est dicendum in aliis motibus veris, scilicet in qualitate et quantitate. Et ideo dicit Commentator, quod Aristoteles vult declarare omnia sic esse in alterato et in augmento sicut in motu locali." Summa, P.III, cap.18. MS cit., fol.47ra.

that whatever can be said of the velocity of locomotion must also be said of alteration and augmentation; that is, the laws of motion are identical whether discussing augmentation, alteration or the fundamental form of motion, namely locomotion.

Applying these general principles to condensation and rarefaction, it is clear that their velocities depend upon the amount of density lost or acquired, the spatia acquisita vel deperdita. Rarity and density are qualities which can be possessed to a greater or less degree by a body, but qualities which arise from the proportion between volume and a constant mass. Contrary qualitates intensibiles, according to Dumbleton, are not really distinct latitudes, but one is related to the other as positio to privatio.(146) Regarding condensation and rarefaction Dumbleton seems to consider the latitude of rarefaction to be per modum positionis arising from a proportion of greater inequality between volume and matter, while condensation is considered per modum privationis, arising from a proportion of lesser inequality.(147) For Dumbleton an increase of rarity depends

(146) See also Summa, P.III,c.7, MS cit., fol.41vb. This is also a fundamental doctrine for Richard Swineshead (cf. Calculationes, esp. Tract.I and Tract.V), who derives it from the Tractatus de proportionibus of Thomas Bradwardine: "Consimiliter habitudo maioris ad minus et minoris ad maius sunt eadem secundum rem sola ratione differentes, et habitudo maioris ad minus est proportio maioris inequalitatis, et habitudo minoris ad maius est proportio minoris inequalitatis; ideo ille proportiones solum secundum rationem differunt..., ut venerabilis magister Thomas Bardwardino in suo libro de proportionibus liquide declarat." Calculationes, Tr.I, ed.cit., fol.4rb.

(147) "Ideo potest dici quod per modum privationis se habet condensatio in dispositione corporum et raritas per modum positionis, ut intelligamus raritatem in corpore sicut intensionem in qualitate et densitatem in eodem sicut remissionem in remissibili qualitate." Summa P.III,cap.19. MS cit., fol.46ra. This is the secunda positio listed and rejected by Swineshead (loc.cit., fol.17ra). But in Oxford, Merton College MS 279, P.III,cap.19 ends with a sentence not found in the other MSS: "Aliud est advertendum quod non magis argumenta facta in loco probant ut densitas se habet per modum privationis quam raritas, sed probant hoc satis quod altera latitudo

upon and is directly proportional to the increase in volume, ipso manente continue uniformi, or as he more often expresses it, respectu eiusdem. That is, as long as the quantity of matter remains the same, or as long as the quantitas materiae of body A is equal to that in body B, then increase in rarity is directly proportional to the increase in volume: "omne corpus uniformiter rarum, si duplum fiat /in quantitate/ solum per rarefactionem, ipso manente continue uniformi, duplam raritatem acquirere necesse est."(148) With respect to the same body the degree of rarity is doubled, if the volume is doubled: "sicut fiet in duplo magis rarum, ita fiet in duplo magis quantum precise."(149) Conversely, the density of the body is doubled only if the volume is halved.

If two bodies unequal in rarity, that is, having the same volume but unequal in mass, are uniformly doubled (duplata) in equal times, this means not that equal quantities are added, but only equal proportions.(150) Thus

(note 147 cont.) ita se habet, et quod utraque non sint infinita, nam si deperditur utraque latitudo tam raritatis quam densitatis, sit infinita." This may have been originally a scribal addition.

(148) Summa, P.III, cap.20, MS cit., fol.47ra.

(149) Ibid.

(150) "Post has sequuntur quedam conclusiones probande. Prima: propositis duobus corporibus uniformibus inequaliter raris vel densis augmentandis ad duplum in hora per rarefactionem, in qua proportione unum alio est rarius in eadem proportione illud maiorem latitudinem rarefactionis acquirere necesse est. Ponamus duo corpora uniformiter rara et inequaliter et assignetur primi, scilicet A, raritas per 6, et raritas secundi, scilicet B, per 4. Et fiat utrumque in hora per duplum precise per rarefactionem. Iuxta suppositionem prius positam, patet quod tam A quam B in fine hore erunt in duplo rarius quam ium sunt, ex hoc quod utrumque per rarefactionem fiet duplum. Sed cum raritas in A se habet sicut 6 et raritas in B sicut 4, sequitur quod in illa hora acquiret A 6 de raritate et B 4 de raritate, inter que acquisita est precise proportio sesquialtera. Et sic patet propositum." Ibid., fol.48v.

in the proportion that one body is more dense, that is, having more matter in the same volume, in that proportion will it acquire a greater degree of rarity.(151)

The important point is that for Dumbleton increase of rarity in two equal bodies is equal to increase of volume only if the two bodies are equally rare and dense, that is, only if the quantity of matter in both are equal and remain constant.(152) Thus rarefaction depends, not simply upon volume, as Dumbleton seems to have stated at the opening of his discussion, but upon volume respectu eiusdem materiae. Even though Dumbleton ostensibly accepted Ockham's identification of matter with extension, he found it necessary to distinguish volume (extension) from matter in order to explain condensation and rarefaction. He distinguished the three factors: quantity of matter, density and rarity, and volume. He implied that a proportional increase of volume depends upon matter and density taken together, and that an increase of rarity depends upon matter and volume taken together. Dumbleton thus prepared the way for Richard Swineshead and the mathematization of mass.

Richard Swineshead is more explicit in his notion of quantitas materiae. In discussing "penes quid raritas et densitas attendantur," Swineshead notes that there are only two reasonable opinions concerning the question:

(151) "Aliud est quod ex istis ostenditur, videlicet, quanto corpus densius est, tanto per rarefactionem per maiorem latitudinem raritatis proportionaliter fit maius." ibid.

(152) "Ex istis apparet quod raritas et quantitas non sic proportionaliter et equevelociter corporibus augmentandis acquirunt, quod liset equalia corpora et equaliter proportionaliter augmentando equalem quantitatem acquirant, non tamen equalem latitudinem raritatis acquirunt nisi ipsa sint equaliter rara et densa." ibid.

> Una ponit quod raritas attenditur penes proportionem quantitatis subiecti ad eius materiam et densitas attenditur penes proportionem materie ad quantitatem. Secunda ponit quod raritas attenditur penes quantitatem non simpliciter, sed in materia proportionata vel in comparatione ad materiam. (153)

Both opinions, Swineshead observes, have this in common that they consider rarity and density to be a certain proportion between quantity (volume) and matter (mass). Rarity and density cannot be identical with mere extension, or the "distantia punctorum a seinvicem," for then all equals in quantity would be equally dense. It is clear that there is more matter (plus de materia) in a cubic foot of earth than there is in the same measure of air, otherwise earth would not be more dense. Thus if fire is generated from earth, the whole quantity (volume) is increased, and the whole is rendered more rare than it now is. But since no matter is lost or acquired, there must be more matter now in earth than there will be in an equal measure of fire. Parenthetically, Swineshead adds, that by plus he does not mean that matter increases, "but that there is equally as much matter in earth as there will be in fire when it is completely generated, and now there is more matter in a given quantity (volume) of earth than there is in an equal quantity of generated fire."(154) Therefore rarity and density must depend

(153) Calculationes, Tract.V, ed.cit., fol.16vb.

(154) "Pro istis est notandum quod plus est de materia in pedali terre quam in pedali ignis, quia aliter non videtur rarior ignis quam terre, ut si ignis generetur ex terra, tota eius quantitas maioratur, et sic totum fieret rarius quam nunc est. Nihil tamen deperdet de materia nec acquiret; et ideo nunc est plus de materia in illa terra quam est in quantitate equali ignis generandi, non intelligendo ly plus sicut quod tota materia fit maior quantitative, sed quod equaliter est de materia que est materia terre sicut erit in fine in igne generando, et nunc est plus de illa materia in quantitate terre quam est in quantitate equali ignis generandi." Ibid.

upon the proportion between volume and the amount of matter.

But the two opinions are different,(155) Swineshead explains, because the first holds that "just as the proportion of quantity to matter is greater, so is the rarity greater; thus if rarity were to be doubled, the proportion of quantity to matter would have to be doubled." The second opinion, however, holds that "proportionabiliter sicut tota quantitas fit maior manente materia eadem, ita raritas est maior, ut si nunc sit aliqua raritas, ad duplationem illius raritatis non sequitur duplatio proportionis quantitatis ad materiam, sed solum duplicatio quantitatis, si maneat materia." In other words, the first opinion would compare rarity in bodies merely according to the size of the proportion, without considering the amount of matter or the degree of density or rarity in those bodies. Swineshead objects that such a formulation of the law does not hold for all cases, and therefore ought to be formulated more accurately, that is, with the 'condition' as part of the law. He argues that according to the first opinion all bodies of equal volumes increasing equally in volume would rarify with equal velocity; but this is not true in the case where bodies are unequally rare to begin with.(156) For example; A and B are two bodies, equal in volume and unequal in rarity (e.g., air and water); let the volumes of both be doubled in equal times. According to the first opinion the rarities of both should be doubled with equal velocity; but since the rarer

(155) L.Thorndike notes these two opinions (A History of Magic and Experimental Science, III,378), but he is unable to understand the difference. A. Maier (Studien, I,98 note 33) remarks that the first opinion assumes the Aristotelian function for the dependence of density on mass and volume, while the other assumes the Bradwardine function.

(156) "Contra primam positionem arguitur unico fomte. Ex hoc sequitur quod omnia equalia in quantitate sive equo rara sive inequaliter rara equalia aequirantia de quantitate equevelociter rarefiant." Calculationes, loc.cit.

body acquires a greater degree (latitudo) by being doubled than the less rare, they do not cover equal distances (equalia spatia acquisita) in equal times.(157) Therefore, provided that the matter and its densities(158) are the same, increase in rarity is proportioned to the increase in volume. This condition Swineshead includes in the law when he says, "Raritas attenditur penes quantitatem non simpliciter, sed in materia proportionata vel in comparationem ad materiam." Thus just as the rarity of a single body is increased merely by increasing the volume, manente materia, so -- in a universal law -- all rarefaction is proportional to increase of volume in materia proportionata, that is, given the same amount of matter in water as in air.(159)

Swineshead explains his universal law by showing the relative proportions between mass, volume and rarity in every possible case, of which there are only four;(160)

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(157) "Et quod hoc sit impossibile arguitur sic; Sint A, B equalia et inequa rara que rarefiant equales quantitates acquirendo, tunc proportionabiliter sicut maioratur quantitas alicuius illorum, ita proportionabiliter acquiretur raritas, quia sicut totum erit maioris quantitatis, ita partes a seinvicem distabunt; et sicut puncta distabunt plus fiet rarius, iuxta descriptionem raritatis.... Si ergo tam A quam B maioratur ad duplum, sequitur quod unum maiorem latitudinem raritatis acquiret quam reliquum; et si sic, non equaliter rarefient, penendo velocitatem rarefactionis attendi penes latitudinem raritatis acquisite; sequitur ergo conclusionem esse falsam." ibid.

(158) In the following chapter Swineshead defends the position that density and not rarity se habet positive (cf. ibid., fol.16ra-vb.).

(159) "Ideo ponitur alia positio, scilicet raritas attenditur penes distantiam punctorum ad seinvicem, non simpliciter, sed in materia proportionata vel in comparatione ad materiam." ibid., fol.17ra.

(160) "...sic intelligendo; [1] si duo subdupla inequalia equaliter habeant de materia, proportionabiliter sicut unum est alio maius, ita plus habet de materia; [2] et si equalia sint inequa rara, equaliter habebunt de materia; [3] et si inequalia sint equa rara, proportionabiliter sicut unum est alio maius, ita plus habet de materia; [4] et si equalia sint inequa rara proportionabiliter sicut unum est alio rarius, ita minus habet de materia." ibid., fol.17ra.

1) If two bodies have equal mass, as the matter of water compared to the matter of air generated in change, then proportionally as the volume of one is greater, so is its rarity.
2) If two bodies are equal in volume and equally rare, then "equaliter habebunt de materia."
3) If unequal in volume and equal in rarity, then proportionally as one is greater than the other, "ita plus habet de materia."
4) If equal in volume and unequal in rarity, then proportionally as one is more rare, "ita minus habet de materia."

Thus in the doctrine of Richard Swineshead not only is the quantitas materiae conserved absolutely whatever the change, but that quantity can be determined clearly -- at least in principle. The quantity of matter can be determined, not by volume alone, nor by density alone, but "ex illius densitate et magnitudine comiunctim."(161)

By the middle of the 14th century the problem of individuation was no longer discussed seriously in the schools, but the suggestion of Averroes had produced far reaching results. The development of the quantitates indeterminatae by Giles of Rome had led to the 14th century clarification of quantitas materiae as a constant mass which is not increased or decreased in changes from one elementary state to another. Thus as Miss Maier observes,(162) the Schoolmen had the principle of the conservation of mass not only as a general metaphysical thesis, but also as a concrete physical law. But more than that, the early 14th century discussions of condensation

(161) I.Newton, Principia, def.I.
(162) A.Maier, Studien I,26.

and rarefaction by Roger Swineshead, William Heytesbury and John Dumbleton led in the writings of Richard Swineshead to a universal principle whereby the "quantity of matter" could be mathematically determined, namely by the ratio arising from its density and volume conjointly. The failure of the Schoolmen to give a quantitative value to mass does not lessen the importance of this mathematical law of physics. The fact that for the Schoolmen 'weight' (pondus) was a property only of 'heavy' bodies precluded their conceiving mass as "proportional to the weight." Later Newton was to conceive weight as the gravitational force exerted on a given mass; hence for him the measure of mass (quantitas materiae) would be proportional to the weight.

CHAPTER V

PROBLEMS OF LOCAL MOTION

The phenomenon of motion, so obvious to the senses, is one of the most difficult to understand and to explain. The very familiarity and universality of movement in nature has made it the backbone of every fundamental theory of physical science. One might even venture to say that a philosopher's evaluation of motion moulds his whole outlook upon the world of nature. Clearly this was so for Aristotle: "We must therefore see that we understand the meaning of 'motion', for if it were unknown, the meaning of 'nature' too would be unknown."(1) The early 14th century saw a revolution in the understanding of motion. Oxford thinkers in particular, as we shall see, reduced all motion to a univocal category modelled upon change of place. For Ockham this category was the word 'motion'. For Thomas Bradwardine and the Mertonians it was the mathematical laws of motion which were identical for alteration, augmentation and local motion; all motion was conceived as a velocity, a ratio, an "acquisitio vel deperditio spatiorum" in a given time.

In this chapter we will consider first the nature of motion as understood by the early Schoolmen and the development of ideas to the views of Ockham and the Mertonians. Second we will discuss the peculiarly Mertonian contribution to the mathematization of motion, namely the proportion of velocities. Finally we will consider briefly the failure of the Oxford school to accept the Parisian theory of impetus.

(1) Phys., III, c.1, 200b13-14.

I. The Nature of Motion

For Aristotle the fact of change, or movement in the universe is obvious to the senses, and to deny it would be to reject the very foundation of natural science. The task of the philosopher of nature is to define the precise nature of motion and to distinguish the various types. "It is hard to grasp what motion is,"(2) because it is essentially imperfect, fluid, not yet in a state of completion. Once a body begins to move, it has a certain new actuality, but as long as it is in motion, it is still tending towards completion in its final cause, still deprived of the full realization of that cause. Motion, therefore, as a process, is simultaneously a kind of actuality and a kind of potentiality. The act which is motion is not the static act of a form, however imperfect, but the fluid act which necessarily and essentially tends to otherness: 'omne quod movetur, movebitur.'(3) It is this simultaneous actuality and potentiality which Aristotle expressed in his formal definition of motion, as such: "It is the act (entelechia) of a thing existing in potency, in so far as it is in potency."(4) This same idea is expressed in Aristotle's second definition, the definitio materialis, as the Schoolmen called it:(5) "motion is the act of the moveable in so far as it is moveable."(6) Thus "the actuality of the buildable as buildable is the process of building."(7)

(2) Phys., III, c.2, 201b33.
(3) Although the term 'motion' is a noun, it signifies a process which is more accurately expressed by the participial form of the verb.
(4) Phys., III, c.1, 201a10-11.
(5) St.Albert, Phys., III, tr.I, cap.7 (ed.cit., III, 196b); St.Thomas, In III Phys., lect.4, n.1; Dumbleton, Summa, III, cap.22 (MS Vat.lat.6750, fol. 49va-b); Termini Naturales (MS Vienna, Dom.bibl. cod.93/57, fol.99ra).
(6) Phys., III, c.2, 202a6-7.
(7) Phys., III, c.1, 201b9-10.

Aristotle's view of movement as a process embraces all types of change, as such. But in Book V of the Physics Aristotle distinguishes motus in the strict sense from mutatio, which is applicable to such instantaneous changes as substantial generation and corruption. In the strict sense motus signifies changes from one positive contrary to another; therefore the word is not applicable to substantial changes.(8) Further, only in three categories of accidents, quantitas, qualitas and ubi, can there be motion strictly so called, since only in these categories are there positive contraries capable of being possessed secundum magis et minus.(9) Moreover, all motion in the strict sense is a successive acquiring of a form, that is, motion requires a temporal order of acquisition; hence, there can be no motus in instanti.

Clearly for Aristotle motion is not a 'form'; it is a process by which form is acquired, a via ad formam. But if the ten categories are a complete division of real being, the question arises: "To what category does motion, as such, belong?" In the De Predicamentis motion is discussed after the division of the ten categories, because different types of motion are found in different categories.(10) But motion itself, it would seem, belongs to the category of passio,(11) and this seems to be Aristotle's view when he discusses actio and passio in the Physics.(12) Nevertheless in his fuller discussions of the question Aristotle implies that local motion reduces to the category of ubi, alteration to qualitas, and augmentation to quantitas.(13)

(8) Phys., V, c. 2, 225b10-226a19.
(9) Phys., V, c. 2, 226a19-b18.
(10) Categ., c. 14.
(11) Ibid., c. 9. This interpretation was undoubtedly encouraged by the view of Averroes: "Dictum est in libro de predicamentis ipsum [motum] esse in predicamento passionis." Phys., III, comm. 4. Ed. Venetiis 1489, no foliation.
(12) Phys., III, c. 3.
(13) For example in Phys., III, c. 1 and Metaph., XI, c. 9.

The question, however, was sufficiently obscure to provoke considerable discussion among the Schoolmen.

a. Motion as 'fluxus formae' and 'forma fluens'

In the 13th and early 14th centuries the nature of motion was often discussed in the form, "Qualiter motus cadit in predicamento?" The discussion frequently centred around the question whether motion is a forma fluens or a fluxus formae. By the beginning of the 14th century it was thought, "sicut communiter dicitur et accipitur a Commentatore,"(14) that motion considered as a forma fluens belongs to the category of the term of motion, and motion considered as a fluxus formae belongs to the category of passio. "Et dicit Commentator quod prima opinio est verior, scilicet quae ponit motum esse formam imperfectam et fluentem; alia autem opinio est famosior, scilicet quod motus est fluxus et via quaedam huius formae ad aliquid ulterius acquirendum."(15) Hence it was commonly thought that Averroes introduced the distinction, and defended his view of motion as a forma fluens against the view of motion as a fluxus formae.(16) But this distinction is not found in the writings of Averroes. Though rejecting the distinction, John Marbres remarks, "Dico quod nunquam fuit ista distinctio Commen-

(14) Ioannis de Ianduno, Super octo libros Arist. de Physico Quaestiones, lib.III,q.96, ed. Venetiis 1552, fol.42va. These questions on the Physics, as we know, were published by Jandun in 1303: "Explicit questiones super Phisicorum Aristotelis ordinate per mag. Johannem de Genduno anno domini M°CCC°iij°." MS Vienna, Dom.klos., cod.161/131, fol.87v.

(15) Ioannis de Ianduno, ibid.

(16) Joannis Canonici, Super octo libros Physicorum Quaestiones, Lib.III,q.1, ed.cit., fol.34rb; Walter Burley, Expositio in libros Physicorum (early version), Lib.III, text 4, Cambridge MS, Caius College 448/409, p.254a, also Lib.V, pp.343-4; William Alnwick, Determinationes, q.18, "Utrum motus sit de genere termini ad quem est." MS Vatican, Pal.lat. 1805, fol.148r-151r. Miss Maier considers these Determinationes of Alnwick to have been given at Bologna about 1323 (cf. "Wilhelm von Alnwicks Bolognesser Quaestionen gegen den Averroismus (1323)," Gregorianum, XXI (1949),265-267). See also John Dumbleton, Summa, P.III, cc.22-23. MS Vat.lat.6750, fol.49va-51rb.

tatoris, sed Avicenna in sua Physica ponit quasi derisive istam distinctionem."(17) But neither is the distinction to be found in the writings of Avicenna.

Modern scholars, following A.Maier, believe that it was Albertus Magnus who first presented the alternative solutions: motion is a forma fluens or a fluxus formae.(18) It is also believed that the view of motion as a forma fluens, defended by Averroes and Albert, prepared the way for Ockham's denial of motion as a reality distinct from form.(19)

In his commentary on the Physics(20) St.Albert raises the question of how motion is to be classified among the categories. After a paraphrase of the text Albert adverts to the comment of Averroes. In the De Predicamentis motion seems to be considered as belonging per se to the category of passio, and hence really distinct from the form of substance, quantity, quality, or place. But in the Physics motion is considered as a "generatio partis post aliam illius perfectionis ad quam intendit motus donec perficiatur," and thus it is not really distinct from those perfections. Averroes considers the view expressed in the De Predicamentis to be "famosior," while that

(17) Joannis Canonici, loc.cit. Also Peter Aureolus, Sent.II, dist.1,q.3, a.1: "Ista distinctio nunquam fuit Commentatoris" (quoted by A.Maier, Studien, I,11).

(18) A.Maier, "Die scholastische Wesensbestimmung der Bewegung als forma fluens oder fluxus formae und ihre Beziehung zu Albertus Magnus," Angelicum, XXI (1944),97-111; this study is enlarged in Studien, I, 9-25. E.J.Dijksterhuis, Die Mechanisierung des Weltbildes, (Springer Verlag 1956), 196-8. See also Olaf Peterson, "The Development of Natural Philosophy, 1250-1350," Classica et Medievalia, XIV (1953), 86-155.

(19) William of Ockham, it may be noted, was under the unusual impression that Averroes defended the view of fluxus formae (II Sent.,q.9, obj. 7, ed.cit. H), and he seems to have misunderstood the point of the distinction (ibid., ad 7 S; Tract. de successivis (De motu), ed.cit., pp.49-52).

(20) St.Albert, Phys., III, tr.I,cap.1 (ed.cit., III, 181-190).

expressed in the Physics is "verior."(21)

Albert, however, considers the solution of Averroes "obscura et dubia" and determines to review the opinions of all the Peripatetics concerning the genus of motion. Three of these opinions were already mentioned by Avicenna, but Albert adds two more.

The first opinion compares motion to the mover, and believing motion to be the act of the mover, places it in the category of actio, as Gilbert de la Porrée seems to do.

The second opinion compares motion to the moving body, and considering motion to be the actuality of the moving body by which something is acquired, places it in the category of passio. This is the "modus famosus" mentioned by Averroes.

All other opinions are based on a consideration of the end and term of movement, saying that "motum esse fluxum alicuius entis in id quod est terminus motus, sicut nigrescere fluxus est in nigredinem." Some, however, insist, as Averroes does, that no fluxus is different from the term of motion "differentia specifica sive per essentiam," but only in esse. Since

(21) The passage of Averroes under discussion is as follows: "Ad hoc autem dicemus: quoniam motum secundum quod non differt a perfectione ad quam vadit nisi secundum magis et minus, necesse est ut sit de genere illius perfectionis; motus enim nihil aliud est quam generatio partis post aliam illius perfectionis ad quam intendit motus donec perficiatur et fit in actu. Unde necesse est ut motus qui est in substantia inveniatur in genere substantie, et motum qui est in quantitate in genere quantitatis, et similiter qui est in ubi et qualitate. Secundum autem quod est via ad perfectionem que est alia ab ipsa perfectione necesse est ut sit genus per se; via enim ad rem est aliud ab ipsa re; et secundum hoc fuit positum predicamentum per se. Et iste modus est famosior; ille autem est verior. Et ideo Aristoteles induxit illum modum famosum in predicamentis, et istum modum verum in hoc libro." Phys., III, comm.4, ed.cit. The distinction is repeated by Averroes in Phys.,V, comm.9.

"nigrescere est nigredo pertransiens sive fluens," motion is a via ad terminum and not distinct from the term except as "esse in via et in quiete." Others, on the other hand, insist that the fluxus is specifically and essentially distinct from the term of motion. Among these, some, like Avicenna, would not classify motion in any predicament, insisting that a forma fluens in motum[22] and the term of motion cannot belong to the same species, for motion is really a "principium" and "via ad rem predicamenti." Finally others would consider motion to be a category of its own (per se) and univocally predicable of the various types of motion. But Albert says this is the weakest of all the opinions and already disproved by him.

Among the opinions concerning motion these five, according to Albert, are the more famous. But since the question is extremely difficult, Albert proposes to argue for and against each opinion, particularly for and against the third and fourth, before selecting the view of Averroes as "magis verum."

From what has been said it is clear that Albert himself never used the expressions, forma fluens and fluxus formae, in opposition. He never asked whether motion is one or the other; what he did ask was whether motion reduces to the category of the term, or whether it is a separate category. Nor is his use of the terms sufficiently exclusive to restrict one expression to the view of Averroes and the other to that of Avicenna. How later generations came to consider forma fluens an Averroist view, and fluxus formae an Avicennian view can easily be understood.

In Albert's discussion of the fourth opinion, that defended by Avicenna,

(22) St. Albert, loc. cit., p. 186a. Thus in Albert's classification of opinions there is no consistent and exclusive use of the terms "forma fluens" and "fluxus formae."

even arguments proving that motion is a distinct predicament, namely passio, are added to strengthen the case that motion is a reality, a process, essentially distinct from the term of motion.(23) Thus the important question from Albert's point of view is whether or not motion, as such, is distinct essentialiter et specifice from the term of motion, that is, belonging to a predicament other than that of the term of motion. This is the view which later generations came to represent by calling motion a fluxus formae, a special reality strictly belonging to the predicament of passio, and hence essentially distinct from the term of motion.(24) Clearly this is not the view of Avicenna, and Albert never said it was; but it is the opinio famosior noted by Averroes.

"Although there are many opinions concerning the predicament to which motion belongs, these two are the more famous, namely that motion is in many according as the terms of motion are different, and that motion is in the predicament of passio, for the reality of motion is undoubtedly in the moving body either as a forma fluens, or as an affectio of that body, as we have said."(25)

For Albert passio strictly speaking is not motion itself, but the mod-

(23) See especially argument 5: "ergo moveri est in uno predicamento, et forma recepta per motum in alio..." ed.cit., 186a-b.

(24) "Item Commentator videtur intendere, quod ipse fluxus formae, qui est motus secundum opinionem famosiorem, est de genere passionis." John of Jandun, loc.cit., fol.42va.

(25) "Et ideo licet multae sint sententiae de motu in quo praedicamento sit, tamen istae duae sunt celebriores, scilicet quod sit in pluribus secundum numerum eorum in quibus est terminus motus, et quod sit in praedicamento passionis, quia esse motus absque dubio in mobili est, aut ut forma fluens, aut ut affectio mobilis, sicut diximus." Albert, loc.cit., p.187a. See also Phys., V, tr.I, cap.4, ed.cit., p.363.

ification produced in the moving body by motion.(26) Motion is rather a forma fluens de esse in esse. This does not mean that for Albert motion is merely a succession of forms, or that motion is identical with form, or that motion itself is a special form. Clearly for Albert to be in motion and to be in the term of motion (in quiete) are two really different states of being, "in esse diversificentur."(27) But since some term (a form) is necessarily intrinsic to every motion at every instant, that termination belongs essentially to the motion; therefore motion is not "per essentiam" different from the form which terminates it.(28) In other words, that which really exists at any given instant of movement, as in alteration, is some form, some existing act. This form in itself is not motion; but this form as tending to further perfection (forma fluens ut fluens) is the reality of motion. As long as the existing form is fluens there is motion. The 'fluidity' or fluxus of the form for St.Albert reduces to the same predicament as the term of motion, and he clearly denied that the 'fluidity,' or motion constitutes a separate predicament such as passio.(29) Thus St.Albert

(26) "Si autem consideratur motus secundum quod est affectio mobilis, quae affectio causatur a motu, hoc est, a forma fluente de esse in esse, eo quod movetur, sic motus est in praedicamento passionis secundum rei veritatem." Ibid.,p.187a.

(27) Ibid., p.188a; see also pp.187a, 189b.

(28) "...quia quilibet motus habet proprium terminum, ergo relinquitur quod terminus motus intrinsecus sit per essentiam motui; ergo est idem cum ente fluente ad ipsum per essentiam, licet non per esse." Ibid.,p.185a.

(29) See also Albert, Phys.,V,tr.I,cap.4 (ed.cit.,p.363). This is basically the view of St.Thomas, who holds that "quantum igitur ad id quod in rerum natura est de motu, motus ponitur per reductionem in illo genere quod terminat motum, sicut imperfectum reducitur ad perfectum." (In III Phys.,lect.5,n.17). But St.Thomas adds: "Quantum ad id quod ratio apprehendit circa motum, scilicet esse medium quodam inter duos terminos, sic iam implicatur ratio causae et effectus... Et secundum hoc, motus pertinet ad predicamentum actionis et passionis." (ibid.). That is to say, what actually exists of motion is a forma fluens; but to understand motion in its totality the mind must consider it as in the body moved (passio) and as produced by some agent (actio). This does not mean that motion, as such (ut fluens vel fluxus), belongs to passio.

rejected the view which later came to be associated with fluxus formae, a distinct predicament.

Not all the Schoolmen, however, considered forma fluens and fluxus formae to be opposing views of the nature of motion. Some believed that according to Aristotle and the Commentator motion can be viewed in both ways. Notably the Oxford Franciscan, William of Alnwick, taught at Bologna (c.1323) that motion materially considered is a forma fluens belonging to the predicament of the term, but formally considered motion is a fluxus formae, essentially distinct from such terms as quantity, quality and place.(30) In the Bologna Determinationes William of Alnwick strongly attacked the view, defended by Grosseteste and Henry Harclay, that a continuum is composed of indivisibles,(31) and he resolutely insisted on the essential divisibility of quantity, time and motion. Against Richard of Mediavilla(32)

(30) "Item sexto. Hoc probatur ex intencione Commentator 5 Phys., comm.9 et 3° Phys., comm.4, in quibus locis precipue loquitur de ista materia. Dicit enim super 5 Phys., comm.9, quod motus habet dupliceм consideracionem. Consideratur enim secundum suam materiam, et sic accipitur pro forma fluente, nam forma que fluit a termino in terminum est materialiter motus; et sic non differt a termino ad quem, nisi sicut imperfectum differt a perfecto...; sic igitur patet secundum ipsum quod motus acceptus materialiter, scilicet pro forma fluente in qua est motus, est in genere termini ad quem est motus. Alio modo consideratur motus secundum suam formam prout est forma in materia, et sic est fluxus formе. Sic enim est transmutacio coniuncta cum tempore; et sic dicit quod non est in genere termini, sed differt realiter a termino, quia ut dicit 3 Phys., comm.4, via ad ipsam rem est aliud ab ipsa re. Sic igitur patet secundum Commentatorem, quod motus secundum suam formam sive formaliter acceptus non est de genere termini ad quem — quod est propositum." Determinationes, q.18. MS Vatican, Pal.lat.1805, fol.150v.

(31) See especially q.2 (fol.6v-17) against Grosseteste and "magister henricus Cancellarius quondam Oxonie" on the divisibility of the continuum, and q.17 (fol.128-137v) on time. For a detailed description of this MS, see A.Ledeux, OFM, in Fr.Guillelmi Alnwick, O.F.M., Quaestiones Disputatae de esse intelligibili et de Quodlibet, Quaracchi 1937, pp.xxiii-xlv.

(32) "Quantum ad primam conclusionem est sciendum quod doctor quidam, scilicet frater Ricardus de Mediavilla, in questionibus suis disputatis et in scripto dicit quod continuacio non est de essentia motus, set est accidens motui." Determinationes, q.18. MS cit., fol.145r.

he maintained that continuity necessarily belongs to the nature of motion, the continuity which is characteristic of quantity. Therefore, William concluded, "motus secundum suam racionem formalem qua est fluxus forme continuus cum tempore est per se quantitas successiva."(33) Thus in the doctrine of William of Alnwick motion formally considered as a fluxus formae is "per se in genere quantitatis;"(34) it is formally a quantitas successiva essentially distinct from the term of motion. For him forma fluens signifies the 'matter' involved in motion, namely the succession of such forms as quantity, quality and place; but fluxus formae, the formality of motion, belongs not to passio, as suggested by the "opinio famosior" noted by Averroes, but to quantity.

In his early Expositio on the Physics (certainly before 1316) Walter Burley interpreted Averroes as meaning that motion can be considered in two ways. In one way motion is considered as not yet having reached its perfection, but more or less shares in the ultimate perfection towards which it is tending. In another way motion is considered as a via, distinct from that perfection. "Vel sub aliis verbis, motus potest accipi pro forma fluente, vel pro fluxu forme. Forma fluens dicitur terminus ad quem secundum quod est in adquiri; fluxus forme dicitur esse adquisicio termini."(35) But

(33) Ibid., fol.149v.

(34) "Hic ostendum tres conclusiones ordinem habentes, quarum prima est quod continuatio sive continuitas non est accidens motui, set essentialiter convenit motui; secunda conclusio est quod motus est per se in genere quantitatis; tercia conclusio est quod motus non est formaliter eiusdem generis cum termino, set tantum materialiter." ibid., fol.148r.

(35) "Ad questionem dicendum quod motus potest accipi dupliciter secundum quod vult Commentator 4° comm. huius libri tercii et comm.5 /sic/ quinti Phisicorum: uno modo accipitur motus secundum quod nondum a perfectione ad quam vadit nisi secundum magis et minus; alio modo accipitur secundum quod est via ad perfectionem istam, alia ab ista perfectione." Expositio lib. Phys., lib.III, text 4. Cambridge, Gaius College MS 448/409, p.254a; also lib.V, pp.343-344.

in his final version of the Expositio in libros Physicorum (c.1325) Burley maintains that motion is not to be conceived as the succession of forms, which he calls forma fluens, nor as fluxus formae, but as a forma diminuta by which a moving body flows and tends toward the perfect form.(36) It is this idea of motion as a forma diminuta, distinct from the body in motion, which Walter Burley defends against the view of William of Ockham.(37)

b. William of Ockham's view of motion

In his lectures on the Sentences, delivered at Oxford about 1317-1318, William of Ockham discussed the nature of motion in a lengthy question preserved in the reportatio.(38) He was not concerned with whether motion is a forma fluens or a fluxus formae. Rather he attacks the fundamental idea, common to both 'views', that motion is a positive reality, a "quid successivum", distinct from res permanentes. "Hic est una opinio communis omnibus quod motus addit aliquid distinctum ex natura rei super mobile et terminum; et illud secundum aliquos est absolutum, secundum aliquos est respectivum."(39)

The inspiration for Ockham's doctrine of motion seems to have been Peter John Olivi, who presented two opinions concerning whether "motus sit idem cum forma quae per motum educitur."(40) One anonymous view is that

(36) "Tertio est notandum secundum Commentator hic [comm.47], quod modus accipiendi motum pro via et fluxu est famosior, sed aliud modus, scilicet ille quo accipitur motus pro forma diminuta est verior... Ad aliud dico quod forma diminuta non est forma fluens de esse imperfecto ad esse perfectum, sed forma diminuta est illa sub qua mobile existens fuit et transit ad formam perfectam." Burley, Expositio in libros Physicorum, lib.III, text 4, ed. Venetiis 1501, fol.50vb and fol.52va.

(37) See Burley, ibid., fol.64rb-65va; in this refutation it is mainly Ockham's commentary on the Sentences II,q.9 and his Expositio in libros Physicorum (incorporated in the De successivis), which Burley has in view.

(38) Sent.II,q.9 (ed. Lyon 1495); Balliol College MS 299, fol.136r-144r (= Sent.II,q.5).

(39) Ibid., B.

(40) Joannis Petri Olivi, Quaestiones in II Lib. Sententiarum, q.27, ed.cit., I, 465-482.

motion is identical with the new forms educed from matter in the sense that there is no real difference between a res successiva and a res permanens. The other opinion is that motion adds to form a "certain imperfect and successive essence." Olivi himself cautiously defends the first view, "quamvis oppositam aliquando temerim."(41) But he concludes that since his manner of speaking about the identity of motion and form, and of the identity of successivi et permanentis appears impossible and ridiculous to many, one could hold the other view, as he had previously held, and answer all the objections noted in the questio; but he does not venture to declare with certitude which view is the more true.(42) Olivi's identification of motion with permanent forms is clearly different from St.Albert's view of motion as a forma fluens not differing "per essentiam" from the term of motion.(43)

In his lectures on the Sentences Ockham asks the question, whether motion is a real thing outside the mind (vera res extra animam) differing really from the moveable body and the term of motion. After listing ten arguments in favour of the traditional affirmative response, Ockham presents his own view in six conclusions.

(41) Ibid., p.466.

(42) "Quoniam autem totus iste modus de identitate motus et formae et de identitate successivi et permanentis multis videtur esse impossibilis et ridiculosus, ideo qui praedicta non placent, potest dicere, sicut et aliasdixi, quod motus addat super formam quandam essentiam imperfectam et successivam; et tunc habet pro se omnes rationes in arguendo factas. Quae autem istarum sit verior non est meum certitudinaliter definire." ibid., pp.481-482.

(43) It is not accurate to speak of Albert's view of forma fluens as an "identification" of motion with form, the term of motion (E.J. Dijksterhuis, Die Mechanisierung des Weltbildes, ed.cit., 196-197).

1) The motion of alteration does not imply anything positive over and above the absolute and relative permanent things (res permanentes), because motion is not a species of either quantity or quality.

2) The motion of augmentation is not really distinguished from rebus permanentibus, because that motion is not a quality or a quantity. It is not a quality, because at least by divine power there can be increase in size without any qualities present; it is not a quantity, because then it would be the same as the quantity which terminates the increase.

3) Local motion is not distinguished from rebus permanentibus, because, since local motion is not more perfect than ubi, the term of motion, movement cannot imply (dicit) anything over and above the term of motion and the res permanentes.

4) Motion is not something absolute (quid absolutum) which reductively belongs to some category, because any absolutum which is reductively in one genus, belongs per se to another; but motion does not belong per se to anything or to any category.

5) Generally stated, no motion implies anything absolute over and above all the res permanentes. Since "omne absolutum prius duratione alio absoluto" can be preserved forever by divine power without the latter addition, God could then conserve motion forever without it ever coming to any term.

6) Similarly motion does not imply anything relative (aliquid respectivum) over and above the res permanentes. Every real respectivum must have some foundation relative to something else. But motion cannot be founded in the mover, for then all movers would themselves have to be moved; nor can motion be founded in the terminus a quo, nor ad quem, nor in time, for none of these are moved; nor can motion be founded in the subject itself,

for every respectus subiecti, for example, matter relative to form, is permanent and hence independent of motion.

Ockham's general view of motion, therefore, is that no change whatever implies anything absolute or relative over and above the res permanentes, "puta a termino et subiecto."(44) This is true of both mutatio and motus. Mutatio, or instantaneous change, signifies principally the new form itself and the non-existence of the preceding form.(45) Motus likewise signifies principally the existing res permanens and connotes the non-existence of forms yet to come. "Et per tales negationes et affirmationes salvatur successio in motu." For Ockham the 'negation' implied in motus is not the non-existence of a previous form, but of a future form; all successive motion is the acquisition of additional parts. Just as in augmentation and alteration the previous form of quantity or quality is not lost, but remains with the additional form, so it is with local motion. Although in actual fact a body moving through space ceases to exist in one place and acquires another, God can by his absolute power make a body to move in space without losing its previous position, as happens when a body exists simultaneously in two places at once.(46) Since all forms acquired through motion can

(44) "Ideo dico aliter quod secundum intentionem Philosophi, ut firmiter credo, primo de mutatione, secundo de motu. De primo dico quod mutatio nullam rem absolutam dicit aliam a permanentibus, puta a termino et subiecto, sicut prius patuit, nec respectivam ultra res permanentes." II Sent., q. 9 H.

(45) "Sed secundum istam viam mutatio componitur ex positivo et negativo, quia dicit ipsam formam et negationem eius immediate precedentem." ibid.

(46) "Nam in motu augmentationis et alterationis manifestum est quod partes priores manent cum posterioribus, quia augmentatio fit per additionem unius partis ad partem..., similiter in motu locali, licet de facto unus locus vel ubi continue deperdatur sicut aliud continue acquiritur; tamen de potentia dei possunt omnia acquisita simul manere, quia deus potest facere quod corpus moveatur localiter, et quod semper quando acquirit novum locum retineat primum locum et secundum, et sic deinceps, quia deus potest facere ut idem corpus sit in diversis locis; et tunc hoc posito, tantum esset motus localis acquisitivus, non deperditivus. Patet ergo quod omnes forme acquisite per motum possunt

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exist simul, as is actually the case in augmentation and alteration, the negation implied in the concept of motion is the non-existence of forms not yet acquired. It is this 'negation' which accounts for succession in motion, and for the difference between a moving body and one at rest.

If one wishes to consider motion a respectus, or quid respectivum, then the term or concept 'motion' signifies the new forms continuously and successively acquired in a subject, the 'relation' of those forms to the subject matter and the agent, and the 'negation' of all subsequent forms, which are infinite. But if one does not wish to call motion relative, then 'motion' simply signifies the form partibiliter acquisitam and connotes the non-existence of all subsequent parts.(47)

Since this negation is not a res, but an ens rationis, there is no reality to motion over and above the existing res permanentes, namely quantified substance and qualities. There is no "real" difference between movement and the series of successive forms. But Ockham never identified motion and rest; for him rest is the perfection of motion, as there is no longer the connoted negation of subsequent parts.(48) However Ockham

(note 46 cont.) simul manere, et manent de facto quando est motus ad formam acquisitivus."[24] See also a similar notion in Olivi's commentary on the Sentences II,q.27, ed.cit., p.470.

(47) "...ita quod hoc nomen motus vel conceptus eius significat formam continue et successive acquisitam in aliquo subiecto, et respectus eius forme ad passum et ad agens, et negationes omnium partium sequentium, que infinite sunt, ita quod omnia ista sunt de totali significato motus ponendo respectus; vel motus significat formam partibiliter acquisitam connotando negationes partium sequentium seinvicem, et hoc non ponendo respectus." ibid.

(48) "...quia quies illa est ipsum positivum in motu, et ideo illa quies non est proprie privatio motus, sed eius perfectio secundum Commentatorem in multis locis. Tamen potest quies dici privatio motus quantum ad negationes quas motus includit, quia quies in termino ad quem dicit tantum illud positivum sive affirmativum quod est in motu sine negatione alia inclusa." ibid.

refused to see any difference between the process of acquiring and the series of absolute and permanent terms; the difference for him was only in the abstract name, the noun.

The fictio nominum abstractorum derived from adverbs, conjunctions, prepositions, verbs and syncategorematic terms is considered by Ockham to be the cause of a great many difficulties and errors, since some imagine that distinct nouns correspond to distinct realities.(49) Such abstract nouns as motion, change, movement, action, passion, heating, freezing, and the like which are derived from verbs, are used in human speech, according to Ockham, only "causa brevitatis loquendi vel ornatus locutionis."(50) Thus the noun 'local motion' briefly expresses the complex phrase, 'a body which was in one place, and later will be in another place, in such a way that at no time does it rest in any place.' But this should not be taken to mean that local motion is a reality over and above the body in place.(51)

Ockham conceived all motion as an acquisition of parts. But local motion for Ockham was different from other motions in that ubi (being in place) is not a form, a reality intrinsic to the body in place.(52) For him place (locus) is nothing but the locating body, the surrounding body, and to be in place is to occupy a determined position in absolute space, which exists permanently.(53) Thus although the denomination of ubi is

(49) Tract. de successivis (de motu), ed. P.Boehner, 1944, p.46; also De Sac.Altaris I,q.1, ed.cit.,pp.52-66; Summulae in Libros Physicorum, P.III,c.7, ed. Venetiis 1506, fol.15v.
(50) Tract. de successivis, ed.cit., p.37.
(51) Ibid., p.45.
(52) Cf. Sent.,II,q.9 O; Summa Logicae,P.I,cap.60, ed.cit., pp.173-4.
(53) De Sac.Altaris II, ed.cit.,p.238; Tract. de successivis, ed.cit., pp.69-96; Sent.II,q.9 O (above note 49); see also Ockham's arguments concerning place and quantified substance, discussed above in Chapter IV, pp. 176-181.

extrinsic to the body, movement from one position in space to another is absolute and determined in reference to absolute space, even though nothing real is actually acquired.(54) Far from advocating any 'relativist' view of motion, Ockham insisted that all motion is merely a noun signifying the "successive parts acquired," whether those parts be absolute forms (res absolutae) or fixed positions in space.(55)

c. The Mertonian view of motion

In his Summa, Part III, John Dumbleton patently accepts Ockham's nominalist teaching on motion. But this is only a part of Dumbleton's view of the nature of motion. It is the non-Ockhamist part which may be called typical of the Mertonian physicists.

In his explanation of the definitio materialis of motion, Dumbleton quotes Averroes, rather than Aristotle: "Motus est acquisitio partis post partem illius termini ad quem vadit res mota donec perficiatur per motum ut sit in actu."(56) Hence it follows that motion in the generation of a substance belongs to the predicament of substance, and similarly motion in quality and quantity. "quasi diceret Commentator, quod res acquisita per motum est materia motus, sicut spatium in motu locali est eius materia, et in motu in qualitate qualitas acquisita est spatium, et ideo materia motus

(54) Sent.II,q.26 M (text quoted and discussed below, pp.266-8.).
(55) Prof.E.J.Dijksterhuis (op.cit.,p.198) remarks that Ockham's relative notion of movement is closer to modern scientific views than the "absolutistische Bewegungslehre" of his successors, the Parisian Terminists who prepared the way for Newton. But it may be doubted whether Ockham's "relativist" view of motion has anything in common with modern Relativity Physics, or whether the "absolutist" view of the Parisian Terminists has anything in common with Newtonian Physics. Ockham's "followers," the Parisian Terminists, merely rejected Ockham's nominalist view and defended the reality of motion as a forma fluens.
(56) Summa,P.III,c.22: "Definitio materialis est hec, posita a Commentatore, comm.4..." MS Vat.Lat.6750, fol.49va.

est qualitas."(57) This is Dumbleton's interpretation of the "opinio verior." But when Averroes speaks of motion as a via and as a genus per se, he is conceiving motion as though it were a 'form' (ac si motus localis esset forma) by which the moving body acquires the 'spaces.' Thus Dumbleton understands the Averroist "opinio famosior" to signify an imagined form (forma imaginata) by which given spaces, the 'matter' of motion, are acquired. Hence only those predicaments which have true spatia divisibilia can be the subject of motion.(58)

In discussing the precise nature of motion Dumbleton notes that there are four opinions.(59) The first holds that motion is an accident in a subject. This position is twofold: the first holds that it is a permanent accident (fixum), the other holds that motion itself is fluxibile, so that at every instant there is a different accident of motion. The third opinion considers motion to be nothing but a privation. The fourth opinion, a modification of the third, considers motion to be the body itself inasmuch as it is actually acquiring some term.

Dumbleton rejects the first opinion (the traditional 13th century view)

(57) Ibid.

(58) "Sed Commentator in eodem 3°, comm.4, dicit, quod motus secundum quod est via ad perfectionem alia ab illa perfectionem est, ut sit genus per se; in quo innuit Commentator motum esse tanquam formam motus per quam actuatur mobile ut sit motus in actu, ac si motus localis esset forma, qua forma vel forma sibi simili in genere mobile motum novo locali est motum in actu, ut omne album est album forma que est albedo. ... Et ita imaginatur Commentator quod est una forma re vel /fol.49vb/ ratione in mobili, qua acquiritur aliquod spatium in aliquo predicamento. Et ideo predicamenta que non habent vera spatia divisibilia secundum rem in illis, non potest esse verus motus." ibid.

(59) "Quid et qualis res sit motus, quatuor sunt opiniones. Una dicit motum esse accidens in subiecto. Hec positio bipartita est; una dicit motum esse accidens fixum, et secunda dicit motum esse fluxibile, ita quod solum de eo manet unum indivisibile sicut instans manet de tempore et continue est alius motus et alius. Tertia dicit motum nihil esse, sed privationem. Quarta dicit motum esse mobile prout mobile est actualiter in terminum aliquem acquirendo." P.III, c.23, MS cit., fol.49vb.

at great length with the usual Ockhamist arguments and concludes that neither rest nor motion are accidents really distinct from natural bodies, but only mentally distinct.(60)

The second opinion, probably an adaptation of Burley's well known view of intension and remission,(61) considers motion to be an infinite succession of indivisible motions. But this is rejected because time is not composed of instances, nor is any degree (gradus) of motion composed of indivisibles. Further, according to this view motion itself could not be a proportion, for "omnis proportio quadrupla componitur necessario ex duabus duplis"; but if motion is indivisible it cannot be composed of two half ratios, and thus motion itself would not be a ratio.(62) Furthermore, according to this position "motus non sequitur proportionem geometricam nec arithmeticam," that is, there could be no proportion in the increase of velocities.(63) But the fundamental assumption of all the Mertonian calculatores, as we shall see, is that all motion is a velocity, a ratio, and increases in

(60) "Et ideo neque quies neque motus sunt accidentia distincta a subiectis suis, scilicet a corporibus naturalibus, in re, sed ratione distinguuntur." ibid., fol.51rb.

(61) It is not certain whether Burley himself held this view, but he would have, if he thought of velocity as a quality. For Burley's view of intension and remission of forms, and for Dumbleton's rejection of it, see below, pp. 258-9.

(62) "Item si Sortes continue haberet alium motum et alium, sic quod habeat B gradum in medio instanti, quod sit C, et proveniat A ism ex proportione dupla, et B ex proportione quadrupla, /tunc/ Sortes habet ism proportionem duplam secundum quam movetur A gradu. Sed cum in C instanti habebit quadruplam secundum quam movebitur in C, et omnis proportio quadrupla componitur necessario ex duabus duplis, igitur in C instanti Sortes habebit duas duplas. Igitur habebit duos motus realiter vel imaginarios, quorum alterum erit A vel sibi equalis in velocitate, et alium habebit Sortes in C respectu alterius proportionis duple." P.III, c.24, fol.51va.

(63) "...sicut proportio habet partes suas simul eam componentes imaginarie vel realiter, ita habet motus suas partes; et ille simul sic sumpte sunt gradus motus." ibid., fol.51va.

geometric proportionality. If however motion is an indivisible quality, it has no velocity, nor can it accelerate.

Dumbleton himself defends the third opinion with a certain modification,[64] which is in fact the Ockhamist fourth opinion. For Dumbleton 'motion' is an abstract term, and as such, cannot be predicated of a body; it can be predicated only in concreto.[65] This means nothing more than that concretely what exists is an individual body actually acquiring some term, some spatium. Abstractly, the term 'motion', as a form of motion, is potentiality for future terms; it is the privation, or negation of subsequent terms; it is in fact Ockham's negationes.[66]

But more significantly, local motion for Dumbleton is a latitudo which can be intensified or decreased, just as qualities and quantities can be increased and decreased.[67] But increase of local motion means an increase of velocity, that is, more 'spaces' acquired in equal time. Therefore, local motion in itself is really a velocity, that is, a ratio, a proportion between time and the spatia acquisita. As all velocity depends upon the proportion, or ratio, between mover and resistance, the increase in velocity depends upon the proportional increase of the moving power over resistance. This means that motion itself is a given velocity, distance acquired in a given time, proportional to the force of the mover over resistance. That

(64) "Hec sententia cum quadam modificatione dicenda cum quarta opinione tenenda est." P.III,c.23, fol.52ra.

(65) "...igitur motus non predicatur de mobili quod est eius subiectum prout motus accipitur pro forma motus. Et ideo sequitur quod hoc nomen 'motus' non predicatur de mobili in abstracto, sed in concreto." ibid., fol.51vb.

(66) See above, pp.224-6.

(67) "Quarta suppositio: quod latitudo motus et proportionis inter se equaliter acquirantur et deperdantur..." P.III,c.7, fol.40vb.

is to say, though the matter of motion is spatia acquisita, the formality of motion ut est forma realis vel imaginata is the velocity with which that distance is traversed.

Briefly, then, although Dumbleton accepted a nominalist interpretation of local motion, his view is that motion as such is formally a velocity, a ratio of distance to a given time; the 'matter' of motion is the spatia acquisita vel deperdita; and the efficient cause of this ratio is the ratio of the mover's power over resistance. Because motion in itself was conceived as a velocity, Dumbleton together with the other Mertonians could commonly speak of motion as "an acquisition or loss of proportions."

According to Gaetano di Thiene, who lectured at the University of Padua from 1422 until 1465, and Simon de Lendenaria, his contemporary, William Heytesbury followed Ockham in holding that motion and time are not realiter distinguished from the body moved.(68) Heytesbury himself never discussed the nature of motion, at least not in any work known to be by him. In one passage he says that "many false figments concerning instants, time, and motion are admitted in the common manner of speaking for the sake of brevity and an easier expression of the mental concept," but "in the nature of things there is no instant as such, nor time as such, nor motion as such."(69)

(68) "Sed adverte quod Hentisberus, temendo opinionem Occham, scilicet quod tempus, motus et primum mobile non distinguuntur realiter, concedit quod infinite partes temporis erunt simul." Recolecte mag. Simonis de Lendenaria super septem sophismatibus hentisberi, Venice MS, San Marco, lat.VI,cod.160 (2816), fol.224ra. Gaetani de Thiene, Recol. super de incipit et desinit Hentisberi, ed. Venetiis 1494, fol.28vb.

(69) Regulae solvendi sophismata, c.4 (de incipit et desinit), ed. Venetiis 1494, fol.26ra.

Heytesbury, therefore, may have accepted the Ockhamist view of motion as the series of absolute and permanent terms acquired, as Dumbleton had done.

However, throughout the whole of his influential treatise De tribus praedicamentis contained in the Regulae solvendi sophismata Heytesbury is concerned only with the velocities of motion, their comparison and their variations uniformly and difformly, as will be explained in the following section. Even in his discussion of motions in the category of quantity and quality, it is only with the velocity of intension and remission that he is concerned. He conceives all motion, local motion, alteration, augmentation and diminution, as an intensive quality, the 'latitude' of which can be increased in a given time. The ratio of distance to time is velocity; but this velocity may be uniform or difform, uniformly or difformly uniform and difform. Heytesbury is concerned with variations of these velocities. Thus clearly Heytesbury conceives motion itself to be velocity, the proportion between time and the spatia acquisita. Therefore, the formality of motion as such, ut forma realis vel imaginata, is a ratio, a proportion, namely velocity.

The most explicit statement, thus far noticed, of the 'Mertonian view' of motion is to be found in an anonymous Tractatus de motu locali difformi, contained in Cambridge, Caius College MS 499/268, fol.212ra-213rb. This closely written parchment of the 14th century contains the Calculationes of Richard Swineshead and two other treatises ascribed to Swineshead.(70) How-

(70) Tractatus /de intensione et remissione/, inc.: "In primo de celo Philosophus commento 35 arguit, corpus infinitum circumvolvi... quantum ipsa aqua scilicet tres filius latitudinis. Explicit tractatus de Swyneshede." (fol.204-211v) Tractatus de motu locali, inc.: "Multe possint elici conclusiones sive regule super variationem proporcionum et motus... hinc inde motus alteracionis et quemadmodum variata fuerit ipsa proportio, ita et velocitas. Explicit tractatus de Swineshede de motu locali." (fol.213rb-215rb).

ever the treatise De motu locali difformi is not ascribed to him.(71) The author begins by saying that since all natural effects come into being by motion, a natural philosopher must first of all know what motion is. But according to Aristotle nothing is known perfectly, except through its proximate and remote causes. Thus to understand motion it is expedient to examine its principal causes, which are the material, formal, efficient and final. For the anonymous author the "causa materialis seu materia" of motion is the ipsum acquisitum per motum. That is, the material cause is the spatium acquisitum, or the degree of 'latitude' acquired by motion. This is the same sense in which Dumbleton speaks of motus ut materia as the spatia acquisita vel deperdita, and "res acquisita per motum est materia motus." The "causa formalis" is defined by the anonymous author as a transmutatio quedam continuata cum tempore; that is, the formality of motion is the rate at which the spaces are acquired, or the velocity. This is what Dumbleton meant by motion "ut forma imaginata vel realis" by which given spaces are acquired in a given time. The efficient cause of motion is the proportio maioris inequalitatis potencie motive super potenciam resistivam. It is important to note that in this common teaching of the Mertonians, the efficient cause is formally called a proportio. The final cause according to the anonymous author is the terminus intentus per motum, that is, the terminus ad quem intended in local motion, alteration and augmentation.

(71) Inc.: "Cum omnis effectus naturalis per motum ad esse producitur, inquisicionem naturalium volenti insistere precognicio motus esse necessaria dinoscitur.... vel per tantum continuaret talem motum pro quolibet instanti talis motus attenditur. Esse finis." According to information given by Father Thomas Kaeppeli, O.P., this treatise is also anonymous in Seville, Colombina MS 7-7-29, fol. 27va-28vb.

This classification of the causes of motion brings out most clearly the vast difference between the 'Mertonian view' and the traditional Aristotelian view, which saw motion as an act of a being in potency, intrinsically motivated toward an end. The Mertonians are not interested in motion as a forma fluens or a fluxus formae, a real accident inherent in a subject. Aristotle considered velocity a property of motion. But for the Mertonians motion is the acquisition of 'spaces' in a given time; the ratio of spaces acquired to a given time is the velocity, the "formal cause" of motion. Thus the predominantly qualitative view of the nature of motion possessed by the earlier Schoolmen is replaced by a quantitative view of motion as velocity. In other words, for Aristotle motions can be measured by their velocity; but it is only in this velocity and the variations of velocities that the Mertonians are interested.

Velocities are themselves ratios of linear, or continuous measures: the distances traversed in a given time. But when different velocities are compared, the ratios of continuous measures are themselves divided, and hence are considered as discrete quantities in a certain ratio, or proportion. Proportions themselves can be compared according to different mathematical functions. Thus the Mertonians could speak of uniform acceleration as the "acquiring of proportions", that is, a proportional increase in velocity; they could speak of uniform deceleration as the"loss of proportions", that is, a proportional decrease in velocity.

This new way of considering motions, so different from that of earlier centuries, is due to the enormous influence of Thomas Bradwardine's treatise, De proportione velocitatum in motibus.

II. The Proportion of Velocities.

In the seventh Book of the Physics[72] Aristotle discusses two distinct points. His first point (cc.1-3) is that there must exist a first mover, which is not itself moved by physical motion. This he does by showing that everything which is moving must have been moved by something else[73] and that the mover must be in immediate contact with the body when it is 'moved'.[74] Since an infinite regress in such movers is impossible, some unmoved mover must exist. The second point (cc.4-5) is concerned with the question of whether or not every motion is commensurable with every other in velocity.

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(72) On the authenticity and the text of Book VII, see W.D.Ross, Aristotle's Physics, Oxford 1936, pp.11-19. The Schoolmen, of course, accepted Book VII as an integral part of the Physics and considered it to be a discussion of motion "per comparationem ad motores et mobilia" (St. Albert, Phys.,VII,tr.I,cap.1; St.Thomas, In VII Phys.,lect.1,n.1).

(73) Aristotle's phrase, ὅταν τὸ κινούμενον ὑπ' ἄλλου ἀνάγκη κινεῖσθαι, also discussed in Phys.,VIII,5 and 10, is difficult to translate accurately, and it has frequently occasioned some misunderstanding. The almost tautological Latin rendering of it as "omne quod movetur, necesse est ab aliquo moveri," is closer to the true meaning than the English "everything that is in motion must be moved by something." The sense is not that everything which is moving, here and now is moved by something else in actual contact with it, (the meaning given to the Phrase by Ross, Duhem and many others). Rather Aristotle means that since there is no 'first part moved' in motion, moving bodies cannot be the cause of their own motion; therefore the 'cause' of that motion must be a soul in animal motions, or a generator of the natural form in natural inanimate motion, or an extrinsic force in violent motions (cf. Phys.,VIII,4-5 and 10). For Aristotle the 'form' is an active, spontaneous principle of motion; but the form is generated (moved) from potency by an external agent, and hence "ab alio." This has been discussed elsewhere; see J.A.Weisheipl, "The Concept of Nature," TNS, XXVIII (1954), 395-405.

(74) Aristotle never considered the 'form' of inanimate bodies to be the 'mover accompanying bodies.' In Scholastic thought this interpretation is derived from Averroes, Phys.,IV, comm.71, De Celo,III, comm. 22, and De Celo,IV, comm.28. (cf. J.A.Weisheipl, ibid.,398-404).

Since all motion takes place in time, motions can be termed 'fast' or 'slow' according as a certain motion is accomplished in more or less time. Motions are of equal velocity when they traverse equal distances in equal times. But it seems absurd to say that rectilinear motion and rotational motion are of equal velocity, or to say that an alteration is faster or slower than movement in place. Hence it would seem that not every motion is commensurable with every other.

In his solution of the difficulty Aristotle admits that not all motions are commensurable in velocity; there is no comparison of velocities in rectilinear and rotational motions, nor in alterations and local motions, for they have nothing in common except 'time'. For the comparison of velocities three factors are required: (1) that there be no equivocation in the use of the terms, such as 'distance'; (2) that like be compared to like, that is, quantity to quantity, qualities to qualities, and so forth; (3) that it be the comparison of the same species of motion. Thus alteration and local motion cannot be compared in velocity, since they are entirely different categories of motion. Even within a single category such as local motion, rectilinear and rotational motions cannot be compared in velocity, since the magnitudes traversed are incommensurable; only those local motions are of 'equal velocity' which cover equal magnitudes in equal times.(75) Alterations are of equal velocity if the same species of quality,

(75) St.Thomas expresses Aristotle's thought clearly when he says, "Concludit ergo primo, quod ex quo motus non sunt comparabiles nisi sint unius speciei; et motus locales non sint unius speciei nisi sit eadem magnitudo secundum speciem; sequitur quod illa sint aeque velocia, quae moventur in aequali tempore secundum magnitudinem eandem." In VII Phys.,lec.8,n.7. For Aristotle linear distance and the circumference of a circle are incommensurable magnitudes (248a18-b7, 248b10-12), hence rectilinear and rotational motions cannot be compared according to distance. See T.Heath, Mathematics in Aristotle, Oxford 1949, 140-142.

in the same intensity, are changed in equal times. Generations and corruptions can be compared in velocity if the same indivisible species is generated in equal times.

Aristotle then proceeds to explain how velocities can be compared within a given species of motion. Every corporeal mover acts upon another body, and in doing so produces a certain result, for example, a given distance traversed in a certain amount of time. First he gives rules for the comparison of local motions, that is, for the proportion of velocities in rectilinear motion.

1) If a mover A moves a body B in time D over a distance C, it or an equivalent force moves half of B in time D over twice the distance, and in half the time D over the whole distance C.

2) The mover A moves the body B in half the time over half the distance, and half the force A moves half the body B during the full time over the whole distance.

But Aristotle is careful to point out that a force could not necessarily move twice the body in half the distance in the same time, for if the force of the mover is not greater than the resistance, no movement at all will take place. Nor will half the force move the body B with half the velocity, for the same reason. But it is clear that twice the force will move twice the body with the same velocity as the single force moves the single body, "for in this case the rules of proportion apply."(76)

Aristotle then notes that these rules are also valid, everything else being equal, for the motions of augmentation and alteration, since an agent produces a certain degree of increase in a certain amount of time. Thus

(76) Phys., VII, 5, 250a28-29.

twice the amount of time is required to produce twice the degree of alteration or augmentation; and to alter half the degree, the same agent requires only half the time. Although the same rules apply, *ceteris paribus*, to all the categories in which motion is possible, it does not follow for Aristotle that their velocities are commensurable one to the other; only those velocities are commensurable in which there is no equivocation in such terms as *distantia*, and which belong to a specific type of motion.

The essential point of the Aristotelian rules of dynamics is that from doubling the moving power or from halving the resistance, there follows, everything else being equal, twice the velocity; but it does not necessarily follow that from halving the force or by doubling the resistance there results half the velocity, but only when the proportion of force to resistance remains the same.(77)

Before the time of Thomas Bradwardine these rules were re-phrased, simplified, or clarified by the Schoolmen, who confined the cases considered to the doubling and halving of the two independent variables. No attempt was made to formulate a general law valid for all variations of velocity.

a. The Treatise of Thomas Bradwardine.

Thomas Bradwardine, as far as is known, was the first to direct full attention to this special problem of the variation of velocities. In his treatise *De proportione velocitatum in motibus*, published in 1328, Bradwardine

(77) Cf. T.Heath, *Mathematics in Aristotle*, *ed.cit.*, pp.142-6.

states the purpose of his work in the *procemium*.(78) Since all successive motions are proportionate one to the other in velocity, natural philosophy, which studies motion, must not ignore the proportions of motions and of velocities. And because an understanding of this is necessary and extremely difficult, "nec in aliqua parte philosophiae tradita est ad plenum, ideo de proportione velocitatum in motibus faciemus istud opus."(79) The treatise is, in fact, concerned with dynamics, rather than with kinematics.(80)

Bradwardine's treatise is divided into four chapters. The first presents the elementary mathematical knowledge necessary for the purpose of the treatise, "for, as Boethius says, whoever dismisses mathematical studies has destroyed the whole of philosophical knowledge." This chapter, containing definitions and divisions of *proportio* and *proportionalitas*, together with certain axioms (*suppositiones*) and theorems (*conclusiones*), is based upon Euclid's *Arithmetica* and *Elementa*, Campanus of Novara's *Commentary*, and upon the Arabic-Latin tradition represented, for example by Ahmad ben

(78) Although the recent edition of the treatise based on four MSS by H.L. Crosby (*Thomas of Bradwardine, His Tractatus de Proportionibus*, Univ. of Wisconsin Press, Madison 1955) is not perfectly satisfactory, references will be made to it, rather than to the less satisfactory Venice edition of 1505. For incidental corrections I have used the following MSS: Vat.lat.1108,fol.69-81, and fol.104-119v; Vat.lat.2185, fol.23v-27v; Vat.lat.4429,fol.23-29; Oxford, Canon.Misc.177,fol.164-170v.

(79) *Ed.cit.*, p.64.

(80) The distinction between dynamics and kinematics was represented in early 14th century physics by the two groups of problems, "penes quid attenditur velocitas tamquam penes causam" and "penes quid attenditur tamquam penes effectum," as, for example, in Albert of Saxony's *Tractatus de proportionibus* (ed. Padnae 1482). See P.Duhem, *Etudes*, III, 302-309. As C.Wilson has already noted (*op.cit.*, 194-5), Gaetano di Thiene expresses the distinction more clearly when he says that the science of the "proper passions" of motion (quickness and slowness, uniformity and difformity) is twofold, *a priori* and *a posteriori*. The *a priori* consideration deals with variation of velocity as it depends on the ratio of the mover to the moved, that is, as it depends on the magnitude of the cause (dynamics). The *a posteriori* consideration deals with variation of velocity as measured by the magnitude of the effect produced (*quoad effectum in equali tempore*), independent of any consideration of how the motion is caused (kinematics). *Expositio super De motu locali*, ed. Venetiis 1494, fol.37ra.

Yusuf's De proportione et proportionalitate.(81) The second chapter is devoted to the refutation of four erroneous opinions. In the third chapter Bradwardine expresses his own doctrine, while in the fourth he discusses the proportion of velocities in rotational motion.

The first erroneous opinion claims, on the authority of certain texts in Aristotle and Averroes, that "proportionem velocitatum in motibus sequi excessum potentiae motoris ad potentiam rei motae," that is, the ratio of velocity would follow the arithmetical difference between force and resistance. Symbolically this opinion could be expressed as follows:(82) if V and V' are the velocities, F and F' the moving force, R and R' the resistance, then

(81) I have examined this "epistola" in Paris, Bibl.Nat.lat.9335, fol.64r-74r, Vienna, Nat.Bibl. 5292,fol.158-179v, and the 16th century text in Vienna, Nat.Bibl. 5277,fol.307v-320v. But I have not been able to make any satisfactory study of the numerous and often variously ascribed latin treatises De Proportione derived from Greek and Arabic sources.

(82) Crosby (op.cit.,p.32) represents this theory as KV=F-R, where k is a conversion constant, and objects to Maier's formulation, V:V'=(F-R)-(F'-R'). Cf. "Der Funktionsbegriff," Divus Thomas, XXIV (1946),153. Dr.Crosby believes (ibid.,p.188, note 84) that the opinion is not to be understood as involving a "proportion of velocities," but rather a "proportion of forces," since the "excess" of the power of mover over moved is spoken of in the singular number. He further believes that the opinion intends to speak of a "geometric proportion." From Bradwardine's arguments against the first opinion there can be no doubt that what is intended by the erroneous opinion is the proportion of velocities following an arithmetical difference (see also Dumbleton's presentation of this opinion, Summa P.III,c.5, MS Vat.lat.6750,fol.39ra, mentioned below, p257-9). This is more clearly expressed in the school-text, De proportionibus: "Sententia huius opinionis est haec: si due potencie et due resistencie et per maiorem excessum excedit prima potencia suam resistenciam quam secunda suam resistenciam, tunc per maiorem velocitatem excedit prima potencia suam resistenciam quam secunda suam resistenciam. Exemplum: sit A una potencia ut 8, B sua resistencia ut 4, C una alia potencia ut 2, D sua resistencia ut 1. Tunc in quadruplo maiori velocitate movetur A cum B, quam C cum D, quia in quadruplo maior est excessus A ad B, quam C ad D." (London MS, Brit.Mus.,Royal 8 A.XVIII,fol.77v). Substituting these numbers for the above symbols we get: 4-1 = (8-4)-(2-1).

$V-V'=(F-R)-(F'-R')$. Bradwardine easily dismisses this view because it does not accord with the Aristotelian rules, for example, that half the force should move half the resistance over the whole distance in the full time. If the ratio of velocities follows the arithmetical difference, as the first view proposes, then half the force would move half the resistance only over half the distance in the full time.(83) Bradwardine declares that Aristotle and Averroes never intended 'proportion' to be understood as arithmetic proportionality, or equality of difference.(84)

The second erroneous opinion holds that "proportionem velocitatum in motibus sequi proportionem excessus potentiae motoris super potentiam rei motae," that is, the ratio of velocity would be determined by the ratio of the differences. Symbolically this view could be expressed as follows:(85) $\frac{V}{V'} = \frac{(F-R)}{(F'-R')}$. Bradwardine briefly rejects this, because if the force moves

(83) "Secundum istum modum sequitur quod, aliquo motore movente aliquod mobile per aliquod spatium in aliquo tempore, medietas motoris /non moveret/ medietatem moti /per idem spatium in equali tempore, sed tantum/ per medietatem /spatii. Consequentia patet.../." op.cit., p.86. Crosby's text is very faulty here. I have inserted only those necessary words found in the five MSS examined.

(84) "Nec potest dici quod Aristoteles et Averroes intelligunt, in locis praedictis, per proportionem seu analogiam, proportionalitatem arithmeticam seu aequalitatem excessuum, ut dicunt quidam." ibid., p.88.

(85) Dr.Crosby (op.cit., note 86, p.189) objects to Miss Maier's formulation, because this is his interpretation of the first erroneous opinion, and he gives in its stead: $_{RV} = \frac{F-R}{R}$. But the fundamental point of the second theory, according to Bradwardine, is that the proportion of excess alone is accounted responsible for the velocity. This is also clear from the school-text, De proportionibus: "Sentencia huius opinionis est hec: si sint due potencie et due resistencie et in maiori proportione se habet excessus prime potencie ad suam resistenciam quam excessus secunde potencie ad suam resistenciam, tunc maiori velocitate movebitur prima potencia cum sua resistencia, quam secunda cum sua." MS cit., fol.77a. For the numerical example see text in Appendix II, but when the numbers given are substituted in the formula, we get: $\frac{4}{2} = \frac{(5-1)}{(3-1)}$.

only by the ratio of excess, then in the case where the excess is equal to the resistance, no motion at all would follow from this proportion of equality.(86)

The fourth and last opinion need only be mentioned in passing. This holds that there is no "proportion" or ratio between force and resistance, but only a "habitudo naturalis," since such intensive qualities are not quantitates eiusdem generis. This is a very legitimate objection from the earlier scholastic point of view, and may perhaps represent the attitude of Albertus Magnus and Thomas Aquinas. However Bradwardine uses the classical example of music to show that sounds and voces are governed by the theory of proportions. He is convinced that behind all sense phenomena there lies mathematics and that all motions can be compared according to the mathematical laws of proportionality.

Only the third erroneous opinion is taken seriously by Bradwardine, judging from his detailed refutation of this position. It is, in fact, the traditional(87) Aristotelian formulation of the geometric proportion of velocities: "ponit proportionem velocitatum in motibus, manente eodem motore vel aequali, sequi proportionem passuum, et manente eodem passu vel aequali, sequi proportionem motoris."(88) This position can be represented loosely as $V = \frac{F}{R}$. Against this position Bradwardine argues: (1) that it is "insufficiens,

(86) Dr. Crosby (ibid) considers Bradwardine's objection to be meaningless on the basis of Miss Maier's formulation. But Bradwardine merely takes one case in which motion would be impossible if velocity followed the proportion of excess, and not "totum suum potentiam" (cf. second objection, ibid., p. 94).

(87) This is clearly presented in Walter Burley's exposition, even though it was written after Bradwardine's treatise, Phys. VII, text 34-36, ed. Venetiis 1501, fol. 221rb-222vb.

(88) Ed. cit., p. 94.

quia non docet proportionem velocitatum in motibus nisi in quibus est idem motor vel aequalis, seu idem mobile vel aequale," (2) that it is founded "super mendacio consequentis," because it would follow from this that "quodlibet mobile a quolibet motore potest moveri." In other words, the law is insufficient because it does not consider those cases where both force and resistance vary, and it neglects an essential condition of motion, namely that the force must always be greater than the resistance. According to this third view a force will move twice the body with half the velocity, four times the body with one-fourth the distance, and so forth ad infinitum. But the essential condition of all motion is not acknowledged, for unless the force is greater than the resistance, no motion at all will take place. Bradwardine's task, therefore, is to find a formula, or a function of $\frac{F}{R}$ which will contain the condition, that is to say, a function which vanishes when the resistance is greater than or equal to the force of the mover.

Miss Maier was the first to rediscover the importance and the true meaning of Bradwardine's function.(89) Bradwardine's formulation of his own position in the third chapter is obscure and not quite accurate: "proportio velocitatum in motibus sequitur proportionem potentiae motoris ad potentiam rei motae."(90) But is is clear from what follows that the diversity (proportio) of velocities depends upon the diversity of the proportion (proportio proportionum) of the moving power over the resistance.(91) That

(89) "Der Funktionsbegriff in der Physik des 14. Jahrhunderts," Divus Thomas (Frib.), 3rd series XXIV (1946), 147 ff.; enlarged in Studien I, 81-110.

(90) Ed. cit., 110.

(91) "Et hoc est quod vult Averroes super 4 Physicorum, comm. 71, sic dicens: Universaliter manifestum est quod causa diversitatis et aequalitatis motuum est aequalitas et diversitas proportionis motoris ad rem motam." ibid. That Bradwardine intends to talk about the proportio proportionum is clear throughout his entire treatise.

is to say, the change of velocity follows the change of the entire ratio of force and resistance $\left(\frac{F}{R}\right)$. But in Bradwardine's theory a double velocity follows from the ratio duplata, that is, not multiplied by two, but by itself, for twice a proportio tripla is one which contains the ratio 3:1 twice. But if this ratio is multiplied by two the result is 6:1, which contains only one proportio tripla, for 6:1 is composed of $\frac{6}{3} \cdot \frac{3}{1}$. Only the ratio 9:1 contains the ratio 3:1 twice, for it is composed of $\frac{9}{3} \cdot \frac{3}{1}$; thus only the ratio squared can give twice the velocity. Similarly triple velocity follows from the ratio triplata, that is, raised to the third power. Conversely, half the velocity would follow from the mediatas of the ratio, that is, the square root of the fraction; one third the velocity follows the cube root, and so forth. The functional equation which Bradwardine proposes between force and resistance on the one hand and velocity on the other is that raising the ratio to the second, third, fourth, or fifth power corresponds to the doubling, tripling, and so on of the velocity; and the extraction of the square root, cube root, and so on corresponds to dividing the velocity by two, three, four and so forth ad infinitum. Symbolically, Bradwardine's functional equation can be expressed as $n^{*}V = \left(\frac{F}{R}\right)^{n}$, or in modern notation as $V = \log_{n}\left(\frac{F}{R}\right)$. Bradwardine's function at least solves the difficulty involved in the Aristotelian formulation in that for Bradwardine the resistance can never become equal to or greater than the moving power. There is no longer any danger that in the variation of velocities the proportion of moving power to resistance may become a proportio aqualitatis or minoris inequalitatis, from which no motion would result.

Given the problem and the Aristotelian assumption, Bradwardine's solution was successful from the mathematical point of view. For him it was not

a question of empirical discovery or experimental verification; it was only a question of dissolving a mathematical inconsistency and incompleteness. But Bradwardine himself had no doubt that his solution lay behind all natural motions, rectilinear, rotational and the actions of elements, as his treatise amply shows.

Bradwardine embodied his solution in a series of twelve "conclusions" designed to show the resulting velocity from variations affecting the moving force or resistance when their original ratios are equal to, greater than, or less than a proportio dupla. For example, if the ratio of moving force to resistance is 2:1, double the force will move the same resistance, and the same force will move half the resistance, with exactly twice the velocity; but if the ratio of moving force to resistance is greater than 2:1, twice the moving force will produce less than twice the velocity;(92) and if the ratio of force to resistance is less than 2:1, then twice the force will produce more than twice the velocity.(93) Bradwardine's complicated conclusions were sometimes copied without proof or explanation.(94)

(92) This can be explained by a simple numerical example. If the relation of force to resistance is 3:1 (thus greater than a proportio dupla), and the force is doubled, then the ratio of the resulting velocity is 6:1. But for twice the velocity there must correspond the squaring of the ratio, i.e., $(3/1)^2 = 9/1$. Since 6/1 is less than 9/1, doubling the force yields less than twice the velocity. In the language of the 14th century this would be expressed as follows: the proportion of 3:1 is a proportio tripla; double the moving force results in a proportio sextupla, 6:1, which is less than a double proportio tripla, i.e., one containing 3:1 twice, for 6:1 is composed of 6/3 : 3/1, i.e., only one proportio tripla, the other being a proportio dupla. Twice proportio tripla would be 9:1, which is composed of 9/3 : 3/1. Therefore doubling the moving force of the proportion 3:1 yields less than a double velocity.

(93) See Maier's explanation, Studien I, 92-93, note 22.

(94) For example the anonymous compilation found in London, Brit.Mus., MS Harley 257 (membr.xiv), fol.228r-229r, inc.: "Proportio dicitur duobus modis, scilicet proportio propria dicta et proportio communiter dicta..."

But his junior contemporaries apparently understood clearly what was meant by the common, but ambiguous statement, "velocitas motuum sequitur proportionem geometricam."

The fourth and last chapter of Bradwardine's treatise is devoted to the special problem of rotational motion. The significance of this last chapter has not been sufficiently noticed. As we have pointed out, Aristotle maintained that the velocities of rectilinear and rotational motion, such as that of the celestial spheres, could not be compared, because a line and a circle are incommensurable. In this fourth chapter Bradwardine attempts to define the velocity of rotational motion in such a way that it will be comparable to the velocity of rectilinear motion. After rejecting three opinions, Bradwardine proposes his own solution. Since the velocity of motion consists in a body's traversal of a great fixed space (real or imagined) in a short time, it seems reasonable to say that, "velocitas motus localis [circularis] attenditur penes velocitatem puncti velocissime moti in corpore moto localiter."(95) Since that spatium fixum is not a volume (from the rejection of the first opinion), nor a surface (from the rejection of the second opinion), it must be a spatium lineale. Therefore, the velocity of a spherical moving body must be determined by the largest linear interval described by a point of the body; this is the punctum velocissime motum. In the case of the celestial spheres it is a point on the surface at a diameter which is at right angles to the axis of rotation. This at least allows Bradwardine to give some meaning to a comparison of rectilinear and

(95) Ed. cit., 130.

rotation velocities.[96]

b. The contribution of Heytesbury and Dumbleton.

Bradwardine's treatise of 1328 seems to have found immediate acceptance among his junior contemporaries. At least it forms the basis for the whole 'Merton school'. His treatise was soon incorporated into the curriculum of arts and there are extant numerous commentaries and *questiones* on the text, the greater number of which seem to belong to the second half of the 14th century.[97] For the beginner in the schools there were simpler versions, *Textus de proportionibus*,[98] which are paraphrases or extracts from Bradwardine's treatise with explanatory notes; on these standard texts there are also numerous *expositiones* and *questiones*. Although these texts, paraphrases, and summaries offer nothing new scientifically, they are of interest in showing how beginners in the Faculty of Arts were introduced to the new doctrine of Bradwardine.

With the exception of Walter Burley, whose *Expositio in libros Physicorum* reflects more the atmosphere of Paris and the traditional teaching of his youth than of the new thought at Oxford, the whole of 'Mertonian physics' is

(96) P.Duhem discusses this fourth chapter in his *Études* III, 298-299, and he expresses surprise at Bradwardine's definition of velocity. Duhem failed to realise that Bradwardine is here defining the velocity of a circle, or sphere, and not determining its mean velocity; he also failed to see the relation of this chapter to the treatise as a whole.

(97) The extant MSS of commentaries and *questiones* are too numerous to sort out, and it is not always easy to determine whether the *questiones* are on Bradwardine's own treatise or on one of the many simpler versions. But attention may be drawn to an unusual *questio disputata de proportionibus motuum*, "determinata per me, Franciscum de Ferraria, Padue, ad preces quorundam scolarium, a.D. 1352, die X mensis Decembris" found in Oxford MS, Canon.Misc.266, fol.58-70, beginning: "Quoniam materia de proportionibus agentium ad passa..."

(98) One such text *de proportionibus* is included in Appendix II. This seems to have been in common use, although there is nothing corresponding to Bradwardine's fourth chapter. The longer text, beginning, "Omnis proportio aut est communiter dicta, proprie dicta, vel magis proprie dicta ...", does contain a section on rotational motion.

based upon Bradwardine's doctrine. Heytesbury's sophismata on motion, especially those in his Regulae c.6, De tribus praedicamentis, presuppose it and are unintelligible without it. Dumbleton expounds the contents of Bradwardine's treatise in the third part of his Summa (cc.5-8) and presupposes the truth of the doctrine throughout his work. Furthermore Dumbleton presented new and fuller proofs of the six conclusions of Bradwardine's fourth chapter, now preserved, as far as I know, in a single Parisian manuscript.(99) The anonymous sophismata De motu contained in Oxford MS, Digby 190, fol.105v-127v, entirely presuppose the work of Bradwardine.(100) And the Liber Calculationum of Richard Swineshead assumes the doctrine as unquestionably established, as Maier has pointed out.(101)

Even those Oxford Masters who were not Fellows of Merton College accepted Bradwardine's teaching in the same spirit. For example, Roger Swineshead explicitly states in his De motibus naturalibus that he is assuming the definitions of Chapter I and the "truth" of Chapter III, contained "in quodam tractatu de proportionibus intitulato,"(102) before presenting his five conclusions on the "possible proportions" of velocities. According to the opinion preserved by an anonymous commentator on the

(99) Bibl.Nat., Nouv.Acq.lat. 625 (membr.xiv), fol.70v-71v, beginning, "In hoc compendio intellectum sex conclusionum quarti capituli tractatus proportionum mag. Thome Bradwardin intendo brevissime declarare..." A transcription of this work is included in the Appendix.

(100) Incp.: "Sequitur que species sint ab ipso Aristotele..." According to Sir Maurice Powicke (The Medieval Books of Merton College, Oxford 1931, p.158), this item, the Quatuor tractatus de corde of Richard Wallingford, and certain items now contained in MS Digby 191, once formed a single volume bequeathed by Thomas Allen (1632) to Sir Kenelm Digby, and the first folio of MS 191 states 'Liber domus scolarium de Merton' in Oxonia'. In the early table of contents the sophismata de motu are entitled falsegraphie geometrie; it is not a treatise, strictly speaking.

(101) A.Maier, Studien I, 96.

(102) Diff.7, cap.2, Erfurt, MS Amplon. F.135, fol.44rb.

Sentences,[103] Richard Kilmington, Provost of Oriel College in 1333,[104] also fully accepted the teaching of Bradwardine on the proportion of velocities. The anonymous author of the Tractatus de sex inconvenientibus clearly assumes the Bradwardine function in his dependence upon Heytesbury's Regulae.[105] John of Holland's treatise, De velocitate motus,[106] depends

(103) Comm. In Sent., II, q.3, MS Vat.lat. 896, fol.56ra-b. See also A.Maier, Studien I,97 note 32 and her study, "Verschollene Aristoteleskommentare des 14. Jahrhunderts", loc.cit., pp.531-2.

(104) Letters dimissory for the subdiaconate dated 20 March 1333. Registrum Hamonis Hethe, Diocesis Roffensis, (Cant. and York Soc.), Oxford 1942, p.1123. It is sometimes assumed that Richard Kilmington was a Fellow of Merton (e.g., F.M.Powicke, The Medieval Books of Merton College, p.25; C.Wilson, op.cit., 170, note 10). But there is no evidence to support this assumption. Richard Kilmington seems to have been once confused with Jeffry de Kylminton, a Fellow of Merton in 1296 (cf. G.C.Bredrick, op.cit., 179); the Sophismata ascribed to Jeffry by Tanner (op.cit., 455) are possibly the well known Sophismata "datus a magistro ricardo de kiluinteun" (London, B.M., MS Royal 12 F. XIX, fol. 174v), of which there are numerous manuscripts, and which Miss Maier dates "before 1330" (Studien III, 266-7 note 27). His Commentary on the Sentences, of which there are a number of manuscripts extant, could be dated about 1335, by which time he was a Bachelor in Theology (Cal.Pap.Letters II,520). Richard is also the author of Decem questiones morales super X libros Ethicorum Aristotelis, edite a magistro Ricardo Chentonis (MS Vatican, Ottob.lat.179, fol.25-59ra; also found in Vienna, Nat.Bibl.lat.5431, fol.292-336v, and Erfurt, Amplon F. 35, fol.121-160v (Schum, Beschr. Verzeichnis... p.29) and the Questiones magistri Ricardi de Kilkington de Generatione et Corruptione (Cambridge, Peterhouse MS 195, fol.48-69; a portion of this work, namely q.6 ff., may be identical with Erfurt, MS Amplon. O.74 (before 1342), fol.35-86v, described by Schum, ibid., p.731). Richard was Dean and Canon of St.Paul's, London, when he died in 1361.

(105) Ed. Venetiis 1505. I have also used Oxford MS, Canon.Misc. 177, fol. 182v-212v, Venice, San Marco, lat.VIII, cod.19 (3267) fol.65v-144v, and Paris, Bibl.Nat.lat.6559, fol.1-49. Miss Maier has suggested (Studien I,96 note 30; and III,267) that the author may have studied under Heytesbury. Besides frequent references to Bradwardine and Heytesbury, the author refers to "mag. Adam Pyprwelle," a Fellow of Merton College certainly in 1325 and in 1327 (Mert.Rec. 3655-3656) and to an unknown "mag. Richardus de Versellis." But such statements as "sicut ponit tota schola Oxon." and "tertia opinio tenet tota schola Oxon." would seem to suggest the foreign composition of the work. The author may have been one of the many foreigners who studied at Oxford.

(106) Inc.: "Motuum localium quidam est uniformis, quidam difformis. Motus localis uniformis est duplex..." Oxford, MS Canon.Misc.177, fol.100v-109; Venice, San Marco, lat.VIII, cod.19 (3267), fol.1-26. See also Maier, Studien III,365.

upon Heytesbury and Swineshead, and presupposes the acceptance of Bradwardine's function.(107) Possibly when more is known about the Oxford Masters in the early 14th century the number of those who accepted Bradwardine's function may be increased.(108) Clearly the acceptance and development of Bradwardine's mathematical view of physics was not restricted to Fellows of Merton College.

The result of Bradwardine's treatise was that it focused attention on the velocities of motion. Inspired by his treatment of uniform velocity in local motion, his successors attempted to formulate general "rules" which would express "penes quid attenditur velocitas" in all types of motion, in the action of elements, and in the action of luminous bodies. Sophismata arising from these rules were discussed and solutions offered.(109)

The De tribus praedicamentis of Heytesbury, written in 1335, is one of the earliest explicit attempts to determine the velocity of various motions in all the Aristotelian categories in which motion is possible.(110) Heytesbury first defines the various classes of motion. Uniform motion is one which traverses equal spaces in equal parts of time. Difform motion, that is, non-uniform motions, can be uniformly difform (uniformly accelerated)

(107) It is well known that his treatise De primo et ultimo instanti was composed "in universitate Pragii sub anno milesimo CCC 69," (MS Canon.Misc.177,fol.61v), and that he there composed the school texts De insolubilibus ("Textus insolubilium Holandrini") and De obligationibus ("Obligationes Holandrini"). But his intimate knowledge of Burley, Bradwardine, Heytesbury, Dumbleton and Swineshead strongly suggests that he studied at Oxford.

(108) The anonymous Parisian commentator on the Sentences (MS Vat.lat.896) may have been an Oxford Master, and he may have come from "the circle of the Bradwardine school," as Maier suggests (Studien I,96 note 26). But it would seem that the commentary was composed about 1370 (cf. above, Chap.II, p. 77 , note 139.).

(109) Curtis Wilson has discussed Heytesbury's sophismata concerning motion in his William Heytesbury: Medieval Logic and the Rise of Mathematical Physics, Madison 1956, pp.115-147.

(110) Ed. Venetiis 1494 together with the commentaries of Gaetano di Thiene, Messinus and Angelo da Fossombruno. Quotations have been collated with Erfurt, MS Amplon. F.135, fol.13r-17r.

or difformly difform, that is, one which traverses unequal spaces without any uniformity. Uniform and difform motions may be spoken of with respect to the subject which is moving (quoad subiectum), or with respect to the time (quoad tempus). Difformity of motion quoad subiectum arises when different points of the body move with unequal velocity, as in the rotation of a wheel when the linear velocity of different points on the wheel varies with the distance from the axis and the velocity of any given point remains constant; but when the wheel is rotated at an ever increasing rate, the motion is difform both with respect to subject and with respect to time. In the free fall of a body the motion is difform quoad tempus, but uniform quoad subiectum. These common definitions are incorporated in the beginners' text, Termini Naturales, ascribed to Heytesbury in Clm.8997.(111)

Velocity always means distance covered in a given time. But besides the linear quantities of time and distance, there is also the "latitudo motus seu velocitatis." The term latitudo was first used of qualities which could be possessed secundum magis et minus; it signified the whole range or extent of intensibilitas of a quality,(112) and the 'degree' of latitude meant the extent to which that quality is radicated in a subject. Applied to velocities, motion is conceived as a quality (speed) which has a latitude of all velocities from zero grade, or non gradus, to the summus gradus. Thus a "degree of velocity" is the intensity of motion in a body; as with other qualities, this degree of velocity was usually expressed by the early 14th century Schoolmen as "gradus ut 2" or "velocitas ut 8." In uniform

(111) The text, Termini Naturales, is included in Appendix II.
(112) P.Duhem (Etudes III,319) and A.Maier (Studien II,32) have noted that Henry of Ghent seems to have been the first to use the term latitudo in this context. Cf. his Quodl.IV, q.15 and Quodl.V, q.19.

motion the degree of velocity remains constant and no 'latitude of motion' is acquired or lost; hence there is no difficulty in conceiving the 'degree' of velocity in uniform motion, for it is simply the distance covered in a given time. But in accelerated or decelerated motion latitudo motus intenditur vel remittitur. Thus the 'quality of motion,' or the 'degree of velocity' at any given instant cannot be the ratio of the whole time to distance, but the velocity at that instant. But what is the meaning of 'velocity at that instant' when velocity always means the linear quantities of time and distance? It is one thing to talk about the quantity of the whole motion, that is, the total velocity (velocitas totalis) of distance covered uniformly in a given time. But it is a different thing altogether to speak about the degree or intensity of motion, the qualitas motus, at any given instant (velocitas instantanea), much less to assign a value to that degree.(113) This is the central problem Heytesbury discusses in the section De motu locali.

The difficulty Bradwardine considered in the fourth chapter of his treatise was how circular motion of a sphere can be commensurate with uniform rectilinear motion. As we have seen, he imagined the fastest moving point on the circumference to be moving uniformly in a straight line tangent to the circle; thus the velocity of a point on the circumference of a circle is denominated by the total velocity that point would have, if it were

(113) Bradwardine himself distinguished between the quantitas motus, which he defines as the "longitudo vel brevitas temporis," and the qualitas motus, "quae est velocitas vel tarditas." (Tract. de proport. veloc., cap.3, pars 2, ed.cit., p.118). The quantity of motion, or velocitas totalis, as it came to be called, is the ratio of distance and time, but the quality of motion, or velocitas instantanea, is the "intensity" of velocity at any given instant. This latter is an attempt to express the rate of change in velocity, or acceleration. Cf. A.Maier, Studien I, Kap.5, "Velocitas Totalis und Momentangeschwindigkeit," pp.111-131.

moving uniformly over a straight line in that time. Heytesbury, first of all, agrees with Bradwardine's denomination of circular motion, namely that it is measured "penes lineam a puncto velocissime moto descriptam, si quis huiusmodi fuerit."(114) Heytesbury then applies the same idea to the denomination of difform motion at any given instant. At any given instant difform motion can be said to have a 'velocity,' if the motion at that instant were imagined to continue uniformly in that grade.(115) That is, the velocity of difform motion at any instant (velocitas instantanea) is denominated by the ratio of distance and time (velocitas totalis) covered if the body were to move uniformly with the constant velocity possessed at that instant. This is the way, in fact, that changes of velocities are denominated; for example, at any given moment a body is said to be travelling so many miles an hour.

The central problem which Heytesbury raises, however, concerns the quantity, or value of the whole velocity of a uniformly accelerated motion. In other words, to what velocitas instantanea is the total velocity of accelerated motion equivalent? It is clear that the total velocity of accelerated motion cannot be equivalent to the terminal velocity, for the motion begins at a lesser rate. Since it is impossible to determine directly the rate of change, Heytesbury reduces accelerated motion to its corresponding uniform motion, which is exactly one half of the terminal velocity. For, he says, every latitude whether beginning at zero grade or not, as long as it terminates in a finite degree and is uniformly acquired or lost, "Correspon-

(114) Ed.cit., fol.37vb. MS Amplon. F.135, fol.13rb.
(115) "In motu autem difformi in quocunque instanti attendetur velocitas penes lineam quam describeret punctus velocissime motus, si per tempus moveretur uniformiter illo gradu velocitatis, qui movetur in eodem instanti, quocunque dato." MS cit., fol.13va; ed.cit., fol.38vb.

debit equaliter gradui medio sui ipsius, sic scilicet quod mobile illud ipsum uniformiter acquirens vel deperdens in aliquo tempore dato equalem omnino magnitudinem pertransibit, sicut si ipsum per equale tempus [continue] moveretur medio gradu illius."(116) In the Regulae Heytesbury does not prove this important "theorem," which has come to be called the "Merton Rule" of mean speed.(117) He merely says it can be proved and uses it in the proof of the corollaries. But there is a proof in the Probationes Conclusionum,(118) which shows that the distance traversed in any given time interval by a uniformly accelerated body is the same as if during that time interval the body moved with a constant speed equal to the arithmetic mean between the initial and final velocities of the accelerated motion. That is to say, the latitude of the whole motion has the value of one half the terminal velocity, or the velocity of the whole accelerated motion 'corresponds' to a uniform motion with a constant velocity equal to the 'middle grade' during the same time interval.(119) Although a successful differential comparison between uniform and accelerated motion requires more mathematical means than Heytesbury had at his disposal, he did find a way of giving a value to the velocitas totalis of uniformly accelerated motions, and indeed to any designated latitude, namely by reducing it to its equivalent uniform motion. This, Heytesbury shows, is an imagined motion in

(116) MS cit., fol.13vb; ed.cit., fol.40ra.
(117) M.Clagett, Giovanni Marliani and Late Medieval Physics, New York 1941, pp. ; "Some General Aspects of Physics in the Middle Ages," Isis, XXXIX (1948),29-44; E.A.Moody, "Laws of Motion in Medieval Physics," The Scientific Monthly, LXXII (1951),20-21; "Galileo and Avempace: The Dynamics of the Leaning Tower Experiment (II)," Journal of the History of Ideas, XXII (1951),401-402; A.C.Crombie, Augustine to Galileo, London 1952, p.261; I.B.Cohen, "Galileo's Rejection of the Possibility of Velocity Changing Uniformly with Respect to Distance," Isis, XLVII (1956),252-255.
(118) Ed. Venetiis 1494, fol.198vb-199ra. The text is too long to quote, but it has been discussed in detail by M.Clagett, Giovanni Marliani, pp. , and by C.Wilson, op.cit.,122-123 and notes p.198.
(119) Miss Maier has clearly shown the equivalence of this formulation to the modern formula $s=1/2\ at^2$. See Studien I, 119-120; see also E.A. Moody, "Laws of Motion in Medieval Physics," loc.cit.

equal time with a constant velocity of the arithmetical mean between the initial and final velocities of the accelerated motion or of any part of it.

Following the example of Bradwardine, Heytesbury lists four rules which follow from his theorem:

1) A body which moves with uniformly accelerated velocity beginning from zero degree and terminating at some finite degree traverses half the distance traversed by a body moving uniformly during the same time interval with a velocity equal to the terminal velocity of the accelerated motion; "est gradus summ medius subduplus ad gradum eandem latitudinem terminantem."(120)

2) If the initial velocity of the accelerated motion is greater than zero, then that motion will cover more than half the distance traversed by a body moving throughout the same period at a constant velocity equal to the terminal velocity; "est gradus medius maior quam subduplus ad gradum intensiorem eandem latitudinem terminantem."(121)

3) When the acceleration takes place uniformly from zero, the distance traversed in the first half of the time will be exactly one third of the distance traversed in the second half of the time, since the arithmetic mean of initial and final velocities for the first half of the motion is a third of the arithmetic mean for the second half of the motion.(122)

4) When the acceleration takes place uniformly with an initial velocity greater than zero, the proportion of the distance traversed in the

(120) MS cit., fol.13vb; ed.cit., fol.40ra. See also Probationes Conclusionum, ed.cit., fol.199rb.

(121) MS cit., fol.13vb; ed.cit., fol.40ra. See also Probationes Conclusionum, ed.cit., fol.199rb.

(122) MS cit., fol.14ra; ed.cit., fol.41ra. See also Probationes Conclusionum, ed.cit., fol.199va.

first half of the time to the distance traversed in the second half will equal the proportion of the two arithmetical means above mentioned, whatever may be their exact value.(123)

In his discussion of motion in the other Aristotelian categories Heytesbury clearly assumes that the velocity of those motions penes causam depends upon the proportion of the moving power and resistance according to the rule of Bradwardine. However, Heytesbury is directly concerned with velocity penes effectum, and more precisely with the meaning of 'velocity' in such categories as quantity and quality. What does it mean to say that one body rarefies more quickly than another? Or what does it mean to say that one body becomes hot or cold more quickly than another? That is the meaning of the rather obscure 14th century formulation of the question, penes quid attenditur velocitas in augmentatione et in alteratione. Velocity always means distance covered in a given time. Eventually all the 14th century Schoolmen came to recognise velocity in alteration and augmentation as a ratio of latitude, or spatia acquisita vel deperdita to a given time. But not all agreed on the conditions, or further qualifications of such a statement.

With regard to the velocity of augmentation (condensation and rarefaction), Heytesbury, as we have seen in the last chapter,(124) considered the velocity of condensation and rarefaction to depend upon the proportion of quantity acquired or lost to the original volume in a given interval of time. That is, a body which acquires a greater latitude of quantity (volume) relative to its original quantity than another body in equal time is said to rarefy 'more quickly'.

(123) MS cit., fol.1½ra; ed.cit., fol.4¹rb-va. Probationes Conclusionum, ed.cit., fol.199va.
(124) Above, pp. 199-200.

In considering the velocity of alterations Heytesbury does not think it necessary to include the size of the subject under-going change as an essential factor. For him a body which acquires a greater latitude of form in a given time alters 'more quickly' than one which acquires a smaller latitude in the same time.(125) It remained for later Mertonians, especially for John Dumbleton and Richard Swineshead, to apply this with qualifications to subjects which are difform in alteration and to mixtures.

John Dumbleton first discusses motion in the context of intension and remission of forms. After discussing matter and form in the second part of his Summa (cc.1-13), he asks how anything can be received "magis et minus" (cc.14-18). He concludes that magis et minus in the strictest sense is verifiable only of those forms which possess a real latitude, or distance (spatium) which can be acquired partibiliter. But concerning the manner of intension and remission, there are four opinions "circa quas disputatio moderna maxime versatur."(126)

The first opinion is that of the earlier Schoolmen, including Albertus Magnus and Aquinas, who maintained that when qualities are intensified there is no real loss or acquisition, but the action of an agent causes a greater actualization of a potentiality, and that the 'distance' covered is an imaginary means of designating the increase in a simple quality. Dumbleton rejects this because all real motion requires a real divisible latitude, and not merely an imaginary one.(127) That is to say, the 'distance' traversed

(125) "Tertia ponit quod velocitas universaliter attenditur penes latitudinem talis forme qui uniformiter acquireatur alicui subiecto sive maiori sive minori." Erfurt, MS Amplon. F. 135, fol.16ra.
(126) Summa P.II, cap.19, MS Vat.lat.6750, fol.28ra.
(127) "Cum igitur secundum istam positionem nullum est spatium realiter divisibile in qualitate, non potest esse, sequitur quod in qualitate non est, non esse potest, verus motus et continuus." Ibid., fol.28rb.

is any physical motion must be a divisible magnitude, a real distance divisible quantitatively(128) or qualitatively. The fundamental error of this first opinion is that it imagines a 'degree' to be more intense than another solely insofar as it is more or less distant from zero degree, even though that grade is in itself really indivisible intensively and containing no intrinsic latitude, just as if someone were to imagine that the point terminating a magnitude of one foot contained in itself more quantity than a point terminating a magnitude of half a foot.(129)

The second opinion, which in fact is that of Walter Burley, holds that a quality is not really intended or remitted, but to each instant of the time there corresponds a different indivisible quality in such a way that in the advent of the new, more intense or remiss form, the earlier one is corrupted.(130) Dumbleton rejects this view because one cannot speak of velocity or distance, if the continuum is composed of indivisibles; and even

(128) Thus for Dumbleton there is not and cannot be "verus motus in vacuo, quia non est spatium, quod requiritur ad verum motum." ibid., fol.28vb.

(129) "Causa decepticnis ponentium istam positionem est hec: ipsi solum imagina/n/tur solum gradum intensiorem alio secundum quod plus vel minus distat a non gradu latitudinis illius speciei, licet tamen ille gradus in se sit realiter indivisibilis intensive, nec aliquam latitudinem contineat in se, ac si hoc imaginetur quod punctus terminus terminans pedalem quantitatem contineret magis in se de quantitate quam punctus terminans semipedalem." ibid., fol.28vb.

(130) "Secunda positio namque nullam qualitatem ponit intendi vel remitti, sed in alteratione semper cuicumque instanti temporis correspondere nova qualitas que solum manet per instans et que posterius est inducta per seipsam est intensior quacumque prius inducta, et econtra est in remissione." ibid., fol.28rb. This position is refuted in Chapter 20 (fol.28vb-29va). Burley's position is found mainly in his Tractatus de causa intrinseca intensionis et remissionis formarum (ed. Venetiis 1496, fol.2-15v). In MS Vat.Lat.2185, fol.2r, the scribe notes after copying a few columns: "... Non plus scribo de hoc tractatu, quia frustra esset, cum nunc nil tenetur de eo, quod ipse imponitur." This scribal note was noted by Michalski ("La physique nouvelle...," 1928, p.7), but for "ipse imponitur" he reads "ipse imponit." Miss Maier dates Burley's treatise around 1320 (Studien II, p.77, note 8), because she presumes that Ockham refers to it when he says: "si tenerem aliquam istarum quattuor /sic/, tenerem quartam /que/ ponit quod in adventu forme perfectioris forma precedens totaliter corrumpitur et alia totaliter generatur" (Sent.III,q.6 B). But it is not certain that Burley was the first to hold this opinion.

if the existing indivisible form is said to have a 'velocity', there can be no velocity, or ratio, which is not composed of its halves. Thus a quality is a latitude quantitatively extended and not an indivisible form.

The third position holds that a quality is intense or remiss in the inverse proportion to the amount of its contrary present in the same body.(131) This is rejected because qualities which have no contraries, as light, or these which are not coexistent with a contrary would have no intensity, or else be of infinite intensity.

The fourth position, which is defended by Dumbleton, is Ockham's well known theory of increase by addition, namely that "no quality is increased or decreased, but the subject of quality is intended and remitted by the real acquisition and loss of qualities, just as a quantity is increased or decreased by the addition and subtraction of the parts."(132) Dumbleton goes on to explain(133) that according to this position qualitates intensibiles et remissibiles are composed of coexisting qualitative parts, just as an extension is made up of its quantitative parts existing simultaneously. The 'grade' of a latitude is nothing but the sum total of existing qualitative parts. Thus the gradus summus is composed of two half grades, and a half grade is composed of two quarter grades. The grades are "true distances

(131) "Tertia dicit qualitatem non habere intensionem nec remissionem nisi secundum quod magis et minus coextenditur cum suo contrario." ibid., cap.19, MS cit., fol.28rb. This position is refuted in Chapters 21-22 (fol.29va-29vb).

(132) "Quarta opinio, que tenenda est, ponit quod nulla qualitas intenditur et remittitur, sed subiectum qualitatis intenditur et remittitur per acquisitionem et remissionem realem qualitatum, sicut quantum maioratur vel minoratur per appositionem partium et motionem earundem." ibid., c.23, fol.30ra.

(133) "Item hec positio ponit qualitates intensibiles et remissibiles componi ex qualitatibus eiusdem speciei simul coextensis, que sunt partes generate in motu alterationis, et qualibet manet in fine, et omnes sic coextense faciunt gradum, sicut partes quantitative faciunt quantitates. Et duo gradus simul coextensi sub medio faciunt duplum gradum intensive, qui est summus, sicut duo pedales in longitudine faciunt duplam longitudinem quem facit unum eorum." ibid.

in quality,"[134] each grade containing in itself the whole latitude of lower grades. "Ex his palam concluditur quod omnis gradus qualitatis, sive fuerint qualitates imaginarie sive vere sive ratione, necessario totam latitudinem continent."[135] However there is a difference for Dumbleton between quantitative and qualitative parts. Quantitative parts are always dimensive magnitudes. Qualitative parts, on the other hand, are lesser degrees of the same quality or elements which comprise the whole, as matter and form are 'qualitative parts' of material substance, and 6 and 2 are 'qualitative parts' of the number 8. In other words, a given grade of velocity (a quality) really contains within itself the whole latitude of lower grades, that is, the ratio of distance and time called 'velocity' contains within itself all the ratios of which it is composed. When velocity is intensified, as in uniform acceleration, larger and larger proportions are added, thus increasing the qualitative latitude, without destroying the previous proportions.

After discussing why motion is possible only in three categories (P.III, cc.1-4), Dumbleton inquires "qualiter velocitas in motibus veris et successivis producitur et causatur." First he discusses velocity in local motion (cc.5-13), then velocity in alteration (cc.14-17), and finally velocity in augmentation (cc.18-20). Chapters 5 to 8 parallel the second and third

(134) Ibid., fol.30ra. See also fol.33rb: "Hic dubitatur si sit distantia qualitativa realis..." (cap.26).

(135) Cap.23, fol.30va. For Dumbleton the distance or latitude between two grades is the real cause of intension and remission of qualities. "Secunda suppositio est hec: causa precisa et essentialis intensionis in qualitate intensibili et remissibili est distantia sive latitudo in qua fit motus verus in qualitate. Hec sic patet: destructa distantia qualitativa inter gradus, qui sunt termini alterationis motus, nihil est intensius alio, neque divisibile neque indivisibile. Sed posita illa latitudine inter gradus, est aliquid alio intensius. Igitur illa distantia qualitativa inter gradus propria et per se est causa intensionis in qualitate." cap.26, fol.32va.

chapters of Bradwardine's treatise and present the identical doctrine. Dumbleton mentions three opinions concerning the question. The first holds that the velocity of motion follows the excess of the moving power over resistance in the sense that 4 moves 2 as quickly as 3 will move 1, because "eadem est proportio arithmetica." The second opinion holds that motion follows a geometric proportion, "ita quod si sit tanta proportio inter agens et passum, sive fuerit in motu locali sive in motu alterationis, quod tanta velocitas correspondent necessario tante proportioni precise, ita quod ... si agens fiat duplum, velocitas duplabitur, et si /in/ sequialtera proportione vel in alia rationali vel irrationali /proportione/ fiat potentia agentis, maior ceteris paribus secundum illam proportionem augmentatur motus in velocitate."(136) This, as we have seen, is the traditional Aristotelian interpretation. The third opinion, according to Dumbleton, is that "of Aristotle and the Commentator, which is to be held." This is, in fact, the new doctrine of Thomas Bradwardine.(137) Dumbleton, however, adds nothing new in his presentation of the Bradwardine function.(138)

Then Dumbleton proposes to prove that "latitudinem motus suo medio gradui correspondere" (c.9). From his proof it is clear that Dumbleton has in mind the identical problem proposed by Heytesbury, namely to what uniform velocity does the velocitas totalis of uniformly accelerated or decelerated motion correspond. His conclusion is identical with that of Heytesbury and

(136) P.III,c.6, fol.39ra. The words in square brackets are found in Oxford MS, Merton College 306,fol.30vb and in Vatican MS, Pal.lat. 1056, fol. 38va ; on the whole, these last two MSS contain a less perfect text than Vat.lat. 6750.

(137) "Tertia opinio Aristotelis et Commentatoris, que tenenda est, est talis, quod motus sequitur proportionem geometricam et remittitur et intenditur secundum hoc quod proportio maior est vel minor ad proportionem priorem, ita quod motus excedit alium motum secundum quod una proportio se habet ad aliam proportionem, secundum quas proportiones fiunt illi motus inequales." ibid., fol.39ra.

(138) The text of Dumbleton's treatment is included in Appendix II.

the other calculatores. But his method of proof is different from that presented in the Probationes Conclusionum. Dumbleton proves the 'Merton Rule' indirectly by showing the absurd consequences which would follow if the latitude of accelerated and decelerated motion were greater than or less than its gradus medius.(139) He then concludes that every latitude of uniformly accelerated motion beginning or terminating at rest must correspond to its arithmetical mean velocity, that is, the same distance will be covered in a corresponding time by a body moving uniformly with a velocity equivalent to one half the terminal velocity of the accelerated motion. Since every ratio contains within itself all its qualitative parts, the terminal velocity is composed of twice its mean degree.

From the mean speed theorem proved for both acceleration from rest and deceleration to rest, Dumbleton draws four conclusions. (i) Even if the motion is not terminated at rest, the velocity of the whole will correspond to its middle grade. (ii) If a moving power begins by being equal to the medium against which it moves, and is uniformly increased while the medium remains constant, the force will increase the velocity only in a finite degree. (iii) If the medium were uniformly decreased, the moving power remaining constant, motion would not begin increasing with infinite slowness. (iv) If one takes two unequal forces moving against two unequal resistances in such a way that the smaller force is equal to its resistance, and both forces are uniformly increased, then the smaller force will begin to increase its velocity more quickly.(140)

(139) Dumbleton's proof is included in Appendix II.
(140) Dumbleton's conclusions together with their proofs are presented in P.III, cc.11-12 (fol.43ra-vb) and included in the Appendix.

From what has been said it is clear that Dumbleton and Heytesbury are in fundamental agreement on the important law of uniformly accelerated motion (penes effectum), and that they both accept Bradwardine's dynamics (increase of velocity penes causam) without modification. It has been suggested, however, by H.Lamar Crosby, Jr.,(141) that Dumbleton's theory of increase in 'intensive' magnitudes "leads inevitably, not only to his conclusions regarding the relation of distance to time in a uniformly accelerated motion, but to the realization that a constant proportion of force to resistance must produce just such a motion."(142) Dr.Crosby claims that a careful examination of Bradwardine's Tractatus and Dumbleton's Summa shows that "what is actually being compared is not an increase of force associated with an increase of velocity, but rather an increase of force associated with an increase of instantaneous rate."(143) He therefore believes that in Dumbleton's development of Bradwardine's dynamics there is necessarily implied the modern principle that constant forces produce constant accelerations.(144)

It is difficult to find the basis for Dr.Crosby's view.(145) From our discussion above of Bradwardine's treatise it seems clear that the purpose of Bradwardine's function is to express precisely the amount of variation produced by an increase of force or decrease of resistance. Bradwardine's basic assumption is that constant force produce uniform (constant) velocity;

(141) Thomas of Bradwardine, His Tractatus de Proportionibus, Univ. of Wisconsin Press, Madison 1955, pp.50-54.
(142) Ibid., p.52.
(143) Ibid., p.53.
(144) Ibid., p.52.
(145) Dr.Crosby acknowledges (ibid.,p.191 note 100) that his references to Dumbleton are based upon a translation by E.A.Moody of selections taken from Oxford MS, Merton College 306. Prof.Moody has graciously sent me a copy of his translation, but I find no basis in the translation for Dr.Crosby's view.

his problem was to find the function which would express the uniform velocity produced when force was doubled, trebled, and so forth, as already explained. Bradwardine never said that a double force produces a double acceleration, but the uniform velocity squared. To read 'acceleration' into Bradwardine's thesis is to misunderstand the historical problem. Further, Dumbleton's view (actually a common view) of velocity as a qualitas intensibilis in no way supports Dr.Crosby's suggestion. Velocity, as such, was never considered an intensio, but only as intensibilis; if a moving force is not increased, velocity is not 'intended' (non intenditur). When Dumbleton speaks about the "latitudo qualitatis intensivae," he is discussing a velocity (potens effectum) which is actually being intended whatever the cause may be; the variation of the ratio potens causam are clearly thought to follow the Bradwardine rule. The two problems posed by Heytesbury and Dumbleton, as we have seen, were (i) what is the 'meaning' of diffcom velocity, and (ii) what is the value, or equivalent of diffcom velocity in terms of the meaningful uniform motion. As Gaetano di Thiene later observed, "non potest assignari velocitas illius motus, sed est reducendus talis motus difformis ad uniformem."(146) The reduction of all motion to constant acceleration would have been unintelligible to the early 14th century Mertonians.

Dr.Crosby further suggests that Dumbleton's view of velocity as an intensive quality "either inspired or anticipated" the theory of 'impetus' defended by John Buridan and his school.(147) It may be well to make a few

(146) Gaetani de Thienis, Recollecte super Hentisbari Regule solvendi sophismata, ed. Venetiis 1494, fol.38vb.

(147) Op.cit., p.52.

observations about the theory of 'impetus' and the Oxford Masters of the early 14th century.

III. The Theory of Impetus and the Merton School.

The theory of 'impetus' proposed by Francis de Marchia OFM to explain projectile motion is too well known to need repetition here.(148) P.Duhem's claim, that the theory developed in Paris by John Buridan and his 'school' anticipated the 17th century principle of inertia, has been examined elsewhere.(149) But sufficient research has not yet been made concerning the reaction of the Oxford Masters to the new Parisian theory. Here I only wish to make a few observations concerning Ockham, Burley and Dumbleton.

The main objection(150) to dating Ockham's lectures on the Sentences before 1320, as proposed in the second chapter,(151) seems to be the mention by Ockham of the impetus theory (Sent.II, q.26 M). As far as is known, Francis de Marchia was the first to suggest a virtus derelicta in lapide a motore(152) in order to explain the continued motion of a projectile after leaving the source of projection. This Marchia proposed in his lectures on the fourth Book of the Sentences, delivered at Paris sometime during the academic year 1319-20.(153) If it can be shown that Ockham did not necessarily have the theory of 'impetus' in mind, then other considerations become more significant in the dating of his Oxford lectures.

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(148) See especially C.Michalski, "La physique nouvelle...", 1928, pp.47-49; A.Maier, Studien II, 113-314.

(149) J.A.Weisheipl, "Natural and Compulsory Movement," TNS, XXIX (1955), 50-81. This study agrees with Miss Maier's view.

(150) A.Maier, AFH, XLVI (1953), 166-168; Studien II, 158-159.

(151) See above, pp. 47-8.

(152) Text edited by A.Maier, Studien II, p.174, line 305.

(153) "Explicit lectura fratris francisci de marchia super primum secundumreportationem factam sub eo tempore quo legit sententias parisius Anno domini 1320." Naples MS, Bibl. Naz. VII. C. 27 (quoted by A. Maier, Studien II,165). See Fr.Stegmüller, Repertorium Commentariorum, Würzburg 1947, vol.I,n.237,p.105.

The passage in question has been prepared from Oxford MSS, Balliol College 299, fol. 161rb (= Sent.III,q.4), Merton College 100, fol.182rb-va (= Sent.III,q.13), and from the Lyon edition of 1495 (= Sent.II,q.26 M). These will be represented in the variant readings as B, M and L respectively.

Item notandum quod in motu proiectionis est magna difficultas de principio motivo et effective illius motus, quia non potest esse proiciens, quia potest corrumpi existente motu. Nec aer, quia potest moveri motu contrario, sicut si sagitta obviaret lapidi. Nec virtus in lapide, quia quero a quo causatur illa virtus; non a proiciente, quia agens naturale equaliter approximatum passo equaliter semper causat effectum. Sed proiciens quantum ad esse absolutum et respectivum in eo potest equaliter approximari lapidi et non movere sicut quando movet; potest enim manus tarde moveri et approximari alicui corpori, et tunc non movebit ipsum localiter; et potest velociter et cum impetu moveri, et tunc approximatur eodem modo sicut prius, et tunc causabit motum, et prius non. Igitur ista virtus quam tu ponis non potest causari ab aliquo absoluto vel respectivo in proiciente. Nec a motu locali ipsius proicientis, quia motus localis nihil facit ad effectum nisi approximat activa passivis, sicut sepe dictum est. Sed esse positivum in proiciente equaliter approximatur proiecto per motum tardum sicut per velocem. Ideo dico quod ipsum motivum in tali motu post separationem mobilis a primo proiciente est ipsum motum secundum se, et non per aliquam virtutem in eo absolutam vel respectivam, ita quod movens et motum et penitus indistinctum. Si dicas quod effectus novus habet aliquam causam, sed motus localis est effectus novus, dico quod motus localis non est effectus novus absolutus nec respectivus, et hoc negando sic:

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2. effective: efficiente B
4. moveri: movere M
5. illa: om. B
7. passo: passivo L
9. et: om. M
10. manus: mea add. L // tarde moveri: spatium vacuum M
11. cum: cum L, tamen M
12. eodem: eo L
13. Igitur: Ergo L // ista: ita /sic/ B
14. non potest causari: causari non potest M // in: re add. M
16. ad: om. M // approximat: approximare L
17. positivum: positum L
19. dico: om. B // motivum: movens L
20. ipsum motum: ipsummet M
21. se: motum add. M
21-22. in eo...respectivum: absolutam in eo respectivam L, absolutam in eo nec respectivam M
22. quod: hoc add. B
24-25. novus...effectus: om. M (homoteleuton)
25. nec: vel M // sic: ubi L

quia non est aliud nisi quod mobile coexistit diversis partibus spatii, ita quod cum nulla una coexistit dum contradictoria verificantur. Unde licet qualibet pars spatii quam transit mobile sit nova respectu mobilis transeuntis, quatenus mobile nunc transit per illas partes et prius non, tamen nulla pars est nova simpliciter. De hoc dictum est alias. Mirabile enim esset si manus mea causaret aliquam virtutem in lapide per hoc quod motu locali tangit lapidem.

As Ockham sees the problem of projectile motion, the cause of the continued motion cannot be the thrower, for it can cease to exist, nor the air, for the same air would produce contrary motions when a thrown stone deflected the flight of an arrow, nor any virtus in lapide, for this virtus cannot be produced by the thrower or by his local motion. It cannot be produced by the thrower, for every natural agent equaliter approximatum passo produces the same result. But a 'thrower' can approach the projectile (potest equaliter approximari lapidi) in exactly the same way (eodem modo), whether the projectile is thrown or not. If the hand of the thrower moves quickly and cum impetu, motion is produced. In either case the agent equaliter approximat passo. Therefore the thrower cannot be the cause of the virtus in lapide. Nor can the local motion of the thrower be responsible for the virtus, since local motion does nothing more than bring active forces into proximity with passive receptivities. But the proximity is the the same whether the agent moves slowly or quickly, as just explained. And so, Ockham says, the cause of projectile motion after it has left the thrower is motion itself, and not something produced by motion. Returning

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26. coexistit: coexistat L
27. cum: om. M
28. qualibet: om. M
28-29. transit mobile: mobile transit M // mobile: mobili M
30-31. tamen...simpliciter: tamen illa pars non est novus simpliciter L
31. alias: om. L

to his fundamental thesis, Ockham concludes, therefore motion and the thing moved are absolutely identical (penitus indistinctum). And since 'to be in one place after another' is not really something new, that is, nothing new is really produced, there is no need to look for a principium effectivum of projectile motion; it is the body itself occupying one position of space after another sine omni quiete media[154] which explains projectile motion.

Whatever may be thought of Ockham's conclusion, the reason for his rejection of any virtus in the projectile is the assumption that every mover equaliter approximat passo whether motion is produced or not. But surely if Ockham had in mind Francis de Marchia's theory, this is no answer at all. Marchia's whole argument, later developed by Buridan, is that the projectile itself and not the medium is magis proportionatum subiectum istius virtutis, because a convenient weight can be thrown longius et etiam facilius than chaff or air.[155] For Marchia it is precisely because movers do not equaliter approximant passo, that a virtus or impetus must be acknowledged in the projectile rather than in the medium. Thus it is not certain that Ockham had Marchia's theory in mind when he wrote the passage above quoted.

It seems rather that Ockham intended to reject the view of Peter John Olivi. In question 29 of his commentary on the Sentences, Olivi discusses whether or not motion is produced immediately by the mover.[156] Some hold that all motion is produced immediately by the mover without any intermediate

(154) Tract. de successivis, ed.cit., p.46. This is the meaning of the phrase, ita quod cum nulla una coexistit dum contradictoria verificantur, in the above text, lines 27-28.

(155) Text edited by A.Maier, Studien II,171-2; see also Buridan, Quaestiones in lib. Physicorum, lib.VIII,q.12, ed. A.Maier, ibid., pp.209-212, and Quaestiones de Caelo et Mundo, lib.III,q.2, ed. E.A.Moody, Cambridge, Mass. 1942, pp.242-3.

(156) Ed.cit., pp.499-504.

influentia. Others hold that all motion (second opinion), or at least projectile motion (third opinion) is produced by means of a certain "similitudo seu impressio a motore in mobili." Olivi presents eight arguments(157) to show that motion must be produced by some intermediate impressio, vis, influentia, inclinatio, or whatever one wishes to call it. He notes that if one considers motion to be identical with the form produced by motion, it is all the more clear that motion is not the "prima impressio facta a motore in mobili."(158) In his reply to the eighth argument for the first opinion Olivi explains that a body which is moved has three inclinations toward the term of motion; the original impact of the mover, an habitual inclination which can cause projectile motion, and the inclination of motion itself.(159) Thus all motion is caused by some intermediate "impressio a motore in mobili."

Ockham, as far as we know, did not discuss the question again in any other work attributed to him.(160)

Thus it would seem that there is no absolute necessity to interpret the passage in question as a refutation of the impetus theory proposed by Francis de Marchia. It is possible, and even probable, that Ockham had in mind the view of Peter John Olivi. If this is granted, then there is no

(157) Ockham's presumption that all movers equaliter approximant passe whether motion is produced or not, may have been derived from Olivi's first argument: "Primo, ex experimento quod videmus in projectis et in omnibus iis quae a nobis vel ab aliis moventur per impulsum; videmus enim in istis quod primo impelluntur et inclinantur ad certum terminum loci, antequam localiter moveantur; unde et contingit quod aliquando impelluntur, et tamen motus localis non sequitur, ut patet in fortiter impellente magnam navem vel maximum lapidem." Ibid., pp.500-501.

(158) Ibid., p.502.

(159) Ibid., p.504.

(160) See also A.Maier, Studien II, 154.

insert note 164: aut movetur ab aliquo movente et moto, et huno quero de illo sicut prius, et sic erit processus in infinitum, vel oportet dare aliquod movens sufficiens ad movendum se et proiectum

reason why Ockham's lectures on the Sentences cannot be dated earlier than 1320.

Walter Burley, as I have shown, revised his commentary on the last two Books of the Physics some time between 1334-1337. In his earlier exposition of Book VII Burley discussed projectile motion in passing and entirely in the traditional Aristotelian sense.(161) In his final version Burley greatly expanded the dubium, "Utrum omni motu movens et motum sunt simul," and included two additional arguments videtur quod non,(162) the second of which argues that in projectile motion the mover and moved are not in contact, and therefore not all local motion requires continual contact. Burley replies briefly that it is the air which continues the motion, and hence mover and moved are in continual contact in projectile motion. Then Burley adds, "Quidam tamen dicunt quod a primo proiciente causatur in proiecto aliqua virtus que movet proiectum quando primum proiciens cessat a movere." It is clear that Burley intends quidam to refer to Francis de Marchia, for at the beginning of his commentary on Book VII of the Physics Burley states, "Ideo aliqui credunt quod proiectum, primo proiciente cessante, movetur ab aliqua virtute derelicta in eo a primo proiciente, et sic quod movetur ab extrinseco."(163) They argue, according to Burley,(164) that a projectile

(161) Cambridge MS, Caius College 448/409; see for example, pp.479b, 481b, 482a-b.

(162) The original question is to be found in Caius College MS 448/409, p.482a; in the printed version the question is attached to text 10, ed. Venetiis 1501, fol.200ra-201rb.

(163) Lib.VII, text.1, ed.cit., fol.199rb.

(164) "Quod probant sic: cessante primo proiciente, aut proiectum movetur a se /a/ut ab aliquo alio extrinseco movente. Si detur primum, habetur propositum, videlicet quod in proiecto est aliqua virtus movens proiectum. Si vero detur secundum, tunc queritur de illo corpore extrinseco movente, quia aut movetur a se, et tunc superfluaret primum proiciens, cum illud movens extrinsecum sit sufficiens ad movendum se et proiectum /sine primo proiciente." Lib.VII, text 10, ed.cit., fol.210ra. This argument has not been found in the writings of Marchia or of any

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must be moved either by itself, or by an extrinsic mover; if it is moved by an extrinsic mover, then there is either an infinite regress in movers, or else the immediate mover moves itself, in which case the thrower is superfluous; therefore "in projecto est aliqua virtus movens projectum." Burley rejects this opinion, saying that there is no need to regress infinitely in movers, for the air which moves the projectile receives its motion and power to continue motion from the original thrower.(165)

Burley not only presented the view of Francis de Marchia inaccurately,(166) but he also rejected it without serious consideration. It would seem that Burley was motivated to reject Marchia's theory largely by his lifelong acceptance of the Aristotelian and Averroist explanation. Burley does not seem to have known Buridan's development of the theory of impetus. Although this part of Burley's commentary was written after Bradwardine's De proportionibus, Burley makes no reference to it explicitly or implicitly.

John Dumbleton discusses the question of projectile motion in Part VI of his Summa, chap.9, when he asks whether the motion of the medium in projectile motion is natural.(167) Throughout his discussion Dumbleton assumes two fundamental principles: first, that in every motion the mover and moved are in contact, and second, that all violent motion is reducible

(note 164 cont.) other author, and it is a misrepresentation of the theory proposed by Marchia.

(165) "Sustinendo quod projectum movetur ab aere, primo proiciente cessante, est dicendum quod projectum movetur ab aere, et quod aliquis aer movens projectum movetur a motore extrinseco; nec est procedere in infinitum, quia est devenire ad aliquem aerem qui movet per se, quia a primo proiciente recipit motum et virtutem continuandi motum ex se. Et cum dicitur quod esset primum proiciens superflueret, dico quod non est verum, quia aer habet virtutem continuandi motum, cessante primo proiciente, et hoc non habet a se, sed a primo proiciente." ibid., fol.201ra-b.

(166) Cf. J.A.Weisheipl, loc.cit., pp.58-61; A.Maier (Studien II, 255) also notes that Burley's presentation is confused and illogical.

(167) MS Vat.lat.6750, fol.89ra-90rb.

to some natural motion.(168) With these principles presupposed Dumbleton argues that the motion of the media (water and air) cannot be natural, for then the motion of projectiles would never cease. Furthermore, if projectiles were moved by the air, either a forma motiva is produced in the projectile, or else it is moved entirely "ab aere extrinseco pellente." But it is evident that no such form is produced, for then "ille lapis movetur ex se ab illa forma ad locum quem illa forma appeteret." But this is false because the stone ceases to move when the air ceases. Besides, Aristotle says that air must move the projectiles, because such bodies would not be moved after being thrown unless air or another body rushed in from behind.(169) Nor can the projectile be moved entirely from without, for then the air which moved one body would take up in its rush any other body at rest; and from this it follows that a body in a great wind would move to every place. But to this one might reply that the air receives a principium motivum a pellente, as the Commentator believes in De Cele, III,comm.28, "et ita videntur quidam dicere quod inducitur forma a pellente, qua generata, habet pulsum motum ab illa forma inducta."(170) Against this view Dumbleton argues: "cum illa forma sit motiva naturaliter cuius est forma," it makes no difference whether the forma motiva is in the air or in the body; in either case it would have to tend toward (appetit) one specific place or indifferently toward any place. If the induced forma motiva tends toward

(168) Ibid., fol.89ra.

(169) "Tunc Aristoteles in 7° Phisicorum et 3° de Cele, textu 28, dicit aerem movere talia, quia aliter talia non moventur post separationem pellentis, nisi aer vel aliud corpus insequeretur quod moveret tale pulsum; et ad illum intellectum exponit Commentator Aristotelem in utroque loco allegato." Ibid., fol.89ra. This is the basis for Dumbleton's own explanation of projectile motion.

(170) It is not clear whether Dumbleton is referring to Marchia, Buridan, or to hearsay. Dumbleton's refutation is quoted and discussed by Maier (Studien II,229-231).

one specific place, then it must be directed by human intelligence; but there are many projectile motions which are not directed by human intelligence, "nam in tonitruo sunt gravia propulsa per impetum venti cui deficit intentio hominis et alterius motoris naturalis et imaginatio." From which it is evident that "pellens non inducit formam in talia pulsa, ut ratio dictat." This is all Dumbleton has to say about the Parisian theory of impetus!

In his own explanation of projectile motion Dumbleton returns to the two suppositions enumerated earlier, namely that all violent motion is reduced to a natural motion, and that "movens et motum sunt simul."(171) In the preceding chapter Dumbleton explained that every body has two motions, one belonging to it because it is a certain species (for example, fire moving upward), another because it is a body and hence tends to follow other bodies.(172) Since, from the preceding arguments, the motion of projectiles is not caused by a new form induced by the thrower, nor simply by the surrounding medium, it must be caused by <u>its own form</u> following other bodies "lest there be a vacuum."(173) So just as water follows water, and smoke follows smoke, "ita illa proiecta quodammodo insequitur aerem aive aliud corpus ante ea motum, sicut ferrum sequitur adamantem."(174) Thus a projectile is moved naturally by its own form lest a vacuum be produced, and

(171) "Pro isto dubio est notandum primo quod in omni motu movens et motum sunt simul, et hoc est necessarium sustinendum pro vero in motibus veris trium predicamentorum..." <u>Ibid.</u>, fol.89vb.

(172) Cap.8, fol.88rb. "...ita insequitur ut adductum est prius, capitulo precedente, quod cum omne corpus naturale duplicem habet motum, scilicet motum competentem corporibus talis speciei enumeratum /sic/ et alium motum quo naturaliter aliud corpus insequitur." fol.90ra.

(173) "...ideo videtur quod ipsa quodammodo moventur insequendo aerem a forma propria ne sit vacuum in motu tali que omne corpus naturaliter est mobile ut alteri corpori sit immediatum." fol.89vb.

(174) <u>Ibid.</u>, fol.89vb-90ra.

it comes to rest when the medium ceases to move.(175)

Having rejected the Parisian theory of impetus, Dumbleton sees only two possible ways of explaining projectile motion. One is to attribute the entire cause of movement to the medium; the other is to explain such motion by the natural tendency of the moving body to follow other bodies, lest there be a vacuum. Either explanation is possible, according to Dumbleton, but he believes the latter ought to be held, "cum communior est."(176)

The interesting point is not so much Dumbleton's Platonic interpretation of projectile motion, the "more common opinion," but his casual rejection of the impetus theory. He rejects it in passing and without serious consideration; and it is clear that his acceptance of the new teaching of Bradwardine had nothing whatever to do with his rejection of the Parisian theory, nor with his explanation of projectile motion. If the view of velocity as an intensive quality "inspired or anticipated" the theory of impetus, as Dr. Crosby suggests, Dumbleton himself never realized it. And as far as can be judged at present, Dumbleton reflects the view of the whole Merton school, at least with regard to the theory of impetus.

The Parisian theory may or may not have had the scientific consequences which P.Duhem claimed. But at Oxford little interest was taken in the theory. The Mertonians were more interested in the velocities of motion and in the mathematical properties of velocities. They were more interested in the mathematization of all motion.

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(175) "et sic naturaliter movetur projectum, et quiescente medio mota, quiescit projectum, ut ferrum quiescit quiescente adamante." Ibid., fol.90ra.

(176) Ibid., fol.90rb.

CONCLUSION

Early 14th century Oxford witnessed considerable intellectual activity in its schools of arts. Though some of the roots of this activity are to be found in earlier centuries, Oxford also saw the birth of new ideas, ideas which were to influence the thought and teaching of future centuries. Not all of the novel teaching was restricted to the Faculty of Arts, by any means, but it was the Oxford schools of logic and physics that particularly inspired the teaching at Paris, Prague, Padua and other continental universities.

This new teaching in the schools of arts was not homogeneous. There were two distinct tendencies. Oftentimes these were found in a single master or in a single treatise; nevertheless, in themselves these tendencies are distinct approaches to the physical world.

One tendency was that of William of Ockham, a Franciscan, who proposed his novel views at Oxford while lecturing on the Sentences in the Faculty of Theology. It is commonly believed that these lectures were given during the academic year 1319-20. But it is possible that they were delivered two years earlier, and that Ockham was obliged to leave the Oxford convent in 1320, without having lectured as a regent master. In the philosophy of Ockham only two classes of absolute reality are admitted, individual substance and individual qualities. Everything else is merely a term, a noun or some other part of speech. Thus 'quantity', 'motion', 'time' and the like, are merely terms, mental or written, having no reality as such in the world of nature. In this nominalism, or terminism, as it came to be called, problems of physical science are reduced to problems of logic and grammar. The teaching of Ockham and the earlier view, which held that every

word in a proposition must have a given 'supposition', aroused considerable interest in the schools of logic. But it contributed little or nothing to the new mathematical approach to physics.

The second tendency was that of Thomas Bradwardine and of the new teaching in the schools of physics for which he was responsible. The ideal, admired by Grosseteste, Kilwardby and Roger Bacon, of finding mathematical truths behind the world of physical phenomena was realised to a certain degree by Bradwardine. For him, "it is [mathematics] which reveals every genuine truth, for she knows every hidden secret and bears the key to every subtlety of letters."(1) But Bradwardine did not merely praise mathematics and consider it a higher and more perfect science, as the earlier theoriticians of science had done; he claimed to have found the actual mathematical laws which govern natural motion. In his important treatise De proportione velocitatum in motibus he proposed a new mathematical function for the comparison of velocities, and he proposed new laws of dynamics. Bradwardine was led to this new function in dynamics, not because he discovered new facts experimentally or could verify it empirically, but because he desired to overcome a mathematical inconsistency and incompleteness in the Aristotelian formulation. Indeed Bradwardine's laws of dynamics cannot be empirically verified, even though he himself considered the mathematical laws a true expression of natural motions, rectilinear and rotational. But the important point is that in the formulation of his laws he replaced the qualitative conception of motion with a quantitative one. That is, instead of considering motion as a process, a transition from potentiality to actuality, Bradwardine thought of motion as a velocity, as a ratio of distance to time, a proportion.

(1) Tractatus de continuo, Erfurt MS, Amplon. Q. 485, fol. 31v.

Bradwardine's treatise and the simpler versions of it became the basis of the 14th century discussions of motion. But more significantly, the new quantitative concept of local motion was refined by the disciples of Bradwardine and applied to such motions as alteration, condensation and rarefaction. In the Merton 'school' of the early 14th century, the formal cause of all motion was considered to be a ratio, a proportion called 'velocity'; the material cause was the distance, or spaces acquired; and the efficient cause was the ratio of moving power to resistance. Again, though Bradwardine had shown that different velocities must be compared in geometrical proportionality according to his new function, he had not discussed how the velocity of a single moving body can be continuously intensified or decreased; that is, he had not discussed acceleration or deceleration (velocitas penes effectum). In discussing the meaning of accelerated and decelerated motion, the Mertonians, particularly Heytesbury and Dumbleton, distinguished the 'total velocity' of a moving body from the velocity an accelerated motion would have at any given instant. In attempting to give meaning to 'velocity at an instant' (velocitas instantanea), Heytesbury discovered the equivalence of the whole accelerated motion to a uniform motion with a rate of half the mean speed. This 'Mertonian theorem of mean speed' was incorporated into classical physics.

It has often been asserted that the 17th century revolution in physics really consisted in replacing the qualitative notions of Aristotelian physics with quantitative notions. If this is the fundamental philosophical aspect of classical physics, then already such a revolution took place at Oxford in the early 14th century. It is true that the early 14th century Mertonians did not measure terrestrial motions of actual experience or possess the

mathematics necessary to express such measures in valid equations. At Oxford in the early 14th century discussions of physical motion were too often encumbered by the foliage of logical sophismata; the criterion of truth was more often logical and mathematical consistency, rather than actual experience. It required the genius of Galileo to establish the Mertonian view of physics on the firm ground of observable and measurable experiment; and it required the genius of Newton to formulate the universal mathematical principles of natural philosophy. Nevertheless, the Mertonians did prepare the way in a very concrete manner by substituting the notion of velocity, a quantitative value, for that of a process.

In a like manner they prepared the way for the Newtonian concept of mass by their treatment of the notion of quantitas materiae. This notion, discussed by Averroes and Giles of Rome, was clarified by the early Mertonians and given a theoretical precision by Richard Swineshead. For Dumbleton and Swineshead the 'quantity of matter' not only remains constant in all substantial changes, but that quantity can be theoretically determined by considering the volume and the density of the body conjointly. Nevertheless it required the genius of Newton to consider the 'quantity of matter' to be the measure of matter (mensura ejusdem), proportional to the weight, and governed by the law of inertia.

With due respect to the researches of P.Duhem, it would seem from the present study that Richard de Bury was correct when he claimed that "admirable Minerva ... has passed by Paris, and now has happily come to Britain."(2) The Faculty of Arts at Oxford in the early 14th century could boast of its schools of logic and physics, which drew the attention of the

(2) Philobiblon, chap.9, ed.cit., p.212.

whole academic world. Many of the new logical treatises written by Oxford Masters became standard texts at continental universities, or at least were the model of later abbreviations and revisions. In physics such Oxford treatises as Bradwardine's De proportione velocitatum, the anonymous simplifications De proportionibus, and the Termini naturales were incorporated into the university curriculum at Oxford and at continental universities. And the writings of Heytesbury and Swineshead permanently affected the teaching of physics, particularly in Italian universities. In other words, the original writings of many of the early 14th century Merton Masters became standard works, upon which later generations reflected and built.

The Calculationes of Richard Swineshead marks the end of this period of intense intellectual activity in the Faculty of Arts at Oxford. After the middle of the 14th century a noticeable indifference and half-heartedness permeates the Faculty of Arts, and the masters seem content to comment upon or simplify the writings of the early 14th century masters. This may partially have been due to the ravages of the Black Death. But whatever may have been the result of the plague academically, it is clear that after the controversy provoked by Wyclif at Oxford nothing remained of the earlier glory in the Faculty of Arts. It was rather at Prague, Padua, Bologna and other continental universities that the new Mertonian views took root and flourished during the following centuries. This mysterious transfer of "admirable Minerva" still requires the attention of historians.

APPENDIX I

REPERTORIUM MERTONENSE

NOTE

This is a list of the MSS of the works of certain Merton Masters between 1300 and 1350, which I have noted in the course of my research. It contains mainly the writings pertaining to the Faculty of Arts, whether written in Oxford or elsewhere, but it contains also some theological treatises. There is no pretence to completeness, but I have attempted to see as many as were known to me. Those which I have not seen personally are marked with an asterisk.

The Masters are listed in alphabetical order of place name, and their writings are arranged according to the curriculum of studies. The works of Thomas Wilton are omitted, because I have nothing to add to Glorieux's list (Répertoire des Maîtres en Théologie de Paris, n.228, t.I, 460-462).

LIST OF MERTON MASTERS

1. Ashinden, John. . . . . page 283
2. Billingham, Richard. 285
3. Bradwardine, Thomas. 287
4. Bredon, Simon. 292
5. Buckingham, Thomas. 293
6. Burley, Walter. 294
7. Campsale, Richard de. 316
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12. Heytesbury, William. 321
13. Maduith, John. 326
14. Rede, William. 327
15. Segrave, Walter de. 327
16. Sutton, William de. 328
17. Swineshead, Richard. 329
18. Tewkesbury (? John). 331

1. ASHINDEN, JOHN

Biogr. Merton College Fellow in 1336-7 (Mert.Reg.3487) and still in 1355 (Mert.Reg.6032). Noted by Bale, Leland and Tanner under the forms of "Aeschendenus" and "Eastwode".

Works.

1) Summa judicialis de accidentibus mundi.

Inc.Lib.I: "Intencio mea in hoc libro est compilare sentencias astrologorum..."
Expl.Lib.I: "...completa est ergo hec compilacio tractatus primi summe iudicialis de accidentibus mundi in civitate Oxonie per mag. Joh. de Aschelden, 20 die mensis Julii anno 1347."
Expl.Lib.II: "...gracias quantas sufficio referens Deo patri cui sit honor et gloria per infinita secula Amen. Completa est hec compilacio tractatus secundi summe iudicialis de accidentibus mundi 18 die mensis Decembris anno Christi 1348."

*Erfurt, Amplon. F. 207a (membr.xiv), fol.1-
" Amplon. F. 379 (s.xiv), fol.99v-159
Oxford, Bodl. 369 (SC 2479), (s.xv), fol.1-379
" Bodl. 714 (SC 2621), (s.xiv), fol.1-235v
" Savile 25 (SC 6571), (membr.xiv), fol.1-163 [2nd Bk.]
" Digby 225 (SC 1803), (membr.xv), fol.1-243vb
" Oriel College 23 (membr.xv), fol.1-226
Paris, Universitaire 598 (membr.xv), fol.1-136

Ed. Venice 1489, 1542.

2) Tractatus de significatione coniunctionis Saturni et Martis in Cancro, que erat isto anno Christi 1357, octavo die Junii, et de significatione coniunctionis magne Saturni et Jovis, que erat anno Christi 1365 in 30 die Octobris hora 5 minutis 22.

Inc.: "Sicut dicit Ptholomeus in Centilogio...
Expl.: "...ad presens sufficiant."

Cambridge, Emmanuel College 70 (s.xv), fol.4v-14v.
London, B.M. Harley 637, fol.
" " Royal 12 F.XVII, fol.2-
Oxford, Ashmole 393, (SC 6734), p.82-89
" Digby 176 (SC 1719), (membr.xv), fol.42-49v

3) Prognosticon de eclipsi lune universali, que contingit anno Christi 1345.

Inc.: "Significatio eclipsis lune universalis...
Expl.: "... predicta significabit magnam sortitudinem in predictis significationibus."

Oxford, Bodl. Digby 176, (SC 1719), (membr.xv), fol.9-16

2. BILLINGHAM, RICHARD

Biogr. Merton College Fellow in 1344 (Mert.Reg.3676) and still in 1361 (Mert.Reg.6031). Frequently Bursar of the College. He, together with Richard Swineshead and others, was a supporter of Mag. John Wylyot in his tumultuous election to the Chancellorship in 1349 (Cal. of Close Rolls, Edw.III, 1349-1354, p.74).

Works

1) Speculum iuvenum (or, De probationibus propositionum)

Inc.: "Terminus est in quem resolvitur propositio ut in subiectum et predicatum..."
Expl.: "...et possibile est hoc esse post sui corruptionem, sed ista est falsa, igitur et illa."

*Assisi, Conv. 690, fol.189-225 [anon.]
*Erfurt, Amplon. Q. 30 (s.xiv), fol.144v-149v
* " Amplon. Q. 243 (s.xiv), fol.52-53v [incompl.]
* " Amplon. Q. 245 (s.xiv), fol.209-232v
* " Amplon. O. 75 (s.xiv), fol.1-18
Florence, Nas.Cent.,Magl.V.43 (membr.xiv-xv), fol.1-12
Oxford, Bodl. Aust. F.5.23 (SC 2674), fol.1-4
Padua, Antoniana XIX, 407 (a.d. 1469), fol.40v-45v
" Bibl.Univ. 1123 (membr.xiv), fol.11vb-14ra
*Vatican, Vat.lat. 674 (s.xiv), fol.110-114
" Vat.lat. 3038 (s.xv), fol.1-13
" Vat.lat. 3058 (s.xv), fol.47-67v
" Vat.lat. 3065 (s.xv), fol.1-11v
Venice, S.Marco, Z.lat. 277 (1728), (s.xiv), fol.2-5v [with comm.]
Vienna, Nat.Bibl.lat. 4698 (a.d. 1383), fol.104-108
Worcester, Bibl.Cathed. F. 118 (s.xv), fol.43vb-45vb [with comm. of mag. Edward Upton]
*Wurzburg, Minorit. I, 63, fol.46v-51

2) De sensu composito et diviso

Inc.: "Pro sensu composito et diviso est sciendum et primo de compositione est notandum quod nunquam est propositio in sensu composito nisi..."
Expl.: "...significare que non consummuntur secundum compositum vel divisum. Ideo hoc pro facilitate puerorum comprehensionem feci et brevi. Explicit tractatus de sensu composito et diviso mag. Ricardi Bilingm anglici valde utilis et brevis."

Paris, BN,lat. 14715 (membr.xiv), fol.79-82

3) Conclusiones.

Inc.: "Tu credis aliquam propositionem esse veram quam nullus homo credit esse veram..."
Expl.: "...ad illud concludendo conclusionem."

Padua, Bibl.Univ. 1123 (membr.xiv), fol.29ra-31rb /Expliciunt conclusiones date a mag. Riccardo bylyngham complete/
Vatican, Vat.lat. 3065 (s.xv), fol.21-25v
Vienna, Nat.Bibl. lat. 4698 (a.d. 1373), fol.108-114v

4) Sophisma

Inc.: "Numquid scire sit credere..."
Expl.: "...Explicit sophisma mag. Ricardi Bylyngham, quod sic incipit, numquid scire sit credere, etc."

Worcester, Bibl.Cathed. F. 35 (s.xv), fol.107-109vb

5) De significato propositionis

Inc.: "Utrum propositio affirmativa vel negativa..."
Expl.: "...Explicit intencio Bylyngham de significato propositionis."

Worcester, Bibl.Cathed. F. 35 (s.xv), fol.109vb-110va

Doubtful

1) Consequentiae

Inc.: "Quia in sophismatibus probando..." /Pits. 489/

2) Proportiones

Inc.: "Proportio quedam est communiter dicta..."

/attributed to Billingham by Tanner (p.100) and reference to MS Bodl. sup. A. 1 Art 98, fol./

3. BRADWARDINE, THOMAS

Biogr. Born about 1295, probably in the diocese of Chichester. First noted as a Fellow of Balliol College in August 1321, but by 1323 he became at least a probationary Fellow at Merton. His necessary regency in Arts probably between 1321-1324. In 1335 he relinquished his fellowship at Merton and joined the household of Richard de Bury. Chancellor of St.Paul's Cathedral, London, from September 1337 until 1349. Appointed to the archbishopric of Canterbury on June 19, 1349, and consecrated at Avignon on July 10, 1349. Died of the Plague at Lambeth, August 26, 1349.

Works.

1) Insolubilia (12 capitula)

Inc.Prol.: "Salvere non est ignorantis vinculum 3° Metaph., capitule primo. Quia ergo insolubilium vinculo...
Inc.cap.1: "Scias igitur quod insolubile capitur dupliciter secundum quod solubile vel solucio..."
Expl.: "...et sic ista sufficiant ad omnia insolubilia dissolvendum."

Cambridge, Caius College 434/434 (membr.xiv), fol.10v-12v (incomplete)
*Erfurt, Amplon. Q. 76 (membr.xiv), fol.6-21v
" Amplon. Q. 276 (a.d. 1295-1333), fol.163-167 (first 6 cap.)
* " Amplon. F. 135 (membr.xiv), fol.17v-20v [without prologue and subtitle "incipiunt insolubilia Swynesheyt. data Oxonie"]
London, B.M. Royal 12 F. XIX (membr.xiv), fol.149-152v (incomplete)
Munich, Clm. 23530 (s.xv), fol.210v-222 ["Belnardini de Anglia"]
Oxford, Canon.Misc. 219 (a.d. 1393-5), fol.53-57
*Praga, Capit. Metrop. 1327 (s.xiv), fol.47 ff.
Vatican, Vat.lat. 2154 (s.xv), fol.13-22rb ["Thome bradwardini anglici"]
" Vat.lat. 3065 (s.xv), fol.107v-116v [without prologue]
Venice, S.Marco, Z.lat. 301 (1576), (s.xiv), fol.27-37

2) Arithmetica speculativa

a) Inc.: "Horum que sunt aliud est continuum aliud discretum..."
Expl.: "...hec est sesquioctava proportio differencia. Explicit arismetica Bragward."

*Erfurt, Amplon. F. 375 (s.xiv), fol.15v-17v, 88v-92v
* " Amplon. Q. 23 (s.xiv), fol.75-81v

Ed. Paris 1495, 1502, Valencia 1503

b) Inc.: "Numerus est duplex: mathematicus qui dicitur numerus numerans, et naturalis qui dicitur numerus numeratus. Numerus autem mathematicus..."
Expl.: "...in sesquialtera proportione. Explicit arismetica Bragwardini."

Munich, Clm. 24809, (s.xv), fol.100v-106
Vienna, Nat.Bibl.lat. 4951 (a.d. 1501), fol.273-304v (with anon. commentary)
" Nat.Bibl.lat. 4953 (a.d. 1466), fol.36-61v [with anon. commentary]

3) Geometria speculativa

Inc.: "Geometria est assecutiva..."
Expl.: "...sicut deducitur per hanc communionem evidenter; et in hoc completa [est] quarta pars et ultima huius libri, Deo Gracias. Expl. geometria Bragwardini."

*Erfurt, Amplon. F. 375 (mid xiv), fol.1-15
* " Amplon. Q. 343 (late xiv), fol.1-38
Vatican, Vat.lat. 3102 (membr.xiv), fol.85-111v

Ed. Paris 1511, 1530

4) Tractatus de proportione velocitatum in motibus (1328)

Inc.prol.: "Omnem motum successivum alteri in velocitate proportionari contingit..."
Inc. cap.1: "Proportio vel est dicta communiter vel proprie. Est accepta communiter in omnibus..."
Expl.: "...situatur; sic ergo quid volumus lucide demonstratur. Perfectum est enim opus de proportione velocitatum in motibus cum illis moteris auxilio a quo motus omnes proceduntur."

*Bruges, Bibl. de la Ville 500, fol.158-172v
Cologne, Stadtbibliothek XII, 1, W.8°. 15 (membr.xiv) [anon. attr. to Albertus Magnus in cat.]
Erfurt, Amplon. F. 135 (membr.xiv), fol.20v-25
* " Amplon. F. 380 (membr.xiv), fol.49-58v
* " Amplon. Q. 325 (s. 1369), fol.13-22
* " Amplon. Q. 348 (a.d. 1393), fol.13-22
* " Amplon. Q. 385 (late xiv), fol.1-16v
* " Amplon. Q. 387 (late xiv), fol.1v-8
London, B.M. Harley 3243 (membr.xiv), fol.1-8v
Oxford, Bodl. 676 (SC 2593), (s.xv), fol.162-163v [anon.]
" Canon.Misc. 177, (a.d. 1395), fol.164-170v
" Digby 76 (SC 1677), fol.110-120
" Digby 228 (SC 1829), fol.56-61

*Padua, Antoniana XX, 431, (s.xv)
Paris, BN,lat. 6559 (membr.xiv), fol.49-58
" BN,lat. 14576 (membr.xiv), fol.255-261v
" BN,lat. 14734 (s.xv), fol.1-34
" BN,lat. 15105 (a.d. 1402), fol.1-24
" BN,lat. 16621 (s.xiv), fol.202v-212v
" BN, Nouv.Acq.lat. 625, (a.d. 1348), fol.62-70v
Rome, Angelica 1017 - (R.6.32), (membr.xiv), fol.50-56v
" Casanatense 267 (s.xiv), fol.1-10
Vatican, Vat.lat. 1108 (s.xiv-xv), fol.69-81
" Vat.lat. 1108 (s.xiv-xv), fol.104-119v
" Vat.lat. 2185 (s.xiv), fol.23v-27v
" Vat.lat. 4429 (s.xiv), fol.23-29
" Ottoban.lat. 179 (s.xiv), fol.92-98
Venice, S.Marc. lat.VI, 62 (2549), (s.xv), fol.99-111
" S.Marco lat.VI, 155 (3377), (s.xv), fol.92v-105
" S.Marco lat.VIII, 77 (3223), (s.xiv), fol.1-14
(mutilatus in principio)
" S.Marco lat.VIII, 38 (3383), (a.d. 1391), fol.1-8
Vienna, Dominikanerkloster 192/158 (membr.xiv), fol.146-152v
" Nat.Bibl.lat.1312 (s.xiv), fol.223v-242 (incompl.)

Ed. Paris , Venice 1505 (fol.9-16v), Madison 1955

5) Tractatus de continuo

Inc.: "Continuum est quantum cuius partes ad invicem copulantur. Continuum permanens..."
Expl.: "...igitur continuatur et finitur seipso. Sic igitur primus liber, qui est de compositione continui ad sua essentialia, finem capit. Amen. Explicit tractatus Bradwardini de continuo."

Erfurt, Amplon. Q. 385, (late xiv), fol.17-48 /anon./
Paris, BN, Nouv.Acq.lat. 625 (membr.xiv), fol.71v /asc. but only beginning/
Tourn, Quarto, 2, (late xiv), pages 153-192 /asc./

6) Tractatus de futuris contingentibus (partially published by B.M. Xiberta in Festschrift M. Grabmann (B.G.P.M.A., Suppl. III,2), pp.1169-1180)

7) Summa de causa Dei contra Pelagium et de virtute causarum

a) Inc.prol.: "Magnarum et multorum peticionibus..."
Inc.Lib.I: "In primis firmissime supponatur quod Deus est eterne perfectus...

Cambridge, Corpus Christi 24 (membr.xiv), fol.1-271v
/perscriptum Lond. 1344/

London, Lambeth Pal. 32 (membr.1385; perscriptum Cantab.) fol.1-257
Oxford, Merton College 71 (membr.xiv), [perscriptum London. 1344]
" New College 134 (membr.xiv), fol.3-322 [perscriptum London 1344]
" Canon.Misc. 244 (membr.xiv Vincenza), fol.1-221
Paris, Bibl.Nat.lat. 15390 (paper 1477)
" BN,lat. 15976-15977 (membr. a.d.1356)
" BN,lat. 3153 (membr.xiv), [imperfect beg. and end]
*Rome, Angelica 623 = (Q.1.10), (membr. perscriptum Paris 1352), fol.1-204
Vatican, Vat.lat. 1039 (perscriptum Paris.1357), fol.1-175v
" Vat.lat. 1040 (a.d. 1411), fol.1-305v
Vienna, Dominikanerkloster 91/67 (membr.xiv), fol.1-147v [lib.II-III]
" Nat.Bibl.lat.1312 (membr.xiv), fol.9-79v [incomplete]
" Nat.Bibl.lat.1521 (membr. perscriptum Paris, 1345), fol.1-166r

Ed. Paris 1495, 1500, Venice 1505, Vienna 1515, London 1618.
Cf. Stegmüller nn.896-898,2; Doucet ibid.

b) Epitome Summe de causa Dei

Inc.: "Magnitudinem huius operis michi videbatur extervis prospicienti tam in auctoritatum profunditate...

Vatican, Ottobon.lat. 662 (membr.xiv), fol.1-120

8) Tractatus de meditatione

Inc.: "O magne, O mirabilis Deus noster...
Expl.: "...ut quis tibi sufficienter retribuet summe pater."

Vienna, Nat.Bibl.lat.4487 (a.d.1430), fol.305-315 [acarb]
* " Schottenkloster 321 (a.d.1433), fol.122-131v [acarb]

Doubtful

1) Ars memorativa

Inc.: "Ad artificialem memoriam duo requiruntur, scilicet locus certus..."
Expl.: "...in dextro pede vas aquaticum nobile et in sinistro pede pistes mirabiles."

London, BM Sloan 377f (late xv), fol.7v-8v

2) Tractatus de predestinatione et libero arbitrio

Inc.: "Quia plerosque sollicitat an predestinationis divine similiter et reprobationis aliqua causa in predestinato et reprobato consistat..."

Vienna, Nat.Bibl.4306 (s.xiv-xv), fol.90r-105v

3) Sermo coram Edwardo III

Inc.prol.: "Deo gracias qui semper triumphat, etc. Licet dominus noster rex habeat multos clericos..."
Inc.sermo: "Nos Karissimi nos est in factis armorum...

Oxford, Merton College 180, (membr.xiv), fol.183^{v}-185^{v} [anon.]

4) Tractatus de incipit et desinit

Inc.: "Ad maiorem et clariorem noticiam illorum terminorum 'incipit' et 'desinit' habendam...

Vatican, Vat.lat. 2154 (s.xv), fol.24-29v [anon.]
" Vat.lat. 3066 (s.xv), fol.50v-52ra [anon.]

5) Tractatus insolubilium

Inc.: "Quia a pluribus queratur facilius invenitur maxime [sic] si humilitas et concordia...

Vatican, Vat.lat. 2154 (s.xv), fol.22va-24ra [anon.]

4. BREDON, SIMON

Biogr. Merton College Fellow in 1330 (Mert.Reg.3660) and still in 1341 (Mert.Reg.3712). Canon of Chichester by papal provision 9 May 1348. Died in 1372, having made his will at Battle Abbey, Sussex, dated 12 Oct. 1368; the will was proved on April 18, 1372 (Will published by F.M.Powicke, The Medieval Books..., 82-86).

Works.

1) Arsmetrica continens sententiam arsmetrice Boecii

Inc.: "Quantitatum alia continua, que magnitudo dicitur, alia discreta, que multitudo seu numerus nuncupatur..."
Expl.: "...geometricalis proportio inter secundum et tercium terminum reperitur. Explicit Ars Metrica Bredon."

Cambridge, Univ.Lib. Ee.III.61, (s.xv), fol.92v-101
*Escorial, i.II.6 (paper 1489), fol.63-70 [ascr. to Bradwardine]

2) Aritmetica theorica et practica

Inc.prol.: "Scientia de numero ac virtute numeri...
Inc.Pars I: "Numerus quem pro presenti..."

Oxford, Bodl. 465 (SC 2459), (s.xv), fol.18-194v

3) Expositio super quedam capitula Almagesti Ptholomei

Inc.: "Nunc superest ostendere quanta sit maxima declinatio Ecliptice ab equinoctali..."

Cambridge, Univ.Lib. Ee.III,61 (s.xv), fol.40-44 (imperfect)

4) De equationibus planetarum

Inc.: "Tempus correspondens an / 1392 / completus ultimo die decembris 23 secund. et 12 primis annorum / et ultimo die decembris anno 1393, 23 secund. et 13 primis etc. Tabule reductionis annorum extense ad..."

*Cambridge, Peterhouse 75 (s.xiv), fol.1-50

5) Expositio super libro Theorice Planetarum

Inc.: "Circulus excentricus et egrosse cuspidis et circule egredientis..."

Oxford, Digby 93 (SC 1694), (s.xv), fol.37-49v [imperfect]
" Digby 98 (SC 1699), (s.xv), fol.132-145

5. BUCKINGHAM, THOMAS

Biogr. Merton College Fellow in 1324 (Mert.Rec. 3654) and Master in Arts by 1331 (Cal.Pap.Let.,II,365). It seems he left Merton in 1340. On March 25, 1346 he became Chancellor of Exeter; at that date he was already a Master in Sacred Theology. He seems to have died by 1356, when a new Chancellor was appointed.

Works.

1) Tractatus de infinito tam logice quam philosophie naturali utilis

Inc.: "Utrum aliquid sit actualiter infinitum..."
Expl.: "...pars esset divina a toto."

*Erfurt, Amplon. F. 135 (a.d. 1337), fol.48-59 (according to Schum also ascribed to Guillelmus Collingham in margin)

2) Questiones theologice (QQ.66)

Inc.: "Utrum credere prophetas de aliquo contingenter futuro sit meritorium creature. Primo tractavi de contingentia futurorum..."
Expl.: "...amorimur et consepelimur Christo."

Oxford, Merton 143 (membr.xv), fol.1-84
" New College 134 (membr.xiv), fol.324-438v

Cf. M-D.Chenu, Studia Mediaevalia R.J.Martin, 229-241.

3) Questiones super libros Sententiarum

Inc.: "Querendum istam questionem in primo libro, vis. ex hoc quod scientia precognit in scito necessario imperfectionem impediat de Deo esse scientiam proprie dictam..."

Florence, Laurenz. Conv.Soppr. 129 (a.xv), fol.1-47v
Paris, BN,lat. 15888 (membr.xiv), fol.6-64v
" BN,lat. 16400 (membr.xiv), fol.2-109
*Prague, Univ. 2357, XIII.F.19, fol.127v-174
Vatican, Vat.lat. 1089 (membr.xv), fol.1-107v

Ed. Paris (J.Barbier) 1503

6. BURLEY, WALTER

Biogr. Born about 1275, probably in Yorkshire. He was already Master of Arts in 1301, and the earliest mention of Burley as Fellow of Merton College is in the Records for 1305 (Mert.Rec.363⅓). Probably lectured in Arts at Oxford until his departure for Paris in 1310. Remained at the University of Paris until early in 1327, when he was appointed envoy of Edward III to the Papal Court at Avignon. Burley received constant encouragement from Richard de Bury, to whom he dedicated numerous works. He was still alive on January 12, 1344.

Works.

I. On Logic:

1. Expositio super lib. Porphyri

a) Inc.: "Cum sit necessarium grisatorii, etc. Primo querende sunt cause huius libri quia secundum Aristotelem 1° Phis., tunc arbitramur unumquodque cognoscere quando cognoscimus eius causas..."
Expl.: "...et sic patent differencie et convenienzie inter omnia universalia."

Cambridge, St.John's Coll.,100 (membr.early xiv), fol.47-49vb

b) Inc.: "Quia de dictis in logica intendo quoddam compendium compilare dicendo sunt primo tria circa logicam in communi..."
Expl.: "...et species non continet genus. Comparaciones quinque universalium sunt tantum dicte. Differencia est prior quam /sic/ species quam /proprium/. Et hic finitur. Explicit liber Porphyrii secundum expositionem mag. Walteri Burley doctoris evangelice veritatis."

Cambridge, Caius Coll. 139/79 (membr.xiv), pp.12-42

c) See below, n.n. 5,6,7.

2. Expositio super lib. Predicamentorum

a) Inc.: "Equivoca dicuntur, etc. Intencio huius libri est determinare de decem predicamentis quius subiectum est ens..."
Expl.: "...Alii sunt modi quod est habere, set hii qui sunt dicte sunt magis principalia."

Cambridge, St.John's Coll.,100 (membr.xiv), fol.49vb-54rb.

b) Inc.: "Equivoca dicuntur, etc. Impossibile est cognoscere totum partibus ignotis. Cum igitur demonstratio, que est finis logici negocii, sit ex proposicionibus..."
Expl.: "...set que sit ordinacio istorum predicamentorum et species et genera subalterna, in libro de sex principiis planius apparebit."

Cambridge, Caius Coll. 448/409 (membr.xiv), pp.1-31a [incom.]
" St.John's Coll.,100 (membr.xiv), fol. 55-66v [ascr.]
" Peterhouse 184 (membr.xv), fol.171-189v
London, BM, Royal 12 F. XIX (membr.xiv), fol.3-13v [second part only]
Vatican, Vat.lat. 3048, fol.21-88

c) See below, n.n. 5,6,7.

3. Expositio libri sex principiorum

a) Questiones quatuor de sex Principiis

Inc.: "Forma est compositioni, etc. Queritur utrum forma..."
Expl.: "...[later hand] Explicium questiones M. Adam burley."

Cambridge, Caius Coll. 668*/645 (membr.early xiv) fol.9-13v

b) Inc.: "Forma est compositioni, etc. Iste liber intitulatur de sex principiis. Cum tamen sit de sex predicamentis, genera generalissima sunt principia..."
Expl.: "...fit minus nobile sive in substancia sive in accidentibus; et oppositio modo est de corrupcione. Et in hoc [finitur] liber sex principiorum."

Cambridge, Caius Coll. 139/79 (membr.xiv), page 131-153
Vatican, Vat.lat. 9341 (s.xiv-xv), fol.77-92

c) Inc.: "Quamvis Aristoteles in libro Predicamentorum sufficienter quantum est de intencione logici determinavit, tamen ut facilius et evidencius habetur cognicio..."
Expl.: "...generatur minus nobile sive in substancia sive in accidentibus. Et oppositio modo est de corrupcione. In hac completur intencio Porretani in sex principiis."

Cambridge, Caius College 448/409 (membr.xiv), pp.57-87b [incom.]
" Peterhouse 184 (membr.xv), fol.156v-171 [ascr.]

d) Expositio vetus

Inc.: "Iste liber intitulatur de sex principiis. Cum tamen sit de sex predicamentis; genera enim generalissima et sunt principia et sunt predicamenta...

Expl.: "...et cum aer generatur ex igne, est generacio secundum quid respectiva. Ista satis patent ex 1° De Gen. et hoc finitur liber sex principiorum. Explicit expositio Burley super librum sex principiorum, que dicitur expositio vetus."

London, Lambeth Pal. 70 (membr.xiv), fol.35-43
" Lambeth Pal. 143 (s.xv), fol.141-150

e) Expositio nova

Inc.: "Quamvis Aristoteles in libro Predicamentorum sufficienter quantum est de intencione logici determinavit, tamen ut facilius et evidencius habeatur cognicio predicamentorum Gilbertus Porretanus hunc librum composuit..."

Expl.: "...et quando ex magis nobili fit minus nobile est generacio secundum quid respectiva. Unde cum ignis generetur ex aere est generacio simplex absoluta; et cum aer generatur ex igne est generacio secundum quid respectiva; ista satis patent ex 1° de gen. Explicit expositio Burley super librum sex principiorum."

London, Lambeth Pal. 70 (membr.xiv), fol.43v-55v

f) (written after leaving Paris, i.e., after 1327)

Inc.: "Iste est liber qui intitulatur de sex principiis. Cum tamen sit de sex predicamentis. Genera enim generalissima sunt principia et predicamenta... Et istam opinionem tenui parisius et eam declaravi in primo tractatu de formis accidentalibus..."

Expl.: "...Unde cum ignis generatur ex aere est generacio simplex absoluta, et cum aer generatur ex igne est generacio secundum quid respectiva."

Vatican, Vat.lat. 2147 (s.xv), fol.81-102

g) See below, n.n. 6,7.

4) Expositio super lib. Peryermenias

a) Questiones quinque date a mag. Waltero de Burley super librum Peryarmenias a.d. 1301

Inc.: "Queritur utrum vox primo significet rem..."

Cambridge, Caius College 668°/645 (membr.xiv), fol.60-76

b) Inc.: "Primum oportet constituere, etc. Iste liber qui intitulatur liber periarmenias est de interpretacione, quia periarmenias dicitur a peri quod est de et armeneias quod est interpretacio..."

Cambridge, St.John's College 100 (membr.xiv), fol.47-54v /incompl./

c) Inc.: "Primum oportet, etc. Cum cognicio sillogismi sit finis logice et cognicio partis precedit cognicionem totius et sillogismus habet partes propinquas et remotas..."
Expl.: "... sunt magis quam que enunciant minus contrarie quam illa que enunciant contraria de eadem. Explicit tractatus libri peryarmenyas datus a mag. Waltero de Burley."

Cambridge, Caius Coll. 448/409 (membr.xiv), pp.32-56b
" Caius Coll. 139/79 (membr.xiv), pp.153-164 /incompl./
" St.John's Coll. 100 (membr.xiv), fol.67-73rb
London, BM, Royal 12, F. XIX (membr.xiv), fol.14-23ra

d) See below, n.7.

5) Expositio in Aristotelis librum Priorem /sic/ et Predicam

Inc.: "Questio est utrum logica sit necessaria ad alias scientias..."
Expl.: "...Explicit scriptum libri Prior /sic/ et Pred.Arist. per mag. Burleum, precleriissimum famosum doctorem in logica nec non in naturali philosophia."

*Padua, Antoniana, XXII, 536 (s.xv), fol.1-89

6) De universalibus, de predicamentis et de sex principiis

Inc.: "Circa universalia sunt dubitaciones notande..."
Expl.: "...Explicit Burleus super Arte Veteri per me Joannem de Lovanio Alemano, an. 1448."

Padua, Antoniana, XVIII, 402 (s.xv), fol.1-91

7) Expositio super Artem Veterem a.d. 1337

Inc.: "Quia de dictis in logica quoddam compendium intendo compilare... Circa librum predicamentorum est sciendum quod... Quamvis Aristoteles in libro Predicamentorum sufficienter... Liber Peryarmenias quem ad presens intendimus exponere..."
Expl.: "...Astem tamen materiam alibi diffusius pertractavi, et in hoc finitur secundus liber peryarmenias. Completa est hec expositio quinta die mensis Augusti anno domini millesimo CCC° trigesimo septimo et anno etatis expositoris sexagesima secundo."

Cambridge, Caius College 139/79 (membr.xiv), pp.12-131
Florence, Laurenz. Ashburnh. 171 (a.d.1443), fol.1-10 [incompl.]
" Laurenz. Ashburnh. 1145 (a.d.1458-60), fol.2-144v
" Laurenz. Plut. 71, cod.23 (a.d.1427), fol.1-72v
London, Lambeth Palace 70 (membr.xiv), fol.1-84
" Lambeth Palace 143 (s.xv), fol.151-185 [Peribar.]
" BM, Royal 12 B. XIX (s.xv), fol.19-34v [Porph.]
" BM, Royal 12 F. XIX (membr.xiv), fol.3-53v [incompl.]
Naples, Naz.Gent. lat.VIII. E.15 (a.d.1463), fol.1-125v
" Naz.Gent. lat.VIII. E.1 (s.xv), fol.1-76v [incompl.]
" Naz.Gent. lat.VIII. G.72 (s.xv), fol.31-150v
" Bibl. dell' Oratorio, cod.Fil.XVI,n.X
Oxford, Bodl. 643 (SC 2256), (s.xiv), fol.1-69
" Canon.Misc. 180 (s.xv), fol.1-42
" Canon.Misc. 460 (s.xv), fol.1-109
" Magdalen College 47 (membr.xv), fol.37v-54 [Porph.]
" Magdalen College 146 (membr.xiv), fol.1-83
Rome, Angelica 1498 - (V.3.5.), (a.d.1442), fol.1-119
Vatican, Vat.lat. 2146 (membr.xiv), fol.1-87
" Vat.lat. 2147 (s.xv), fol.1-102v
" Vat.lat. 2148 (s.xv), fol.1-45v [Peribar.]
" Vat.lat. 3048 (s.xv), fol.1-111v

Ed. Venice 1481, 1497, 1519.

8) Commenta super II Priorum Analyticorum

Inc.: "Cum omnis scientia erit inquisitiva..."
Expl.: "...quod non est inconveniens."

*Erfurt, Amplon. Q. 276 (a.d.1295-1333), fol.63-97v

9) Expositio super libros duos Posteriorum Anal.

a) Inc.: "Omnis doctrina, etc. Secundum Philosophum in moralibus in quibuscumque actibus nostris accidit rectitudo et peccatum, ideo necessario indigemus arte..."
Expl.: "...et hoc quando statim cognoscitur, quia sic est de omnibus singularibus sicut est de uno singulari. Explicit expositio mag. Walteri de Burley super librum posteriorum Aristotelis."

Cambridge, Caius Coll. 448/409 (membr.xiv), pp.117a-171b /mom./
London, BM, Royal 12 B. XIX (s.xv), fol.244-301
" Lambeth Palace 70 (membr.xiv), fol.149-169

b) Inc.: "Omnis cognitio nostra vel est sensitiva vel intellectiva..."

Ed. Venice (per mag. Otinum Papiensem) 1497

c) Questiones super librum Posteriorum (10 qq.)

Inc.: "Queritur utrum aliquis posset adquirere aliquam sciencian de novo. Videtur quod non per argumentum illorum qui negabant sciencian..."
Expl.: "...per quod aliquid aliud debet determinari. Explicit questiones super librum posteriorum date a domino Waltero de Burley."

Cambridge, Caius Coll. 668*/645 (membr.early xiv), fol.119v-132r

10) Expositio super libros Topicorum

Inc.: "Ut de discussis in hoc opere cognicio distincter habetur, distinguam librum istum totalem..."
Expl.: "...sed pecius immediate et hoc plenius determinari habet in fine posteriorum. Explicunt notule octavi libri topicorum Aristotelis."

London, Lambeth Pal. 70 (membr.xiv), fol.170-266va
Oxford, Merton Coll. 295 (membr.xiv), fol.1-92 /lib.I-VII/
Vatican, Vat.lat. 2146 (membr.xiv), fol.113-204

11) Expositio super librum Elenchorum

a) Questiones libri Elenchorum

Inc.: "De sophisticis autem elenchis, etc. Queratur utrum de sillogismo sophistico est sciencia. Quod non..."
Expl.: "...esse nisi inter accidens et passionem. Explicium questiones date super librum elenchorum."

Cambridge, St.John's College 100 (membr.early xiv), fol.153-162va

b) Inc.: "De sophisticis autem elenchis, etc. Modi arguendi sunt duo ut ait Philosophus 1° Elenchorum; unus est secundum dictionem, alius extra dictionem..."
Expl.: "...et eodem modo est hec falsa: omnia que non vident et sunt apta nata videre sunt ceca. Explicit lib. elenchorum W.Burley."

Cambridge, Caius Coll. 448/409 (membr.xiv), pp.95b-115a /Hic explicit quidem tractatus qui vocatur modus arguendi/
London, Lambeth Pal. 70 (membr.xiv), fol.134vb-144ra

12) Suppositiones

Inc.: "Eorum que dicuntur, quedam dicuntur cum complexione et quedam dicuntur sine complexione..."
Expl.: "...ideo non valet quia arguitur a pluribus determinatis ad unum determinatum. Explicium suppositiones date a mag. W. de Bourl/ey/."

Cambridge, Caius Coll. 434/434 (membr.xiv), fol.13-19
London, BM, Royal 12 F. XIX (membr.xiv), fol.130-133r

13) De puritate artis logicae

a) (shorter and earlier version)

Inc.: "Ut invenes in quolibet problemate disputantes possint esse expeditati et velociter obviantes..."
Expl.: "...possunt categorematice vel synkategorematice accipi. Explicit burleus minor."

*Los Angeles, House Library 6 (s.xiv), fol.77-88
Vatican, Vat.lat. 3066 (a.d.1347-49), fol.26-33v

Ed. P. Boehner, N.Y. 1955

b) (longer version, after 1324)

Inc.: "Suppositis significatis terminorum incomplexorum, in hoc tractatu intendo perscrutari..."
Expl.: "...eodem modo est syllogizandum hic, sicut in simplicibus categoricis de inesse."

*Brugghe 501, (s.xiv), fol.1-69v
*Erfurt, Amplon. F. 120 (s.xiv), fol.74-98v
* " Amplon. Q. 259 (a.d.1340), fol.159-208
* " Amplon. Q. 291 (s.xiv), fol.51-64v
* " Amplon. Q. 67 (a.d.1329), fol.123v-134 /extracts/
Florence, Laurenz. S.Croce, Plut XII, sin.cod.2, (membr.xiv), fol.167-203
London, Lambeth Pal. 70 (membr.xiv), fol.85-109v
Munich, Clm 1060 (a.d.1347), fol.97v-130v
Paris, BN lat. 16130 (s.xiv), fol.80-110v
*Treviso, Bibl.Comm. 377 (membr.xv), fol.97-121v /mutil. at end; AL,1078/
Vatican, Vat.lat. 2146 (a.d.1397), fol.204v-234r
" Vat.lat. 3066 (a.d.1349), fol.34-50
Vienna, Dominikanerkloster 160/130 (membr.xiv), fol.61-74v
*Venice, S.Marco lat.261 (s.xiv), fol.31-44

Ed. P.Boehner, N.Y. 1955

14) Notabilia de logicis

1) Tractatus de relativis
Inc.: "Circa relativa est sciendum quod relativum est duplex in genere, scilicet relativum grammaticale et relativum logicum seu reale..."
Expl.: "...prout descendit ab hoc adiectivo hic et hoc animalis et hoc animale."

London, Lambeth Pal. 70 (membr.xiv), fol.114ra-115ra
Vatican, Vat.lat. 2146 (membr.xiv), fol.248-249

11) Tractatus de abstractis
Inc.: "Sed dubium est quid huiusmodi abstracta humanitas et animalitas significant, utrum formam tantum vel aggregatum..."
Expl.: "...ponentes quod affirmatio eiusdem de se est necessaria."

London, Lambeth Pal. 70 (membr.xiv), fol.115ra-116b
Vatican, Vat.lat. 2146 (membr.xiv), fol.249v

iii) De divisione entis
Inc.: "Circa divisionem entis per se in decem predicamenta..."
Expl.: "...et sic antichristus dicitur esse nichil, eodem modo est de non ente."

London, Lambeth Pal.70 (membr.xiv), fol.115va-116ra
" Lambeth Pal.143 (s.xv), fol.139r-v
Oxford, All Souls Coll. 85 (membr.1428), fol.131-132
" Bodl. Add. A.370 (s.xv), fol.173-175
Vatican, Vat.lat. 2146 (membr.xiv), fol.249v-250

iv) De finito et infinito
Inc.: "Circa finitum et infinitum est sciendum quod finitum et infinitum quantitati conveniunt..."
Expl.: "...iste terminus infinita potest teneri categorice vel sincategorice."

London, Lambeth Pal.70 (membr.xiv), fol.116va-vb
Oxford, All Souls Coll. 85 (membr.1428), fol.171rb-va
Vatican, Vat.lat. 2146 (membr.xiv), fol.250r

v) De toto et parte
Inc.: "Intelligendum quod pars et totum multipliciter accipiuntur. Pars enim accipitur pro partibus essencialibus..."
Expl.: "...nisi corrupto subiecto, nec falsa nisi manente subiecto."

London, Lambeth Pal.70 (membr.xiv), fol.116ra-va
Oxford, All Souls Coll. (membr.xv), fol.169r-v
" Bodl. Add. A.370 (s.xv), fol.175-176
Vatican, Vat.lat. 2146 (membr.xiv), fol.250r-v

vi) Tractatus de sensibus
Inc.: "Nota quod in homine sunt quinque sensus interiores sicut exteriores..."
Expl.: "...consentium illas qualitates et econtra experimentum."

Cambridge, Univ.Lib., Hh.IV.13 (s.xv), fol.58v-60
London, Lambeth Pal.70 (membr.xiv), fol.116vb-117vb
" Lambeth Pal.143 (s.xv), fol.139v-140v
" BM, Royal 12 B. XIX (s.xv), fol.301v-304
Oxford, Oriel College 15 (membr.xv), fol.97v-99
Vatican, Vat.lat. 2146 (membr.xiv), fol.246-247
" Vat.lat. 2151 (membr.xv), fol.117-119

vii) De duobus primis principiis
Inc.: "Notandum quod tantum sunt duo principia prima substancie secundum rem, scilicet materia et forma..."
Expl.: "...per operacionem artis applicantis artificialiter partes domus ad invicem."

London, Lambeth Pal. 70 (membr.xiv), fol.117vb-118ra

London, Lambeth Pal. 143 (s.xv), fol.150va-b
Oxford, All Souls Coll. 85 (membr.xv), fol.169vb-171rb
Vatican, Vat.lat. 2146 (membr.xiv), fol.247r-v

viii) De qualitatibus
Inc.: "Sciendum quod quatuor sunt species qualitatis..."
Expl.: "...iracundia ex aliquo displicibili, et ita de aliis."

London, Lambeth Pal.70 (membr.xiv), fol.118va-119rb
Oxford, Bodl. Add. A.370 (s.xv), fol.171v-173
Vatican, Vat.lat. 2146 (membr.xiv), fol.245r-v

ix) De tribus in toto universo per se agentibus
Inc.: "Notandum est quod in universo tria sunt agencia per se, scilicet Deus, natura et ars..."
Expl.: "...per operacionem artis applicantis artificialiter partes domus adinvicem."

London, Lambeth Pal. 70 (membr.xiv), fol.118ra-va
Oxford, All Souls Coll. 85 (membr.xv), fol.170va-171rb
" Bodl. Add. A.370, (s.xv), fol.168-169v
Vatican, Vat.lat. 2146 (membr.xiv), fol.247v-248

x) De divisione potentie in activam et passivam
Inc.: "Sciendum quod duplex est potencia, scilicet activa et passiva. Et patatur..."
Expl.: "...passo super quod dominatur de necessitate agit."

London, Lambeth Pal.70 (membr.xiv), fol.119rb-va
Oxford, Bodl. Add. A.370, (s.xv), fol.176v-177
Vatican, Vat.lat. 2146 (membr.xiv), fol.245v-246

xi) De diffinitione sive de modo diffiniendi
Inc.: "Sciendum quod duplex est modus diffiniendi, scilicet compositionis et divisionis..."
Expl.: "...sed loco istius ponitur eius diffinicio."

London, Lambeth Pal.70 (membr.xiv), fol.119va-vb
Naples, Bibl.Naz. VIII.F.10 (a.d.1426), fol.96v-106r
Oxford, Magdalen Coll. 196 (membr.xiv), fol.46v-49
" Bodl. Add. A.370, (s.xv), fol.170-171
Vatican, Vat.lat. 2146 (membr.xiv), fol.244v-245

15) De probationibus

Inc.: "Quoniam innata est nobis via a communibus..."
Expl.: "...sed totum ratione partis."

*Erfurt, Amplon. Q. 276 (a.d.1295-1333), fol.6-19v

16) De exclusivis

Inc.: "Circa dicciones exclusivas est sciendum quod diccio exclusiva addita subiecto removet predicatum ab oppositis subiecti..."
Expl.: "...aliud quam Plato ex quo non sequitur quod Sortes non differe a Cathone. Explicium exclusive mag. W. de Burleye."

London, BM, Royal 12 F. XIX (membr.xiv), fol.123-126

17) De exceptivis

Inc.: "Hoc signum 'preter' aliquando tenetur exceptive, aliquando diminutive..."
Expl.: "...sed subiectum in comparacione ad actum, ideo non oportet consequencium valere. Explicium exceptive mag. W. de Burl."

London, BM, Royal 12 F. XIX (membr.xiv), fol.126v-129v

18) De syncategorematibus

Inc.: "Quaritur de obliquis utrum possit fieri syllogismus..."
Expl.: "...consequentias necessarias, licet non syllogisatis."

*Erfurt, Amplon. Q. 276 (s.xiv), fol.19v-21v

19) De consequentiis

a) Inc.: "Quia in sophismatibus prohendis et improbandis consequentiis utimur, et ideo circa naturam consequentiarum multa oportet scire..."
Expl.: "...non fit una obiectio tantum [sed] plures diverse. Explicium consequentie edite a mag. Gualtero de burley."

Cambridge, Gaius Coll. 434/434 (membr.xiv), fol.1-10
Florence, Laurens. Plut XII,sin.cod.2 (membr.xiv), fol.203v-212

b) Inc.: "Consequentiarum quedam simplex, quedam ut nunc. Consequentia simplex est illa que tenet pro omni..."
Expl.: "...quia substantia predicatur de homine, et ideo hec est vera, homo est species. Et sic est finis. Explicium consequencie a ven. arcium doc. mag. Burley composite."

Vatican, Vat.lat. 3065 (s.xv), fol.39vb-43rb

20) De obligationibus

a) Inc.: "In disputacione dialectica due sunt partes, scilicet opponens et respondens. Opus autem opponentis..."
Expl.: "...dummodo non fit una obiectio tantum, sed plures et diverse. Explicit optimus tractatus de obligacionibus datus a mag. Waltero de Burleye anno domini Millesimo trecentesimo secundo."

London, BM, Royal 12 F. XIX, (membr.xiv), fol.138-148
Venice, S.Marco, Z.lat.301 (1576), (s.xiv), fol.47-57v

b) Inc.: "Obligacio secundum quod nos utimur hoc nomine in sophismatibus est prefixio..."
Expl.: "...ad omnia enim respondendum est dubie. Explicient obligaciones date a mag. Galtero Burley."

*Erfurt, Amplon. Q. 259 (a.d.1340), fol.209-214v
Paris, BN lat. 16130 (membr.xiv), fol.110v-114
Venice, S.Marco, Z.lat. 302 (1873), (s.xiv), fol.151-240

c) Inc.: "Cum ars obligatoria nit..."
Expl.: "...in es Rome. Explicit obligaciones."

*Erfurt, Amplon. Q. 76 (s.xiv), fol.34v-36

21) De insolubilibus

Inc.: "Circa insolubilia queritur duo; primo circa insolubile simplex, secundo circa insolubile compositum..."
Expl.: "...sed sufficit veritas huius partis et sic de insolubilibus dicta sufficiant. Explicium insolubilia mag. Waltheri Wurley, Anglici."

London, BM, Royal 12 F. XIX (membr.xiv), fol.133v-138
Paris, BN, lat. 16621 (s.xiv), fol.243-247v /Explicium sophismata insolubilia mag. Galtheri de Burley anglici mag. in theologia./
Vienna, Dominikanerklosterbr 160/130 (membr.xiv), fol.60r-v and 125va-126vb

22) De sophismatibus cum sua sophisteria

Inc.: "Circa signa universalia quatuor proponimus inquirere..."
Expl.:"...in se duo contradictione opposita."

*Erfurt, Amplon. Q. 276 (s.xiv), fol.22-62
*Rome, S.Isidoro 1/10, fol.2 ff. /ascr. "Bonaventura"/
Venice, S.Marco, Z.lat.302 (1873), fol.1-50 /Burley, "Flores totius logice"/

Ed. S.Bonaventurae, Opera Omnia, Bassani 1767, col.467 ff.

23) Tractatus de universalibus realibus

Inc.: "Circa universalia sunt dubitationes non pauce. Prima utrum universalia existant in rerum natura..."
Expl.: "...representantem chimeram."

Cambridge, Caius Coll. 139/79 (membr.xiv), fol.1-11 /beg. imperfect/
London, Lambeth Pal.70 (membr.xiv), fol.110-113v
Naples, Bibl.Naz. lat. VIII.E.1 (s.xv), fol.11v-16
Oxford, Bodl. Add. A.370, (SC 29621), (s.xv), fol.207-216v
* " Univ. Coll. 120 (membr.xiv)
" Magdalen Coll. 196 (membr.xiv), fol.43-46v
Vatican, Vat.lat. 2151 (s.xv), fol.119-126v
" Vat.lat. 3048 (s.xv), fol.121-130
Vienna, Dominikanerkloster 14/14 (s.xiv), fol.40-46

Ed. Venice 1492-3 /GW 5770/

II. On Natural Philosophy

24) Expositio librorum Physicorum

a) (early version before 1316)
Inc.: "Quoniam autem intelligere, etc. Iste liber habet duas partes..."
Expl.: "...nec in corpore, sed etiam indivisibilis et impartibilis, nullam habens magnitudinem. Explicit exposicio omnium librorum phisicorum edita a mag. Walthero de Burley cum questionibus optime disputatis."

Cambridge, Caius College 448/409 (membr.xiv), pp.172-543b
" St.John's Coll. 100 (membr.xiv), fol.76-85v /frag. from Lib.V, comm.9 = Caius Coll. MS pp.361a-376b/

b) Divisiones, sententiae et conclusiones Burlei super VIII lib. Physicorum

Inc.: "Naturalis philosophiae principales partes sunt octo..."
Expl.: "...Hec igitur dicta de libro physicorum breviter sufficiant..."

*Erfurt, Amplon. F. 297 (early xiv), fol.1-20v

c) (final version, begun after 1324)
Inc.: "Quoniam quidem intelligere etc. Aristotelas determinaturus de rebus naturalibus..."
Expl.: "...virtutem resistivam mobilem non esset aliqua proportio, et hic finitur exposicio super totum librum Physicorum."

Basel, Univ.Bibl. F.II.30 (membr.xiv), fol.3 ff
Florence, Naz.Cent.,Conv.Soppr. D.1.1362 (a.d.1364), fol.15-147
" Naz.Cent.,Conv.Soppr. A.1.1361 (a.d.1465), fol.1-226v
London, Lambeth Pal.70 (membr.xiv), fol.1-53va /questions extracted from comm./
Naples, Bibl.Naz. VIII.E.35 (s.xv), fol.1-175v /incomplete/
" Bibl.Naz. VIII.E.47 (a.d.1446), fol.1-303v
Oxford, All Souls Coll. 86 (membr.xiv), fol.1-199
" Balliol Coll. 91 (membr.xiv), fol.5-246
Padua, Antoniana, XVI,n.365 (a.d.1447), fol.1-244
Paris, BN, lat. 6528 (s.xv)
Rome, Angelica 226 = (C.2.3), (a.d.1442), fol.1-174 /first 4 Bks/
" Casanatense 267 (s.xiv), fol.86-89 /frag. lib. III/
Vatican, Vat.lat. 2149 (s.xiv), fol.1-122 /first 6 Bks/
" Vat.lat. 2150 (s.xiv), fol.1-223 /incompl. beginning of Bk. VII/
* " Vat.lat. 4591 (a.d.1411)
Vienna, Nat.Bibl.lat. 5267 (s.xv), fol.1-311

Ed. Venice 1482, 1491, 1501

d) Questiones super libros Physicorum

*Basel, Univ. Bibl. F.V.12, /incompl. cf. S.H.Thomson, Mitt. Inst. Österr. Gesch. LXII (1954), 390-405/

e) Notulae super libris Physicorum

Inc.: "Philosophia secundum definitionem vocis sic definitur..."
Expl.: "...cuius ipsum est motor efficiens."

*Erfurt, Amplon. Q. 312 (before 1323), fol.1-14

f) Quaedam questiones naturales

Inc.: "Prima questio est super hoc quod dicit Aristoteles in lib. Posteriorum quod questio quia est..."
Expl.: "...per hoc quod videtur, idest per formam."

*Erfurt, Amplon. Q. 290 (s.xiv), fol.57-62

25) Questio de duratione

Inc.: "Utrum per aliam potentiam alia creatura possit durare per solum instans. Et arguitur quod non primo sic: quia inter adquisitionem et deperditionem..."
Expl.: "...Ad decimum dico ad minorem quod res in potencia de potencia obiectiva habet esse eternum, sed non de potencia subiectiva, et sic non valet. Explicit questio Galteri e burley."

Rome, Casanatense 267 (s.xiv), fol.89-91v

26) De principiis naturalibus

Inc.: "Sicut fructus est..."
Expl.: "...Explicit tractatus m. Walteri Burley de principiis naturalibus."

*Madrid, Bibl. de Palacio 3092, fol.190-194v
Oxford, Balliol Coll. 93 (membr.xiv), fol.7-11

27) Expositio de Celo et Mundo

Inc.: "In hoc libro qui dicitur de celo et mundo sunt quedam communia scienda..."
Expl.: "...quam corpus resistens, tunc corpus resistens dividitur et fit motus decrum. Explicit expositio W.Burley super libros de celo et mundo."

London, Lambeth Pal.74 (membr.1390), fol.110-151v [imperf.]
Oxford, All Souls College 86 (membr.xiv), fol.222v-256
" Magdalen Coll. 63 (membr.xv), fol.2-58 [imperf. at end]
" St.John's College 113 (membr.xiv), fol.62-120v [imperf.]

28) Expositio super de Generatione et Corruptione

a) Inc.: "In prohemio huius libri proponit Philosophus suam intencionem, dicens quod intendit in hoc libro determinare de rebus universalibus..."
Expl.: "...tum quod est corruptum non redit idem in numero. Et in hoc terminatur liber de gen. Explicit expositio Walteri Burley super libros de gen. et corrup."

London, Lambeth Pal.74 (membr.1390), fol.9-30ra [imperf.]
Oxford, All Souls Coll. 86 (membr.xiv), fol.199v-212

b) Inc.: "De generatione autem et corruptione, etc. Inquirit in hoc libro de generabili in communi..."
Expl.: "...tetigit hoc quod est motivum."

*Erfurt, Amplon. Q. 312 (before 1323), fol.14-20v

29) Expositio super Metheorum libros quatuor brevissime

Inc.: "De primis ergo causis, etc. Liber metheorum dicitur quasi liber metheorum logicorum. Et dicitur..."
Expl.: "...formam alicuius rei tunc scimus principia eius et notum per Aristotelem. Explicit expositio m. Walteri Burley super 4 libros metheorum secundum litteram brevis et utilis."

Cambridge, Trinity College 1109 (membr.xiv), fol.395-411
Oxford, Balliol College 93 (membr.xiv), fol.90v-108
" Digby 98 (s.xv), fol.49-61v
" Bodl. Add. A.370, (s.xv), fol.191-203

30) Tractatus de planetis et earum virtute

Inc.: "Sciendum si quis nascatur in aliqua hora diei in qua..."
Expl.: "...si fecerit prima digna a bono divino, suscipiet scilicet vitam eternam. Explicit tract. de planetis et earum virtute."

London, Lambeth Pal.70 (membr.xiv), fol.147vb-149va [anon]
" Lambeth Pal.74 (membr.1390), fol.8va-b [anon.]

31) Problemata Aristotelis

Prol.: "Felix qui potuit causas, etc. Felicitas quandoque sive beatitudo est summum bonum..."
Inc.expos.: "Abstinencia: quare labor et abstinencia sunt salubres..."
Expl.: "...Zephirus, vere ventus. Explicient abbreviacio libri problematum Aristotelis secundum ordinem alphabeti laborata per Walterum Burley, doctorem in theologia, Universitatis Oxon."

Oxford, Digby 206 (s.xiv), fol.96-129
" Magdalen College 65 (s.xv), fol.1-58

32) Expositio librorum De Anima

a) Inc.: "In prohemio primo probat necessitatem scientie de anima..."
Expl.: "...scilicet vegitabilem et sensibilem."

*Erfurt, Amplon. Q. 312 (before 1323), fol.20v-28

b) Questiones super libros de Anima (18 qq.)

Inc.: "Queritur utrum anima sit substancia simplex vel composita. Et videtur composita..."
Expl.: "...quod ordinat aliquod ad opus hic actio vel operacio."

Cambridge, Caius College 668*/645 (membr. early xiv), fol.150-173 /first two books assr. to 'mag. Adam de burely' in upper margin; third to 'Walterus de Burley'/

c) Expositio

Inc.: "Honorum honorabilium, etc. Sicut dicit Themistius primo huius, que sunt perfectiora..."
Expl.: "... Explicit expositio super libros de anima secundum mag. Walterum de Burley, doctorem preclarum."

London, Lambeth Pal. 74 (membr.1390), fol.33-109v
" Lambeth Pal. 143 (s.xv), fol.76-138
Oxford, Balliol College 92 (membr.xv), fol.1-198
" Oriel College 12 (membr.xv), fol.2-69v
" Magdalen College 146 (membr.xiv), fol.123-130 /imperfect/
Vatican, Ottoban.lat. 2165 (membr.xiv), fol.48v-63v
" Vat.lat. 2151 (membr.xiv), fol.1-88

33) Tractatus de potentiis anime

Inc.: "Ut dicit Philosophus 2° de anima, potenciarum anime quibusdam animatis..."
Expl.: "...appetitus sensitivus in irrascibilem et concupiscibilem. Explicit tractatus de potenciis anime compilatus ab eximio doctore mag. Gualtero Burleo."

Cambridge, Caius College 668*/645 (membr.xiv), fol.13v-18v /'notabilia'/
*Durham, Bibl.Cathed. V.II.5, (item 7; cat.p.146)
Florence, Laurenz. Plut.83,cod.28 (s.xv), fol.9-30
London, Lambeth Pal.70 (membr.xiv), fol.120r-124rb
" Lambeth Pal.74 (membr.1391), fol.190- /'notabilia'/
" BM, Royal 12 B. XIX (s.xv), fol.46-55v
Munich, Clm. 19680 (a.d.1376), fol.169-181
Naples, Bibl.Naz.lat. VIII.F.10 (a.d.1426), fol.80v-96
Oxford, All Souls College 88 (membr.1428), fol.87-95
" All Souls College 87 (a.d.1473), fol.228-236 /anima/
" Balliol College 93 (membr.xiv), fol.3-7 /until/
" Corpus Christi Coll. 293 (membr.xiv), fol.110-128
" Magdalen College 47 (membr.xv), fol.54v-67
" Magdalen College 146 (membr.xiv), fol.107-
" Bodl. Add. A.370 (s.xv), fol.177-190

Vatican, Vat.lat.901 (membr.xiv), fol.163-168v
" Vat.lat. 2146 (membr.xiv), fol.252v-256v
" Vat.lat. 2151 (s.xv), fol.252v-256v
Venice, S.Marco, lat.VI,160 (2816), (a.d.1443), fol.67-73
Worcester, Bibl.Cathed. F. 86 (s.xv), fol.1-8v

34) Expositio de sensu et sensato

Inc.: "Sciencia de anima in tres partes..."
Expl.: "... Explicit tractatus libri de sensu et sensato datus a mag. Waltero Burley."

London, Lambeth Pal.74 (membr.1390), fol.175-184vb
Oxford, Magdalen College 146 (membr.xiv), fol.95-99
" Oriel College 12 (membr.xv), fol.86v-97v

35) Expositio de memoria et reminiscentia

Inc.: "In prohemio huius libri qui durat ibi usque..."
Expl.: "...propter hoc de facili mittat eas, et in hoc terminat. Explicit exposicio mag. Walteri Burley de mem. et reminiscencia."

London, Lambeth Pal.74 (membr.1390), fol.185-189v
Oxford, Magdalen College 80 (membr.xiv), fol.63v-68
" Magdalen College 146 (membr.xiv), fol.112v-117

36) Expositio de somno et vigilia

Inc.: "Intencio philosophi in hoc libro..."
Expl.: "...et hic finis est libri quid dicitur liber de somno et vigilia secundum mag. Walterum de Burley."

London, Lambeth Pal.74 (membr.1390), fol.158-174
Oxford, All Souls 86 (membr.xiv), fol.212-222v
" Magdalen College 146 (membr.xiv), fol.83-95
" Oriel College (membr.xv), fol.69v-86v

37) Expositio de longitudine et brevitate vitae

Inc.: "Intencio Philosophi in hoc tractatu est determinare de causis longitudinis et brevitatis vite..."
Expl.: "...secundum speciem longitudinis vite in aliis viventibus. Explicit exposicio."

London, Lambeth Pal.74 (membr.1390), fol.152-158
Oxford, Magdalen Coll. 80 (membr.xiv), fol.180v-185
" Magdalen College 146 (membr.xiv), fol.117v-123
" Oriel College 12 (membr.xv), fol.109-115 [anon.]

38) Expositio de motu animalium

Inc.: "De motu autem, etc. Secundum Philosophum 3° Phys., volentem considerare de natura necesse est considerare de motu..."
Expl.: "...in uno tempore et non in alio. Postea recapitulant, ut patet. In hoc finitur liber. Explicit liber de motu animalium W. Burley."

London, Lambeth Pal.70 (membr.xiv), fol.144rb-147vb
" Lambeth Pal.74 (membr.1390), fol.30rb-32v /incomplete/
Oxford, Magdalen College 80 (membr.xiv), fol.177v-180v
" Oriel College 12 (membr.xv), fol.115-119 /anon. and incompl./

III. On Other Subjects

39) Expositio super Averrois De substantia orbis

Inc.: "Prohemium huius libri continet duas partes..."
Expl.: "...corporis celestis cum habitudine ad motorem primum. Explicit expositio de substancia orbis."

London, Lambeth Pal.74 (membr.1390), fol.1v-8 /anon./
Oxford, Oriel College 12 (membr.xv), fol.99-109 /anon./

40) Expositio et quaestiones super Metaphysicae Arist.

Inc.: "Incipit questio metaph. Liceat nobis parumper dissenere de quadam propositione quam dicit Arist. in veteri philosophia..."
Expl.: "...expresse significant oppositionem. Explicit questio super librum prime philosophie.

*Erfurt, Amplon. Q. 290 (s.xiv), fol.1-40v

41) Divisiones et sententiae summarie super Metaph.

Inc.: "Quoniam temporis interruptione..."
Expl.: "...inquantum substancia est."

*Erfurt, Amplon. Q. 290 (s.xiv), fol.46-56v

42) Tractatus de formis (contra Ockham)

Inc.: "Notandum quod materia prima est materia remotissima respectu cuiuscumque compositi ex ea..."
Expl.: "...que intencio non est directe cognita ab intellectu. Explicit tractatus burley de formis."

London, Lambeth Pal. 70 (membr.xiv), fol.125ra-134vb
Oxford, Bodl. Add. A.370 (s.xv), fol.143-166v
Vatican, Vat.lat. 2146 (membr.xiv), fol.235-244v
" Vat.lat. 2151 (membr.xv), fol.131-148

43) Quodlibet: De primo et ultimo instanti (Toulouse; before 1327)

Inc.: "Queritur utrum sit dare primum et ultimum instans rei permanentis sui esse..."
Expl.: "...est dare ultimum. Et sic patet quid dicendum sit de ista questione secundum burlecm."

Florence, Bibl.Naz. II, IV. 553 (a.d.1455), fol.65-67v
Oxford, Canon.Misc. 177 (a.d.1399), fol.11-14ra
" Canon.Misc. 506 (s.xv), fol.452-458
Paris, BN, lat. 16401 (s.xiv), fol.120-125v
" BN, lat. 16621 (notebook xiv), fol.238-240v
Rome, Casanatense 267 (s.xiv), fol.136-142v
Vatican, Vat.lat. 3066 (s.xiv), fol.52v-54
" Chis. E.V.161 (a.d.1401), fol.45-49v
" Ottoban.lat. 381 (s.xv), fol.34-36

Ed. Venice 1501

44) Commentarium in lib. Sententiarum (lost)

Inc.: "Cupiens aliquid, etc. In hoc pro[logo]..." [Bale]

45) Tractatus primus

Inc.: "In prima questione quarti Sentenciarum dixi quedam que aliquibus dubia et aliquibus sophistica videbantur. Ideo ad requisicionem..."
Expl.: "...et hec de questione ad presens sufficiat. Explicit tractatus de comparacione specierum."

*Bruge, de la Ville 501 (s.xv), fol.70-105
*Erfurt, Amplon. O. 76
London, BM, Harley 3243 (membr.xiv), fol.92-100 [anon.]
*Leipzig, Univ.Bibl. 529, fol.127-132
Rome, Casanatense 267 (s.xiv), fol.92-117v
Vatican, Vat.lat. 817 (membr.xiv), fol.203-223
" Vat.lat. 2148 (s.xv), fol.46-54vb
" Ottoban.lat. 318 (s.xv), fol.101r-105v
Venice, S.Marco, lat.VI,160 (2816), (a.d.1443), fol.48-96
Vienna, Dominikanerkloster 160/130 (membr.xiv), fol.83-89v

46) Questio disputata; utrum contradictio sit maxima oppositio

Inc.: "Questio est utrum contradictio sit maxima oppositio, et est quinta questio de numero questio burlei in suo primo tractatu. Et arguo primo ad partem quam credo fore veram, scilicet quod contradictio non sit maxima oppositio..."
Expl.: "...illa que in nullo conveniunt, quare etc."

Vatican, Vat.lat. 2148 (s.xiv-xv), fol.54-56.

47) Tractatus secundus

Inc.: "In hoc tractatu secundo intendo perscrutari de causa intrinseca susceptionis magis et minus..."
Expl.: "...veritati fidei christiane."

*Bruge, De la Ville, 501 (s.xv), fol.111-158v
Munich, Clm. 4377 (s.xv), fol.153v-160v
Reims, Cassanatense 267 (s.xiv), fol.61-86
Vatican, Vat.lat. 817 (membr.xiv), fol.227-257v
" Vat.lat. 2148 (s.xv), fol.57-70v
" Vat.lat. 2185 (membr.xiv), fol.21-23 [incompl.]
" Vat.lat. 3026 (s.xv), fol.1-14

Ed. Venice 1496, fol.2-15v

48) Expositio librorum Ethicorum

Inc.: "Etsi multorum scriptorum in disciplina morali commentatorum..."
Expl.: "...et ei qui dedit intelligere sint gracie iusticie. Amen."

Cambridge, Caius College 490/486 (membr.xiv), fol.75-265
" Peterhouse 93 (membr.xiv), fol.1-102v [first three books missing]
Florence, Laurenz. Pesul. 168 (membr.xiv), fol.169-230v
Oxford, Balliol Coll. 95 (membr.xv), fol.2-159 [mutil.]
" Canon.Misc. 251 (a.d.1424), fol.1-151
" Magdalen Coll. 205 (membr.xiv), fol.1-141
" New College 242 (membr.xiv), fol.2-168
" Oriel College 57 (membr.xiv), fol.1-208
*Paris, BN, lat. 6169 (membr. 1401)
Venice, S.Marco, lat.VI,88 (2530), (membr.xiv), fol.1-247

Ed. Venice 1481, 1500

49) Expositio super libros Politicorum

a) Questiones super Politica

Inc.: "Ut dicit philosophus Ethicorum quinto...in hoc libro primo sunt noven. Explicit prohemium. Amen. Prima questio est quid est servus..."
Expl.: "...sint gracie infinite. Amen."

Cambridge, Caius College 505/383 (membr.xiv), fol.1-101

b) Scriptum super libros Politicorum

Inc.: "Subiectum libri Politicorum est civitas in qua pro materia est multitudo hominum sufficiens ad omnia exercenda..."
Expl.: "...et per consequens facilius attingent ad felicitatem; et in hoc finitur intencio Aristotelis super totum quod translatum est de greco in latinum super librum Politicorum."

Cambridge, Univ.Lib. Ii.2.8. (membr.xiv), fol.1-69v
" Caius Coll. 490/486 (membr.xiv), fol.1-74r
" Peterhouse 93 (membr.xiv), fol.104r-166
Florence, Laurenz. Plut XII,min.cod.12 (membr.xiv), fol.2r-84r
" Laurenz. Conv.Soppr.455 (s.xiv-xv), fol.77-129va /incompl.; ends in lib.7/
Oxford, Balliol College 95 (membr.xv), fol.161-232
" Balliol College 282 (membr.xiv), fol.124r-202 /imperf./
" Magdalen Coll. 295 (membr.xiv), fol.141-202v
Vatican, Barberin 129 (membr.xiv), fol.1r-148v /with dedication to Clement VI/
Vienna, Dominikanerkloster 93/97 (s.xiv), fol.109-192

(For further MSS of Burley's commentary on the Politica see the D.Phil. Thesis of Conor Martin, 1949, and H.H. Thomson, "Walter Burley's Commentary on the Politics of Aristotle," Mélanges A.Pelzer, 1947, p.564).

50) De Vitis et Moribus Philosopharum

7. CAMPSALE, RICHARD DE

Biogr. Fellow of Balliol College in 1304 (Balliol Deeds (O.H.S.) 141, 285), but mentioned as Fellow of Merton College in 1305 (Mert.Rec.3630) and still in 1311 (Mert.Rec.5978). He was regent Master in Arts ("in artibus apud Oxoniam actualiter regens" Snappe's Formulary (O.H.S.), 66) on April 6, 1308; and on October 18, 1322 he is mentioned as "sacre theologie professor" (ibid., 71). He is last mentioned as the Chancellor's Commissary who absolved the Mayor of Oxford on January 10, 1326 from the censure of excommunication. (Mun. Acad. Oxon. (R.S.), I.114-6).

Works

1) Questiones date a Ricardo de Campsal super librum priorum Analeticorum (17 qq. on lib.I-II)

Inc.: "Quaeritur utrum sillogismus sit unus. Quod non, quia si..."

Cambridge, Caius College 668*/645 (membr.xiv), fol.76v-117

2) Logica valde utilis et realis contra Ockham

Inc.: "Domine Jesu, qui est terminus sive termino..."
Expl.: "...et non convertitur, sicut patet lex contrariorum."

*Bologna, Bibl.Univ. 2657 (s.xv), fol.1-99v [Fol.44-45 missing and cap.63 incompl.]

Cf. Synan, "Richard of Campsall, an English Theologian of the 14th century," Mediaeval Studies XIV (1952), 1-8; Texts (Mediaeval Studies), I, 183-252.

3) Questiones super tres libros Physicorum and Notabilitates breves super quosdam libros Physicorum

Mentioned in the ancient catalogue of the library of St.Augustine's Abbey, Canterbury, n.1423 (fol.105, col.2. n.6, items 12 and 13). See M.R.James, Ancient Libraries of Canterbury and Dover, pp.362-3.

4) Notabilia quedam mag. Ricardi Campsale pro materia de contingenti et presciencia Dei (= 16 propositiones)

London, BM, Harley 3243 (membr.xiv), fol.78v.

8. COLLINGHAM, WILLIAM DE

Biogr. Born in the diocese of York. Mentioned as a Fellow of Merton in 1331 (Mert.Reg.3666). But nominated a Fellow of Queen's College by the founder in 1341, and he was still at Queen's in 1348 (cf. Magrath, I. 334-8).

Works

1) Tractatus de infinito tam logice quam philosophie naturali utilis.

Inc.: "Utrum aliquid sit actualiter infinitum..."
Expl.: "...pars esset divisa a toto."

*Erfurt, Amplon. F. 135 (a.d. 1337), fol.48-59

(according to Schum this treatise is ascribed to both Buckingham and "Guilelmi Collingham")

2) Due questiones naturales colyngham

Inc.: "Sciendum quod dicit Aristotelos 3° Metaph. in textu suo..."
Expl.: "...non plus sequitur nisi quod aliquid corporeum et a seipso per accidens, et istius propositionis causa satis fuit superius declarata. Et sic finitur questio prima magistri Willelmi de Colingham Oxon."

Inc.: "Textus quem exponere intendo est textus Aristotelis...
Expl.:"...et sic patet quod argumentum factum in contrarium non procedit. Et sic finis est questionis Collingham exposicione 5a p'p' phisicorum."

Paris, BN, lat. 6559 (membr.xiv), fol.133-190v

Mentioned in the catalogue of the ancient library of the Austin Friars in York, n.306 F (cf. M.R.James, "The Catalogue of the Library of the Augustinian Friars at York," Fasciculus Ioanni Willis Clark Dicatus, Cantabrigiae 1909, p.48).

9. DUMBLETON, JOHN

Biogr. Dumbleton was born about 1310 in Gloucestershire within the diocese of Worcester. He is noted as a Fellow of Merton College in 1338 (Mert.Reg. 3673) and still mentioned in 1347-8 (Mert.Reg. 3680). He was named as a Fellow of Queen's College in the founder's statutes of February 10, 1340, at which time Dumbleton must have completed his necessary regency and begun the study of theology. But he is again noted as a Fellow of Merton in 1344-45 (Mert.Reg. 3676-7). He seems to have been a Bachelor of Theology at the time of his presumed death in 1349.

Works

1) Summa logicae et philosophiae naturalis

Inc.prol.: "Plurimorum scribencium grati laboris..."
Inc. P.I: "Incipiendum est a primis cum minimus error in principio in fine maxime est causa..."
Expl.P.IX (incompl.): "...procul respicit et a longe."

Cambridge, Gains College 499/268 (membr.xiv), fol.1-162v
" Peterhouse 272 (membr.xiv), fol.1-111 (ends imperfectly in P.II, c.46)
*Dubrovnik-Ragusa (Jugoslavia), Dominikanerbibliothek 32 (s.xv), fol.89-200 (Cf. Starine (Jugoslavenska Akademija Znanosti i Umjetnosti), 28 (Zagreb 1896), p.4)
London, BM, Royal 10 B. XIV (membr.xiv), fol.1-244
" Lambeth Palace 79 (membr.xiv), fol.1-212
Munich, Clm 4377 (s.xv), fol.161-195v [frag.: section of P.II-III]
Oxford, Magdalen 32 (membr.xiv), fol.1-292
" Magdalen 195 (membr.xiv), fol.1-131
" Merton 272 (membr.xiv), fol.4-179v [ends imperf. in P.VIII, c.4]
" Merton 306 (membr.xiv), fol.9-118 [mutil. end of P.IX]
Padua, Bibl.Antoniana, XVII, 375 (paper xiv-xv), fol.1-205
Paris, BN lat. 16146 (membr.xiv English), fol.2-141ra
" BN lat. 16621 (paper xiv), fol.117v-123v; fol.169-180v [frag. from P.III]
" Universitaire 599 (membr.xiv English), fol.1-193 [mutil. at end of P.IX]
*Prague, Capit.Metropol. 1291 (L.XLVII)
Vatican, Vat.lat.954 (paper xv), fol.1-201 [exer. to Ockham]
" Vat.lat.6750 (membr.xiv), fol.1-202
" Pal.lat.1056 (paper xiv), fol.1-144 [ends in P.VIII]
Venice, S.Marco lat.VI, 79 (2552), (membr.xiv), fol.1-229 (fol.230-232v = tabula librorum)
Worcester, Bibl.Cathed. F.6 (membr.xiv), fol.1-165
" Bibl.Cathed. F. 195 (membr.xiv), fol.91-126v (ends in P.III, c.8)

2) Expositio capituli quarti Bradwardini De proportionibus

Inc.: "In hoc compendio intellectum sex conclusionum quarti capituli tractatus proportionum mag. Thome Bradwardin intendo brevissime declarare..."
Expl.: "...ad proportionem superficierum suarum eodem ordine est sexquialtera, igitur etc. Explicit Dumumlton."

Paris, BN. Nouv.Acq.lat. 625 (membr.xiv), fol.70v-71v

Doubtful

1) Liber de insolubilibus, de significatione et suppositione terminorum, de arte obligatoria, etc.

Inc.: "De sophismatibus que non re sed nomine insolubilia extant, supereest pertractare..."
Expl.: "... Explicium tractatus de diversis insolubilibus, et de significatione et suppositione terminorum, et confusione et distributione eorunden, et de modis signis universalibus et de arte obligatoria cum eam aliis incidentibus."

Oxford, Merton College 306 (membr.xiv), fol.1-7v

10. ESTRY, WILLIAM DE

Biogr. Fellow of Merton in 1305. He seems to have retained his Fellowship until 1315, when he became Rector of Stowting, Kent.

Works (lost)

1) Lectura magistri W. de Estry super libros phisicorum

Mentioned in the ancient catalogue of the library of St.Augustine's Abbey, Canterbury, n.1423, (fol.105, col.2. n.6, item 14). See M.R.James, Ancient Libraries of Canterbury and Dover, pp.362-3.

11. HENNOR, WILLIAM DE

Biogr. Bachelor Fellow of Merton College in 1299 and Fellow by 1301. He is still mentioned in the records for 1305.

Works (lost)

1) Lectura brevis magistri W. de hennor' super 9^{m} a^{m} et 14^{m} metaphisice

Mentioned in the ancient catalogue of the library of St.Augustine's Abbey, Canterbury, n.1423, (fol.105, col.2. n.6, item 16). See M.R.James, Ancient Libraries of Canterbury and Dover, pp.362-3.

12. HEYTESBURY, WILLIAM

Biogr. Born before 1313, probably in Wiltshire in the Salisbury diocese. He is first mentioned as a Fellow of Merton College in 1330 (Mert.Rec. 3660). In February 1340 he was named one of the foundation Fellows of Queen's College together with Dumbleton. But shortly he returned to Merton. He was a "Doctor in Theology" by July 1348 (Mun.Acad.Oxon.,I,167). Heytesbury may have been Chancellor of the University from 1353 until 1354, and again from Pentecost 1370 until Pentecost 1372. He died in December of 1372 or in January of 1373.

Works

1) Insolubilia

a) Inc.: "Iam sequuntur regule de insolubilibus, et primo videndum est quid sit casus..."
Expl.: "...affirmative respondens."

*Erfurt, Amplon. Q. 270 (membr.xiv), fol.37-42v
Vatican, Vat.lat. 3065 (s.xv), fol.28-30v [anon., "secundum unum hentsenic"]

b) Inc.: "Insolubile est propositio affirmativa vel negativa aliqualiter esse vel aliqualiter non esse significativa..."
Expl.: "...sic dicendum est ad omnia consimilia. Explicunt insolubilia valde utilia secundum hetysbery."

Padua, Bibl.Univ. 1123 (membr.xiv), fol.22vb-24rb

2) Tractatus consequentiarum

Inc.: "Iuxta hunc textum tantum in libro Perihermenias de quolibet dicitur affirmacio vel negacio. Ideo quero hanc questionem, utrum aliqua sit consequentia bona et formalis que de se non valet..."
Expl.: "...quia totum antecedens includit contradictionem sicut antecedens, etc. Explicit tractatus 'Iuxta hunc textum' nuncupatur."

Cambridge, Caius College 182/215 (s.xv), page 102-116. [expl.: "...qui sunt quam pro omnibus qui erunt."]
" Corpus Christi College 244 (245), (membr.xv), fol.39v-58v [expl.: "...ad inquidem."]
" Corpus Christi College 378 (s.xv), fol.82-84v [incomplete]
Padua, Bibl.Univ. 1123 (membr.xiv), fol.24rb-28vb [anon.]
Rome, Casanatense 85 (a.d.1410), fol.13va-22rb ["Explicit tractatus qui vocatur iuxta hunc textum correctus secundum mag. robertum Alyngton."]

Vatican, Vat.lat. 3065 (s.xv), fol.76ra-83va [expl.: "... satis evidenter sequitur antecedens esse verum, et consequens falsum, quapropter non valet consequencia, ergo etc."]
Venice, S.Marco, Z.lat.277 (1728), (a.1399), fol.23-33

Ed. Venice 1517, fol.108v-115v

3) De propositionibus multiplicibus

Inc.: "Qui autem nominum virtutis sunt ignari et ipsi disputantes et alios audientes paralogizant de facili, primo elencorum. Cum igitur in disputacione cuiuslibet de vocali significante debeat..."
Expl.: "... Unde et de propositionibus multiplicium significacionibus iam hec dicta ad presens pro inventibus informandis sufficiant. Amen. Explicit tractatus Hantisberi de propositionum multiplicium significacione valde raro inventus."

Venice, S.Marco, lat.VI,160 (2816), (a.d.1443), fol.252-253v

4) De veritate et falsitate propositionis

Inc.: "Omnis propositio est vera vel falsa..."

Ed. Venice 1494, fol.183v-188

5) Casus obligatorii

Inc.: "Primo ponitur talis casus quod heri videmus: Sortes et nullus alius a Sorte videmus et bene... Secundo ponitur talis casus quod inter duo..."
Expl.: "... Explicium casus obligatorii habeas."

Oxford, Canon.Lat. 278 (s.xiv), fol.70-72
Venice, S.Marco, Z.lat. 310 (1577), (s.xv), fol.96va-b

6) De sensu composito et diviso

Inc.: "Arguendo a sensu composito ad sensum divisum frequenter fallit argumentum, unde non sequitur..."

*Copenhagen, Thott 581 (s.xv), fol.119-127
Florence, Naz.Cent., Magl.V.43 (numbr.xiv-xv), fol.[illegible]-44v
Oxford, Canon.Misc. 219 (a.d. 1395), fol.4-6
Rome, Casanatense 85 (s.xv), fol.8-12v
Vatican, Vat.lat. 2136 (s.xiv), fol.32v-36
" Vat.lat. 2139 (s.xiv), fol.153v-179v [with comm.]
" Vat.lat. 2154 (s.xiv-xv), fol.43-67 [with comm.]

Vaticanus, Vat.lat. 2189 (s.xv), fol.39v-50 [with comm.]
" Vat.lat. 3038 (s.xv), fol.15-22
" Vat.lat. 3065 (s.xv), fol.30vb-34vb ["Explicinunt consequencie compilate a venerabili artium doc. mag. Rodulfo Strode"]
Venice, S.Marco, Z.lat. 277 (1728), (membr.xiv), fol.12-16
" S.Marco, Λ.lat. 310 (1577), (s.xv), fol.49-53

Ed. Venice 1494, fol.2-4

7) Sophismata XXXII

a) Inc.: "Omnis homo est omnis homo..."
Expl.: "...set uterque modus loquendi est impossibilis de vi vocis."

Cambridge, Peterhouse 102 (membr.xiv), fol.141-218 [ends imperfectly]
*Erfurt, Amplon. Q. 332 (membr.xiv), fol.3-100v [first sophisma lacking]
Oxford, Trinity College 138 (s.xiv-xv), fol.1-176
" Ganon.lat. 311 (membr.xv), fol.9-28v, 37-38, 29 [anon.; attr. to Thomas Walleys or Herveι in Catalogue]
" Canon.Misc. 203 (s.xv), fol.75-99 [selected sophismata with comm.]
Padua, Bibl.Univ. 1123 (membr.xiv), fol.97-172v
Paris, BN, lat. 16134 (membr.xiv), fol.81-146
Vaticanus, Vat.lat. 2137 (s.xiv), fol.1-78v [24 sophismata]
" Vat.lat. 2138 (membr.xiv), fol.1-86
Venice, S.Marco, Z.lat. 310 (1577), (s.xv), fol.54-78v ["Sex sophismata principalia edita et compilata per mag. Guillelmum Hentisberum..."]

rectius St. John's

Ed. Venice 1494, fol.77v-170v [with comm. of Gaetanus di Thiene]

b) Epitome Summe Sophismatum Guilelmi Hentisberi completum anno domini M°CCC° octogesimo octavo in nostro collegio de Mertone

Inc.: "Adspicientes a longe condicionem invenum elegancium suis ingeniis tanquam visibus aquilinis..."

Vaticanus, Vat.lat. 3056 (s.xiv), fols.1-41
Venice, Conv. S.Giovanni e Paolo, cod.539 (paper xv), fol.1-69 ["Explicunt Sophismata magistri Wilhelmi Hentisberi, scriptum Cxunii anno Domini MCCCLXXXXIX post quartum sextum noctis Dominice prime quadragesime per fr. Thomam Utinensem Ord. pred."]
This codex is now lost, but described by D.M. Berardelli, Codicum auctum Latinorum et Italicorum qui manuscripti in Bibliotheca SS. Joannis et Pauli Venetiarum apud PP. Praedicatores asservantur

Catalogus. Nuova Raccolta d'Opuscoli scientifici e filologici, t.38, Venezia 1783, opusc.II, p.149.

8) Regulae solvendi sophismata (a.d. 1335)

Inc.:prol.: "Regulas solvendi sophismata non ea que quidem apparenti contradictione..."
Inc.cap.1: "Secundum Philosophum in Predicamentis, cap.4°, quadratura circuli si est scibilis..."
Inc.cap.2: "Scire multis modis dicitur, sed sive..."
Inc.cap.3: "In terminis relativis sophismata multa..."
Inc.cap.4: "Incipit dupliciter solet exponi..."
Inc.cap.5: "Circa finem seu terminum tam active potentie..."
Inc.cap.6: "Tria sunt predicamenta vel genera quorum..."

Erfurt, Amplon. F. 135 (a.d.1337), fol.1-17 [cm. prol.]
* " Amplon. F.313 (s.xiv), fol.192-209 [exc. c.6]
* " Amplon. Q.270 (s.xiv), fol.1-36v [cap.2-5]
Munich, Clm 23530 (s.xv), fol.222v-255 [prol. and cap.1 omitted; cap.5 entitled: "Incipit tractatus de potentia activa et passiva, et de latitudine intensiva in motu"]
Oxford, Canon.Misc. 221, (s.xv), fol.60-85
Padua, Antoniana, XIX, 407 (s.xv), fol.26-30v [prol. and cap.1]
" Bibl.Univ. 1123 (membr.xiv), fol.50rb-65v [cap.2,4,5 and 6]
Vatican, Vat.lat. 2136 (s.xiv), fol.1-32
" Vat.lat. 2138 (s.xiv), fol.89-109v
" Vat.lat. 2130 (s.xv), fol.173-177 [cap.5 with comm.]
" Vat.lat. 3058 (s.xv), fol.122-139 [cap.6 with comm. of Thomas of Udine O.P.]
" Chigi E.V.161 (a.1401), fol.63v-70v [cap.2]
" Ottoben. lat. 662 (membr.xiv), fol.121-127v [cap.5]
Venice, S.Marco, Z.lat.310 (1577), (s.xv), fol.1-3v [prol. and cap.1]
" S.Marco, Z.lat. 277 (1728), (a.d.1399), fol.17-22 [cap.5 with comm.]
" S.Marco, lat.VI,160 (2816), (a.d.1443), fol.255-275 [cap.6 with comm.]

Ed. Venice 1494, fol.9v-52

9) De probationibus conclusionum

Inc.cap.1: "A est scitum a te et idem A est tibi dubium..."
Inc.cap.2: "Infinite sunt partes Sortis..."
Inc.cap.3: "Una propositio que non est plures..."
Inc.cap.4: "Quod non sit dare maximum quod Sortes..."
Inc.cap.5: "Aliquis est motus uniformis quoad tempus..."

Florence, Laurenz. Ashb. 171 (a.d.1440), fol.13-31ra
Oxford, Canon.Misc. 376 (s.xv), fol.23-32 [frag.]
Vatican, Vat.lat. 2189 (s.xv), fol.13v-38
Venice, S.Marco, Z.lat. 277 (1728), (a.1399), fol.34-39v [anon.; cap.1 only]
" S.Marco, Z.lat. 277 (1728), (a.1399), fol.40-45 [cap.2-3 with comm.]
" S.Marco, lat.VIII,38 (3383), (a.d.1391), fol.40-54v

Ed. Venice 1494, fol.188v-203v

10) **Termini Naturales**

Inc.: "Natura est principium motus et quietis in quo est primo per se et non secundum accidens. Istam diffinicionem ponit Philosophus et Commentator in 2° Phys..."
Expl.: "...cuiusmodi est tabula. Hec complecio terminorum philosophie compilata a mag. Wilhelmo Heshri."

Florence, Laurenz. Plut.83, cod.28 (s.xv), fol.1-7v
London, BM, Royal 8 Z. XVIII (membr.xiv), fol.69v-75 [anon.]
Munich, Clm. 5961 (a.d.1441), fol.22-26 ["Explicium termini naturales sec. usum Oxonii"]
" Clm. 8997 (s.xiv), fol.163-167 ["compilata a mag. Wilhelmo Heshri"]
Naples, Bibl.Nas. VIII.F.10, (a.d.1425), fol.107-114 [anon.]
Oxford, Canon.Misc. 393 (a.d.1402 Padue), fol.78-83 [anon.]
" New College 289, (s.xv), fol.38-50v [with comm. of John Garisdale]
Padua, Bibl.Univ. 1125 (membr.xiv), fol.36vb-39rb [anon.]
Paris, BN, lat. 6673 (s.xv), fol.14-18 [anon.]
Vatican, Vat.lat. 5132 (s.xv), fol.41-45v [anon.]
Vienna, Dominikanerkloster 93/57 (s.xiv), fol.99-109v [anon.]
" Nat.Bibl.lat. 4698 (s.xiv), fol.114v-120v
Worcester, Bibl.Cathed. F. 118 (s.xv), fol.32rb-35rb

13. MALVITH, JOHN

Biogr. Born in the diocese of Worcester, he is mentioned as a Fellow of Merton College in 1309. (Mert.Reg.3636). This Fellowship he seems to have vacated in 1319, but he was granted licence for further study on October 4, 1319 and October 4, 1320 (Reg. Cobham, Worc., Worces.Hist.Soc.,254, 256, 260). He was a member of the 'familia' of Richard de Bury, and was appointed dean of Auckland, Durham, in 1343, a few years before De Bury's death.

Works

1) Tabulae Mathematicae (a.d.1310)

Inc.: "Quia scientia astronomie sine debitis..."

Tab. prima: De chorda, et arcu recto et verso, umbris, etc.
Tab. secunda: De arcu equinoctiali elevato, et horis etc.
Tab. tertia: De altitudine stellarum, et arcu diurno stelle, et distancia ab equinoctio.
Tab. quarta: De ascensionibus regionis tue

Oxford, Laud. Misc. 674 (SC 504), (membr.xiv) fol.67-73

2) De doctrina theologica (Tanner)

Inc.: "Legimus in Scripturis Sacris..."

14. REDE, WILLIAM

Biogr. Born in the diocese of Exeter, he was reared by Master Nicholas of Sandwich (cf. Powicke, Medieval Books...,90). He is listed as a Fellow of Merton College in 1344 (Mert.Reg.3676) and still in 1357 (Mert.Reg.4148). He was appointed Bishop of Chichester on October 11, 1368 and consecrated at Avignon on September 2, 1369. He died on August 18, 1385. (Will published by F.M.Powicke, The Med. Books..., 87-92).

Works

1) Tabulae astronomicae (or Canones Tabularum)

Oxford, Bodl. 432 (SC 2589), (a.d.1460), fol.28-35
" Wood D. 8 (SC 8538), (s.xv), fol.48v-
" Jesus College 46 (membr.xiv), fol.1-42 /Iste liber constat Willelmo Rede/

15. SEGRAVE, WALTER DE

Biogr. Fellow of Merton College in 1321 (Mert.Reg.3621) and still in 1357 (Mert.Reg.4147b). Elected dean of Chichester May 17, 1342 (Cal.Pap.Let., III,209, 211, 254), and Chancellor of Richard de Bury in 1340 (Reg.Palat. Dunelm., (R.S.), III, 426). He seems to have died by June 1349.

Works

1) De insolubilibus

Inc.: "Sicut vult Philosophus 2° Metaphisice, non solum debemus..."
Expl.: "...tamen intelligitur in illo generali."

Erfurt, Amplon. Q. 276 (a.d.1295-1333), fol.159-162 /Explicit insol. mag. Walteri (erasure) de Anglia./
" Amplon. O. 76 (membr.xiv), fol.21v-34 /"... mag. Walterii de Sex Greve de Anglia"/
Oxford, Canon.Misc. 219 (SC 1395), fol.1-3v /beginning missing/ "...expliciunt insolubilia mag. gualterii de segreve cuius anima requiescat in pace"/

16. SUTTON, WILLIAM DE

Biogr. Fellow of Merton College from 1330 (Mert.Rec.3417) until 1346 (Mert.Rec.4141). Vicar of St.Peter's in the East, Oxford, from February 1, 1346, until his death. Seems to have died by December 1349.

Works

1) De suppositionibus

Inc.: "Ut iuvenes habeant faciliorem cognicionem in suppositionibus terminorum, breves regule atque generales sunt ponende. Primo videndum est quid sit suppositio quantum ad eius esse, et quomodo..."
Expl.: "...et iste stat mobiliter. Explicit textus de suppositionibus."

Munich, Clm. 4379 (s.xiv), fol.198
" Clm. 4384 (a.d.1340), fol.123v-131v [with comm. "suppositiones edite a magno cetu philosopharum in anglia"]
Vienna, Dominikanerkloster 160/130 (membr.xiv), fol.123ra-zb
" Dominikanerkloster 160/130 (membr.xiv), fol.96-100v [13 sophismata curialia on the text]

2) De consequentiis

Inc.: "Quia in sophismatibus probandis et improbandis utimur consequentiis, que...
Expl.: "...ne igitur prolixitas animi reportantium perturbet esse finis. Explicit textus de consequentiis."

Vienna, Dominikanerkloster 160/130 (membr.xiv), fol.123-124
" Dominikanerkloster 160/130 (membr.xiv), fol.100v-109v ["scriptum Sutonis Anglici" with commentary]

17. SWINESHEAD, RICHARD

Biogr. Earliest mention of 'Richard' Swineshead as a Fellow of Merton College is in 1344-45 (Mert.Reg. 3676), and he is still listed in 1355. Together with Richard Billingham and others, he was a supporter of Mag. John Wylyot in his election to the Chancellorship in 1349 (Cal. of Close Rolls, Edw.III, 1349-1354, p.74). He was ordained deacon to the title of Fellowship on March 29, 1354. It would seem that Richard must be distinguished from Roger, who later became a Benedictine, and John, a Fellow of Merton College, who distinguished himself in Civil and Canon Law.

Works

1) Calculationes

Ino.: "Penes quid habent intensio et remissio qualitatis attendi plures sunt posiciones. Pro quo tamen primo est notandum quod intensio potest dupliciter..."
Expl.: "...ad puncta intrinseca quam ad extremum remissius; patet ergo prima pars conclusionis, etc."

Cambridge, Caius College 499/268 (membr.xiv), fol.165-203v
*Erfurt, Amplon. Q. 78 (a 1396), fol.1-36v [attr. to "Glymiten"]
Paris, BN, lat. 6558 (membr.xiv), fol.1-70va ["Richardi de Glymi Anhedi"]
" BN, lat. 16621 (s.xiv notebook), [fragments]
*Pavia, Aldini 314
*Perugia 1062
*Rome, Angelica 1963
* " Vittorio Emmanuele 250
Vatican, Vat.lat. 3095 (s.xv), fol.1-118v ["Ricardi suisset Anglici"]
* " Vat.lat. 3064
" Chigi E. IV. 120 (s.xv), fol.1-112v ["magistro Ricardo de Swynisheede"]
Venice, S.Marco, lat.VI,226 (2565), (s.xv), fol.
Worcester, Bibl.Cathedr. F. 35 (s.xv), fol.27-65rb, 70ra-75v [frag.]

Ed. Padua 1477, 1480, Pavia 1483, Venice 1505, 1520

2) Tractatus de motu locali

Ino.: "Multe possunt alicui conclusiones sive regule super variationem proporcionum et motu ex variatione potencie motive ad suam resistenciam, et econtra. Et quia omnis variatio potencie motive seu resistive vel est uniformis vel difformis..."
Expl.: "...hic inde motum alteracionis et quomodocumque variata fuerit ipsa proporcio, ita et velocitas; ideo etc. Et sucp finis. Explicit tractatus de Swineshede de motu locali."

Cambridge, Caius College 499/268 (membr.xiv), fol.213rb-215vb
*Seville, Colombina 7-7-29 (s.xv), fol.29ra-33rb

3) Tractatus de intensione et remissione formarum (6 cap.)

Inc.: "In primo de celo Philosophus comm.35 arguit corpus infinitum circumvolvi non posse; ad cuius probacionem capit quod sicut..."
Expl.: "... Cum igitur aer ante B, totam latitudinem deperdet quantam ipsa aqua, scilicet 3 illius latitudinis. Explicit tractatus de Swynshede."

Cambridge, Caius College 400/268 (membr.xiv), fol.204-211v
Worcester, Bibl.Cathed. F.35 (s.xv), fol.65va-69vb

Doubtful

1) Questiones quatuor super Physicas magistri Ricardi

Inc.: "Utrum in omni motu potencia motoris excedit potenciam rei motae. Et probo quod non, quia tunc vel esset..."
Inc.q.2: "Utrum qualitas suscipit magis et minus...
Inc.q.3: "Utrum aliquod corpus simplex possit moveri eque velociter in vacuo et in pleno..."
Inc.q.4: "Utrum omne transmutatum in transmutacionis inicio sit in ee, ad quod primitus transmutatur..."
Expl.: "...in tractatu suo de coloribus, ponendo tamen quod albedo sit lux et opatitiis /sic/ admixti; respondetur per dicta in alia questione, etc.

Vatican, Vat.lat. 2148, fol.71-75, fol.76 /frag. of qq.1-2/
" Vat.lat. 4429, fol.64-70v /quest.2/
Venice, S.Marco, lat.VI, 72 (2810), (s.xv), fol.81-112
" S.Marco, lat.VI, 72 (2810), (s.xv), fol.168-169v /quest.4/

18. TEWKESBURY

Biogr. A certain Tewkysbury is mentioned as a Merton College Fellow in 1340-1 (Mert.Rec. 3673; cf. Mert.Mun. (O.H.S.), 37). It is not certain whether this is the same as "Johannes Teukesbury" mentioned by Tanner (Bibl.Brit.-Hib., 706)

Works (doubtful)

1) Sophisma de alteratione

Inc.: "Uniformiter continue variari..." [Bale]

It is not certain whether the work seen by Bale is identical with:

a) "Uniformiter continue variabitur alteracio uniformis. Ad quod sophisma arguitur sic..."

Venice, S.Marco, lat.VIII, 19 (3267), (s.xv), fol.193-211

b) "Uniformiter continue variatur alteracio uniformis..."

Paris, BN. lat. 16621 (s.xiv), fol.124-130

APPENDIX II

TEXTUS INEDITI SELECTI

Gualteri Burley

Epistola Dedicatoria ad Univ. Paris.

Omnium librorum Physicorum

Oxford, All Souls College
MS 86, fol.1r

Carissimis amicis suis et dominis magistris et scolaribus Parisiis in philosophia studentibus, Walterus de Burley, Anglicus, vestre Universitatis alumpnus, Salutem, et si quid desiderabilius est, Salute.

Per Reverendum in Christo Patrem et dominum meum Dominum Richardum, Dunelmensis sedis episcopum, augmentacionibus sciencie ferventissimum zelatorem, bene advertentem quod sciencia non adquiritur postericeribus perfecte nisi per priorum studium et laborem, qui propter hoc singulis magistris et doctoribus cuiuscumque facultatis clericis suis precipit quod studeant in hiis que melius noverunt, meliora et utilioria que conceperint in scriptis redigant; ac omnia utilia ab antiquis tradita, quorum copia poterit inveniri, facit de novo scribi futuris studentibus relinquenda, rogatus sum, et ego inter ceteros minimus clericos eius, ut qui dudum modo meo textus logicales Aristotelis exposueram, apparatum iam facerem super textus sciencie naturalis eiusdem, set ad votum Domini mei complendum, timidus efficior et perplexus. Nam, cum michi iam advesperaseit et accelerem ad vite transeuntis occasum, ac ingenium in me senectutis incommodo sit obtusum, durum michi videtur, ut qui quondam iuvenis scripseram super sex libros Physicorum, super duos reliquos scribam iam senex; set longe durius tanti Patris precibus, immo verius imperio, contraire. Preces

1. Parisiis: parisius cod.
5. Dunelmensis: Donolmensem cod.
12. clericos: clericis cod.

namque sue apud me obtinet viam precepti, iuxta illud "est orare ducum species violenta iubendi". Propter quod, etsi talentum sciencie non habeam, set minutum, hoc tamen in gazophilacium mittere me oportet, non obstante quod pertimescam subsannacionis et invidie quibusdam materiam ministrare. De quibus quidam sapiens attestatur, quod "eo securius aliena subsannant, quo sua consimili periculo non exponunt". Horum igitur occasione nullatenus prima peditus incepti quondam operis principium et medium vobis mitto cum fine. Eundem modum et ordinem observando in septimo et octavo quos tenui in sex libris Physicorum supradictis, et etiam in expositione libri Ethicorum quam nuper ad preceptum dicti Patris aliter qualiter compilavi, excepto ergo, ut sciatur facilius que pars et particula sint declarativa innumerando conclusiones principales a conclusionibus annexis, quod in aliis operibus non solebam, discrecioni vestre supplicans, quantum possum, quod si quid inprovide vel erronee scripserim, velitis parcere michi seni, sex librorum defectum assignantes iuventutis ignorancie et residuorum insufficienciam vel excessus decipientis senis scribentis ingenio iam obtuso. Et si quid reperiatur in hoc opere bene dictum, non michi, set principaliter Deo qui dedit intelligere, deinde Domino meo predicto, qui me ad laborem istum, qui de gravi sompno exsitavit, totaliter ascribatis.

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20. obtinet: optinet cod.
22. gazophilacium: gazofilactum cod.
31. declarativa: declarative cod.
32. solebam: solvebam cod.
35. scribentis: scribentes cod.

Gualteri Burley

Epistola Dedicatoria ad Univ. Paris.

Lib. VII-VIII Physicorum

Oxford, All Souls Coll.
MS 86, fol.159v

Carissimis amicis suis et dominis magistris et scolaribus Parisiis in philosophia studentibus, Walterus de Burley, Anglicus, vestre Universitatis alumpnus, salutem, et si quid desiderabilius est.

Rogatus per Reverendum in Christo Patrem ac Dominum meum Dominum Richardum, Dunelmensis sedis episcopum, augmentacionibus sciencie ferventissimum zelatorem, bene advertentem quod scienoia non adquiritur posterioribus perfecte, nisi per priorum studium et laborem, qui propter hoc singulis magistris et doctoribus cuiuscumque facultatis clericis suis precipit quod studeant in hiis que melius noverunt, meliora et utiliora que conceperint in scriptis redigant, ac omnia utilia ab antiquis tradita, quorum copia poterit inveniri, facit de novo scribi futuris studentibus relinquenda, ut cum dudum Parisiis studens sex primos libros Physicorum Aristotelis exposuerim, complere super duos libros residuos opus illud, factus sum timidus et perplexus. Nam cum michi iam advesperaseit et accelerem ad vite transeuntis occasum, et ingenium in me senectutis incommodo sit obtusum, durum michi videtur super hiis plus scribere, set

1. Parisiis: Parisius cod.
5. augmentacionibus: augmentacionis cod.
7. priorum: priorem cod.
9. utiliora: utilia cod.
12. Parisiis: Parisius cod.

longe durius tanti Patris precibus, immo verius imperio, contraire. Preces namque sue obtinent vim precepti iurta illud, "est orare ducum species violenta iubendi". Propter quod, etsi talentum scientie non habeam, set minutum, hoc tamen in gazophilacium mittere me oportet, non obstante quod pertimescam subsannacionis et invidie materiam ministrare, quia, ut quidam sapiens enunciat, "eo securius aliena subsannat quo sua simili periculo non exponit". Septimum igitur et octavum Physicorum exponere sic disposui, tenendo modum et ordinem quos tenui in sex libris supra dictis et in exposicione Ethicorum quam nuper ad preceptum dicti Patris venerabilis compilavi, excepto quod, ut sciatur facilius que pars et particula sunt declarativa, numerando conclusiones dictorum duorum librorum, distinguo conclusiones principales a conclusionibus annexis, quos in aliis operibus non solebam.

Discrecioni vestre supplico quantum possim. Si quid inprovide vel erronie scripserim, velitis parcere michi seni. Et si quid reperiatur in hoc opere bene dictum, non michi, set principaliter Deo qui dedit intelligere, deinde Domino meo predicto, qui me ad istum laborem, qui de sompno gravi excitavit, totaliter ascribatis.

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18. obtinent: optinent cod.
20. gazophilacium: gazephalactum cod.
24. disposui: disposita cod.
25. quem: qua cod.
30. Discrecioni: Discrecione cod.

Anonymi

Tractatus De Proportionibus

Abbreviatus ex tractatu De proportione velocitatum in motibus
mag. Thomas Bradwardine

S I G L A

London, Brit.Mus. MS Royal 8 A. XVIII, fol.75-80v. . . . . R

Vienna edition 1515, fol.17v-27 V

Tractatus de Prop. vel. in motibus of Bradwardine . . . . T

NOTE: The text here presented is basically that contained in MS Royal 8 A. XVIII. (the whole of this text is found on the following pages, either in the final version or noted in the apparatus. The text of the Vienna edition is utilized only where necessary, and mention of it is made in the apparatus only where the variant reading is significant

Anonymi

Tractatus Brevis Proportionum

abbreviatus ex libro de proportionibus D. thome Bragwardini Anglici.

75r

Omnis proportio aut est communiter dicta vel proprie dicta. Proportio communiter dicta est duarum rerum comparatarum adinvicem habitudo. Proportio proprie dicta est duarum rerum ejusdem generis adinvicem habitudo sive comparatio. Proportio proprie dicta dicitur duobus modis, scil. rationalis et irrationalis. Rationalis est illa que immediate denominatur ab aliquo certo numero, ut dupla a duobus, tripla a tribus. Irrationalis est illa que non immediate denominatur ab aliquo certo numero, ut medietas proportionis duple. Quantitates communicantes, commensurales seu rationales sunt quibus est una mensura communis quamlibet illarum precise mensurans, sicut tripedale et bipedale, quarum utrumque pedale mensurat. Quantitates non communicantes seu irrationales vel incommensurales sunt quibus non est una mensura communis quamlibet illarum precise mensurans, ut diameter et costa quadrati. Diameter est una linea protracta ab uno angulo ad angulum sibi oppositum. Quadratum est una figura cuius omnes coste habent equales.

Quedam est proportio equalitatis et quedam inequalitatis. Proportio equalitatis est quando sunt duo equalia comparata adinvicem, ut 4 ad 4. Proportio inequalitatis est quando duo inequalia comparantur adinvicem, ut 4 ad 2 et econtra. Et ista dicitur duobus modis, quia quedam est proportio maioris inequalitatis, et quedam minoris inequalitatis.

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12. mensura communis : mensura R, ratio communis V
14. oppositum. : Unde add.R
15. figura : mensura R

Proportio maioris inequalitatis est quando maius comparatur ad minus, ut 4 ad 2. Proportio minoris inequalitatis est quando minus comparatur ad maius, ut 2 ad 4. Proportio maioris inequalitatis dicitur quinque modis, vis. multiplex, superparticularis, superpartiens, multiplex superparticularis, et multiplex superpartiens. Multiplex vero proportio /fol.75v/ est habitudo maioris quantitatis ad minorem illam multotiens continentis, ut 6 ad 2. Superparticularis est quando maius semel continet minus et aliquam partem aliquotam ejus ultra, ut 3 ad 2. Pars aliquota est que aliquotiens sumpta reddit equaliter totum, ut 2 ad 6. Pars non aliquota est illa que multotiens sumpta non reddit totum precise, ut 3 ad 5. Proportio superpartiens est quando maius semel continet minus et aliquas partes ultra, ex quibus non fit pars aliquota respectu minoris numeri, ut 5 ad 3. Proportio multiplex superparticularis est quando maius multotiens continet minus et aliquam partem vel aliquas partes ultra, ex quibus fit aliqua pars aliquota, ut 10 ad 4. Multiplex superpartiens est quando maius multotiens continet minus et aliquas partes ultra, ex quibus non fit pars aliquota aliqua respectu minoris numeri, ut 8 ad 3, 12 ad 5.

Proportio multiplex est habitudo maioris quantitatis ad minorem illam multotiens continens, sed hec potest esse infinitis modis; si maior numerus continet bis minorem, tunc est proportio dupla; si ter, tripla. Unde pro denominatione in illa specie oportet respicere quotiens maior numerus continet minorem.

Proportio superparticularis est habitudo maioris quantitatis in

54. minus ; unus R
59-88. Proportio multiplex... ut 5 ad 3 : om. V

minorem istam semel continens et aliquam partem ultra, ex qua fit pars aliquota, ut 3 ad 2. Superpartiens est quando maius continet minus et aliquam partem non aliquotam ultra, ut 5 ad 3. { Pro denominatione proportionum sciendum est quod proportio dupla est quando antecedens bis continet consequens, tripla quando ter, et sic in infinitum. Antecedens proportionis est primus terminus. Consequens est secundus terminus.} Sesquialtera est quando maius continet minus et eius medietatem ultra, ut 3 ad 2. Duplasesquialtera est quando maius bis continet minus et illius medietatem, ut 5 ad 2. Et sic in infinitum ascendendo. Sesquitertia est quando maius semel continet minus et tertiam partem minoris numeri ultra, ut 4 ad 3. Duplasesquitertia est quando maius bis continet minus et eius tertiam partem ultra, ut 7 ad 3. Et sic in infinitum ascendendo. Et omnes iste proportiones sunt in specie superpartiendari.

Sed ulterius pro denominatione proportionum in specie superpartienti videndum est quotiens maius continet minus: si enim semel et tales duas partes, tunc dicitur proportio superbipartiens, ut 5 ad 3; si vero semel et tales tres partes ultra, dicitur proportio supertripartiens, qualis est proportio 7 ad 4. Viso tunc qualiter maius continet minus, et quot tales partes ultra ex quibus non fit aliqua pars aliquota, videndum est quantus sit /fol. 76r/ qualibet illarum partium respectu minoris numeri, numquid 3 vel 4 et sic de aliis, et iuxta illud constituitur ultima particula denominationis proportionis illius ; ut capta proportione in 5 et 3 istam particulam denominationis bi- habebit, quia continet duas partes ultra ex quibus non fit aliqua pars aliquota

67. istam particulam : ista particula R

respectu minoris numeri, sed istam particulam denominationis tertias habebit quia qualibet illarum partium ultra contentarum est 3a pars respectu minoris numeri, ut proportio inter 5 et 3 est proportio superbipartiens tertias. Et si maius semel continet minus et tales tres partes ultra ex quibus non fit pars aliquota respectu minoris numeri, quarum qualibet pars est quarta pars respectu minoris numeri, tunc dicitur proportio superbipartiens quartas, qualis est proportio inter 7 et 4. Et sic in infinitum. Si maius bis continet minus et tales duas partes ultra ex quibus non fit aliqua pars aliquota, quarum qualibet est tertia pars respectu minoris numeri, tunc dicitur proportio dupla superbipartiens tertias, qualis est proportio inter 8 et 5. Et sic in infinitum.

Proportio minoris inequalitatis dicitur tot modis, et tot nominibus specificis appellatur, sicut proportio maioris inequalitatis, ista propositione sub- proposita.

Differentia est inter proportionem et proportionalitatem, nam proportio dicitur duobus modis, ut prius dictum est. Proportionalitas est ordo proportionum, et dicitur tribus modis, scil. proportionalitas arismetrica, geometrica, et armonica. Proportionalitas arismetrica est quando equalis est excessus inter primum et secundum, sicut inter secundum et tertium, et sic de aliis, ut 6 4 2. Proportionalitas geometrica est quando sunt multi termini et equalis est proportio inter primum et secundum sicut inter secundum et tertium, ut 8 4 2 1. Proportionalitas armonica est

69. sed istam : secundam R
75. minoris : om. R
81-83. Proportio... proposita : om. V

quando sunt tres termini tantum, et equalis est proportio inter primum et tertium sicut est proportio inter excessum primi termini ad secundum et excessum secundi termini ad tertium; exemplum: 6 4 3.

Permutatim proportionalia sunt quando sicut se habet antecedens unius proportionis ad antecedens alterius proportionis, sic consequens illius ad consequens alterius, ut 8 4 2 1. Equalis proportionalitas est quando sunt duo numeri, et in utroque sunt tres termini, et sicut se habet primus terminus primi numeri ad suum secundum sic se habet primus terminus secundi numeri ad suum secundum, et sicut se habet primus terminus primi numeri ad suum tertium sic se habet primus terminus secundi numeri ad suum tertium. Exemplum ut 8,4,2 et 4,2,1 etc.

Sequuntur quedam suppositiones.

Prima suppositio est ista: omnes proportiones, quarum denominationes sunt equales, sunt equales, ut 6 4, 2 1.

Secunda suppositio est hec: si sint tantum tres termini, et primus terminus est maior secundo, et secundus maior tertio, tunc proportio primi ad ultimum componitur ex illis, ut 8 4 2.

Tertia suppositio est hec: quando sunt multi termini, et primus est maior secundo, et secundus maior tertio, et sic de aliis, proportio primi ad ultimum componitur ex proportione primi ad secundum, secundi ad tertium, et sic de aliis, ut 16 8 4 2 1.

95-105. Permutatim... 4,2,1 etc. : om. R
96-97. unius... ad consequens : om. V, supplied from R
98. numeri : termini V
105. Sequuntur... suppositiones : om. R

Quarta suppositio est hec : quando duo equalia comparantur ad aliquod tertium, eadem est proportio inter unum illorum et illud tertium sicut inter relicum illorum et illud tertium, ut 4 4 1.

Quinta suppositio est hec : si due quantitates inequales comparantur ad aliquod tertium, maior est proportio maioris /fol.70v/ illarum ad illud tertium quam minoris illarum ad illud tertium; et econtra minor erit proportio minoris illarum ad illud tertium quam maioris illarum ad illud tertium, ut 6 4 2.

Sexta suppositio est hec : quando aliquid componitur ex duobus equalibus, tunc illud compositum erit duplum ad quodlibet illorum. Et si fuerit compositum ex tribus equalibus, tunc illud compositum erit triplum ad quodlibet illorum, ut 8 ad 4 <et 4 ad 4,> 8 ad 2 <et 2 ad 2.>

Septima suppositio est hec : quando aliquid componitur ex duobus inequalibus, tunc illud compositum est plus quam duplum ad minus, et minus quam duplum ad maius, ut tripedale, bipedale et pedale.

Quinque prime suppositiones patent 5° libro Euclidis, et due ultime patent per rationem.

Sequuntur quedam conclusiones.

Prima conclusio probanda ex istis suppositionibus est ista : si fuerit proportio maioris inequalitatis primi ad secundum et secundi ad tertium proportionalitate geometrica, tunc proportio primi ad ultimum est dupla ad proportionem primi ad secundum et secundi ad tertium. Hoc

118-120 minor... ut 6 4 2. : maior erit proportio illius tertii ad minorem quantitatem quam istius tertii ad maiorem quantitatem. V. cf. T
128 suppositiones : conclusiones R. cf. this sentence with T. Note also that suppositiones 6 and 7 do not occur in Bradwardine.
130 Sequuntur... conclusiones : om. R

probatur sic : capio istos tres terminos 8 4 2. Tunc arguitur sic : inter 8 et 4 dupla est proportio, inter 4 et 2 dupla est proportio, igitur iste proportiones sunt equales. Consequentia tenet per primam suppositionem, scil. omnes proportiones etc. Tunc sic : hic sunt tres termini adinvicem proportionati proportionalitate geometrica et primus terminus est maior secundo et secundus maior tertio, igitur proportio primi ad ultimum componitur ex illis. Sed equalis est proportio primi ad secundum sicut secundi ad tertium, igitur proportio primi ad ultimum componitur ex duobus equalibus, igitur erit dupla ad quemlibet illorum. Consequentia tenet per sextam suppositionem.

Secunda conclusio est ista : si fuerint 4 termini adinvicem proportionati proportionalitate geometrica, tunc proportio primi ad ultimum erit tripla ad proportionem primi ad secundum et secundi ad tertium et tertium ad quartum. Hoc probatur sic : capio istos quatuor terminos 8 4 2 1. Tunc hic sunt 4 termini quorum primus est maior secundo, et secundus maior tertio, et tertius maior quarto, igitur proportio primi ad ultimum componitur ex illis. Consequentia tenet per tertiam suppositionem. Sed equalis est proportio primi ad [illegible] sicut secundi ad tertium et sic de aliis, igitur proportio primi ad ultimum componitur ex tribus equalibus, igitur est tripla ad quodlibet illorum. Consequentia tenet per sextam suppositionem. Et si sint 5 termini erit quadrupla ad quodlibet illorum, et sic de aliis.

Tertia conclusio est ista : si primum fuerit maius quam duplum

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138-140 Tunc sic... maior tertio : Et tunc arguo per 2am suppositionem, quando tres termini,etc. Sed hic sunt tales tres termini, V
157 maius : magis R
157-159 duplum secundi : secundum R

secundi, fuerit et secundum equaliter duplum tertii, proportio primi ad tertium erit minor quam dupla ad proportionem primi ad secundum, et maior quam dupla secundi ad tertium. Hoc probatur sic : capio istos tres terminos 6 3 1. Tunc arguo per secundam suppositionem: si sint tres termini etc. Sed hic sunt tales tres termini, igitur proportio primi ad ultimum componitur ex illis. Sed maior est proportio primi ad secundum quam secundi ad tertium, igitur proportio primi ad ultimum [folio 77r] componitur ex duobus inequalibus, igitur est plus quam duplum ad minus et minus quam duplum ad maius. Consequentia tenet per septimam suppositionem. Sed maior est proportio primi ad secundum quam secundi ad tertium, igitur proportio primi ad ultimum est minor quam dupla ad proportionem primi ad secundum, et maior quam dupla ad proportionem secundi ad tertium.

Quarta conclusio est ista : si fuerit primum duplum ad secundum, fuerit[que] secundum maius quam duplum tertii, tunc proportio primi ad ultimum est minor quam dupla ad proportionem secundi ad tertium. Hoc probatur sic : capio istos tres terminos 6 3 1. Tunc arguo sic per secundam suppositionem : si sint tres termini,etc. Sed hic sunt tales tres termini etc., igitur proportio primi ad ultimum componitur ex proportione primi ad secundum et secundi ad tertium. Sed maior est proportio inter secundum et tertium quam inter primum et secundum, igitur proportio primi ad ultimum componitur ex duobus inequalibus, igitur est plus quam duplum ad minus et minus quam duplum ad maius.

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175 tales : om. R
177 proportione ... tertium : illis R
179-182 igitur proportio... primum et secundum : om. V (homoeoteleuton)

Sed maior est proportio inter secundum et tertium quam inter primum et secundum, igitur proportio primi ad ultimum est minor quam dupla ad proportionem inter secundum et tertium.

Quinta conclusio est ista : si fuerit primum minus quam duplum secundi, fuerituque secundum equaliter duplum tertii, proportio inter primum et tertium erit maior quam ⟨proportio⟩ dupla ad proportionem inter primum et secundum. Hoc probatur sic : capio istos tres terminos 6 4 2. Tunc arguo sic per secundam suppositionem: si sint tres termini etc.. Sed hic sunt tres termini,etc. Igitur proportio primi ad ultimum componitur ex illis. Sed maior est proportio inter secundum et tertium quam inter primum et secundum, igitur proportio primi ad ultimum componitur ex duobus inequalibus, igitur est plus quam duplum ad minus et minus quam duplum ad maius. Sed maior est proportio inter secundum et tertium quam inter primum et secundum, igitur proportio primi ad ultimum est maior quam dupla ad proportionem inter primum et secundum.

Sexta conclusio est ista : si fuerit primum duplum ad secundum, fuerituque secundum minus quam duplum tertii, proportio primi ad ultimum erit maior quam dupla ad proportionem inter secundum et tertium. Hoc probatur sic : capio istos tres terminos 8 4 3. Tunc arguo sic per secundam suppositionem : si fuerit tres termini,etc. Sed hic sunt tres termini,etc. Igitur proportio primi ad ultimum componitur ex illis. Sed maior est proportio inter primum et secundum quam inter secundum et tertium, igitur proportio primi ad ultimum componitur ex duobus inequalibus, igitur est plus quam duplum ad minus et minus quam duplum ad maius. Sed proportio primi ad secundum est maior quam secundi ad

tertium, igitur proportio inter primum et ultimum est maior quam dupla ad proportionem inter secundum et tertium.

Septima conclusio est ista : proportione equalitatis nulla est maior nec minor. Quia proportio equalitatis non est maior vel minor proportione equalitatis, quia omnes proportiones equalitatis sunt equales, igitur nulla est alia maior vel minor. Nec proportio maioris inequalitatis est maior proportione equalitatis, quia si sic, igitur proportio equalitatis poterit augmentari quousque fuerit equalis isti. Consequens falsum quia quantumcumque erit, erit proportio equalitatis, et per consequens nunquam erit maior nec minor /fol.77v/ quam nunc est. Si proportio maioris inequalitatis sit minor proportione equalitatis, igitur proportio equalitatis potest diminui quousque fuerit equalis isti. Consequens falsum, ut prius. Et consimile est argumentum de proportione minoris inequalitatis et de proportione equalitatis.

Sed contra istam conclusionem arguo sic : capio istos tres terminos 6 4 6. Tunc arguo sic per secundam suppositionem : quando sunt tres termini, etc. Tunc proportio primi ad ultimum componitur ex proportione primi ad secundum et secundi ad tertium. Et omne compositum est maius quacumque parte ipsius componente, igitur proportio primi ad ultimum est maior quam proportio inter secundum et tertium. Sed proportio primi ad ultimum est proportio equalitatis, et proportio primi ad secundum est proportio maioris inequalitatis et proportio secundi ad tertium est proportio minoris inequalitatis; igitur proportio equalitatis est maior proportione minoris inequalitatis, et consimiliter maior proportione

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209-210 Quia proportio... proportione equalitatis : om. R
211-212 Nec proportio... equalitatis : om. R
215 equalis isti : equale sibi R (also l.217)
227-228 maioris... est proportio : om. R (homoeoteleuton)

maioris inequalitatis. Pro isto dicitur : quod secunda suppositio sic intelligitur quod proportio primi ad ultimum componitur ex proportione primi ad secundum et secundi ad tertium quando primus terminus est maior secundo et secundus maior terti c. Sed sic non est in istis terminis, ut arguitur est.

Aliter arguitur contra eandem conclusionem : capio istos tres terminos 6 4 4. Tunc arguitur per quintam suppositionem sic : maior est proportio inter 6 et 4 quam inter 4 et 4. Sed proportio inter 6 et 4 est proportio maioris inequalitatis et proportio inter 4 et 4 est proportio equalitatis, igitur proportio maioris inequalitatis est maior quam proportio equalitatis. Pro isto dicitur : quod quinta suppositio habet intelligi de duobus inequalibus comparatis ad tertium eadem genere proportionis.

Tertio obicitur contra eandem conclusionem. Et capio istos tres terminos 6 6 6. Et tunc arguitur sic : per primam conclusionem adjuncta secunda suppositione : equalis est proportio primi ad secundum et secundi ad tertium, igitur proportio primi ad ultimum componitur ex illis, igitur proportio primi ad tertium componitur ex duobus equalibus, igitur proportio primi ad tertium est precise duplum ad proportionem primi ad secundum et secundi ad tertium. Sed proportio primi ad ultimum est equalis et qualibet proportio intercepta est equalis, igitur proportio equalitatis aliqua est maior. Pro isto dicitur : quod prima conclusio

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244-245 per primam... suppositione : per primam adjunctam secundo R
247 equalibus : inequalibus R

loquitur ubi est proportio maiorâs inequalitatis primi ad secundum et secundi ad tertium. Et intellectus secunde suppositionis patet ex predictis. Et sic cessat obiectio; ideo,etc.

/Capitulum 2/

Tres sunt opiniones famose specialiter improbande.

Prima ponit velocitatem in motibus sequi excessum. Sententia huius opinionis est hec : si sint due potentie et due resistentie et per maiorem excessum excedit prima potentia suam resistentiam quam secunda suam resistentiam, tunc in maiori velocitate movebit prima potentia cum sua resistentia quam secunda cum sua resistentia. Exemplum : sit A una potentia ut 6, B sua resistentia ut 4, C una alia potentia ut 2, D sua resistentia ut 1. Tunc in quadruplo maiori velocitate movetur A cum B quam C cum D, quia in quadruplo maior est excessus A ad B quam C ad D. /fol.78r/

Contra istam opinionem arguitur sic : primo per Aristotelem 7° Physicorum et multis aliis locis, ubi ponit velocitatem motus sequi proportionem. Sed forte dicitur quod Aristoteles intellexit de proportione arsmetrica. Sed contra istam glosam arguitur sic :

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254 cessat : omnis add.V
257 excessum : potentie motive super potentiam rei mote add.V
260-261 in maiori... secunda cum sua resistentia : per maiorem velocitatem excedit prima potentia suam resistentiam quam secunda suam resistentiam R
263 quadruplo : duplo R
264 quadruplo : duplo R
266 primo per : ipsa est contra V
267 7° ; 1° R

270 5⁰ Elementorum Euclidis est conclusio prima : si fuerint quotlibet quantitates aliarum totidem eque multiplices, aut eque maiores aut eque minores aut singule singulis equales, necesse est, quemadmodum una illarum ad sui comparem, totum quoque ex his aggregatum ad omnes istas pariter acceptas similiter se habere. Sententia huius conclusionis est 275 ista : si sumantur multe quantitates comparate ad totidem, et in equali proportione una se habet ad suum comparatum sicut alia ad suum comparatum, tunc aggregatum ex omnibus illis antecedentibus se habet in eadem proportione ad aggregatum ex omnibus illis consequentibus sicut primum antecedens se habet ad consequens suum. Quod tamen non est verum de 280 proportione asymetrica, sicut 8 4.

Aliter contra opinionem arguitur sic per experimentum : si esset una musca portans unum parvum pondus et unus fortis homo portans tantum pondus, multo maiori velocitate stat muscam movere cum suo pondere quam illum hominem movere cum suo pondere; et tamen per multum maiorem

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270-274 Si fuerint... se habere supplevi ex T.* Si fuerit aliquarum quantitatum ad earumdem totidem aut eque maiores aut eque minores aut similes sive equales, necesse est una illarum quemadmodum comparari ad aggregatum ex omnibus illis, sicut potest se habere R Si fuerit aliquarum quantitatum comparatio ad earum totidem aut eque maiores aut eque minores aut consimiles, necesse est, quemadmodum una illarum ad sui comparem quantitatem, totum quoque ex his aggregatum ad omnes illarum pariter acceptas similiter se habere V

275 sumantur : fuerint V totidem ; tot XV

277 tunc : om. R

281 per experimentum : om. V

282 portans : om. R

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* Grosby's text of this sentence reads quarumlibet quantitatum for quotlibet quantitates. Manuscripts consulted read as follows : quotlibet quantitates Vat. Ottoboni. Lat. 179 fol. 94r, Vat. Lat. 2165 fol. 24vb, ed. Venice, 1505. quodlibet quantitates Vat. Lat. 1103 fol. 109r. qualibet quantitates Vat. Lat. 1106 fol. 72v, in marg. Vat Lat. 4429 fol. 25ra. quarumlibet quantitatum, in textu Vat. Lat. 4429 fol. 25ra.

285 excessum excedit potentia illius hominis suam resistentiam quam potentia illius muscę suam resistentiam. Igitur opinio falsa.

Secunda opinio ponit velocitatem motus localis sequi proportionem excessus. Sententia huius opinionis est hęc : si sint due potentie et due resistentie, et in maiori proportione se habet excessus prime
290 potentie ad suam resistentiam quam excessus secunde potentie ad suam resistentiam, tunc maiori velocitate movebitur prima potentia cum sua resistentia quam secunda cum sua resistentia; et si equalis est proportio unius et alterius, motus erunt equales. Exemplum: sit A una potentia ut 5, B sua resistentia ut 1, C una potentia ut 3, D sua
295 resistentia ut 1. Tunc per opinionem in duplo velocius movebitur A cum B quam C cum D, quia in duplo maior est proportio inter excessum per quem A excedit B ad B, quam est proportio inter excessum per quem C excedit D ad D, quia prima est quadrupla et secunda est dupla, ut patet. Hec autem opinio fundatur super dictum Averrois 7^{0} Physicorum, commento
300 36, ubi sic dixit : velocitas motus est secundum proportionem excessus potentie motore supra potentiam motam.

Contra istam opinionem arguitur sic per illam conclusionem impossibilem : aliqua potentia movebitur cum aliqua resistentia, et nihil

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287 ponit : om. R
288 excessus : potentiarum super suas resistentias add. V
290-291 quam... tunc : cum R
292-293 resistentia;et... equales : om. V
292 si : sic add. R
294 5 : 2 R 1 : 4 R 3 : 2 R
297 ad B : om. R est proportio : om. R
298 ad D : om. R
299-301 Hec... motam : om. V
300 36 : 38 R
301 motore : movere R cf. infra l. 318
305 - 304 conclusionem impossibilem : consequentiam, impossibile R

potest movere velocius nec tardius illa cum sua resistentia. Quod conclusio sequitur probatur : et pono quod A sit una potentia ut 8, B sua resistentia ut 4. Tunc excessus inter A potentiam et B resistentiam est ut 4. Igitur nullius potentie excessus potest habere se in maiori proportione nec in minori ad suam resistentiam quam se habet ille excessus ad suam resistentiam. Consequentia tenet per septimam [fol. 78v] conclusionem, scil. proportione equalitatis, etc. Igitur per positionem nihil potest movere velocius nec tardius. Tamen quod conclusio sit impossibilis patet, quia quantumcumque fuerit aliqua potentia magna, illa potentia tamen potest movere cum maiori resistentia ergo et tardius, cum minori resistentia et per consequens velocius; igitur conclusio impossibilis. Ad alias auctoritates probantes opinionem 7° Physicorum dico quod quando dicit velocitas motus est secundum proportionem excessus potentie motore supra potentiam motam, dico quod ipse et omnes alii intelligunt quod velocitas motus est secundum proportionem geometricam, et non aliud intelligunt per exemplum quam proportionem geometricam.

Tertia opinio ponit quod velocitas in motibus, manente eodem motore vel

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304 cum sua resistentia : cm. V
307 est : 4, et resistentia etiam add. V habere : in add. R
310 scil. : 6 R positionem : potentiam R
313 illa : aliqua R tamen : tanta V
313-314 ergo et... resistentia : cm. R (homeoteleuton)
315-320 Ad alias... geometricam : cm. V
321-323 ponit....opinio : cm. R (homeoteleuton)

equali, sequitur proportionem passoris, et manente eodem passo vel equali, sequitur proportionem motoris. Et illa opinio est bimembris. Sententia prime partis est hec : si fuerit una potentia sufficiens movere cum duabus resistentiis inequalibus, sicut una est alia resistentia maior, ita tardius sufficit illa potentia movere cum illa resistentia maiori quam cum illa resistentia minori. Exemplum : sit A una potentia ut 8, B sua resistentia ut 4, C una alia resistentia ut 2. Tunc per opinionem in duplo velocius A cum C movebit quam cum B, quia in duplo minor est C resistentia quam B resistentia. Sententia secunde partis est hec : si due potentie inequales sufficiunt movere cum una resistentia, sicut una potentia est alia maior, ita velocius sufficit illa movere cum illa resistencia quam minor. Exemplum : si A sit una potentia ut 8, B alia potentia ut 4, C una resistentia ut 2. Tunc sicut A potentia est maior B, ita velocius sufficit A potentia movere cum C resistentia, quam B cum C resistentia.

Quod ista opinio sit insufficiens probo. Quia non docet penes quid velocitas motus habet attendi ubi sunt diverse potentie et diverse resistentie, vel ubi est solum una potentia et una resistentia.

Contra primam partem arguitur sic per istam conclusionem impossibilem : aliqua potentia sufficit movere cum resistentia aliqua, et cum nulla resistentia sufficit movere in duplo tardius, stante potentia. Quod conclusio sit impossibilis satis patet, quia quantacumque fuerit illa potentia, si sua resistentia crescat ad equalitatem sue potentie,

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325 sicut ; si R
326 ita ; tunc R
339 vel... resistentia ; nisi solum ubi mok sunt duo potentie et una resistentia, vel due resistentie et una potentia V
343 quantacumque ; quodcumque R

stante potentia, in infinitum tarde aliquando movebitur. Igitur falsum est quod non in duplo tardius, igitur conclusio falsa. Et quod conclusio sequitur ex prima parte illius opinionis probatur sic : sit A una potentia ut 8, B sua resistentia ut 4. Tunc probo quod A non potest movere in duplo tardius cum alia resistentia quam cum B. Quia si sic, sit C talis resistentia. Tunc vel est C equalis A vel maior vel minor A. Non equalis A nec maior A, quia tunc A non sufficeret movere cum C, per istam conclusionem : nec a proportione equalitatis, nec a proportione minoris inequalitatis potest provenire motus. Tamen si C sit minor A et maior B arguitur sic. In duplo tardius sufficit A movere cum C quam cum B, igitur in duplo velocius cum B quam cum C. Consequens falsum quia B non est in duplo minus C, quia B est [fol. 78r] precise subduplum ad A et C est minus A. Igitur A non sufficit movere in duplo tardius cum C quam cum B. Consequentia patet per primam partem illius opinionis.

Et contra secundam partem arguitur per experimentum, quia si foret unus homo portans unum magnum pondus quod vix posset portare, et unus eque fortis adiuvaret ipsum, tunc plus quam in duplo velocius moverent illud pondus quam unus illorum per se. Et potentia composita est precise in duplo maior quam una illarum per se. Igitur secunda pars opinionis est falsa.

Quarta opinio ponit quod velocitas motus non sequitur proportionem, quia nulla est proportio inter potentiam et resistentiam. Sed omnia argumenta

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545 in : om. R
550 equalis : equale R
551 equalis : equale R
559 contra : similiter arguitur de quacumque resistentia, sequitur ergo conclusio ex prima parte illius opinionis. Contra V

facta pro ista opinione solum procedunt de proportione proprie dicta. Ideo contra illam non arguitur ad presens.

[Capitulum 3]

Quinta opinio, que est vera, ponit quod velocitas motus sequitur proportionem geometricam. Sententia illius opinionis est ista : si fuerint due potentie et due resistentie, et maior sit inter primam potentiam et suam resistentiam quam inter secundam potentiam et suam resistentiam proportio, velocius movebitur prima potentia cum sua resistentia quam secunda cum sua resistentia, quia sicut una potentia est maior alia ita et motus velocior. Exemplum : sit A una potentia ut 8, B sua resistentia ut 2, C una alia potentia ut 6, D sua resistentia ut 3. Moveatur A cum B et C cum D. Tunc per opinionem in duplo velocius movebitur A cum B quam C cum D, quia in duplo est maior proportio inter A et B quam C et D. Ista opinio patet per Aristotelem 7^m Physicorum, ubi dicit quod velocitas motus sequitur proportionem.

Iuxta istam opinionem sunt iste conclusiones concedendo, quarum prima est hec : si sit una potentia se habens in proportione dupla ad suam resistentiam, duplata potentia, stante resistentia, duplabitur motus. Hoc probo sic : sit A una potentia ut 4, B sua resistentia ut 2, C una alia potentia ut 8. Tunc arguo per primam conclusionem : si fuerit proportio maioris inequalitatis primi ad secundum et secundi ad tertium, etc. Sed hic sunt tales tres termini, et equalis est proportio inter primum et secundum sicut inter secundum et tertium. Igitur pro-

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367 proprie : communiter R
370 geometricam : potentie motoris super potentiam rei mote. Unde add. V
371-372 et suam resistentiam : om. R
374-5 resistentia... velocior : sicut una proportio est maior alia V
380 proportionem : potentie motoris super resistentiam add. V

portio inter primum et tertium est dupla ad quamlibet illorum. Sed motus sequitur proportionem, igitur in duplo velocius movebitur C cum B quam A cum B. Sed si A potentia dupletur, tunc tanta velocitate sufficit A movere cum B sicut nunc sufficit C. Igitur conclusio vera.

Secunda conclusio est hec : si aliqua potentia se habet in proportione dupla ad suam resistentiam in duplo velocius sufficit illa movere cum medietate illius resistentie quam cum tota resistentia. Hec probatur sic : sit A una potentia ut 8, B sua resistentia ut 4, C una alia resistentia ut 2. Tunc arguo per primam conclusionem : si fuerit proportio maioris inequalitatis primi ad secundum, etc. Sed sic est hic, etc. [fol. 79v] Igitur proportio primi ad ultimum est dupla ad quamlibet illarum per se. Sed motus sequitur proportionem, igitur in duplo velocius sufficit A movere cum C quam cum B. Sed C est medietas B. Igitur conclusio vera.

Tertia conclusio est hec : si fuerit una potentia se habens in maiori proportione quam in dupla ad suam resistentiam, tunc, duplata potentia, stante resistentia, non duplabitur motus. Hec probatur sic : sit A una potentia ut 5, B sua resistentia ut 2, C una alia potentia ut 10. Tunc per quartam conclusionem probatur : si fuerit primum duplum secundi fueritque secundum magis quam duplum tertii, etc. Sed sic est hic. Igitur proportio primi ad ultimum est minor quam dupla ad proportionem inter secundum et tertium. Sed motus sequitur proportionem.

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405 duplabitur : dubitatur R
406 5 : 6 V
407 10 : 12 V
408 magis quam duplum : duplum magis quam R
410 Sed : Et R

Igitur non in duplo velocius movetur C cum B quam A cum B. Sed si A dupletur, tunc precise tanta velocitate movetur A cum B sicut nunc movetur C. Igitur conclusio vera.

Quarta conclusio est hec : si fuerit una potentia se habens in maiori proportione quam in dupla ad suam resistentiam, non in duplo velocius sufficit illa potentia movere cum medietate illius resistentie quam cum tota resistentia. Hoc probo sic : sit A una potentia ut 6, B sua resistentia ut 2, C una alia resistentia ut 1. Tunc arguo per tertiam conclusionem : si fuerit primum magis quam duplum secundi, fueritque secundum equaliter duplum tertii, etc. Sed sic est hic. Igitur proportio primi ad ultimum est minor quam dupla ad proportionem primi ad secundum. Sed motus sequitur proportionem. Igitur non in duplo velocius sufficit A movere cum C quam cum B. Et C est medietas B. Igitur conclusio vera.

Quinta conclusio est ista : si sit una potentia se habens in minori proportione quam dupla ad suam resistentiam, duplata potentia movebitur plus quam in duplo velocius. Hoc probatur sic : sit A una potentia ut 6, B sua resistentia ut 4, C una potentia ut 12. Tunc arguo per sextam conclusionem : si fuerit primum duplum secundi, fueritque secundum minus quam duplum tertii, proportio primi ad tertium, etc. Sed sic est hic. Ergo proportio primi ad ultimum erit maior quam dupla ad proportionem secundi ad tertium. Sed motus sequitur proportionem. Igitur plus quam in duplo movebitur velocius C cum B quam A cum B. Sed si A dupletur, tunc tanta velocitate sufficeret A movere cum B sicut

420 Sed sic est hic : Sed hic est sic R
430-431 ad tertium... proportio primi : om. R (homoeoteleuton)

nunc sufficit C cum B. Igitur conclusio est vera.

Sexta conclusio est hec : si aliqua potentia se habeat in minori proportione quam dupla ad suam resistentiam, plus quam in duplo sufficit illa potentia movere cum medietate illius resistentie quam cum tota. Hoc probatur sic : sit A una potentia ut 6, B una resistentia ut 4, C alia resistentia ut 2. Tunc arguo sic per quintam conclusionem : si fuerit primum minus quam duplum secundi, fueritque secundum equaliter duplum tertii, etc. Sed sic est hic. Igitur proportio primi ad ultimum est maior quam dupla ad proportionem primi ad secundum. Sed motus sequitur proportionem. Igitur plus quam in duplo velocius sufficit A movere cum C quam cum B. Sed C est medietas B. Igitur conclusio vera.

Contra istam opinionem arguitur sic : ex istis sequuntur tria inconvenientia. Primum [fol.80r] est hoc : ex proportionibus equalibus proveniunt motus inequales. Secundum est quod a proportione minori provenit tanta velocitas sicut a maiori. Tertium est quod a minori provenit maior velocitas quam a maiori.

Primum arguitur sic : sint A et B terre pure. Sit potentia illius A ut 8, et potentia illius B ut 4. Sint C et D due aeres uniformes proportionabiles A B. Sit C pedalis quantitatis, sit D semipedalis quantitatis. Sit resistentia C ut 2, resistentia D ut 1. Et ponatur

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441 duplum secundi : secundum R
447 sequuntur tria : sequitur tres R
451 a maiori : Sed omnia ista sunt falsa. Ergo opinio 5a falsa est. Falsitas (?) autem illorum trium per istam opinionem est patet add. V
452 terre pure : due certe potentie inequales V
455 aeres : alie res V

quod A pertranseat C et B pertranseat D. Tunc quero numquid in equali tempore A pertransibit ipsum C sicut B D, vel non. Quod sic, patet per illam opinionem, cum in equali proportione se habet A ad C sicut B ad D per casum. Igitur in equali tempore pertransibit A C sicut B D. Et si sic, sequitur prima conclusio. Hoc probatur : A plus pertransibit quam quam B, et A et B ex proportionibus equalibus movebuntur. Igitur conclusio vera, viz. quod a proportionibus equalibus proveniunt motus inequales. Minor patet, quia utraque movetur proportione quadrupla.

Secundam conclusionem probo sic : maioretur resistentia C quousque A sufficiat pertransire medietatem C in tempore quo B sufficit pertransire D. Nunc est equalis proportio A ad C sicut B ad D, et in fine minor erit proportio A ad C quam nunc est quia resistentia C tunc erit maior quam nunc est, et tunc erit tanta proportio B ad D sicut in principio, igitur proportio A ad C erit minor in fine quam proportio B ad D. Et motus A erit eque velox cum motu B quia pertransibunt spatia equalia in tempore equali. Igitur a proportione minori provenit motus eque velox sicut a maiori proportione.

Et quod tertia conclusio sequitur probatur sic : minoretur iterum resistentia C, non tamen ad equalitatem resistentie in casu primo. Tunc adhuc minor proportio est A ad C quam fuerit in primo casu. Et in primo casu fuit tanta proportio A ad C sicut B ad D. Igitur in casu isto erit minor proportio A ad C quam B ad D, et motus A erit velocior in casu isto

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457-458 tempore... equali : om. R
461 A et B ex : a V
462-463 viz.quod... quadrupla : om. V
467 nunc est : B ad D R resitentia : resistentie R
469-470 igitur... B ad D : om.V
470 A : B R B : D R
477 A' : D R

quam motus B, quia A nunc plus pertransibit quam in casu primo et B tantum sicut in casu primo, et in casu primo A tantum sufficiebat pertransire sicut B in tempore equali. Igitur A in isto casu sufficit plus pertransire quam B. Igitur motus A erit velocior quam motus B, et A movetur in C a proportione minori quam B in D. Igitur a proportione minori provenit motus velocior quam a proportione maiori. Igitur sequitur tertia conclusio que erat probanda.

Pro isto dicitur quod in tempore quo B pertransibit D, A solum pertransibit medietatem C. Et tunc ad argumentum : A se habet in equali proportione ad C sicut B ad D. Igitur in equali tempore sufficit A pertransire C sicut B D. Negatur consequentia, quia aliqua se habere ad sua media inequali proportione est dupliciter : aut quantitative aut qualitative. Unde se habere in proportione qualitative /fol. 80v/ ad sua media est quando sunt due potentie et due resistentie et equalis est proportio inter primam potentiam et suam resistentiam sicut inter secundam et suam. Sed se habere ad sua media in equali proportione quantitative est quando sua media sunt equalia in quantitate. Primo modo est equalis proportio A ad C sicut B ad D, et non secundo modo. Ideo non sequitur quod A in equali tempore sufficit pertransire C sicut B D.

Notandum quod nullus motus potest provenire a proportione minoris inequalitatis nec a proportione equalitatis, sed omnis motus provenit ex proportione maioris inequalitatis. Quandocumque fuerit unum mixtum gravius alico simplici, in eodem medio potest movere velocitate maiori, minori, et

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479 tantum : tamen V
489–494 aut quantitative... quantitate : aut quoad qualitatem aut quoad quantitatem, idest, ad motum(motum?) in illis mediis(mediis?) equo velociter, vel pertranseundo ea in tempore equalia V
499 Quandocumque : quantumcumque V 500 medio : modo R

equali cum illo simplici. Hoc probatur sic : sit A unum corpus mixtum cuius gravitas sit ut 8, et sua levitas intrinseca ut 2. Sit B unum grave simplex cuius gravitas sit ut 4, et sit C unum medium cuius resistentia sit ut 2. Tunc tanta velocitate incipit A movere in C sicut B in C, et econtra, quia potentia A est ut 8, sua resistentia intrinseca ut 2, resistentia ejus extrinseca ut 2, igitur tota resistentia est ut 4. Sed inter 4 et 2 est proportio dupla, igitur A et B incipiunt eque velociter movere. Et probatur quod minori velocitate potest A movere cum C quam B cum C, quia diminuatur C resistentia quousque fuerit ut 1. Tunc A potentia erit ut 8, sua resistentia intrinseca ut 2 et extrinseca ut 1, igitur tota resistentia sua est ut 3. Sed inter 8 et 3 est proportio dupla superbipartiens tertias. Et potentia B est ut 4, et sua resistentia ut 1, igitur B movebitur ex proportione quadrupla. Sed A non est tanta, igitur minori velocitate movebitur ex proport. Et probo quod maiori velocitate potest A movere cum C quam B cum C, quia crescat resistentia C quousque fuerit ut 3. Tunc potentia A est ut 8, et sua resistentia intrinseca ut 2 et extrinseca ut 3, igitur tota resistentia est ut 5; sed inter 8 et 5 est proportio supertripartiens quintas. Sed potentia B est ut 4, et tota resistentia sua ut 3. Sed inter 4 et 3 est proportio sesquitertia, que minor est quam proportio in qua A movetur in C. Igitur tota conclusio est vera pro utraque ejus parte, etc.

Explicium proportiones cum opinionibus suis.

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506 resistentia sius extrinseca ut 2 : om. R
508 minori : maiori R
509 @' : B V
519 4 : 8 R

Rogeri Swineshead

Tractatus de Motibus Naturalibus

Diff.3, cap.2, pars 2, dub.2-3.

Erfurt, MS Amplon.F.135,
fol.31ra-va.

Secundo numquid quatuor elementa, scilicet, ignis, aqua, aer, terra, sub eadem specie specialissima reponantur dubitatur. Et quod non arguitur sic:

/1/ Nullum individuum alicuius speciei alterius individui eiusdem speciei naturaliter est corruptivum. Unum vero elementum alterius elementi naturaliter est corruptivum. Maior nota est; et minor ex processu Aristotelis 1° De generacione, et 2° satis innititur.

/2/ Iterum tunc nullum elementum foret corruptibile, et ita materia prima foret continue ens in actu, cuius oppositum tamen vult Aristoteles 1° Phisicorum et 1° De generacione; non igitur elementa sub eadem specie collocantur.

/3/ Iterum motus naturales elementorum specifice differunt; et cum motus naturales inmediate causentur a formis elementorum, ipsarum forme specifice differunt; et ita elementa specifice distinguuntur.

Oppositum tamen ex predictis satis apparet. Nec racio prima procedit ex veris, cum nullum elementum alterius elementi corruptivum existat. Quia tamen Aristoteles 1° De generacione et 2° ac ubique quasi per singulos libros philosophie naturalis, ubi de generacione pertractat, generacionem et corrupcionem in elementis expresse videtur innuere, dicendum quod hec intencio 'generacio' est dupliciter significativa. Prima enim generacionem simplicem, secundo autem generacionem secundum quid significat. Hec autem intencio composita 'generacio simplex' adhuc dupliciter est significativa: primo enim generacionem simplicem absolutarum, secundo generacionem

simplicem respectiverum significat, sicud 1° De generacione apparet. Totidem etiam modis illa intencio 'corrupcio' significativa reperitur. Istis autem modis loquendi suppositis, generacionem et corrupcionem fore in elementis presens declaratis non repugnat. Sicud enim homo musicus corrumpetur esse musicus et generatur esse non musicus, consimiliter igne in aerem ignis facto, ignis corrumpetur esse ignis et generatur esse aeris. Et sicud talis forma non admittitur, 'homo musicus corrumpetur esse musicus, igitur homo musicus corrumpetur', nec ita debet admitti, 'ignis corrumpetur esse ignis, igitur ignis corrumpetur'. Set ad hoc obicitur in 1° De generacione de empedocle recitatur quod posuit in elementa incorruptibilia; ubi tamen Aristoteles ipsum de falso redarguit 'non igitur elementa sunt incorruptibilia', dicendum quod empethocles non solum posuit elementa incorruptibilia, set etiam omni transmutacione intransmutabilia; nec aliter valeret racio Aristotelis contra eum. Dicit enim Aristoteles ipsum contradicere sensui. Sensui enim satis apparet elementa adinvicem transmutari, cum ex terra fiat aqua, et ita de aliis. Generacio tamen aut corrupcio sensui non apparet, sumpta generacio pro transmutacione mediante qua antiqua forma substantialis expellitur.

Secunda etiam conclusio secunde racionis probabilis est et vera, cum ipsa materia prima forma substanciali continue perficiatur. Quia tamen Aristoteles materiam primam entem in potentia, et non entem in actu multotiens asserit, dicendum quod materia prima non est forma neque de se habet formam, eo quod forma non est pars materie prime; et de modo loquendi Aristotelis illa fuerunt equalia, 'materia prima non est ens in actu' et 'materia prima non est forma neque de se habet formam'. Ille tamen modus loquendi cum aliis quam pluris terminis quibusdam iam naturaliter et

aliter quam tunc significantibus transiit in abusum. Set adhuc obicitur: si elementa sint incorruptibilia, elementum et non materia prima foret subiectum in generacione, cuius tamen oppositum vult Aristoteles 1° De generacione manifeste. Dicendum quod elementum est primum subiectum et inmediatum respectu generacionis et corrupcionis. Quia tamen in transmutacione ignis in aerem, nullum subiectum manet quod non mutat nomen preter materiam primam, ideo materiam primam fore subiectum in generacione ponitur ab Aristotele. Neque enim forma neque materia, set totum compositum ex hiis, mediante transmutacione facta per qualitates primas, nomen recipit. Et secundum mutacionem factam in qualitatibus primis non materia neque forma /fol. 31rb/ set totum elementum mutat nomen, quoniam forma sicut materia nomen non mutat. Igitur si materia, quia nomen non mutat, in generacione /non/ subicitur, neque etiam forma; dicendum quod nomen 'subiectum' materie et non forme vere competit. Materia enim prima substat forme prime. Forma tamen quamvis materiam sibi subiecat nulli enti substabit. Totum vero elementum tam formis accidentalibus quam substantialibus substare non poterit. Et quia elementum mutat nomen in transmutacione facta per qualitates primas ac forma nulli alteri substat, ideo in tali transmutacione sole materie prime Aristoteles hoc nomen 'subiectum' attribuit, quamvis tamen elementum subiectum inmediatum in huiusmodi transmutacione consistat. Quia tamen inter dicta Aristotelis et predicta repugnancia/m/ apparentem penitus evadere non potero, intencius petere compellor quatenus inferius dicenda superiusque dicta, quia non Aristotelis aut Platonis nemo condempnet, nec dictis eorum singulis, quia Aristotelis aut Platonis fidem statim

59. facta: insert. margine in cod.
62. quoniam: quam cod.
69. sole: soli cod.
73-4. dicenda superiusque dicta: dicta superiusque dicenda cod.

adhibere quis presumat. In philosophia enim naturali fidem sine racione tenebras erroris a lumine veritatis non distinguente ubi racio naturalis pocius habundat quietem cum fide naturali ibidem apponat.

Tercia siquidem racio non procedit, cum non omnis distinccio motuum naturalium distinccionem formarum aut substancialium presupponat. Distinccio enim inter motus naturales ad loca secundum distinccionem formarum accidentalium que sunt gravitas et levitas attendenda. Quot enim sunt loca specifice distincta ad que mobilia nata sunt moveri, contingit totidem etiam motus naturales specifice distincti evenient. Duo namque sunt loca, sursum scilicet et deorsum, et due forme accidentales, gravitas et levitas; duo etiam motus naturales, ascensus et descensus, predictis correspondent.

Tercio dubitatur numquid ab etheria regione raritas et densitas in elementis procedunt effective. Arguitur quod non: /1/ forma elementaris materiam sub certa densitate sibi determinat; elementares forme etheria regione non sunt causate. Non igitur densitas ab etheria regione procedit effective. /2/ Iterum sic: elementari regione etheria regio continue consimiliter applicabitur; cum igitur regio etheria continue sit eadem et elementaris regio, similiter raritas et densitas acta eadem continue permanebit. Huius tamen oppositum satis experitur.

Pro solucione vero istius dubitacionis descripciones raritatis et densitatis primitus sunt notande. Pro quibus est sciendum quod densitas et raritas non res, set modi rerum consistunt. Sub predicamento enim 'positionis' collocantur, cum sint situs parcium in toto; non igitur res, set modi rerum positivi consistunt, sicud ex parte secunda capituli primi differencie secunde satis apparet. Densitas igitur est situs

91. regione non sunt causate: regio est causata cod.

parcium propinquius iaceneium in toto; raritas vero situs parcium remocius iacencium in toto consistit. Cum igitur mediantibus qualitatibus primis ab etheria regione primo causatis, partes elementorum propinquius aut remocius iaceant in toto, sequitur veritas partis affirmative dubitationis.

Maior autem prime racionis non debet admitti, cum massa elementaris racione qualitatum primarum in densitate et raritate maximam habet difformitatem. Qualitatibus primis tamen plene circumscriptis, raritatem penitus uniformem iam non habitam elementaris massa poterit habere, nec tunc illa raritas per formam foret terminata, cum concavitate coli duplicata vel subduplicata, massa elementaris totum spacium naturaliter poterit occupare.

Ratio autem secunda non concludit. Quamvis totaliter enim regio etheria elementari regioni continue consimiliter applicetur, partes tamen unius partibus alterius non semper applicabuntur. Cum igitur secundum variacionem in qualitatibus primis densitas et raritas varientur in elementis ac diverse partes etheris diversarum qualitatum primarum sunt effective, non uniformis densitas aut raritas per totam elementarem massam remanebit. Difformitas autem masse elementaris in densitate et raritate, manente tunc eodem agente penitus, iuxta difformitatem masse inanimalis in corpore humano convenienter poterit ymaginari, quantumque inanimalis massa in humano corpore recepto fuerit uniformis, per accionem tamen corporis humani in massam predictam quatuor humores, colera, scilicet, sanguis, malencolia /sic/ et fleuma /sic/ producentur. Massa vero elementaris ad regionem etherium, scilicet massa inanimalis ad corpus humanum, consimiliter comparatur. Igitur sicud corpus humanum ex massa inanimali quatuor humores non specifice sed in raritate et

128. non: insert. marg. cod.

densitate ceterisque qualitatibus distinguet, per formam /fol.31va/
etheria regio ex massa elementari quatuor corpora non specifice, set
in raritate et densitate aliisque qualitatibus distincta naturaliter
poterit producere. Microsmum /sic/ enim quid minor mundus appellatur
ad similitudinem maioris mundi quam fabricavit.

132. mundus: insert. marg. cod.
133. quam: § cod.

Guilelmi Heytesbury

Termini Naturales

S I G L A

Canon.Misc.393, fol.78-82va C

Munich.Glm 8997, fol.163-167 . . . . . M

Royal 8.A.xviii, fol.69v-75r . . . . . R

Wien Dominikanerkloster. Cod.93/57, fol.99ra-109vaW

NOTE: The following text is based upon the best reading of the four above-mentioned manuscripts, In the apparatus only important variants are noted.

Exposicio Terminorum Naturalium Philosophie Magistri Wilhelmi Hesbri.

Natura est principium motus et quietis eius in quo est primo per se et non secundum accidens. Istam diffinitionem ponit Philosophus et Commentator 2° Phisicorum et in 5° Metaphisice. Unde natura est principium motus et quietis eius, diversimode tamen. Nam natura est principium motus eius quando ipsum ponitur extra locum suum naturalem, et natura est principium quietis eius quando ipsum ponitur in loco suo naturali. Ut si terra ponatur sursum in aere nisi impediatur statim movetur naturaliter descendendo, ideo natura est principium motus eius; et si terra ponatur in loco suo naturali ibi quiescit et hoc naturaliter, ideo natura est principium quietis eius.

Motus dicitur duobus modis, scil. motus subitus et motus successivus. Motus subitus est talis mutacio qui non causatur ex aliqua resistencia, ut inducio luminis. Nam luminosum inducens lumen in aliquod medium, quia non invenit resistenciam, subito inducit lumen. Set talis motus non proprie dicitur motus set mutacio quedam. Motus successivus est qui causatur ex certa proporcione potencie ad resistenciam. Et talis motus videtur proprie dictus. Unde non potest esse motus proprie dictus nisi sit successivus, et non potest esse successio in motu vel partibilis adquisicio nisi sit ibi resistencia; patet ergo quod non potest esse verus motus nisi sit resistencia. Motus a Philosopho diffinitur sic in 3° Phisicorum: motus est actus entis in potencia secundum quod est in potencia. Motus diffinitur a Commentatore sic: motus est adquisicio

12. mutacio: motus R
20-21. in 3° Phisicorum: om.R V

*Titulus ex M

partis post partem termini illius ad quem tendit res mota. Prima est formalis, 2a materialis. Per istas diffinicionos satis patet quod sit partibilis adquisicio et successio in motu proprie dicto. Duo sunt termini in motu, scil. terminus a quo et terminus ad quem. Terminus a quo in motu est ille a quo incipit motus et deperditur per motum. Terminus ad quem est ad quem terminatur motus et ultimatim adquiritur per motum. Ut si quis iret ab Oxon ad London, tunc esset Oxon terminus a quo et London terminus ad quem.

Decem sunt predicamenta, scil. substancia, qualitas, quantitas, relacio, accio, passio, ubi, quando, posicio, et habitus. In quatuor illorum conceditur a Philosopho esse motum, viz substancia, quantitate, qualitate et ubi. In predicamento substancie sunt due species motus opposite scil. generacio et corrupcio. Generacio est transmutacio de non esse ad esse, corrupcio est transmutacio de esse ad non esse. Unde generacio et corrupcio non sunt motus proprie dicti, quia non sunt motus successivi. Similiter ad hoc quod in alico predicamento sit motus proprie dictus requiritur quod subiectum immediate recipiens illam formam adquisitam per istum motum sit in actu de se et compositum ex materia et forma. Set nullum subiectum est immediate recipiens formam substancialem que adquiritur per motum generacionis, nisi materia prima que de se non est in actu nec composita ex materia et forma. Generacio est duplex, scil. generacio simplex et generacio secundum quid. Generacio simplex est generacio substancie, generacio

28-29. Place-names as given in R
31-35. In ... ubi: om.R
34. opposite: om.M
38. immediate: i mediatum C V om.R
39. formam: immediate add.R

secundum quid est generacio accidentis. Corrupcio est duplex, scil. corrupcio simplex et corrupcio secundum quid. Corrupcio simplex est corrupcio substancie, corrupcio secundum quid est corrupcio accidentis.

In predicamento qualitatis reperitur motus proprie dictus qui dicitur alteracio. Alteracio est transmutacio de una qualitate in aliam, manente eodem subiecto a principio usque in finem, cuiusmodi est calefaccio, frigifaccio, albifaccio, nigrifaccio et similia. In alteracione vera reperitur successio, quia in alteracione est vera resistencia que causatur ex qualitate contraria qualitati inducende.

In predicamento quantitatis reperiuntur due species motus proprie dicti, scil. augmentacio et diminucio. Augmentacio est motus de minori quantitate ad maiorem quantitatem, diminucio est econtra. Ad veram augmentacionem tria requiruntur. Primum est quod subiectum recipiens illam augmentacionem maneat idem a principio usque in finem. Secundum est quod quelibet pars aucti sit aucta. Tercium est quod illa augmentacio fiat per aliquod corporeum de novo adveniens. Et si deficiat aliqua istarum trium condicionum, non est augmentacio proprie dicta. Et econtra de diminucione. Ideo nulla augmententur nisi animata; ideo si inanimata augmententur hoc est improprie, scil. quando rarefiunt vel condensantur. Rarefaccio est parcium remocio inter se sine aliqua novi corporis adquisicione, nam rarum est tale, cuius partes remote iacent, ut ponit Philosophus in Predicamentis cap^{o} de quantitate[1]. Condensacio est parcium adinvicem constriccio sive compressio sine aliqua novi corporis deperdicione, nam densum est tale, cuius partes propinque iacent, ut patet in predicamentis, cap^{o} quo prius.

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52. vera[1]: una M // vera[2]: una M

Quantitas dicitur duobus modis, scil. quantitas continua et quantitas discreta. Quantitas continua est illa cuius partes copulantur ad aliquem terminum communem. Et talis quantitatis sunt 5 species, ut patet in predicamentis cap° de quantitate, scil. linea, superficies, corpus, locus et tempus. Linea est longitudo sine latitudine et profunditate, cuius extrema sunt duo puncta. Superficies est longitudo et latitudo sine profunditate cuius extrema sunt due linee. Corpus est longum, latum et profundum, cuius extrema sunt due superficies. Et ideo de numero istorum solum corpus est perfictum, quia sibi non deest aliqua dimensio. Tres sunt dimensiones, scil. longitudo, latitudo et profunditas. Locus est ultima superficies corporis continentis locatum immobilis. Tempus est mensura motus sec. prius et posterius. Quantitas discreta est talis cuius partes non terminantur ad aliquem terminum communem, et tales sunt due, scil. numerus et oracio. Numerus est quantitas discreta resultans ex collacione unitatum ad invicem. Oratio est vox significativa ad placitum.

Tempus, motus et huiusmodi dicuntur res successive. Unde quedam est res successiva, quedam permanens. Res successiva est illa cuius

73-4. talis ... quantitate: tales sunt 5 M V
75-6. et profunditate: mm.V //extrema: extremitates M V
78. extrema: extremitates M
81. profunditas: Quoddam est corpus sphericum, quoddam rotundum, quoddam densum, quoddam rarum, quoddam circulare, quoddam figuratum, quoddam planum, quoddam columpnaris figure. Corpus sphericum est quod est solidum et rotundum cuius medius punctus omnes lineas extendentes ad circumferenciam facit equales. Et alia patent. add.V. cf. end of treatise.
82. locatum: om.M V // immobilis: om.C R

non omnes partes manent simul in actu cum suo toto, ut dies, hora et huiusmodi. Nam non quelibet pars diei manet simul in actu cum die; quia existente prima hora diei est dies, set tunc secunda hora nondum est. Esse talium successivorum est simul in actu fieri. Nam bene sequitur: dies est in fieri, igitur dies est. Res permanens est illa cuius omnes partes manent simul in actu cum suo toto, ut domus. Nam domus manet simul in actu cum quelibet parte domus. Set esse permanencium presupponit fieri in eisdem. Nam domus prius est in fieri quam in facto esse. Unde non sequitur: domus est in fieri, igitur domus est; set pocius sequitur oppositum.

Nota quod punctus est quoddam indivisibile in linea ad quod copulantur partes linee. Unde quedam sunt puncta extrinseca et quedam intrinseca. Extrinseca puncta vocantur primus punctus et ultimus, vel dicuntur extrema puncta, que eadem sunt. Puncta intrinseca vocantur omnia puncta inter dua puncta extrinseca. Et sic de instanti respectu temporis. Nota quod non sunt plura puncta in linea centipedali quam in linea pedali. Immo tot sunt in linea minori quot sunt in maiori, quia in quacumque linea quantumcumque modica, sunt infinita puncta, et nullum infinitum est alio infinito maius neque minus, nec aliqua infinita aliis infinitis sunt plura aut pauciora.

90. manet simul in: permanet C
91-2. secunda ... non est: non quelibet pars diei est R
93. bene: om.R
95. ut: homo et add.M V
96-7. Nam ... esse: om.M
98. oppositum: Unde bene sequitur prius est domus in fieri quam in facto esse add.M
100-1. Unde ... intrinseca: om.M R V
101-2. Extrinseca ... sunt: om.R // vel dicuntur ... sunt: om.C
102. sunt: et ad quod copulantur linee add.V
103-4. Et sic ... temporis: om.C V

In predicamento ubi reperitur motus proprie dictus, qui dicitur
110 loci mutacio vel motus localis quod idem est. Et motus localis est
mutacio de uno loco ad alium, eodem subiecto manente a principio usque
in finem. Et ille motus solum competit corporibus, ut patet per
auctorem 6 principiorum, capitulo de accione, ubi dicit sic: solum
corpus, eo quod de loco ad locum transit, movetur. Corpus dicitur
115 duobus modis, scil. corpus simplex et corpus mixtum. Corpus simplex
est tale quod non componitur ex contrariis, ut elementum, quod solum
componitur ex materia prima et forma elementari. Materia prima est
maxime simplex, quia non componitur ex materia priori. Unde materia
prima est ista que est prima in via composicionis et ultima in via
120 resolucionis. Et est materia prima ad omnes formas in potencia et
nullam certam sibi determinat. Corpus mixtum est illud quod componitur
ex contrariis elementis, et vocatur corpus mixtum lapis et huiusmodi.
Adhuc corpus mixtum dicitur duobus modis, scil. animatum et inanimatum.
Corpus animatum est illud cuius forma per quam ultimate actuatur est
125 anima, et hoc est triplicíter: primo modo cuius forma ultima est
anima vegetativa, sicut arbor, planta; secundo modo cuius forma ultima
est sensitiva, ut equus, bos; tercio modo cuius forma ultima est anima
intellectiva, ut homo. Corpus inanimatum est illud quod non actuatur
per animam, ut aurum, argentum.

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110. loci mutacio vel: om.C R // quod idem est: om. C R
111. mutacio: motus M
112. solum: aliquando V
112-3. per auctorem ... solum: illegibile in V. cf. Liber de Sex Principiis Gilberto Porretanae asceriptus. ed.A.Heysse OFM, Münster 1953, p.12.
124-5. cuius ... anima: cui forma ultima est anima C, quod causatur per animam R
124. actuatur: est V
125-6. primo ... vegetativa: aut per animam vegetativam R
126-7. secundo ... sensitiva: aut per animam vegetativam et sensitivam R
127-8. tercio ... intellectiva: aut per animam vegetativam et sensitivam et intellectivam R

Sex sunt differencie posicionis, scilicet sursum, deorsum, dextrorsum, sinistrorsum, ante et retro. Unde omne quod movetur movetur per aliquod istorum. Omne corpus corruptibile motum solum movetur versus unicam differenciam posicionis, et hoc naturaliter loquendo de natura elementari, tam de corpore simplici quam de corpore mixto, et tam de animato quam de inanimato. Omne corpus simplex movetur naturaliter versus locum suum naturale; nam ignis qui est corpus simplex movetur naturaliter versus sursum et terra versus deorsum. Et mixta inanimata moventur naturaliter versus unicam differenciam posicionis, cum omne mixtum movetur ad motum elementi dominantis in eo, ut mixtum in quo dominatur ignis movetur ascendendo, et mixtum in quo dominatur terra movetur descendendo. Et sic est de mixto animato, nam animal secundum quod est corpus grave est mobile versus diversas differencias posicionis. Unde omne corpus quod movetur, movetur ex proporcione potencie ad suam resistenciam. Duplex est resistencia, scilicet extrinseca et intrinseca. Resistencia intrinseca est illa que est in re mota, et causatur ex proporcione contrariorum, et illa resistencia reperitur in corporibus mixtis et non in simplicibus. Resistencia extrinseca est illa que est extra rem motam et causatur ex

131-2. Unde ... istorum: om.V
132. movetur per aliquod istorum: aut movetur sursum aut deorsum etc. M // motum solum: om.R
134. natura elementari: corpore elementorum R
135. inanimato: adhuc corpus dicitur duobus modis, scilicet perfectum et imperfectum. Omne perfectum est illud quod componitur ex 4 elementis, corpus imperfectum quod non componitur nisi ex duobus vel tribus. add.R
135-6. Omne ... naturale: om.G M V
138-9. et mixta ... posicionis: om.R
141. descendendo: et tamen non movetur ita velociter sicut tanta terra pura per se, quia ignis, que contrariatur illi terre, nititur movere motu contrario motui illius mixti, resistendo inquantum potest; et illius est resistencia intrinseca. add.R. cf.infra. line 53-6, apparatus
145-7. Resistencia ... simplicibus: om.R
146. proporcione: posicione M V, composicione G

difficultate divisionis medii, ut aeris et aque et huiusmodi. Ut si mixtum descendat, tunc densitas aeris sibi resistit extrinsece, et elementum subdominans sibi resistit intrinsece. Unde si mixtum movetur in medio vel in pleno, quod idem est, illud movetur ex proporcione potencie ad resistenciam extrinsecam et intrinsecam. Et si simplex motum in medio movetur, tunc movetur ex proporcione potencie sue ad resistenciam extrinsecam, quia simplex non habet resistenciam intrinsecam. Set si imaginaretur vacuum, mixtum moveretur in illo vacuo ex proporcione sue potencie ad suam resistenciam intrinsecam solum. Set simplex moveri in vacuo non posset, quia nullam resistenciam haberet.

Motus localis dicitur duobus modis, scil. motus naturalis et motus violentus. Motus naturalis est ille qui procedit a principio rei intrinseco, ut descensus est motus naturalis terre, et ascensus est motus naturalis ignis. Motus violentus est ille qui procedit a principio rei extrinseco, ut si terra pelleretur versus sursum, ille ascensus est motus violentus. Motus naturalis semper intenditur versus finem, ita quod in quolibet instanti posteriori movetur velocius quam in alico instanti priori. Motus violentus semper remittitur versus finem. Motus rectus est ille mediante quo describitur linea recta, ut motus elementorum existencium extra loca sua naturalia. Motus circularis

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150. descendat: debeat descendere C, esset sursum in aere maiori levitate moveretur descendendo et R
151. subdominans: dominans R
153. resistenciam: potenciam M
153-6. Et si ... intrinsecam: Resistencia intrinseca est illa que est in re mota et causatur ex proporcione contrariorum et illa reperitur in corporibus mixtis, et non in simplicibus. Unde si sit mixtum ex terra et igne, illud in que dominatur terra movetur versus deorsum, quia omne mixtum movetur ad motum elementis dominantis in eo, et tamen non movetur ita velociter sicut tanta terra pura per se. add.R
164. pelleretur: poneretur C, ponatur R, moveatur V // sursum: in aere add.R

est ille motus quo describitur figura circularis, ut motus celi, quia nullus motus potest esse perpetuus et continuus nisi motus circularis. Tria requiruntur ad unitatem motus, scilicet unitas motoris, unitas moti et unitas temporis. Motus reflexus non potest esse unus motus et continuus, quia inter quoscumque duos motus contrarios cadit quies media.

Omne quod movetur successive, movetur, movebatur et movebitur, ita quod non est dare primum instans motus successivi nec ultimum. Ideo generaliter sé Sortes incipit moveri, ipse incipit moveri per remocionem de presenti et posicionem de futuro; et si ipsum desinit moveri, desinit moveri per posicionem de presenti et remocionem de futuro. Et sic omnis motus successivus est temporalis et mensuratur tempore. Set motus subitus mensuratur tantum per instans, igitur talium motuum est dare primum instans et ultimum.

Gradus summus est ille gradus qui non est admixtus cum suo contrario, et est ita intensus in sua natura quod nullus gradus illius nature est eo intensior, continens sub se virtute omnem gradum possibilem illius nature. Ut gradus summus albedinis est ille gradus qui nullo modo est admixtus cum nigredine. Non gradus albedinis est pura privacio albedinis, sicut nigredo summa que nichil habet albedinis. Latitudo

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168-170. linea ... describitur: om.M (hom.)
170. figura: linea R
171. continuus: unus M V // nisi: idem M
173. moti: motus M, spacii R // non: om.M
174. et continuus, quia: quia non est continuus V // quia ... duos: inter omnes alios M
178. generaliter ... moveri: quicquid R
179-180. de presenti ... futuro: de preterito M
179. presenti: preterito V // futuro: futuro presenti V
180. presenti: preterito V // futuro: presenti V. For the two expressions of incipit and desinit cf. Heytesbury, Regulae, c.4, ed. Venice 1494, fol 83v
186. virtute: om.R, virtualiter V
187-190. est ... continens: continet R (homoeoteleuton)

albedinis est tota natura albedinis, continens in se omnes gradus albedinis uniformiter dispositos secundum remissius et intensius a non gradu albedinis usque ad summum gradum. Et sic de latitudine aliarum qualitatum. Unde in omne latitudine sunt infiniti gradus sicut in omni tempore sunt infinita instancia, et inter omnes duos gradus cadit latitudo media sicut inter omnia duo instancia cadit tempus medium. Unde gradus dicuntur intensi et remissi penes participacionem cum suis contrariis secundum magis et minus. Ideo albedo dicitur intensa eo quod modicum habet de suo contrario secum admixto, et dicitur remissa eo quod multum habet de suo contrario secum admixto. Unde si sint duo gradus albedinis, in quanto unus minus habet de nigredine secum admixta quam reliquus, in tanto dicitur intensior, et in quanto plus habet de nigredine in tanto dicitur remissior. Et si nichil habeat, tunc dicitur intensissimus, vel summus, quod idem est. Alio modo dicuntur gradus intensi vel remissi penes propinquitatem vel distanciam a suo non gradu. Unde gradus dicitur intensus quia per magnam latitudinem distat a non gradu, et dicitur remissus eo quod per modicam latitudinem a non gradu distat. Unde si sunt duo gradus intensi, ille qui per maiorem latitudinem distat a non gradu dicitur intensior, et qui per minorem latitudinem distat a non gradu dicitur remissior. Unde quilibet gradus, quo aliquis gradus est intensior, dicitur remissus. Ideo, quia quolibet gradu inter non

191. dispositos: difformiter R
201-2. et in quanto ... remissior: om.R
206. et dicitur ... distat: om.R
210. remissus: remissior R // quia: in R // quolibet gradu: om.M

gradum et gradum summum aliquis gradus est intensior et aliquis remissior, nullus gradus est intermedius inter non gradum et gradum summum quin est intensus et remissus. Set summus gradus est intensus et non remissus. Intendere est per aliquam latitudinem mediam gradum perfeciorem adquirere. Remittere est gradum perfeciorem per aliquam latitudinem mediam deperdere. Intendere est dupliciter, scil. inclusive et exclusive. Intendere ad aliquem gradum inclusive est per latitudinem mediam illum gradum adquirere. Intendere ad aliquem gradum exclusive est latitudinem mediam terminatam ad illum gradum adquirere, non adquirendo illum gradum. A non gradu intendere est a pura privacione illius qualitatis gradum aliquem adquirere. Remittere est dupliciter, scil. inclusive et exclusive. Remittere ad aliquem gradum inclusive est totam latitudinem supra illum gradum deperedere, deperdendo illum gradum, et sub illo gradu in fine remissionis non existere. Remittere ad aliquem gradum exclusive est totam latitudinem supra illum gradum deperdere, non deperdendo illum gradum, et sub illo gradu in fine remissionis existere. Ad non gradum remittere est totam latitudinem usque ad puram privacionem deperdere. Intendere ad aliquem gradum sive exclusive sive inclusive est dupliciter,

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212. intermedius : internus V, intrinseous R
214. per... mediam : om.R
216-244. Intendere... movetur : much abbreviated in M
218. adquirere : quarere R // est : per add.V
222. totam : certam V
223. deperdere : non add.V
224-6. Remittere... existere : om.V
225. gradum : habitum add.R
226. Ad non gradum : a non gradu R

scil. uniformiter et difformiter. Uniformiter intendere est tantam latitudinem adquirere in una parte temporis sicut in alia sibi equali. Difformiter intendere est maiorem latitudinem adquirere in una parte temporis quam in alia sibi equali. Remittere similiter est duplex, scil. uniformiter et difformiter. Uniformiter est tantam latitudinem perdere in uno tempore sicut in alio tempore sibi equali. Difformiter remittere est maiorem latitudinem deperdere in uno tempore quam in alio sibi equali. Unde si quis intenderet motum suum uniformiter vel difformiter, difformiter movetur et non uniformiter. Nam qui uniformiter movetur continue eodem gradu motus movetur, nec adquirendo latitudinem motus nec deperdendo; nam uniformiter moveri est tantum spacium pertransire in una parte temporis sicut in alia sibi equali. Set quicquid intendit motum suum vel remittit motum suum adquiret vel deperdet latitudinem motus, et sic aliquando movetur gradu intensiori et aliquando gradu remissiori. Igitur quicquid intendit vel remittit motum, difformiter movetur.

Ad hoc quod aliqua sint activa et passiva adinvicem duo requiruntur. Primum est quod illa sint similia quoad materiam, idest quod sint communicancia in materia. Secundum est quod sint contraria quoad formam, idest quod forme istorum sint contrarie. Unde ad actionem requiritur similitudo materiarum et contrarietas formarum. Item ad hoc quod sit

232-4. Remittere ... equali: om.R
236. difformiter: seu remitteret motum suum uniformiter vel difformiter add.V
245-9. aliqua ... quod: om.R (hom.)

accio requiritur quod sit dominium agentis su ra passum quod patitur sub illo agente. Unde omne agens se habet ad suum passum in proporcione maioris inequalitatis, et requiritur quod p tencia agentis excedat resistenciam passi. roporcio dividitur in pro orcione equalitatis, in proporcione maioris ine ualitatis, et in proporcione inoris inequalitatis. Proporcio maioris inequalitatis est habitudo maioris quantitatis ad minorem, ut 4 ad 2. Proporcio minoris inequalitatis est habitudo minoris quantitatis ad maiorem ut 2 ad 4. Prop roio equalitatis est duarum quantitatum equalium adinvicem habitudo, ut 4 ad 4. Et solum ex proporcione maioris inequalitatis provenit m tus et accio. Aliquid potest agere in aliquo dupliciter, vel ex pro orcione tocius ad totum, vel ex proporcione tocius ad partem. Agens agit in passum ex proporcione tocius ad totum, quando totum agens dominatur supra totum passum, et sic agit maius in minus; et hoc proprie vocatur agere vel accio. Agens agit in passum ex proporcione tocius ad partem, quando agens non dominatur supra totum passum set supra aliquam partem illius; et tunc est accio ex proporcione tocius agentis ad partem illam; et hoc vocatur reagere vel reaccio. Et talis reperitur inter maius et minus, vel inter duo equalia. Aliquid potest pati dupliciter, scil. secundum se totum et secundum partem. Sb secundum partem dicitur repati. Ideo omne agens communicans in materia cum passo in agendo repatitur. Unde partes elementares maxime sunt active et passive, set omnia elementa

256. 2: et de istis habebis in proporcionibus Barwardini add.M
256-8. Proporcio ... ut 4 ad 4: om.M
257. habitudo ... 4: econtra V
271. elementares: elementorum R // set: sicut R

in suis speris sunt equalis virtutis simpliciter. Ideo inter elementa in suis speris est reaccio et repassio, quia agunt adinvicem, et compaciuntur, secundum partes immediatas.

Quatuor sunt elementa, scil. ignis, aqua, aer et terra. Et quatuor sunt qualitates prime, scil. caliditas, frigiditas, humiditas et siccitas, secundum quarum combinaciones resultat numerus elementorum. Nam sex sunt combinaciones primarum qualitatum, quarum due sunt impossibiles; igitur tantum quatuor sunt combinaciones qualitatum primarium possibiles, et tot sunt elementa. Et sic investigatur a Philosopho in libro de generacione ubi dicit quod tantum quatuor sunt elementa in specie. Prima combinacio est caliditas et siccitas, cui correspondet ignis; est enim ignis calidus et siccus in quo dominatur caliditas. Secunda combinacio est caliditas et humiditas, cui correspondet aer, qui est calidus et humidus, in quo dominatur humiditas. Tercia combinacio est humiditas et frigiditas, cui correspondet aqua, que est humida et frigida, in qua dominatur frigiditas. Quarta combinacio est frigiditas et siccitas, cui correspondet terra, que est frigida et sicca, in qua dominatur siccitas. Quinta combinacio est caliditas et frigiditas, et isti combinacioni non correspondet aliquod elementum, quia ista combinacio est impossibilis; quia caliditas et frigiditas sunt qualitates contrarie, et qualitates contrarie non possunt esse in eadem combinacione.

272. speris ... inter: propriis virtutibus, sicut inter duo R
273. quia: que C, et continue R
277. elementorum: elementaris R
277-9. Nam ... tantum: om.V
279. possibiles: om.V
280. et ... elementa: om.M V
281. specie: proporcione R
283. dominatur caliditas: caliditas se habet in predominio M V
289-294. Quinta ... predictam: Alie combinaciones non sunt possibiles: igitur eis nullum elementorum correspondet V
291-2. quia ... combinacione: om.M
292. combinacione: dominacione R

Sexta combinacio est humiditas et siccitas, cui non correspondet aliquod elementum propter causam predictam. Ignis est elementum nobilissimum, rarissimum, levissimum et subtilissimum. Ideo collocatur in supremo loco regionis elementaris, scilicet in concavo orbis lune. Et sub illo immediate est aer, et sub aere aqua, et sub aqua terra, que est elementum gravissimum et vilissimum, et ideo collocatur in loco infimo. Sicut ignis est in decuplo maioris quantitatis quam aer et in decuplo rarior, ita aer est in decuplo maior quam aqua et in decuplo rarior, et ita aqua est in decuplo maior quam terra et in decuplo rarior. Unde elementum in quanto maioris quantitatis est in tanto rarius est, et in quanto minoris quantitatis est in tanto densius. Quedam elementa sunt simbola et quedam dissimbola. Elementa simbola sunt illa que conveniunt in aliqua qualitate prima, ut ignis et aer, aer et aqua, aqua et terra, terra et ignis. Et elementa dissimbola sunt illa que in nulla qualitate conveniunt, ut ignis et aqua, aer et terra. Item inter elementa simbola facilior est accio, ut patet in libro de generacione. Elementa sunt corpora homogenia. Corpora homogenia sunt illa quorum omnes partes sunt eiusdem denominacionis et eiusdem nature cum suo toto, ut elementa; nam quelibet pars aque est aqua, et quelibet pars terre est terra. Corpora etherogenia sunt illa quorum non omnes partes sunt eiusdem nature et eiusdem denominacionis cum suo toto, ut homo et huiusmodi: nam non quelibet pars hominis est homo.

303. rarius ... tanto: om.M (hom.)
306-7. aqua, aqua ... aer et: om.M (hom.)
309. libro: primo M, secundo V; cf. De Gen. et Corr. II,4 (331a26seq.)

De numero qualitatum primarum quedam dicuntur active et quedam passive: active sicut caliditas et frigiditas, passive sicut humiditas et siccitas. Et sic de elementis in quibus dominantur. Et non tamen dicuntur active quia non passive, quia hoc est falsum, set quia principaliter active et ex consequente passive.

Qualitates secunde sunt ille que resultant ex certa proporcione qualitatum primarum adinvicem, ut albedo, nigredo, amaritudo, dulcedo, etc. Quarum quelibet dicitur uniformis vel difformis. Qualitas uniformis est illa cuius quelibet pars est eque intensa cum suo toto. Unde si sit aliqua qualitas uniformis, tunc nulla pars est intensior alia. Tamen in qualitate uniformi una pars est maior alia, non tamen intensior. Unde non eadem causa dicitur albedo intensior alia, et alia maior. Nam albedo dicitur alia maior quia extenditur per maius subiectum quam alia. Set albedo dicitur alia intensior quia per maiorem latitudinem distat a non gradu. Unde intensio qualitatis est ratione distancie a suo non gradu; set magnitudo qualitatis est racione sui subiecti. Unde intensum et remissum sunt proprie qualitatis differencie, ideo qualitas dicitur intensa et remissa per se. Set magnum et parvum sunt proprie differencie

322. difformis: Nota quod albedo resultat ex certa proporcione maioris inequalitatis lucis supra opacitatem, et nigredo econtra. Et sciendum quod opacum idem est quod obscurum, nigrum sive tenebrosum, et sic carbo dicitur corpus opacum. Corpus diaffonum, transparens vel pervium est corpus susceptivum luminis per totum, ut berillus, cristallum vel vitrum. Et sic alie qualitates resultant ex proporcionibus suis et suorum contrariorum. add.R

328-411. latitudinem ...sibi equali: om.R (Fol.deest)

quantitatis, ideo quantitas dicitur magna et parva per se racione dimensionis. Set tamen qualitas aliquando dicitur magna vel parva, et hoc non per se, set per accidens, quia raci ne alterius ut puta quantitatis.

Qualitas difformis est cuius una pars est intensior alia. Qualitas difformis est dupler, scilicet qualitas difformiter difformis et qualitas uniformiter difformis. Qualitas difformiter difformis est talis cuius alique partes immediate secundum extensionem multum distant secundum intensionem, et cuius partes que terminantur ad eundem punctum in quantitate non terminantur ad eundem gradum in qualitate. Ut si A sit unum corpus cuius una medietas sit alba gradu summo secundum se totam, et alia medietas alba gradu medio inter gradum medium et gradum summum secundum se totam, tunc est tota illa albedo difformiter difformis, et hoc corpus est album difformiter difforme; quia alique partes immediate secundum extensionem, vel secundum quantitatem, multum distant secundum intensionem, vel secundum qualitatem; nam due medietates ipsius A sunt immediate secundum extensionem, quia terminantur ad eundem punctum, ut puta ad punctum medium ipsius A, et ille medietates multum distant secundum intensionem, quia non terminantur ad eundem gradum qualitatis set distant qualitative per intensionem et naturam tocius latitudinis albedinis. Aliqua duo esse immediata est dupliciter: secundum intensionem et secundum extensionem. Ille sunt immediata

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336. quantitatis: Sic quantitas dicitur etiam intensa vel remissa non tamen per se set per accidens quia racione alterius quam ut puta qualitatis. add.V
338. difformiter: om.V
339. difformis(1): uniformis M V
341. que: eque C
350-2. et ille ... qualitatis: om.M
352. intensionem et naturam: intensivam quantitatem C

secundum extensionem que terminantur ad eundem punctum. Illa sunt immediata secundum intensionem que terminantur ad eundem gradum.

Qualitas uniformiter difformis est illa cuius omnes partes immediate secundum extensionem secundum intensionem terminantur ad eundem gradum. Et ille gradus ad quem sic terminantur est intensissimus qui non est in parte intensiori, et remississimus qui non est in parte remissiori. Nam ille gradus ad quem sic terminantur tales partes immediate non est in parte intensiori, et quilibet intensior illo est in parte intensiori. Et ille gradus (remississimus est) qui non est in parte remissiori, et quilibet remissior illo est in parte remissiori, qui non est in parte remissiori. Etiam omnis qualitas uniformiter difformis terminatur ad duos gradus qui dicuntur extremi, vel ad gradum vel ad non gradum. Unde quelibet latitudo terminata ad duos gradus quorum neuter est summus terminatur ad unum secundum extremum sui intensius et ad alium gradum secundum sui extremum remissius. Et ille ad quem terminatur talis latitudo secundum sui extremum intensius dicitur remississimus qui non est in ista latitudine; nam ille non est in ista latitudine, et quilibet remissior illo citra certum gradum est in ista latitudine. Et ille ad quem terminatur secundum extremum sui remissius dicitur intensissimus qui non est in ista latitudine; nam ille gradus non est in ista

357. partes: sunt add.C
358. extensionem: sunt mediate add.V //secundum intensionem: et C, et Add.V
360. et ... remissiori: om.C
363. remississimus est: om.C
364. et quilibet ... remissiori: om.C V (hom.)
366. qui ... extremi: exclusive C // vel ad gradum: om.M
368. unum: illum C
368-9. intensius ... remissius: om.V
369. Et ille: om.M, ideo V
370. intensius: et ad alium gradum add.M (cf.line 368).
371. ista: aliqua M
372. certum: centrum C
373. intensissimus: extensissimus M V

latitudine, et quilibet intensior illo citra certum gradum est in ista latitudine. Quelibet qualitas uniformiter difformis terminatur ad duos gradus ad quos terminatur exclusive. Set qualitas difformiter difformis terminatur aliquando ad gradus exclusive, aliquando inclusive. Set qualitas uniformis non terminatur, set potius terminat, quia qualitas uniformis est se habens per modum termini. Quelibet qualitas uniformiter difformis seu latitudo, quod idem est, correspondet gradui suo medio, et est equalis intensionis cum gradu suo medio, et est minus intensa quam medietas eius intensior, et magis intensa quam medietas eius remissior. Unde latitudo a gradu ut 8 ad non gradum est equalis intensionis cum qualitate uniformi ut 4, et sic de aliis.

Motus dicitur 4 modis, scil. motus uniformis, motus difformis, motus uniformiter difformis et motus difformiter difformis. Motus uniformis est ille quo tempore equali pertransitur spacium equale; unde moveri uniformiter est tantum spacium pertransire in uno tempore quantum in alio sibi equali. Motus difformis est ille quo tempore equali pertransitur spacium inequale; unde moveri difformiter est plus de spacio pertransire in uno tempore quam in alio sibi equali. Motus uniformiter difformis est ille quo uniformiter adquiritur latitudo motus vel uniformiter deperditur latitudo motus; ideo moveri uniformiter difformiter est uniformiter adquirere vel uniformiter deperdere latitudinem motus. /Motus

375. certum: centrum C
376-381. terminatur ... difformis: om.M (hom.)
377. terminatur: terminantur C V
383. magis intensa: remissa M
386-7. Motus(1) ... difformiter difformis: Motus est duplex: scil. uniformis et difformis M
390-399. Motus ... motus: om.M
393. uniformiter: moveri C
393. uniformiter$_2$(2) : moveri C
394-5. ideo ... motus: om.C
395-7. Motus ... motus: om.C V (supplevi)

difformiter difformis est ille quo difformiter adquiritur latitudo motus vel difformiter deperditur latitudo motus; ideo moveri difformiter /difformiter/ est difformiter adquirere latitudinem motus vel difformiter deperdere latitudinem motus.

Et quot modis dicitur moveri tot modis dicitur intensio motus vel remissio. Sicut motus se habet ad spacium extra, sic se habet intensio motus ad latitudinem motus; quia sicut per motum adquiritur spacium extra, sic per intensionem adquiritur latitudo. Ideo intensio motus est adquisicio latitudinis motus, et intendere motum est adquirere latitudinem motus. Et remissio motus est deperdicio latitudinis motus, et remittere motum est deperdere latitudinem motus. Ideo intensio motus dicitur 4 modis: uniformis, difformis, uniformiter difformis et difformiter difformis. Sic etiam remissio motus dicitur 4 modis, scil. uniformis, difformis, uniformiter difformis et difformiter difformis. Intensio motus uniformis est qua tempore equali latitudo motus adquiritur equalis, ideo intendere motum uniformiter est tantum de latitudine motus adquirere in uno tempore quam in alio sibi equali. Remissio motus uniformis est illa qua in tempore equali latitudo motus deperditur equalis; ideo remittere motum uniformiter est tantum de latitudine motus deperdere in uno tempore sicut in alio sibi equali. Intensio motus difformis est illa qua in tempore equali latitudo motus adquiritur inequalis; unde

398. difformiter[1]: om.C V (supplevi)
401. sic: motus add.C
402. motum: latitudinem motus C
403. intensionem: motus add.M // latitudo: motus add.M //intensio: latitudo M
403-5. Ideo ... latitudinem motus: om.C (hom.)
405. remissio motus: intendere motum V // deperdicio: vel adquisicio add.V
405-6. et remittere ... latitudinem motus: om.M
406-8. Ideo ... difformiter difformis: Ideo intensio motus dicitur dupliciter, scil. uniformis et difformis; difformis autem est duplex, scil. uniformiter difformis et difformiter difformis C Ideo intensio motus dicitur dupliciter, scil. uniformis et difformis. Similiter (?) remissior (sic) uniformis et difformis M
411-2 & 414-5. ideo ... equali: om.M

intendere motum difformiter est plus de latitudine motus adquirere in una parte temporis quam in alia sibi equali. Remissio difformis est illa qua in tempore equali latitudo motus deperditur inequalis; unde remittere motum difformiter est plus de latitudine motus deperdere in uno tempore quam in alio sibi equali. Intensio uniformiter difformis est illa mediante qua in tempore equali latitudo intensionis motus adquiritur equalis; unde uniformiter difforme intendere motum est tantum de latitudine intensionis motus adquirere in uno tempore sicut in alio sibi equali. Remissio uniformiter difformis est illa qua in tempore equali latitudo intensionis deperditur equalis; unde remittere motum uniformiter difformiter est tantum de latitudine intensionis deperdere in uno tempore sicut in alio sibi equali. Intensio difformiter difformis est illa qua in tempore equali latitudo intensionis adquiritur inequalis; unde difformiter difformiter intendere motum est plus de latitudine intensionis motus adquirere in una parte temporis quam in alia sibi equali. Remissio difformiter difformis est illa qua in tempore equali latitudo intensionis deperditur inequalis; unde difformiter difformiter remittere motum est plus de latitudine intensionis motus deperdere in uno tempore quam in alio sibi equali. Adhuc aliquid moveri uniformiter est dupliciter, scilicet, quoad tempus et quoad subiectum. Quoad tempus movetur illud uniformiter cuius punctus velocissime motus uniformiter movetur. Illud movetur uniformiter quoad subiectum cuius quelibet pars movetur equevelociter cum suo toto. Et sic difformiter moveri. Solus motus successivus est velox et tardus; motus subitus non.

418-435. Remissio ... equali: om. M

Causa dicitur quatuor modis, scil. causa materialis, causa formalis, causa efficiens et causa finalis. Causa materialis est illa ex qua componitur res primo et manet in re. Unde causa materialis et materia idem sunt. Causa formalis est illa per quam res est talis qualis ipsa est, qua posita ponitur res primo, et qua ablata aufertur et res. Causa efficiens est illud agens quod componit principaliter rem vel efficit eandem. Causa finalis est illa causa propter quam fit illa primo et principaliter. Verbi gracia, lapides, ligna et huiusmodi sunt causa materialis domus; talis figura resultans ex coniunctione parcium adinvicem est causa formalis domus; ipse carpentarius est causa efficiens domus; set conservacio corporis a nocivis extrinsecis, scil. ab imbribus et a frigoribus et huiusmodi, est causa finalis domus. Due illarum causarum sunt intrinsece, scil. materialis et formalis; et due extrinsece, scil. efficiens et finalis. Unde in 1° Phisicorum tradita sunt tria principia intrinseca rerum naturalium, scil. materia, forma et privacio. Set prime due sunt per se, et tercia per accidens.

Corpus columpnare est corpus longum figuratum ad modum columpne vel ad modum postis. Corpus piramidale vel piramis, quod idem est, est corpus figuratum cuius extremum acutum vocatur conus et extremum obtusum vocatur basis. Corpus circulare vel sphericum est corpus rotundum in cuius medio est unus punctus a quo omnes linee ducte ad circumferenciam sunt equales, et ille punctus vocatur centrum spere vel circuli. Circumferencia spere vel circuli est extrema superficies illius extra quam nichil est eius.

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452. domus: ut in libro Politicorum 2° conceditur add.M
452-4. Due ... tradita: om.M
459. conus: piramidale vel piramis V, piramis M
461. omnes: equales R // ducte: recte R // circumferenciam: transeuntes add.R

Diameter circuli est linea recta exiens ab uno puncto circumferencie ad punctum oppositum que transiens per centrum dividit in 2 semicirculos. Semidiameter est linea recta exiens a centro circuli ad eius circumferenciam. Semicirculus est medietas circuli. Corpus triangulare vel trilaterum vel trigonum est corpus habens tria latera et tres angulos. Corpus quadrangulum, quadrilaterum vel tetragonum est corpus habens 4 angulos et 4 latera. Et hoc est dupliciter: vel quia habet 4 angulos rectos et omnia latera equalia, et sic est quadratum; vel quia habet 4 angulos rectos et omnia latera equalia opposita, et sic est quadrangulum. Corpus pentagonum est corpus habens 5 angulos. Corpus seragonum habet sex. Corpus septagonum habet septem, et sic deinceps. Angulus rectus est quando una linea recta cadit perpendiculariter super aliam. Angulus acutus vocatur quilibet angulus minor recto. Angulus obtusus vocatur quilibet minor recto. Corpus planum est illud cuius superficies est plana, nullatenus vergens ad asperitatem, ut tabula.

Expliciunt termini naturales.

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465. punctum: angulum R
479. Expliciunt ... naturales: Hec complecio terminorum philosophie compilati a magistro Wilhelmi Hesbri M

Joannis Dumbleton

Compendium Sex Conclusionum

Paris, Bibl. Nat., Nouv. Acq. lat. 625, fol. 70v-71v

In hoc compendio intellectum sex conclusionum 4i capituli tractatus proporcionum magistri thome Bradwardin intendo brevissime declarare.

Prima est: omnium duorum circulorum in duplo maior est proporcio unius ad reliquum quam proporcio dyametri unius ad dyametrum alterius.

Secunda: omnium duorum circulorum in duplo maior est proporcio ⟨u⟩ unius ad reliquum quam est proporcio circumfrincie unius ad circumfrinciam alterius.

Tercia: omnium duarum sperarum in triplo maior est proporcio unius earum ad reliquam quam est proporcio maximi circuli unius ad ⟨ad⟩ circumfrinciam maximi circuli alterius.

Quarta: quod in duplo maior est proporcio superficiei cuiuslibet spere ad superficiem alterius quam proporcio dyametri illius ad dyametrum alterius.

Quinta: quod in duplo maior est proporcio superficiei cuiuslibet spere ad superficiem alterius quam proporcio maximi circuli illius ad circumfrinciam maximi circuli alterius.

Sexta: in sexquialtera maior est proporcio cuiuslibet spere ad reliquam quam proporcio superficiei illius ad superficiem alterius.

Primo pro probacione istarum sex conclusionum illas tres diffinicione et sex supposiciones quas ibi praemittit insuper hic (?) praemitto.

Hic nota quod illas tres ultimas conclusiones universales intelligo licet illas sub illa forma qua ponuntur non ponerim, ut melius ⟨ut melius⟩ intelligantur.

Pro probacione prime conclusionis suppono casum quod A et B sint duo circuli equales. Constituo unum quadratum super dyametrum ipsius A et aliud super dyametrum ipsius B. Primum sit C, secundum D. Tunc arguo sic. Omne quadratum est figura plana superficialis equilatera rectangula. Set tam D quam C est quadratum. Igitur tam D quam C est figura plana etc. Consequencia patet, et maior per primas diffinicione, et minor per casum satis est nota. Tunc sic. Omnes superficies sunt similes quorum anguli unius angulis alterius sunt equales, et latera illos angulos continencia sunt proporcionalia. Igitur C,D, sunt due superficies similes. Consequencia patet ex terminis, maior patet ⌈per⌋ secundam diffinicionem, minorem probo quoad utramque partem sui. Et primo quod C,D, sint due superficies quarum anguli unius angulis alterius sunt equales. Sic. Omnes anguli recti sunt sibi invicem equales. Omnes anguli C et D sunt recti. Igitur omnes anguli C et D sunt equales. Consequencia patet ex terminis, maior patet ⌈per⌋ primam supposicionem, minorem probo. Omnis angulus causatus ex linea perpendiculari stante super lineam rectam est rectus. Omnes anguli C,D, sunt huius ⌈modi⌋. Igitur omnes anguli C,D, sunt recti. Maior est conclusio probata in geometria, minor de se est manifesta. Et sic patet quod omnes anguli C et D ⌈sunt⌋ equales. Tunc ultima. Omnes anguli C et D sunt equales. Igitur quilibet angulus C cuilibet angulo D est equalis. Consequencia est nota de se. Antecedens est probatum. Tunc sic. Quilibet angulus C cuilibet angulo D est equalis, et C,D, sunt due superficies. Igitur C et D sunt due superficies quorum anguli unius angulis alterius sunt equales. Patet igitur. Consequens est probatum, quod erat primum

membrorum minoris probande. Nunc probo secundum membrorum, scilicet,
50 quod latera C,D, equales angulos continencia sunt proporcionalia.
50a Et arguo sic. Omnia que sunt sibi invicem equalia sunt proporcionalia. Latera C et D quadrati sunt huiusmodi. Igitur omnia latera C et D sunt proporcionalia. Tunc sic. Omnia latera C,D, continent equales angulos, igitur sequitur quod omnia latera C,D, equales angulos continencia sunt proporcionalia. Nunc fiat argumentum iterum: omnes
55 superficies sunt similes quarum anguli unius angulis alterius etc.; C,D, sunt hujusmodi; igitur C,D, sunt due superficies similes. Tunc ultima. Omnium duarum superficierum multiangularum similium est proporcio unius ad reliquum tamquam cuiuslibet sui lateris ad relatum latus proporcio duplicata. Set C et D sunt due superficies similes
60 multiangule. Igitur proporcio C ad D est cuiuslibet sui lateris ad relatum latus proporcio duplicata. Set C et D sunt duo quadrata super dyametros A et B circulorum. Igitur proporcio C quadrati ad D quadratum est cuiuslibet sui lateris ad relatum latus D proporcio duplicata. /fol.71r/ Consequencia nota est, et totum antecedens patet ex dictis.
65 Arguo nunc ex consequente. Proporcio C quadrati etc. Set aliquod latus C est dyameter A circuli, et aliquod latus D est dyameter circuli B. Igitur proporcio C quadrati ad D quadratum est dyametri A ad dyametrum B proporcio duplicata. Tunc ultima. Omnium duorum circulorum proporcio unius ad reliquum est sicud proporcio quadrati
70 sui dyametri ad quadratum dyametri alterius. Set proporcio quadrati dyametri A circuli ad proporcionem quadrati B circuli est proporcio in duplo maior quam proporcio dyametri A ad proporcionem dyametri B. Igitur A circuli ad B circulum est dyametri A ad dyametrum B proporcio duplicata. Consequencia nota est de se, et maior patet per tercciam

supposicionem, et minor patet per ultimum argumentum probatum. Sequitur ergo conclusio vera, scilicet, quod proporcio A circuli ad B circulum est in duplo maior quam proporcio dyametri A ad dyametrum B. Et sic est arguendum de quibuslibet circulis et sic patet prima ⟨prima⟩ conclusio, scilicet: omnium duorum circulorum in duplo maior est proporcio unius ad reliquum quam proporcio dyametri unius ad dyametrum alterius.

Secundo conclusio probatur faciliter. Et hujus sic arguendo. Omnium duorum circulorum proporcio unius ad reliquum dyametri unius ad dyametrum alterius est proporcio duplicata. Omnium duorum circulorum circumfrincie sunt suis dyametris proporcionales. Et cum per diffinicionem proporcionalium, proporcionalia sunt illa que in consimili proporcione se habent, igitur consimilis et equalis est proporcio inter quorumlibet duorum circulorum circumfrincias sicud inter earum dyametros. Consequencia nota est ex terminis, maior tenet per primam conclusionem probatam, prima pars minoris patet per quartam supposicionem, et secunda pars patet per diffinicionem porporcionalium. Tunc sic. Ex consequente eadem est proporcio inter quorumlibet duorum circulorum circumfrincias sicud inter eorum dyametros. Igitur per quartam supposicionem primi capituli eadem erit proporcio inter quorumlibet duorum circulorum proporcionem et proporcionem suorum dyametrorum. Consequencia nota est. Set nunc per primam conclusionem probatam: omnium duorum circulorum est proporcio unius ad reliquum proporcio sui dyametri ad dyametrum duplicata alterius. Igitur omnium duorum circulorum est proporcio unius ad reliquum ad proporcionem suarum circumfrinciarum eodem modo proporcio generata, quod est secunda conclusio probanda. Vel concludatur sub verbis quibus ponitur in principio, videlicet,

quod omnium duorum circulorum in duplo maior est proporcio unius ad reliquum quam proporcio circumfrincie unius ad circumfrinciam alterius.

Sequitur probacio tercie conclusionis. Et arguo sic. Omnium duarum sperarum in triplo maior est proporcio unius ad reliquam quam proporcio dyametri unius ad dyametrum alterius. Set omnium duorum circulorum circumfrincie suis dyametris sunt porporcionales per quartam supposicionem: si aliqua quantitas ad duas quantitates equales compararetur, illius tunc ad utramque est equalis et eadem proporcio. Igitur eadem est proporcio circumfrinciarum sperarum et suorum dyametrorum. Tunc sic. Eadem est proporcio circumfrinciarum sperarum et dyametrorum. Set omnium duarum sperarum in triplo maior est proporcio unius ad reliquam quam proporcio dyametri unius ad dyametrum alterius. Igitur omnium duarum sperarum in triplo est maior proporcio unius ad reliquam quam proporcio maximi circuli unius ad circumfrinciam maximi circuli alterius, quod erat probandum. Vel arguitur breviter sic. Omnium duarum sperarum in triplo maior est proporcio unius ad reliquam quam proporcio dyametri unius ad dyametrum alterius. Et omnium duarum sperarum eadem est proporcio suarum circumfrinciarum et suorum dyametrorum. Igitur omnium duarum sperarum in triplo maior est proporcio unius ad reliquam quam proporcio circumfrincie unius ad circumfrinciam alterius. Consequencia patet, et maior patet per quintam supposicionem, et minor per quartam, et sic patet intentum.

Ad probacionem quarte conclusionis. Sint A et B due spere inequales et constituo duos quadrangulos super dyametros istarum, et sit C quadrangulus constitutus super dyametrum A, et D quadrangulus constitutus super dyametrum B. Et suppono quod utrumque latus, tam C quam D, sit triplum ad dyametrum super que constituitur, sicud oportet, ut patet

per quintam supposicionem, que dicit: omnium duarum sperarum in triplo maior est proporcio quam dyametrorum in casu ita posito. Fiant tunc argumenta in eadem forma in qua fuerit ad probacionem prime conclusionis, hoc solo excepto quod loco maioris primi argumenti fiat illa maior: omnis quadrangulus est figura superficialis plana rectangula cuius tantum latera opposita sunt equalia. Et postea dicatur quadrangulus ubi dicitur ibi quadratum, et dicatur spera ubi dicitur ibi circulus. Et ita fiant argumenta omnia quousque perveniatur ad quintum argumentum, loco cuius fiat hoc argumentum. Proporcio C quadranguli ad D quadrangulum est dyametri A spere ad dyametrum B spere proporcio duplicata. Hoc patet per secundam supposicionem que dicit, omnium duarum superficierum similium etc. Set C quadrangulus est tota sive maxima superficies A spere, et D quadrangulus est maxima superficies B spere. Igitur proporcio superficiei A ad proporcionem superficiei B spere est dupla ad proporcionem dyametri /A/ ad proporcionem dyametri B. Et sic arguendum est de aliis speris quibuscumque, et sequitur conclusio probanda, scilicet, quod omnium duarum sperarum proporcio superficiei unius ad superficiem alterius est dupla ad proporcionem dyametri unius ad dyametrum alterius. Vel arguitur. Sic breviter arguitur. Omnium duarum sperarum proporcio superficiei unius ad superficiem alterius est sicut proporcio quadrangulorum super eorum dyametros et lineas eorum et circumfrinciis equalibus constitutorum. Set cuiuslibet talis quadranguli ad reliquum in duplo maior est proporcio quam est proporcio dyametri unius spere ad dyametrum alterius. Igitur omnium duarum sperarum proporcio superficiei unius

128. in triplo: add.marg.
137-9. Hoc patet per ... similium, etc.: add.marg.
145. Hoc argumentum est planum in marg.

ad superficiem alterius est dupla ad pro-/fol.71v/porcionem dyametri unius ad dyametrum alterius. Et/sic patet intentum. Consequentia patet, et maior probatur ex hoc quod sicud se habet quadratum constitutum super dyametrum ad totum circulum, ita se habet quadrangulus super dyametrum spere constitutus ad illam speram modo quo dictum.

Sequitur probacio quinte. Et arguitur sic. Omnium duarum sperarum proporcio superficiei unius ad superficiem alterius est dupla ad proporcionem dyametri unius ad dyametrum alterius. Et omnium duarum sperarum est proportio dyametri ad circumfrinciarum. Igitur omnium duarum sperarum proporcio superficiei unius ad superficiem alterius est dupla ad proporcionem circumfrincie unius ad circumfrinciam alterius. Consequencia nota est, maior patet per quartam conclusionem, et minor per quartam supposicionem. Et sic patet intentum. Vel concluditur illa quinta per formam in tractatu positam.

Sequitur probacio sexte conclusionis. Et suppono quod A et B sint due spere inequales, et sit C proporcio A spere ad B, et sit D proporcio superficiei A spere ad superficiem B spere, et sit E proporcio dyametri A ad dyametrum B. Tunc sic. C est triplex ad E, et D est duplex ad E. Igitur C est sexquialterum ad E. Maior patet per quintam supposicionem et quartam conclusionem. Consequencia tenet sicut videtur in exemplo: sit C 3, D 2, E 1. Tunc fiat argumentum. C est triplum ad E, et D est duplum ad E. Igitur C est sexquialterum ad D. Igitur consequencia est nota. Antecedens patet in exemplo. Tunc sic. C est sexquialterum ad D, et C est proporcio A spere ad B speram, et D est proporcio superficiei A spere ad superficiem B spere. Igitur proporcio A spere ad B speram

160. sperarum: add.marg.

est sexquialtera ad proporcionem superficiei A spere ad superficiem B spere. Quod erat intentum. Et sicud arguitur de A,B,speris et earum superficiebus, ita arguendum est de quibuscumque speris concludentibus
180 illam sextam conclusionem, secundum quod in tractatu ponitur in forma: Quarumlibet duarum sperarum proporcio ad proporcionem superficierum suarum eodem ordine est sexquialtera. Igitur etc. Explicit Dummulton.

Johannis Dumbleton

Summa Logicae et Philosophiae Naturalis

S I G L A

Lambeth Palace 79 L

Magdalen College 32 . . . . . A

Magdalen College 195 . . . . . B

Merton College 306 . . . . . M

Peterhouse 272 . . . . . P

Vat.lat. 6750 V

Vat.Pal.lat. 1056 . . . . . D

S.Marco, lat.VI, 79 . . . . . E

Worcester Cath. F.6 . . . . . W

Worcester Cath. F.23 . . . . . F

NOTE: I have transcribed in full the first three parts of Dumbleton's Summa from MSS Vat.lat.6750 and Merton College 306. A complete collation on the basis of the ten MSS listed is given here only for the Prologue; for the selection from Part III, the text presented is basically that of MS Vat.lat.6750, which on the whole I have found to be the best.

Johannis Dumbleton

Summa Logicae et Philosophiae Naturalis

PROLOGUS

Plurimorum scribencium grati laboris dignique memoria particeps, ad mensuram mee facultatis doni, ex logicali materia communi et philosophica quandam summam, veluti spicarum dispersarum manipulum, quoquomodo immaturatum et incompositum recollegi, nequaquam tanto beneficio librato ut remmeratis eadem me munificum arbitrans, verum moderatis discrecionis, non alta cernentibus et leccione pocius privata contentis, ut digestam utilemque sensui offerendam. Itineranti via recta tendens Oxonie a pluribus edocetur, precisus numerus pedum spacii nequaquam ostenditur. Quis igitur cuiusvis dubii emersi et emergendi, pro

1. Primum capitulum quod tractat de ordine libri, scilicet de divisione parcium eius E
2. grati: gratique V // memoria: memoriam L // particeps: om.L
3. doni: donique A // logicali: logica et D // communi: om.L // et: om.E
3-4. philosophica: philosophia V, phisica M, sophistica D
4. veluti spicarum: spicarum veluti F
4-5. quoquomodo: quoque modo M, quoque A, corr.V
5. immaturatum: maturatum A E F L P, non maturatum M W, maturato D, naturaliter B // incompositum: incompositam E, compositum B // recollegi: recoligi A
6. librato: liberato A D // ut: om.D // remmeratis: remmerato V, remmerans E, remmerare M, remmeratum A // eadem: pro eadem M // munificum: munificencie D, munificatum A // verum: set verumque D, eram W, vir P // moderatis: moderata M, moderatam A
7. discrecionis: discrecione M, discrecioni A, discrecionem D E F P W // cernentibus: secuentibus P // et: set in M, in F W // contentis: contentam A, continens E, contempter B
8. ut digestam: indigestam D // tendens: om.E
9. Oxonie: cotidie add.E // edocetur: set add.M // precisus: interscisus D // numerus pedum spacii: pedum spacii numeros A B D M P
10. Quis: Quid B D // igitur: ergo E

cuiuscumque ingenii quantitate, decisionem ostenderet in scriptis dictancium animos modernorum mulcendo. Primo exigunt brevia, gaudentes compendio infinitorum solucionem pre oculis formari, in eodem querentes cum Anaxagora determinante infinita invenire affectant, hoc testantes antiquum 'non eodem cursu respondent ultima primis'. Insuper istac verba verbaliter inveniunt capciosi, illac quid preter proprie fantasie dictamen proponitur ab invidis censetur presumpcio. Numquid inter latera anguli contingencie neutro eam tangente linea recta intercidet. Nec inter hos veritas in se recta transeat non invisa opinionis Averrois: gravis est mutacio alicuius sentencie Aristotelis; qualiter amputacio admittetur, non sit contencio. Quicquid ideo in hoc opere reperitur indifferentem, expectet examen, ut magis quid dicitur quam quia dicitur, scribentem advertere coniecturent huius laboris susceptum. Ne dum sociorum dumtaxat instancia ast zelus in multis pro veritate

11. cuiuscumque: cuiusque E, materia add.P // ingenii: ingeni F W // decisionem: discrecionem E, distincionem F W, delictionem A, diffinicionem D, desicionem P // ostenderet: extenderet B D P // in: hiis add.E
12. modernorum: moderni A B D E P V
13. formari: formarum D // in: et E // querentes: querentem B
14. determinante: determinato W, determinante A D, om.E // invenire: vel in desire P // testantes: testante D
15. antiquum: antiqui D F M W // respondent: respondunt A // Istac: illa D
16. verbaliter inveniunt: inveniunt verbaliter E // inveniunt: invehunt A D W, om.F // capciosi: copiose D // illac: om.V // quid: quidem D V, quo M, quem B // preter: precem E
17. dictamen: dictamine A // presumpcio: ut add.M
18. latera: om.F // contingentie: in add.V // neutro eam: eam neutro E // eam: latere V W, om.A B D F M W // tangente: latere add.E // intercidet: intereidentes E, interceditur P, intersidet A
19. in se: om.E // in: nisi P // transeat: transiit V, transiet A D F W
20. gravis: quamvis E // alicuius: om.F
21. admittetur: admittitur A // contencio: contempcio E // Quicquid ideo: ideo quicquid A B D E M P // Quicquid: non add.A
22. indifferentem: indifferencium B D F P W // expectet: expectat D
23. laboris: laborem A B E F M P W, laborant D // susceptum: susceptures E
24. ne: non P // ast: at A D // multis: materno add.E // pro veritate: probitate E

signanda nova quedam antiquaque restringere instancius procurabant, et opinio profectus in eventum labore vexatum coaluit, sepius ignaro munus oblatum contempnitur, rara insuetaque arepta tremorem coniungerunt. De generali igitur sentencia huius summe divisio decem membris supposita, temptantes preminuit.

Hec summa quedam dubia magnorum librorum naturalium quinque cum solucione sophismatum logicalium et naturalium continens, exponet sic membratim.

Prima pars quatuor pertractat articulos: 1° significacionis termini et eius imposicionis ad placitum cum aliis incidentibus, causam si que sit naturalem ostendit. 2° quid est prius esse alio, ac magis scire nature et nobis, qualiter confusa magis distinctis, universalia plus particularibus cognoscimus, et de cognicione diffinicionis respectu

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25. antiquaque: antiqua A D M // procurabant: procurabat A D L
26. et: set M // profectus: profecius A // labore: laboris E // coaluit: caluit D
27. munus: minus D // contempnitur: contemplatur A // rara: raro A // rara insuetaque: raraque insueta A // tremorem: timorem D
27-8. coniungerunt: quo ingerunt A F W
29. decem membris: decembris D F
30. supposita: supponitur A
30-1. Hec ... continens: primum hec scil. ex summa quedam dubia quinque librorum magnorum naturalium cum solucione sophismatum insolubilium logicalium et naturalium continens D, Hec summa quinque librorum magnorum naturalium quedam dubia cum solucione sophismatum naturalium et logicalium continens W, Hec summa librorum magnorum naturalium cum solucione logicalium sophismatum et naturalium continens B
30. magnorum ... quinque: quinque librorum magnorum naturalium A B D E M,&L quinque librorum naturalium P
31. sophismatum logicalium: logicalium sophismatum M[1]P // logicalium et naturalium: naturalium et logicalium A F W // continens: contentis A, om.F.
31. exponet: exponitur A B E F P W L
33. quatuor: minor W // quatuor pertractat: pertractat quatuor P // significacionis: significacionem M
34. imposicionis: imposicionem M // causam: causis M, causa D E
35. que: qua D E // naturalem: naturalis D E P, naturales M
36-7. confusa ... cognoscimus: universalia et confusa magis particularibus cognoscuntur M // qualiter: 3° qualiter M // distinctis: distincte D, distincta A
37. cognoscimus: om.E P, cognoscuntur A D F M W L

diffiniti, et eius parcium investigat. 3° de principiis doctrine nostre primarie ac de intensione credulitatis et sciencie quasdam asserit conclusiones.

Secunda pars de primis principiis, scilicet materia et forma, et de opinionibus multipliciter formarum substancialium, primarum qualitatum ac secundarum intensionem ponentibus, et de intensione qualitatis uniformis et difformis latitudinis secundum rem seu secundum nomen dicte, cum descripcione intensionis mixtorum quedam sustinenda demonstrat.

Tercia pars causam veri motus in tribus predicamentis et quam proporcionem motus sequitur, consignificat distanciam et penes quam velocitates motus alteracionis et augmentacionis, et de latitudine raritatis et densitatis vere habent attendi concludit; ultimo de motu et tempore quid et qualia sint racionibus inquirit, et in eadem, motum uniformiter acquisitum medio gradui equivalere cum conclusionibus aliis demonstratur.

38. et: om.L // investigat: investigatur M
39. primarie: om.E // intensione: remissione E
40. asserit: assero F
41. et(2): om.A
42. multipliciter: multiplicibus D
43. intensionem: et remissionem add.M
45. sustinenda: substinenda E
45-6. demonstrat: determinat A M, denotat F
47. causam veri motus: de vero motu M
48. sequitur, consignificat: sensus consignat L // consignificat: consignandis M, consignificatque M // et(2): om.E M, que D, quod L N // quam: quid V
49. velocitates: velocitas A D M, om.L // motus: om.D F // augmentacionis: motus add.D
50. raritatis et densitatis: densitatis et raritatis A D M // vere: unde D, om.P // habent attendi: attendi habent D // attendi: velocitates add.L // concludit ultimo: et ultimo concludit M
51. quid: quod E, om.M // sint: sunt E // racionibus: om.E // eadem: eodem A // motum: motu V
52. acquisitum: om.M // equivalere: equalem D
53. demonstratur: determinat M, demonstrat D

Quarta pars de natura elementorum inquirens: 1° si summa elementa utramque qualitatis summe habeant, et qualiter prime qualitates sunt active ostendere insistit. 2° de reaccione inter easdem et qualiter qualitates prime formas primas, et densitas et raritas summa et remissa corpora naturaliter consequantur diffinit, et si eadem realiter ab aliis qualitatibus sint distincte. 3° item qualiter potencie corporum magnitudines eorum sequantur, et si mixta sese alterent, et qualia sint pura hec eadem quarta demonstrat.

Quinta pars agens de accione spirituali, si lux alicui elemento competat, qualiter simplex vel resultans existat enarrat. Item eadem de differencia formarum superiorum et inferiorum, lumen agencium, et de accione earum uniformi et difformi respectu agentis et passi dubia edisserit.

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54. inquirens: inquirentes E, inquirit M // summa: simplicia D
55. utramque: utique E, om.A F // qualitatis: qualitatem D E L M W, om.A F //summe: summam M // habeant: et quomodo add.D // qualiter: equaliter add.D // qualitates: qualitati P // sunt: sint A E L
56. reaccione: accione L // easdem: eadem D, qualitates add.E // qualiter: qualius V, om.M
57. primas: om.P // et(1): om.E F W
58. consequantur: insequuntur P // eadem: eodem A, om.M // realiter: om.DEL.M
59. qualitatibus: realiter add.A D P // sint: sunt B F L V W, re add.L P, res add.M // item: om.A D E L M P //potencie: potenciis E
60. magnitudines eorum sequantur: sequuntur magnitudines corporum M // eorum: corporum E M // sequantur: consequantur P // mixta: iuxta V // mixta sese: mixtum ad certum gradum se M // alterent: alterant D P // et: si add.E // qualia: gravia D E, graviora L P W, qualiter graviora M
61. pura: puris P, quam mixta add.E // hec eadem quarta: om.M // hec: om.A D F P W // hec ... demonstrat: ea parte ostendit L // hec eadem: hic E // quarta: quarto P // demonstrat: ostendit D, ostenditur M, om.F
62. agens: aget P, agit L M W //spirituali: et add.L
63. competat: existat M, om.L // qualiter: qualitas A F W
63-4. qualiter . . .eadem: om.M // enarrat: narrat A
64. Item eadem: Quinta eadem pars L // formarum: om.A M
65. earum: eorum D, om.M P // uniformi et difformi: uniformiter et difformiter E // respectu: secundum potenciam D

Sexta pars de finibus potenciarum tractans: 1° potenciam activam difficultate terminari docet. 2° de accione naturali et fine formarum, ut sunt motus et quies, deducendo si forma sit proprie mobilis, et si forma et locus attribuuntur equaliter generato, inter ceteras partes hec sexta pars exprimit. Insuper eadem iuxta processum Philosophi circa motores et motus celestes dubia commovens, quomodo corpora naturalia quantitate terminantur, et si ad primum motum sit deviendum, attendendo que corpora ex se moventur, et de aliis que in eodem deficiunt determinat.

Septima pars causam individuorum et specierum generabilium et corruptibilium, quantum ad numerum et ordinem potenciarum materie et agentis persuadet, et numquid primum motorem infinite

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67. tractans: tractat M
68. difficultate: secundum diffinicionem M, diffinit FW // terminari: terminare A B V W // 2°: et M
69 fine: earum add.E // ut: qui M // deducendo: deducendo A, investigando M
70. attribuuntur: attribuantur D M
71. generato: generatur D // inter...exprimit: om.M // hec: ex A D F // sexta pars: om.P // pars: om.A E F W // exprimit: exponit E
72. Insuper: exprimit add.D // eadem: sexta add.V // circa: contra A
73-6. quantitate...determinat: quantitatem et qualitatem ex se moventur et que per se determinat M
73. celestes: celestium D // commovens: moventes E, commovet et M // quantitate: quantitatem A, quantitati L P
74. motum: motorem L M V // attendendo: addendo A D F L W
75. moventur: movetur V // de aliis: om.A B E F L P W // in eodem: om.B L
75-6. de...determinat: que non in eodem determinat D
76. determinat: terminat A
77. pars: om.F W // et specierum: om.M
78. quantum ad: quod E
79. et (2): scilicet A // et numquid: om.E // numquid: om.M, numquam F L

virtutis existere, et mundum et motum non incepisse racione philosophica comprobantur.

In octava parte, primo de generacione substancie a simili et animalium perfectorum et putrefactibilium pertractatur. Item de unitate anime numerali respectu anime sensibilis et intellectualis, et de operacionibus anime intellective tractatum suum consummat.

Nona pars iuxta seriem processus 8° De Anima de quinque sensibus dubia et plurima pertinencia eidem materie et plurimas questiones decidit.

Decima et ultima pars de universalibus, que ideo apud Platonem dicuntur, et de passivitate intellectus humani quantum ad suscep-

80. non: om.A // incepisse: esse add.L
81. philosophica: Philosophi V // comprobantur: improbatur E L
82. In octava parte: Parte octava M // a: suo add.M, re add.L
83. et putrefactibilium: om.B
83-6. Item ... consummat: et qualiter prius et posterius in tempore quantum ad eorum generacionem generabilia exigunt, et qualiter casus et fortuna sunt cause per accidens, et numquam forme substancialis a substanciis abstractis fiunt, et de unitate anime respectu animati cum aliis dubiis M
84. anime: animam V // numerali: materiali D // anime: animati D F L P W
87-95. Nona pare ...: Nona pars de sensibilibus, etc. M
87. De Anima: et add.D L
88. et plurima: om.A B D L P W // plurimas: om.E // questiones: materias L
90. pars: om.B D E L
91. dicuntur: dicitur E // passivitate: passibilitate D E L, potestate B // intellectus: intellecto E // humani: humane A // quantum : in genere L

cionem intencionum ac eius operacione simplici atque complexa quamdam sentenciam concludens huic summe finem imponit. Cuius prima parte et decima intellectus proposicionum significancium pro complexis qualiter-
95 cumque nobis naturalis solucio intimatur.

92. ac eius: alicuius eiusdem V // eius: om.E, huiusmodi A // operacione: operacionis A // complexa: complexorum E // quamdam: quemdam E
93. concludens: concludunt E // summe: summule L // imponit: imponam sic L // parte: pars D
94. intellectus: intelleccionem E
95. naturalis: manifesta D, materialis P

Johannis Dumbleton

Summa Logicae et Philosophiae Naturalis

Pars III, cap. 7-12

Vat.lat. 6750
fol.40va-43vb

Capitulum Septimum

Sequitur dicere qualiter motus sequitur proporcionem et primo, modo exemplari exprimere ut qui in geometria non sunt exercitati, exemplis grossis et sensibilibus veritatem ingrediantur et eius causam videant. Et primo supponendum est quod omnis motus eiusdem /fol.40vb/ predicamenti facti precise secundum eandem proporcionem, sunt equeveloces; et illud patet ab omni opinione. Secunda supposicio: quod omnis motus factus secundum maiorem proporcionem est intensior motu facto secundum minorem proporcionem, ita tamen quod uterque motus fiat in eodem predicamento. Tercia supposicio: quod sive potencia maioretur sive minoretur, ipsa autem manente secundum eandem proporcionem, continue motum equevelocem producit; ista patet immediate ex prima. Quarta supposicio: quod latitudo motus et proporcionis inter se equaliter acquiruntur et deperduntur. Sicut si spacium uniformiter acquiratur alico motu in die, quota pars de motu acquiritur tanta de spacio precise acquiritur et de tempore labitur, ita si latitudo proporcionis uniformi motu intensionis acquiratur, quota pars de latitudine proporcionis acquiritur, que est quasi spacium motus intensionis, tantum precise de latitudine motus sibi correspondentis acquiritur.

1. ut...exercitati: add.marg. V
4. motus: insert.V
13. alico motu: add.marg.V

Ista patent per ultimum argumentum factum contra primam posicionem per hoc quod in omni intensione motus equali latitudini proporcionis acquisite equalis latitudo motus correspondet, quia aliter sequitur quod infinita latitudo motus cuicumque proporcioni correspondet. Consequens falsum et impossibile.

Item hoc sit patet: si ex proporcione dupla proveniat A motus precise, sequitur quod duplata causa, scilicet proporcione, duplabitur effectus, scilicet motus A. Et ex isto sequitur quod motus inequeveloces in proporcione tali sunt inequales, in qua una proporcio excedit aliam secundum quas illi motus fiunt, ut si motus sit factus secundum proporcionem duplam, quecumque proporcio continens illam bis precise duplum motum faciet, et quecumque proporcio illam ter continet triplum motum faciet, et sic in infinitum, ita quod sicut duplatur latitudo proporcionis, sic duplabitur latitudo motus. Hoc sic patet si omnis motus verus sit secundum hoc quod motor duplatur super resistenciam. Set cum motus non sequitur excessum potencie motoris super motum nec proporcionem motoris adinvicem, igitur diversitas motuum sequitur proporcionum diversitatem. Consequencia patet et antecedens [probatur] per argumenta facta contra opiniones improbatas.

Item hoc patet posita [hac] supposicione, ita quod omnes motus facti secundum eandem proporcionem sunt equeveloces, nam si ex proporcione dupla solum proveniat B gradus motus localis, et ex tripla proporcione proveniat A motus, igitur permutatim, sic se habet B motus ad A motum sicut tripla proporcio ad proporcionem duplam. Et sic diversitas inter A et B est secundum diversitatem proporcionum.

Item si B motus fiat secundum proporcionem duplam et quartam partem duple, et A secundum proporcionem duplam, et B est velocior A motu per quartam latitudinis motus contenti in A motu, quia per tantum proporcio ex qua fit B est maior proporcione ex qua fit A. Istud patet sensibiliter in quantitatibus, ut detur linea ABCDE latitudo motus, et linea HFGIK latitudo proporcionis. Tunc ex proporcione 16 ad 1 provenit A motus qui continet tantam distanciam a quiete quanta est ab A usque ad E. Similiter proporcio 16 ad 1 continet totam distanciam proporcionis ab A usque ad proporcionem equalitatis que est terminus latitudinis proporcionis maioris inequalitatis A. Si 16 minorentur ad 8, deperdent proporcionem duplam, puta proporcionem inter 16 et 8, que est dupla proporcio. Et quia dupla proporcio est quasi quarta pars tocius proporcionis 16 ad 1, sicut /fol.41ra/ AB est quarta pars AE linee, ideo A motus deperdet quartam sue latitudinis, puta AB. Et si partibiliter minoretur proporcio usque ad proporcionem equalitatis, partibiliter deperditur motus ac si ad corrupcionem AE linee, corrumpetur HK linea, et econtra. Igitur si addatur proporcio dupla ad istam proporcionem que est AE, fiet motus intensior per quartam, sicut proporcio erit maior per quartam; et si per medietatem duple, tunc per medietatem quarte AE motus augmentabitur, et sic in infinitum. Ut sicut 20 sunt plura 16 per 4, 16 8 per 4, sicut 32 addunt motui AE linee solum quartam, scilicet tantum quantum est inter AB, nam 20 continent 16 et eius quartam partem, sic proporcio 32 ad 1 continet proporcionem 16 ad 1 et eius quartam partem proporcionis, scilicet proporcionem duplam ultra. Et quia numeri ad numerum

61. linee: add.marg.V

est sesquiquarta proporcio, sic proporcio ad proporcionem est sesquiquarta, videlicet proporcio 32 ad 1 est sesquiquarta ad proportionem 16 ad 1. Ista patent per Campanum 5° Euclidis. Istum intellectum habet Aristoteles 4° et 7° Phisicorum cum Commentatore super eundem textum.

Item ponamus lineam OTGM, et intelligamus GM partem continere totam latitudinem proporcionis inter 9 et 4. Et G linea sit motus factus ex ista proporcione, que est 9 ad 4. Tunc tantum distat precise proporcio 9 ad 4 a proporcione equalitatis sicut distat G motus a quiete. Si igitur 9 augmententur ad 16, acquirent respectu 4 duas proporciones equales, scilicet bis sesquitertiam, quia proporcio 12 ad 9 est proporcio sesquitercia, et proporcio 16 ad 12 est proporcio sesquitercia. Ideo tota proporcio 16 ad 9 est composita et fit ex duabus proporcionibus sesquitertiis, sicut linea RG componitur ex linea RK mediante illius partis, et GK alia medietate; et quia A proporcio 12 ad 9 est proportio media inter proporcionem 16 ad 12 et 12 ad 9, ideo proporcio 12 ad 9 continet medietatem tocius proporcionis 16 ad 9. Et per consequens agens cum fuerit sub 12 acquiret et habet medietatem tocius latitudinis motus et proporcionis inter R et G et inter 9 et 16. Non tamen intelligendum est quod tota latitudo proporcionum inter 12 et 9 se habet ad totam proporcionem que est 9 ad 4 sicut proporcio que est inter 16 et 4 se habet ad proporcionem que est inter 12 et 4, quia uniformitas debet attendi penes terminum a quo incipit potencia maiorari

66. ad 1: add.marg.V
67. 5°: add.marg.V
77. RK: 1 K,V

vel minorari resistencia, ut si Sortes pertranseat uniformiter AB spacium in hora, in secunda medietate pertransit CD et DB partes, scilicet quartas. Non tamen ita se habet DA ad CA sicut BA ad DA, set totum est quod pertransitur in tercia quarta sicut in ultima quarta. Consimiliter considerandum est de latitudine proporcionum uniformiter acquisita.

/Prima Conclusio/ Ex hiis patet quod in resistencia difformi omnia agencia que per totam eandem horam sufficiunt movere equales latitudines motus deperdent simpliciter, sive fuerint equalia sive inequalia in potencia; quia si non: detur resistencia AB difformis respectu Sortis et Platonis, qui sunt inequalis potencie, gracia exempli, et sit extremum A signatum ut 4, et B extremum ut 3. Capiatur proporcio inter Platonem et Sortem extremum, et sit 6 ad 4, et sit potencia Platonis maior quam 4, quantum est linea BD maior aliam AB, et sit potencia Sortis ut 3 et proporcio Sortis ad A extremum sicut linea CB ad lineam AB, vel sicut 3 ad 4. Capiatur gradus quem agit Sortes ad B resistenciam, et sit G; et gradus quem agit Plato in B, /et/ sit D. Tunc sic: proporcio Sortis ad B componitur ex proporcione Sortis ad A et A ad B. Item, proporcio Platonis ad B componitur ex proporcione Platonis ad A et ex proporcione A ad B. Igitur proporcio A /fol.41rb/ ad B, que dupla est, est pars communis quia quantitativa respectu proporcionis Sortis ad B et proporcionis Platonis ad B. Set cum equali latitudini proporcionis correspondet equalis latitudo motus, sequitur quod tantam latitudinem motus deperdet Sortes in AB medio sicut Plato — quod est probandum.

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93. fuerint: fuerit V
107. deperdet: corr. habebit V

Vel sic: Si 6 agunt ad B extremum, quod est 2, et 8 ad idem, utrumque movendo usque ad A punctum, scilicet Sortes et Plato deperdent solum proporcionem duplam, scilicet proporcionem inter 4 et 8. Set cum tantam proporcionem deperderet 8 in AB medio, et equali latitudini proportionis equalis latitudo motus correspondet, igitur equalem latitudinem eiusdem motus utrumque, scilicet tam 6 quam 8, vel Sortes et Plato, deperdent.

Vel sic: omne quod movebit per AB medium, stante potencia eius sub eodem gradu et similiter resistencia AB, solum proporcionem duplam deperdet per remissionem motus vel duplam proporcionem per intensionem motus acquiret. Igitur omnia mota in AB resistencia equalem latitudinem motus deperdent.

Hic notandum est quod augmentacio proporcionis semper est attendenda penes terminum a quo incipit augmentari potencia, ut si Sortes sit in 4 et movetur in 2, latitudo proporcionis acquirenda in Sorte attendenda est respectu rei [i.e.,termini] sub quo iam est Sortes, ut pro quolibet instanti sub quo tanta latitudo proporcionis erit acquisita Sorti quanta erit proporcio Sortis pro eodem instanti ad 4. Et ideo pro quolibet instanti Sortes incipit acquirere latitudinem proporcionis a proporcione equalitatis, scilicet respectu termini potencie sub quo ipse est pro illo instanti, et illa sic acquisita et addita proporcioni dupla primo habite inter Sortem et 2 facit maiorem latitudinem proporcionis primo habita sicut quantitas augmentatur per addicionem quantitatis incipientis a non quanto.

[Secunda Conclusio] Preterea ex hiis patet quod quocumque motu difformi accepto terminato citra quietem, sive uniformiter secundum latitudinem sive

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114. vel Sortes et Plato: add.marg.V

aliter acquisito, tantum precise pertransietur illo motu difformi taliter intenso quantum precise pertransietur a duobus mobilibus motis in eodem tempore, quorum unum movetur uniformiter gradu a quo incipit motus difformis per idem tempus, et aliud intendit motum a quiete consimiliter per equalem latitudinem in tanto tempore. Ponamus Sortem intendere motum suum ab A gradu ad B,duplum ad A, in hora, difformiter sive uniformiter, et moveatur Plato A gradu uniformi in eadem hora, et intendat Cicero a quiete ad A, consimiliter acquirendo latitudinem motus sicut Sortes, et proveniat A motus ex proporcione dupla precise. Tunc Sortes non pertransibit plus in hora quam Plato nisi per latitudinem acquisitam supra A, que correspondet precise proporcioni duple, ut patet intellecto casu priori. Set cum Cicero tantum pertransibit precise secundum illam latitudinem motus quantum Sortes habebit supra A, sequitur quod Plato et Cicero tantum precise pertransibunt illis duobus motibus quantum Sortes, qui continue habebit A motum et acquiret latitudinem supra A, correspondentem proporcioni duple -- quod est probandum.

Istud patet per hoc quod omnis latitudo motus sive fuerit addita intensiori sive remissiori gradui semper equaliter de spacio ei correspondet dummodo eodem modo acquiratur illa latitudo motus. Et causa est quia equali latitudini proporcionum et equali proporcioni correspondet, ut si 4 moveant 2 proporcione dupla et intendatur potencia ad duplum et acquirat unum proporcionem aliam duplam, non maius spacium correspondet illi lati-

135. uniformiter: add.marg.V.
153-4. et intendatur...aliam: add.marg.V

tudini proporcionum acquisite; et hoc per se quam si 2 intendantur supra 4 et moveantur in 4, dum tamen eodem modo intendantur motus. Et causa est quia semper gradus potencie a quo potencia incipit augmentari habetur terminus cui terminatur latitudo proporcionis sicut ad equalitatis proporcionem.

[Tercia Conclusio] Item sequitur palam quod omnis latitudo motus terminata ad quietem /fol.41va/ utraque medietas eque intensa est precise, loquendo de medietate intensiva et non de medietate extensiva, nam proporcio quadrupla componitur precise ex duabus duplis quarum utraque est tanta proporcio sicut alia. Cum igitur latitudo motus se habet ad suas medietates intensive sicut proporcio ad suas medietates intensive, sequitur quod utraque medietas proporcionis est alteri equalis.

Item non maior latitudo motus correspondet uni proporcioni dupla quam alii, et hoc precise. Igitur motus proveniens ex proporcione quadrupla componitur precise ex duobus motibus equalibus intensive, sicut quadrupla proporcio componitur precise ex duabus proporcionibus duplis equaliter, quia aliter sequitur quod maior intensio motus correspenderet uni medietati proporcionis quadruple quam alteri, quod est impossibile. Et per hoc concluditur quod motus et proporcio et omnes tales qualitates sive vere sive imaginarie componuntur ex partibus qualitativis in actu, vel saltem illo modo quo sunt qualitates, ita quod quelibet pars est divisibilis in infinitum et intensior qualitas non fit nisi per additionem talium parcium

155-6. 2...4: add.marg.V // intendantur: intendentur V
156. moveantur: moventur V //intendantur: intenderentur V
169-70. motibus...duabus: om.V
171. sequitur quod: om.V
174. imaginarie: imaginacione V
175. pars: om.V

qualitativarum, sicut proporcio non maioratur nisi per proporciones additas
177a incipientes a proporcione equalitatis, ut patet consideranti composicionem proporcionum et eius naturam.

Contra istud sic arguitur, nam ex hoc sequitur quod nulla latitudo
180motus terminatur ad gradum uniformem motus. Ut ponatur quod Sortes moveatur iam A gradu proveniente ex proporcione dupla et acquirat Sortes duplum gradum, scilicet B per potencie augmentacionem, et sit C latitudo precise acquisita a Sorte in hora data. Tunc C per totum terminatur ad quietem. Quod sic arguitur: B componitur precise ex duobus talibus motibus sicut est A, eo
185 quod B est duplus ad A. Igitur sicut A terminatur ad quietem, ita et C latitudo acquisita. Et per consequens nec C latitudo terminatur ad A, nec ad aliquem gradum uniformem, sicut nec quantitas terminatur ad quantitatem eiusdem speciei. Et ita per posicionem sequitur nullam latitudinem terminari ad gradum uniformem; et per hoc potest argui quod nullus gradus uni-
190 formis caliditatis est terminus latitudinis, cuius oppositum, ut communiter dicitur.

Pro isto distinguendum est primo quod aliquid terminatur proprie sive improprie. Improprie ut secunda medietas pedalis terminatur ad aliam, idest post eam immediate in generacione quantitatis sequitur et in computacione
195 sequitur. Et illo modo potest dici quod ternarius est terminus quaternarii, et quinarius est terminus quaternarii, quia immediate succedunt; similiter in infinitum illo modo est terminus infiniti, quia in specie conveniunt.

177. per: add.marg.V
181. et: om.V
183. Tunc: om.V
192. est: om.V
193. Improprie (2): om.V
197. in (1): om.V

Et isto modo terminatur latitudo motus ad uniformem gradum et improprie, sicut prima pedalis alicuius magnitudinis est terminus tocius subsequentis. Proprie dicitur terminus qui cum termino non convenit, ut punctus respectu linee, et linea respectu superficiei, et superficies respectu corporis. Set corpus proprie non terminat corpus,quia omne corpus cum alico in parte vel in toto convenit in quantitate ut in equalitate simpliciter, sed nulla superficies in alico corpore convenit nec convenire potest, eo quod omne corpus omnem superficiem imaginabilem incomparabiliter excedit.

Per hoc quando arguitur, 'C latitudo terminatur ad quietem, igitur non terminatur ad A gradum a quo incipit', negatur consequencia, quia C terminatur ad A improprie et ad quietem proprie. Nam si pedalis quantitatis acquirat aliam pedalem, hec secunda terminatur improprie ad primam pro eo quod sibi immediate additur, ex qua cum quantitate acquisita fit addicio, fit una maior, ita cum Sortes movetur iam a gradu, ille motus acquirendus addetur A gradui, A manente continue in Sorte, ex quo motu acquisito, partibus manentibus imaginarie, scilicet re vel racione, fit motus intensior sicut /fol.41vb/ proporcio dupla respectu alicuius modii manet inter Sortem et suum medium, licet Sortes acquirat aliam duplam. Similiter est imaginandum quod latitudo caliditatis non terminatur proprie ad gradum summum sicut nec pedale terminatur ad pedalem, nisi aliquis velit ponere quod gradus summus se habet ad latitudinem caliditatis sicut punctus ad

202. Set: Et V
203. ut: et V

lineam, quod non est ponendum. Nec secunda medietas latitudinis caliditatis terminatur ad aliam medietatem nisi impproprie, idest, ut eam sequitur in generacione qualitatis summe. Et ideo sicut omnis linea finita terminatur ad duo puncta, ita si latitudo caliditatis vel distancia qualitative caliditatis vel qualitatis alicuius proprium habet terminum, quelibet pars illius distancie et quelibet latitudo talis caliditatis ad eumdem punctum posset terminari. Et quia ponatur ut communiter quod gradus summus terminat aliam medietatem, ideo multi incidunt in inconveniens dicentes unam medietatem esse intensiorem alia, nam proprie dicitur lineam terminari ad punctum, quia in nullo linea cum puncto convenit. Ita dicendum est de termino caliditatis difformis, si terminum proprium habeat; nec aliter proprie debet dici latitudinem terminari.

Secundo contra dicta sic arguitur: si latitudo proporcionum et motus equaliter acquiruntur et deperduntur, sequitur quod latitudo proporcionis maioris inequalitatis equaliter posset deperdi cum motu. Consequens falsum, et consequencia tenet ut videtur. Nam motor movet secundum proporcionem maioris inequalitatis et resistencia resistit secundum proporcionem minoris inequalitatis, eo quod motor ut ipsam movet resistenciam dominatur super eam. Et falsitas consequentis sic arguitur: agant 4 in 2, et fiant 8 per augmentacionem potencie in hora equalia illis 4 per uniformem acquisicionem proporcionis. Tunc immediate ante finem hore infinita magna latitudo proporcionis minoris inequalitatis acquiretur. Nam continue maiorabitur proporcio minoris inequalitatis in infinitum, quia quanto proporcio maioris inequalitatis minor fuerit, tanto maior est proporcio minoris inequalitatis.

222. qualitative: add.marg.V
230. latitudinem: latitudo V
236. ipsam: eam V
239. Tunc: om.V

ut patet per unam supposicionem 5° Euclidis. Set cum in infinitum minuitur proporcio maioris inequalitatis, sequitur quod in infinitum proporcio minoris inequalitatis maiorabitur.

Item non potest esse maior proporcio minoris inequalitatis quam est ante finem here, igitur infinitam latitudinem proporcionis acquiret, et solum finitam latitudinem motus deperdet, igitur non equaliter acquirentur et deperdentur ille due latitudines.

Item sequitur quod non posset aliquid equale fieri aliter nisi infinitam latitudinem proporcionis acquireret.

Item eadem est latitudo proporcionis sive proporcio 4 ad 2, et 2 ad 4. Igitur si una latitudo sit infinita respectu termini qui est proporcio equalitatis, igitur utraque, tam proporcio maioris inequalitatis quam proporcio minoris inequalitatis erit infinita. Vel sic: proporcio 2 ad 4 est dupla ad proporcionem 1 ad 4. Igitur dupla latitudo est sive distancia proporcionis.

Item captis tribus gradibus latitudinis ABC, et distet A a B per certum, et B a C, et econtra, sic quod dupla sit latitudo sive distancia inter B et C quam inter B et A. Sequitur quod econtra B in duplo plus distat a C quam A a C. Sic fiat argumentum de proporcione maioris inequalitatis et minoris: et sit A proporcio quadrupla et B dupla, et C medietas duple proporcionis, et fiat econtra comparacio secundum proporcionem minoris inequalitatis, ut patet intelligenti, quod C in duplo plus distat a B quam B ab A quantum ad proporcionem minoris inequalitatis.

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255. erit infinita: om.V

243. in: om.V
244. in: om.V

Pro isto, ut dictum est prius, omnis latitudo sive distancia, potest dupliciter considerari, pòsitive et privative, ut dicimus qualitatem intensam et ipsam remissam, et eamdam quantitatem magnam et parvam, ita latitudo proporcionum dupliciter intelligitur, positive pro eo quod est proporcio maioris inequalitatis, et privative pro eo quod est proporcio minoris inequalitatis. Nam captis tribus gradibus in caliditate ABC, et sit C in duplo remissior B, et B in duplo remissior A, ex hoc non sequitur quod in duplo maior latitudo est /fol.48ra/ inter C et B quam inter B et A, sed oppositum sequitur, ut patet. Sic intelligendum est in proporcione minoris inequalitatis, quod captis tribus proporcionibus minoris inequalitatis ABC, et sit C medietas duple proporcionis, et B dupla proporcio, et A quadrupla proporcio, C proporcio est in duplo maior proporcione minoris inequalitatis quam B, et B quam A. Non tamen in duplo est maior latitudo proporcionum inter C et B quam inter B et A; immo in duplo minor, quia idem est dicere 'in duplo maior proporcio minoris inequalitatis est inter B et C quam inter A et B', et dicere 'in duplo minor proporcio maioris inequalitatis'. Vel sic: ponatur quod ABC sunt tria puncta equo proportionaliter distancia respectu D termini. Tunc C est in duplo propinquus D quam B, et B quam A. Igitur in duplo maior est distancia inter C et B quam inter B et A. Non sequitur sic est in proporcione minoris inequalitatis, quia secundum quod ista latitudo proporcionum maioratur similiter minoratur, ut secundum quod aliquid fit magis parvum distancia quantitativa minuitur.

274. intelligendum est: intelligo V
275-6. inequalitatis: insert.marg.V
277. A quadrupla proporcio: insert.marg.V
283. Tunc: insert.V

Contra hoc sic arguitur: latitudo proporcionis minoris inequalitatis potest maiorari in infinitum et non per maioracionem proporcionis maioris inequalitatis. Igitur per maioracionem minoris inequalitatis, et per consequens infinita latitudo acquiretur, et hoc proporcionis minoris inequalitatis, si minor equale fiat maiori. Consequencia tenet.

Pro isto intelligendum est quod latitudo proporcionis minoris inequalitatis nulla est prout sic, quia latitudo prout latitudo est, positionem importat, ut intensum in qualitate et magnum in quantitate; et ideo nulla est latitudo in qualitate secundum quod illa est remissa. Quod sic arguitur: secundum quod aliquid deficit de qualitate, illa est remissa, et secundum quod habet distanciam in qualitate intensa est. Set nichil habet de latitudine secundum quod aliquid sibi deficit. Sequitur igitur quod qualitas nullam latitudinem habet secundum quod remissa est. Istud idem intelligo de magno et parvo; et per idem patet quod in proporcione nulla latitudo est maior alia secundum quod est proporcio minoris inequalitatis.

Ad argumentum 'latitudo proporcionis minoris inequalitatis potest maiorari in infinitum' etc., causa sophisticacionis potest concedi quod hoc solum est propter minoracionem proporcionis maioris inequalitatis; sicut latitudo remissionis, si admittatur modus loquendi, maioratur solum per deperdicionem latitudinis intensionis. Ista patent alio exemplo: si remittatur aliquis motus ad quietem secundum quod minoratur proporcio maioris inequalitatis, ita minoratur motus ille. Igitur effectus minora-

292. proporcionis: proporcioni$ V
310. ille: add.marg.V

bitur, scilicet motus secundum quod proporcio maioris inequalitatis maioratur, et secundum quod proporcio minoris inequalitatis maioratur, minuitur effectus, quia motus tardatur iuxta depordicionem proporcionis maioris inequalitatis. Igitur latitudo proporcionis non attenditur, nec
315 attendi potest secundum proporcionem minoris inequalitatis. Et per consequens in duplo maior proporcio minoris inequalitatis non facit duplam latitudinem proporcionis, que est conclusio probanda, sicut in duplo magis parvum non facit duplam distanciam quantitativam.

Capitulum Octavum

Sequitur solvere argumentum quod est alterius posicionis fundamentum. Cum supponitur quod 3 agant in passum quod se habet sicut 2, et agant alia 3 post in eadem 8 equaliter resistiga, sequitur quod illa duo agencia agunt duplum quam unum per se, cum neutrum impedit aliud. Igitur si prima
5 3 agerent unitatem alicuius latitudinis qualitatis in 2, sequitur quod 6 agerent duplum ad idem quod prius egerunt 3.

Item 3 producunt aliquem certum motum localem; sit A ille motus, et fiat ille motus in B medio signato per 2. Igitur sequitur quod 6 producunt duplum motum /fol.42rb/ ad A motum, cum neutrum impedit aliud.

10 Pro istis et consimilibus supponendum est quod in omni accione tota accio est accio agentis et totius cuiuscunque partis respectu illius accionis, ut sive agant 2 sive 4 in unum medium, tota accio 4 est accio unitatis seu actio agentis unitatem per se est accio agentis et cuiuscunque

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311. quod: om.V
315. secundum: add.marg.V
2: quod (1): add.marg.V

partis agentis eadem est accio, ut si A motus producatur a Sorte et a Platone in B, A motus est accio tam Sortis quam Platonis, quorum neutrum motum ita velocem sufficit facere in B A motus. Est accio tam Sortis quam Platonis, et sic utriusque agentis est A motus, quia aliter sequitur quod Sortes faceret unum motum per se et Plato alium. Item si 6 agerent in 2, sequitur quod una esset accio correspondens 3 illorum 6 et alia accio disparata correspondens aliis 3; et per consequens non esset dupla velocitas, set essent due velocitates distincte et due qualitates distincte ab illis seperatim inducte. Consequens falsum, quia eadem racione esset accio correspondens tribus et medietati unitatis et sic infinite acciones distincte, et sic non esset ibi velocitas maxima dande. Consequens falsum et impossibile.

Per hec ad argumenta. Quando concluditur quod 'ducrage agensium quorum utrumque est 3 applicaretur ad unitatem, illa simul applicata, duplum agunt in illud quod agit unum per se, eo quod neutrum impedit aliud, igitur utrumque agit tantum sicut prius egit per se', [illegible] conceditur consequencia et negatur antecedens. Et ulterius ad argumentum, 'igitur agunt duplum ad prius actum', negatur consequencia, quia tota accio est accio utriusque et uterque illud agit, et quia plus est actum quam prius, ideo utrumque plus agit quam prius, et utrumque per iuvamentum alterius velocius agit inquantum proporcio tocius ad passum secundum quam agit agens est maior quam prius erat, illa proporcio secundum quam utrumque per se agens alterabat vel movebat motu locali.

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24. sic: om.V // ibi: om.V
26. ad: hec add.V

Pro isto est Commentator 8 Phys., comm.23, ubi ponit quod ita est de guttis, quarum congregacio operatur in lapide, sicut est de multis hominibus qui movent navem quam unusquisque non movet per se; ita non sequitur quod quelibet gutta non habeat operacionem suam per se, set intelligendum est quod quelibet habeat eandem, ut si Sortes et Plato moveant A mobile B gradu quo neutrum sufficit movere A, B gradus motus est utriusque et cuiuscumque potencie moventis in utroque illorum, non tamen per se, set B accio est motus communis Sorti et Platoni.

Item si quelibet pars agentis haberet accionem per se, sequitur quod quelibet sufficit agere in quodlibet. Consequencia arguitur: agant 4 in 2, et capiatur maximus gradus resistencie quo non resistit pars illorum duorum, ut pars inexistit toti; et sit ille gradus B. Si igitur quelibet pars illorum 4 haberet accionem per se in illis duobus, non est minor gradus resistencie quam B gradus. Igitur quelibet pars illorum 4 ageret per se in tantam resis enciam quanta est una sub B gradu, et sic fieret accio et motus secundum proporcionem minoris inequalitatis. Consequens falsum, quia tunc quelibet ageret in quelibet, cum non esset racio assignanda quare secundum unam proporcionem minoris inequalitatis fieret motus quam secundum aliam. Ideo etc.

Capitulum Nonum

Consequanter probatur latitudinem motus suo medio gradui correspondere. Primo tamen /fol.42va/ monstratur quod si aliqua latitudo motus

46. quelibet: quilibet V // in: insert.V
47. et: om.V
57. motus: om.V

terminata ad quietem intendet gradum suo medio, valet medietatem eius ad quietem terminatam remissiori medio eiusdem medietatis correspondere.

Probatur: Hec sic patet: ponamus AF esse latitudinem motus, B medium gradum eiusdem, D gradum medium medietatis ad quietem terminate, et G gradum correspondere toti AF latitudini uniformiter acquisite; et ponamus R gradum correspondere HF medietati, et sit F quies. Dico quod si G est intensior B, igitur R est intensior D. Nam ponatur Sortem adquirere uniformiter AF latitudinem in hora. Patet quod Sortes tantum pertransibit in prima medietate ac si movisset F gradu. Set cum in secunda medietate hore habebit Sortes BA latitudinem citra quietem terminatam, igitur Sortes tantum pertransibit in secunda medietate sicut duo mota quorum unum movetur B gradu et solum eadem medietate hore, et aliud movetur R gradu eo quod tanta est latitudo HF sicut est BA. Consequencia tenet per conclusionem secundam illius capituli septimi. Et per consequens tantum pertransietur precise in hora AF latitudine sicut a duobus quorum unum movebitur per horam R gradu solum, et aliud solum medietate hore B gradu, ut patet intuenti. Set cum B tantum valet per medietatem hore quantum ad transitum spacii sicut D suis subduplis valet per horam, sequitur quod AF uniformiter latitudo acquisita per horam valet RD gradus per eandem. Set cum HR per horam tantum valet precise sicut unus gradus compositus ex illis precise, sequitur quod G gradus qui tantum distat precise a D quantum R ab F equevalebit AF latitudini uniformiter acquisite per horam. Consequencia tenet per hoc quod G in uno moto per horam valet RD in diversis mobilibus per

5. esse: om.V // motus: insert.V
9. intensior: corr.marg.V
16. septimi: om.V
17. unum: add.marg.V // R: insert.V

horam. Set cum minor est distancia inter R et F quam inter B et D, et G non addit super D nisi latitudinem RF, sequitur quod G est remissior B. Igitur gradus valens totam latitudinem AF uniformiter acquisitam per horam est remissior B, et per consequens C est remissior B -- quod est probandum.

Per idem probatur quod si gradus correspondens RF medietati uniformiter acquisite sit intensior D, quod gradus correspondens totali AF latitudini est intensior B.

Pro conclusione precedenti et aliis probandis in ista materia est hec supposicio, quod si sint duo gradus uniformes motus ut RD inequales sive equales, quod tantum valent precise D et R per horam quantum unus qui tantum addit de latitudine supra D quantum R distat a quiete. Hec supposicio patet per conclusionem primam.

Capitulum Decimum

Sequitur probacio istius quod omnis latitudo, etc. Nam si aliqua latitudo incipiens a quiete uniformiter acquisita in transitu spacii suo medio gradui non correspondet, detur AQ latitudo talis, et sit Q quies et A gradus eandem terminans, et sit B medius totalis eiusdem latitudinis, et D medius BQ medietatis eiusdem. Si igitur AQ latitudo uniformiter acquisita suo medio in transitu spacii non equipolet, detur igitur primo quod C gradus intensior B equevalet AQ latitudini uniformiter acquisite, et sit E gradus correspondens medietati BQ. Quia igitur C est intensior

3. non: insert. V

B, patet per precedentem conclusionem quod E est intensior D. Dico igitur ex ista proposicione sequi quod latitudo uniformiter acquisita in hora gradui ipsam latitudinem terminanti equevalet -- quod est impossibile.

Illud sic arguitur: ponamus Sortem acquirere AQ latitudinem uniformiter in hora. Patet per prius /fol.42vb/ probata quod in prima medietate hore Sortes tantum pertransibit ac si per primam medietatem hore moviaset E gradu et in secunda medietate tantum sicut duo mota quorum unum per medietatem hore movetur solum B gradu uniformi et aliud E gradu per eandem medietatem. Igitur Sortes tantum pertransibit AQ latitudinem uniformiter A gradu quantum pertransiet per totam horam movendo E gradu solum et aliud per medietatem solum B gradu. Et per consequens tantum pertransibit illa AQ latitudine uniformiter acquisita quantum pertransiëtur in hora E gradu et D qui est subduplus ad B. Consequencie tenent intuenti precedentem conclusionem. Igitur D et E gradus per horam facti valent AQ latitudinem per eandem, sequitur quod gradus qui valet AQ latitudinem in hora tantum addit de latitudine supra D quantum distat D a Q. Iste consequencie tenent per supposicionem. Tunc sic equalis est distancia inter D et Q sicut inter E et C. Set cum equaliter distat D a B sicut D distat a Q, igitur equaliter distat E a C sicut B a D. Consequencia tenet per illud medium, 'quecumque equalia sunt alicui tercio,etc.' Si igitur equalis est latitudo DB sicut EC, dempto igitur omni, scilicet BE, illa que relinquantur, scilicet ED et CB latitudines erunt equales. Et per consequens tantum distat gradus correspondens AQ a B medio eiusdem, sicut distat E a medio BQ, que est medietas AQ. Et per idem probatur quod per tantum distat gradus correspon-

15. in: om.V
15-18. per medietatem...pertransiet: add.marg.V
20. hora: insert.V
29. omni: ? communi, as in M

dens quarte AQ a medio gradu eiusdem quarte, sicut distat E gradus a D gradu, et sic in infinitum per 16^{vas} et per 8^{vas}.

Capiamus GQ partem aliquotam AQ latitudinis que sit G, cuius medius gradus sit N. Tunc tantum distat N a G quantum distat E a D, vel quod minor sit distancia inter gradum eius medium et gradum sibi correspondentem quam sit distancia inter C et B. Quod talis sit dando patet, quia AQ latitudo est divisibilis infinitum in partes aliquotas terminatas ad Q gradum, et quiuscumque partis aliquote dante est distancia inter gradum sibi correspondentem et eius gradum medium sicut inter C et B, sicut patet per argumentum factum. Et capiatur gradus correspondens GQ latitudini uniformiter acquisite per tempus, et sit M. Per argumentum factum, sequitur quod tanta est distancia inter M et N gradus sicut inter D et E; igitur tantum distat M ab N sicut G ab N gradu. Et per consequens idem est M gradus et G cui GA latitudo uniformiter acquisita in hora correspondet -- quod est probandum ex dato. Si igitur detur quod nulla est pars aliquota AQ cui medius gradus precise tantum distat ab extremo quantum C a B, capiatur una cuius medius minus distat ab extremo quam C distat a B, et sit illa GQ. Ex demonstracione facta patet quod GQ correspondet intensiori gradui extremali, quod est impossibile.

Si igitur detur pars contraria, quod latitudo uniformiter acquisita valet remissiorem gradum medio eiusdem, sequitur per conclusionem precedentem quod quelibet latitudo minor illa terminata ad quietem remissiori medio suo correspondet.

Intelligamus pro ista probacione C esse medium AQ et B remissiorem

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37. gradum (2): gradus V

C gradu correspondentem AQ latitudini uniformiter acquisitem in hora, et D correspondere CQ latitudini. Ex ista posicione sequitur per aliam latitudinem uniformiter acquisitam nichil acquiri. Iuxta prius probata in ista posicione patet quod AQ latitudo uniformiter acquisita in hora valebit D correspondentem sue medietati per horam et C per medietatem hore; et per consequens valebit AQ latitudo uniformiter acquisita in hora D gradui per horam, et E gradui per eandem horam, qui est subduplus /fol.45ra/ ad C. Set cum B per datum valet AQ latitudinem in hora uniformiter acquisitam, igitur B gradus tantum continet ultra D quantum distat E a Q. Consequencia tenet per suppositum. Set cum equalis est distancia inter E et Q sicut E a C, dempto igitur communi BE, relicte latitudines, scilicet ED et CB, erunt equales. Capiatur igitur aliqua pars CQ medietatis cuius medius gradus precise tantum distat a quiete sicut distat D ab E medio medietatis GQ, et sit latitudo illa GQ cuius latitudinis gradus medius sit N, et gradus eiusdem correspondens sit F, qui est remissior medio, ut patet per conclusionem precedentem. Cum igitur tanta est latitudo inter D et E sicut inter B et C, non obstante quod CQ sit dupla latitudo ad EQ et latitudo GQ vel est quarta pars vel octava latitudinis EQ, ita quod non infinitum excedituŕ ab eadem, sequitur quod tantum distat F gradus correspondens GQ latitudini ab N medio latitudinis GQ, quantum distat D gradus correspondens latitudini GQ ab E medio gradu CQ latitudinis. Set cum quies tantum distat ab N medio GQ latitudinis quantum D distat ab E, igitur F gradus qui correspondet GQ latitudini est quies, et sic sequitur quod per GQ latitudinem uniformiter acquisitam nichil pertransiretur -- quod est probandum ex dato.

Capitulum Undecimum

Aliter probatur quod omnis latitudo motus terminata ad quietem et uniformiter acquisita,etc.

Hec patet posita hac supposicione cum predictis probatis: quod omnium graduum terminancium aliquas latitudines incipientes a quiete ad gradus correspondentes eisdem in pertransicione spacii, eadem est proporcio; ut si AB AC sunt due latitudines ad quietem terminate quarum AB sit maior, et D E sint gradus uniformes, quibus tantum pertransietur in hora sicut AB AC latitudinibus uniformis acquisitis, quod eadem est proporcio B gradus terminantis AB latitudinem ad E gradum, sicut C ad D. Ex ista supposicione sic arguitur, et ponamus AF latitudinem uniformiter acquisitam in hora a Sorte. Dico quod tantum pertransietur AF latitudine in hora sicut a C eius medio gradu, quia si non, detur quod tantum pertransietur AF latitudine sicut a B gradu intensiori gradu medio eiusdem latitudinis, et sit pedale maximum pertransitum a Sorte in hora, et intelligamus F esse quietem AF latitudinis. Capio tunc gradum subduplum ad B, et sit E, qui intensior est D gradu medio medietatis remissiori AF latitudinis, ut patet. Tunc sic: eadem est proporcio A ad C sicut B ad E, quia dupla, igitur permutatim, qualis est proporcio A ad B gradum eadem est C ad E gradum. Consequencia tenet per supposicionem quinti Euclidis. Tunc sic: eadem est proporcio A ad B gradum sicut C ad E gradum, igitur per supposicionem datam, sicut B correspondet AF latitudini uniformiter acquisite, sic E gradus correspondet medietati remissiori eiusdem latitudinis. Consequencia tenet, quia unicus

9. AB: A, V
17. igitur: om.V
18. gradum (1): gradus V

est gradus in AF latitudine qui se habet ad C sicut B ad A. Set quia E est subduplus ad B gradum et Sortes movebitur in prima medietate hore latitudine CF correspondente E, igitur pertransibit quarta totalis spacii pertransiendi AB gradu correspondenti toti AF latitudini. Consequencia patet intelligenti, et per consequens Sortes pertransibit in prima medietate hore quartam pedis. Set cum Sortes in secunda medietate hore habebit uniformiter CA latitudinem, igitur tantum Sortes pertransibit in secunda medietate hore sicut duo mota in eodem tempore quorum unum intendet uniformiter a quiete ad C, et aliud continue moveatur C gradu. Consequencia patet per precedentem conclusionem capituli septimi. Set quia B gradu pertransietur /fol.42vb/ in secunda medietate hore precise semipedale, quia sibi tota latitudo AF correspondet, et C est gradus remissior B per datum; igitur Sortes minus pertransibit in secunda medietate hore per C gradum, et CF latitudinem quam tres quartas pedis. Igitur Sortes in toto tempore non pertransibit pedale, quod est contra hypothesim. Hec consequencia tenet per hoc quod si Sortes moveretur B gradu et illa latitudine, tunc tres quartas pertransiret; set iam minus quam tunc, igitur etc.

Item si gradus correspondens latitudini est remissior medio eiusdem, ponamus igitur AF talem latitudinem, ut prius, et intelligamus B medium gradum eiusdem, et C gradum esse correspondentem toti AF latitudini, qui C sit remissior medio gradu AF, ut datur, et sit E medius gradus EF latitudinis, et sit D subduplus ad C. Per argumentum prius factum patet quod eadem est proporcio A ad D qualis est B ad D; capta proposicione quinti Euclidis, ponamus quod pedale sit maximum quod pertransietur a Sorte in

33. precise: om.V
40. Item: om.V
46. A ad D: om.V

hora uniformiter acquirendo AF latitudinem. Quia igitur C est duplus ad D et pro C gradu pedale precise pertransietur in hora, quia latitudini AF equivalet, sequitur iuxta formam priorem quod Sortes precise pertransibit in prima medietate hore quarta pedis, et in secunda medietate hore Sortes tantum pertransibit precise quantum duo nota in eadem medietate, quorum unum movetur B gradu medio tocius AF latitudinis et aliud movetur acquirendo uniformiter latitudinem FB, ut patet per conclusionem precedentem. Igitur Sortes pertransibit in secunda medietate hore quartam pedis et plus quam duplum ad quartam pedis. Consequencia tenet per hoc quod iuxta ultimum suppositum B est magis quam in duplo D gradu; et sic patet quod plus quam pedalis quantitas erit pertransita AF latitudine a Sorte in hora, quod est contra datum. Consequencie patent pro ista parte intuenti argumenta prius facta.

Hic tamen nota quod hec demonstracio fundatur super hoc quod si latitudo motus incipiens a quiete A, uniformiter sit acquisita in aliquo tempore, necessario in prima medietate eiusdem temporis quarta totalis spacii pertransietur, et hoc medietate remissiori eiusdem. Et ideo neque intensiori medio neque remissiori eiusdem illa latitudo in transicione spacii correspondet.

Ex istis duabus sequitur tercia: <u>quod omnis latitudo finita citra quietem terminata medio suo gradui uniformiter acquisita correspondet.</u> Detur latitudo AB citra quietem terminata cuius remissius extremum sit A. Dico igitur eam uniformiter acquisitam suo medio gradui correspondere. Nam tantum pertransietur AB latitudine uniformiter acquisita in hora sicut A

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53. et: om.V
58-59. a Sorte...datum: M, om.V
59. pro: per V
71. AB: M, om.V

gradu continuato per horam uniformiter et latitudine equali AB incipiente a quiete uniformiter acquisita, ut patet per unam conclusionem prius [illegible] probatam. Set cum omnis latitudo incipiens a quiete et uniformiter acquisita suo medio gradui correspondet, ut patet per precedentem conclusionem, igitur AB latitudine tantum pertransietur in hora sicut a duobus motis per horam, quorum unum movetur A gradu solum per eandem et aliud gradu medio tante latitudinis incipientis a quiete. Consequencia patet per prius probata. Set cum gradus medius AB latitudinis sit compositus ex A gradu uniformi et gradu medio tante latitudinis incipientis a quiete, igitur tantum pertransietur AB latitudine uniformiter acquisita sicut gradu medio eiusdem — quod fuit probandum.

Capitulum Duodecimum

Alia conclusio est hec: si potencia motiva aliqua equalis suo medio uniformiter augmentetur, stante medio, ipsam potenciam solum finite velociter incipere intendere /fol.43va/ motum suum necesse est. Hec sic patet: Ponamus potenciam ut 4, et medium ut 4, et intendatur potencia motiva uniformiter ad 8 in hora. Dico istam potenciam finite velociter incipere intendere motum suum. Nam si non, sequitur quod pro quolibet instanti infinitum velociter incipit intendere. Consequencia tenet. Detur instans in quo potencia erit 6, et sit alia potencia ut 6, sic ut Sortes ad aliquod medium acquiret Sortes duo supra suum medium in medietate hore; per uniformem

2. finite: insert.marg.V
8. ut 6: 6 add.marg.V

augmentacionem potencie utraque isterum potenciarum acquiret proporcionem sesquitercian in hora, scilicet proporcionem inter 6 et 8. Set cum in secunda medietate hore utraque acquiret proporcionem eque velociter, sequitur quod si Sortes incipit pro medio instanti infinitum velociter intendere, pro eo quod ab equalitate resistencie incipit augmentari uniformiter, sequitur quod alia potencia, scilicet prima, infinitum velociter incipit intendere pro tali instanti, cum utraque equaliter incipit acquirere latitudinem proporcionum. Et sic fiat argumentum pro quolibet instanti assignato, quod si essent infinita quorum aliquod pro aliquo instanti inciperet augmentari ab equalitate resistencie sue uniformiter, quod prima potencia pro quolibet instanti hore equevelociter intendet motum suum cum illo.

Et Ex hac patet alia conclusio: quod si medium remittitur uniformiter, stante potencia motiva, quod non infinitum tarde incipit intendere. Nam pro quolibet instanti est accipere unam potenciam, que est equalis medio suo pro eodem instanti, et respectu illius tantam latitudinem proporcionis acquiret in equali tempore sicut incipit respectu primi dati. Igitur si pro hoc instanti infinitum tarde inciperet intendere ista potencia motum suum, sequitur quod pro quolibet instanti potencia equalis resistencie infinitum tarde inciperet intendere. Et per consequens illa pro quolibet instanti infinitum tarde inciperet acquirere latitudinem proporcionis, quod est impossibile. Vel sic arguitur: posito casu priori et quod Plato in medietate hore ante hoc acquisivit 2 super 2, ita quod pro hoc instanti sit equalis Sorti, qui cum suo medio assignatur per 4, ut in lineis AB CD. Si Plato

21. conclusio: om.V
22. non: insert.V

acquirat 4 in hora uniformiter, et Sortes uniformiter 4 supra unam resistenciam in eadem hora, uterque acquiret precise proporcionem duplam, et hoc equevelociter, quia tota proporcio 8 ad 2 componitur ex proporcione 8 ad 4, et 4 ad 2. Quare equevelociter incipit Sortes intendere motum suum sicut Plato, non obstante quod Plato excedit suum medium pro hoc instanti, et Sortes non. Consequencia tenet per hoc quod si sint alia se habencia in proporcione, quocumque intermedio proporcionali, uterque extremo capto, tota proporcio extremi ad extremum componitur ex proporcione extremi ad medium captum et medii capti ad aliud extremum, sive medium fuerit simpliciter medium sive non.

Ex istis patet alia conclusio, que hec est: captis duabus potenciis inequalibus quibuscumque et duabus resistenciis inequalibus, ita quod minor resistencia sit equalis potencie minori et resistencia maior sit equalis potencie maiori, quod si tales potencie uniformiter intendantur et eque velociter in potencia, quod minor potencia velocius incipit intendere motum suum quam maior. Nam minor potencia incipiet intendere motum suum eque velociter sicut iam incipit maior, cum ipsa minor potencia fuerit sub tanto gradu sicut iam est maior, ut patet per argumentum prius factum. /fol.43vb/ Set cum utraque tardius intendet et tardius, sequitur quod minor potencia velocius incipit intendere motum suum quam maior -- quod est probandum.

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