Fred Taylor (1944-2021) Atmospheric physicist, planetary scientist and passionate advocate for the exploration of the solar system by robotic spacecraft, here remembered by Peter Read [and Ray Pierrehumbert].

Fredric (Fred) W Taylor was a distinguished atmospheric physicist with particular expertise in atmospheric radiative transfer. He designed clever instrumentation as well as inspiring and promoting complete space missions to explore the atmospheres of most large planetary bodies in the solar system, including the upper atmosphere of the Earth itself. He was also a prolific writer and populariser of atmospheric science.

Fred Taylor was born on 24 September 1944 in Amble on the coast of Northumberland near the Scottish border. His parents were William Taylor, a joiner by trade, and Ena (née Burns), a primary school teacher. Fred developed an interest in astronomy from an early age, inspired in part by his maternal grandfather, Robert Burns, who was an amateur astronomer, and his uncle Alan, who had an extensive collection of books on astronomy and science fiction. Fred grew up during the birth of the space age, which excited his ambition to visit and explore the planets by spacecraft.

Fred attended the Duke of Northumberland's School in Alnwick, where he excelled in chemistry and English but found physics less inspiring and struggled with maths. School journalism and drama productions would later influence his interests and outlook. He applied and was accepted to read physics at the University of Liverpool. This was during the early 1960s when Liverpool was becoming a major centre of popular culture, which Fred revelled in. Despite these enjoyable distractions, he excelled in his degree. By chance he noticed that Oxford was advertising for a graduate student in atmospheric physics to work

on a new satellite instrument for observing the Earth. He duly arrived to work for his D.Phil. with Prof. (later Sir) John Houghton.

Fred's doctoral project turned out to be pivotal for his career. John Houghton had proposed an ingenious concept for an infrared instrument to measure temperature or composition in the atmosphere, based on gas correlation spectrometry. This entailed using a sample of the particular gas in question as a filter to select the wavelengths at which the gas had strong absorption lines in the infrared. By periodically modulating the gas pressure in the cell, placed in front of a detector observing a region of atmosphere, the radiation received at the detector would include a signal at the modulation frequency that could be used to infer the temperature or column density of the constituent gas in the target atmosphere. Fred implemented this concept for CO_2 into a practical instrument and demonstrated its feasibility by making observations of atmospheric temperature during a balloon ascent into the stratosphere. This was sufficient to prove that the concept could work in practice, and led to similar instruments being proposed and accepted for flight on NASA's Earth-orbiting satellites, starting with Nimbus 6 launched in 1975, to obtain global observations of the stratosphere and mesosphere from space. Similar observations from the Upper Atmosphere Research Satellite (UARS) in the 1990s were crucial to determining the atmospheric circulation associated with the breakdown of the Earth's ozone layer and the response to major volcanic eruptions.

Fred's early days in Oxford were also important in that he met his future wife, Doris (née Buer), a DPhil student in biochemistry. They married in 1969 and shared 52 years together.

After graduating, Fred was hired by Dr Barney Farmer at JPL in Pasadena, initially to work on the design of infrared instrumentation for an ambitious mission concept by NASA to send a spacecraft on a "Grand Tour" of all the outer planets. In the event, the JPL instrument was not selected for what became the Voyager missions to the outer planets. But shortly afterwards, the opportunity arose to propose an instrument for Pioneer Venus, NASA's answer to a succession of Venus missions mounted previously by the Soviet Union. Fred grasped this opportunity with both hands and proposed an instrument that would use the same pressure modulator concept for the Venus atmosphere as used by Houghton and Taylor for Earth. This time the instrument was selected, with Fred as Principal Investigator and his former supervisor as UK collaborator. The Pioneer Venus mission launched in 1978 and was a spectacular success. Fred's instrument probed for the first time Venus's thermal tide and atmospheric circulation, discovering the presence of weird dipolar vortices over its poles.

After ten exciting and productive years at JPL, Fred returned to Oxford in 1980 as Acting Head of Atmospheric Physics because his predecessor, John Houghton, was taking leave of absence to become Director of the Appleton Laboratory. Fred took this opportunity to extend the reach of the Oxford department beyond the Earth towards the other planets of the Solar System, whilst also leading the department to more ambitious Earth orbiting missions (notably ISAMS[1] on UARS) to observe the atmosphere.

[1] Improved Stratospheric and Mesospheric Sounder on the Upper Atmosphere Research Satellite.

This led to involvements in a glittering succession of space missions so that, by the time Fred retired from his post at Oxford in 2011, he and his colleagues had contributed to missions that had visited every planet in the Solar System (apart from Pluto), the Moon and a comet. Despite some notable disasters, including the ill-fated Mars Observer and Mars Climate Orbiter missions (the latter of which crashed into Mars, depositing the first British scientific hardware on Mars, albeit in fragments!), particular highlights included the Cassini orbiter and Mars Reconnaissance Orbiter missions with NASA, and ESA's Venus Express mission. The latter was a particularly notable achievement for Fred himself, who was one of the chief advocates to make the case to ESA for a reflight of the previously developed Mars Express spacecraft to send into orbit around Venus. Using the same spacecraft design for a completely different mission was a novel idea for ESA, but turned out to be highly successful, leading to the launch of the mission in 2005, only 3 years after the original proposal was accepted. Venus Express ended in 2014, having obtained the most comprehensive set of observations of the Venus atmosphere to date.

Fred was a prolific writer, authoring 12 books alongside his many scientific publications, including two undergraduate textbooks and research monographs on atmospheric radiation and the atmospheres of Mars, Venus and Titan. He was appointed the first Halley Professor of Physics at Oxford in 2000 and was the recipient of a number of major awards, including the Rank Prize in Optoelectronics, 14 NASA Achievement awards (including an Exceptional Achievement Medal), the Bates Medal of the European Geosciences Union, and the Arthur C. Clarke Award for Lifetime Achievement. His wife, Doris, notes that Fred was an active member of his college (Jesus), a classic car enthusiast, a lover of country and western as well as 60s music, a fan of Victorian engineering and an avid reader. He retired in 2011 and remained in Oxford until his sudden and untimely death on 16 December 2021.

Peter Read and Ray Pierrehumbert
6 April 2022