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Super-SNID : an expanded set of SNID classes and templates for the new era of wide-field surveys

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1. ABSTRACT

We present an expanded template library for the supernova identification (SNID) software, along with updated source files that make it easy to merge our templates—and other major SNID libraries—into the base code. This expansion, dubbed 'Super-SNID', increases the number of spectra for under-represented supernova classes (e.g., SNe Ia-02cx, Ibn) and adds new classes (e.g., SLSNe, TDEs, LFBOTs). Super-SNID includes 841 spectral templates for 161 objects, primarily from the Public ESO Spectroscopic Survey of Transient Objects (PESSTO) Data Releases 1–4. The library is available on GitHub with simple installation instructions.

2. INTRODUCTION

SNID (Supernova Identification) (Blondin & Tonry 2007) is a widely used tool for determining the type, redshift and age from explosion of a supernova (SN) spectrum via template cross-matching. However, many newly discovered or rare transient classes remain unrepresented in its current library.

A surge in transient detections is expected in the coming years, driven by the Vera C. Rubin Observatory's 10-Year Legacy Survey of Space and Time (LSST; Ivezić et al. 2019). Spectra for many events will be obtained by projects such as Son-of-X-shooter (SOXS; Schipani et al. 2018) and the Time-Domain Extragalactic Survey (TiDES; Swann et al. 2019). However, reliable classification depends on representative comparison libraries. Classes like superluminous supernovae (SLSNe) and tidal disruption events (TDEs) are not included within the standard SNID library – as they were unknown at that time – but are now regularly detected.

We present Super-SNID, an expanded SNID template library including spectra of newly discovered and rare transients, integrated with existing SNID libraries (Blondin & Tonry 2007; Silverman et al. 2012; Modjaz et al. 2016). It is available on GitHub[1] along with installation instructions, updated SNID source files to incorporate new transient classes, and a 'Template Generator' tool for adding additional spectra.

3. METHOD AND RESULTS

Our expanded SNID library contains several new classes, which required modifying SNID's internal source files. New classes for which we provide templates are: SLSNe[2], TDEs, kilonovae, luminous fast blue optical transients (LFBOTs), and 'Gap' transients (including luminous red novae and luminous blue variable eruptions). We also add several sub-classes to the existing classes of Type Ia and core-collapse SNe. The full breakdown of classes and sub-classes is given in Table 1. We have also added to the SNID source files several classes listed on the Transient Name Server[3] for which we do not currently have templates; these are listed in the Table caption. Including these in SNID's class definitions now will simplify the future addition of templates.

We have created 841 new SNID spectral templates for 161 new objects, mainly using Data Releases 1-4 of the Public ESO Spectroscopic Survey of Transient Objects (PESSTO and ePESSTO; Smartt et al. 2015). Each spectrum was downloaded from the Weizmann Interactive Supernova Data Repository (WISeREP; Yaron & Gal-Yam 2012). We

[1] https://github.com/dkjmagill/QUB-SNID-Templates; Super-SNID v1.0.0 Zenodo dataset - doi:10.5281/zenodo.15167198
[2] SNID templates have been created for SLSNe by Liu et al. (2016), but the class does not exist within SNID's class definition files.
[3] https://www.wis-tns.org/

downloaded further data for some well-studied literature objects that were not covered by PESSTO alone. Spectra of the kilonova AT2017gfo were sourced from the ENGRAVE data release (Smartt et al. 2017; Pian et al. 2017). Additional spectra of the LFBOTs AT2018cow (Prentice et al. 2018), CSS1601010 (Gutiérrez et al. 2024) and AT2020xnd (Perley et al. 2021) were downloaded from WISeREP. Spectra of SN Icn SN2021csp were sourced from Perley et al. (2022); Pellegrino et al. (2022). Spectra for various SNe Ia-02es were sourced from Ganeshalingam et al. (2012); Blondin et al. (2012); Foley et al. (2010); Cao et al. (2015); Xi et al. (2024); Maguire et al. (2022).

Several previous SNID template libraries exist, including the standard templates (Blondin & Tonry 2007) and the additional libraries from the Berkeley Ia Supernova Program (Silverman et al. 2012), the NYU Group stripped-envelope SN templates (Liu et al. 2016; Modjaz et al. 2016; Williamson et al. 2019), and the Type II SN templates from Gutiérrez et al. (2017). These templates are available from the SNID webpage[4]. To make the largest template database accessible to any SNID user, we have merged the standard SNID, Berkeley and NYU templates with our own templates in a single directory. We did not include the Gutiérrez et al. (2017) templates for SNe II, as this would require maintaining an additional list of explosion dates, but this class is well covered by PESSTO SSDR1-4. By downloading our merged template directory and updated SNID source files from GitHub, a user can immediately recompile SNID to work with all templates. We hope this will serve as a useful resource to the transient community as we move towards the data-driven era of LSST, SoXS and TiDES. We emphasise that users of Super-SNID must cite the original source papers for existing templates used, in addition to this work.

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Facilities: NTT, VLT, TNS

Software: Astropy (Astropy Collaboration et al. 2013), Numpy (Harris et al. 2020), SNID (Blondin & Tonry 2007), Pandas (The pandas development Team 2023)

[4] https://people.lam.fr/blondin.stephane/software/snid/

Type	Sub-type	No. in Standard SNID	No. with Berkeley/NYU	No. in Super-SNID	References
Ia	Ia-norm	1995	2050	2050	1, 3
Ia	Ia-91T	340	349	388	1, 2, 3
Ia	Ia-91bg	193	196	218	1, 2, 3
Ia	Ia-csm	27	27	38	1, 2
Ia	Ia-pec	103	103	138	1, 2
Ia	Ia-02cx	10	11	18	1, 2, 3
Ia	Ia-03fg	56	56	56	1
Ia	Ia-02es	0	0	16	4, 5, 6, 7, 8
Ia	Ia-Ca-rich	0	0	9	2
Ib	Ib-norm	78	365	371	1, 2, 3, 9, 10, 11
Ib	Ib-pec	0	10	15	2, 9, 10, 11
Ib	IIb	91	289	338	1, 2, 3, 9, 10, 11
Ib	Ibn	0	36	52	2, 9, 10, 11
Ic	Ic-norm	82	294	341	1, 2, 3, 9, 10, 11
Ic	Ic-Broad	0	214	235	2, 9, 10, 11
Ic	Icn	0	0	2	12, 13
Ic	Ic-Ca-rich	0	0	4	2
II	IIP	190	339	601	1, 2, 3
II	II-pec	241	241	247	1, 2
II	IIn	75	143	205	1, 2, 3
II	IIL	27	27	38	1, 2
II	IIn-pec	0	0	6	2
NotSN	AGN	1	1	1	1
NotSN	Gal	11	11	11	1
NotSN	QSO	0	4	4	3
NotSN	M-star	11	11	11	1
NotSN	C-star	0	3	3	3
SLSN	SLSN-I	0	141*	203	2, 9, 10, 11
SLSN	SLSN-II	0	3*	12	2, 3
SLSN	SLSN-IIn	0	11*	11	3
LFBOT	18cow	0	0	11	14
LFBOT	20xnd	0	0	10	15, 16
TDE	TDE-H	0	0	14	2
TDE	TDE-He	0	0	6	2
TDE	TDE-H-He	0	0	36	2
TDE	TDE-Ftless	0	0	10	2
KN	17gfo	0	0	10	17, 18
Gap	LRN	0	0	3	2
Gap	LBV	15	15	18	1, 2

Table 1. Populated spectral classes within our updated SNID library. Columns show the number of spectra in standard SNID, after merging the Berkeley/NYU libraries, and the total in Super-SNID after merging our new templates. These numbers are accurate as of April 2025. We have added further subtypes to the source files, not shown in the table as they are currently unrepresented by any spectra. These are: Ib-Ca-rich, Ib-csm, Ic-pec, Ic-csm, Afterglow, Nova, CV, SLSN-Ib, SLSN-Ic and ILRT. 1 = Blondin & Tonry (2007), 2 = Smartt et al. (2015), 3 = Silverman et al. (2012), 4 = Ganeshalingam et al. (2012), 5 = Blondin et al. (2012), 6 = Foley et al. (2010), 7 = Xi et al. (2024), 8 = Maguire et al. (2022), 9 = Liu et al. (2016), 10 = Modjaz et al. (2016), 11 = Williamson et al. (2019), 12 = Perley et al. (2022), 13 = Pellegrino et al. (2022), 14 = Prentice et al. (2018), 15 = Perley et al. (2021), 16 = Gutiérrez et al. (2024), 17 = Smartt et al. (2017), 18 = Pian et al. (2017). *Class not included in standard SNID files. Adjustments made to metadata files for inclusion within Super-SNID.

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