

Superbowl Advertisement: Open Source Bolometric LC

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Overview

- 1 SuperBoL
- 2 Why Do Theorists Care about L_{bol} ?
 - Model Parameter
- 3 Future Features
 - Web Accessible Data

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SuperBoL: Supernova Bolometric Lightcurves

- Python package
- Implements bolometric lightcurve calculation techniques
- Propagates uncertainties
- Open-source, extensible

<http://github.com/JALusk/SuperBoL>

<http://superbol.readthedocs.io>

Typical usage often looks like this:

```
from superbol import sn

my_supernova = sn.SN('sn1998a')
my_supernova.lqbol()           # quasi-bolometric lightcurve
my_supernova.lbol_direct_bh09() # direct lightcurve
my_supernova.lbol_bc_bh09('B', 'V') # B-V bolometric correction lightcurve
```

SuperBoL propagates uncertainties in the input data through the calculations made by the code, allowing for errorbars to be included in plots of the lightcurve.

Installation

Source code can be found at <https://github.com/JALusk/SuperBoL>.

In order to install SuperBoL system-wide, use:

```
python setup.py install
```

```
pip install --prefix=$HOME/python_lib superbol
```

SuperBoL: Numerical techniques

Python packages:

- NumPy
- SciPy `curve_fit`
- Astropy `units`
- Extinction
- PyTables

SuperBoL: Inputs

Stored in HDF5 file:

- Photometry
- Filter information
 - Flux at zero magnitude
 - Effective wavelength
- Reddening
- Distance
- Explosion date

The screenshot shows a software interface with two main windows. On the left is a 'Tree of databases' window showing a hierarchical structure of data files. On the right is a 'phot SN 2000cb Photometry' window displaying a table of photometric data.

Tree of databases

- sn_data.h5
 - filters
 - telescopes
 - sn
 - sn2009e
 - sn2000cb
 - phot
 - sn1987a
 - sn2006au
 - sn1998a
 - sn2006v
 - Query results

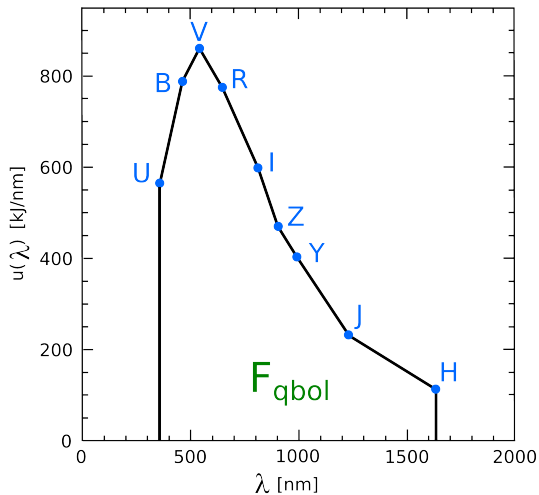
phot SN 2000cb Photometry

filter_id	jd	magnitude	note	reference	telescope_id	uncertainty
1 0	2451658.96	18.72	"	'Kleiser+, 2...	1	0.06
2 0	2451661.97	17.74	"	'Kleiser+, 2...	1	0.06
3 0	2451663.92	17.83	"	'Kleiser+, 2...	1	0.06
4 1	2451663.92	18.78	"	'Kleiser+, 2...	1	0.06
5 2	2451663.92	18.04	"	'Kleiser+, 2...	1	0.03
6 3	2451663.92	17.66	"	'Kleiser+, 2...	1	0.06
7 0	2451665.96	17.42	"	'Kleiser+, 2...	1	0.06
8 1	2451667.86	18.78	"	'Kleiser+, 2...	1	0.07
9 2	2451667.86	17.8	"	'Kleiser+, 2...	1	0.04
10 3	2451667.86	17.3	"	'Kleiser+, 2...	1	0.06
11 0	2451670.96	17.06	"	'Kleiser+, 2...	1	0.06
12 0	2451691.93	16.33	"	'Kleiser+, 2...	1	0.06
13 1	2451692.88	17.73	"	'Kleiser+, 2...	1	0.03
14 2	2451692.88	16.62	"	'Kleiser+, 2...	1	0.02

SuperBoL: Techniques

Techniques:

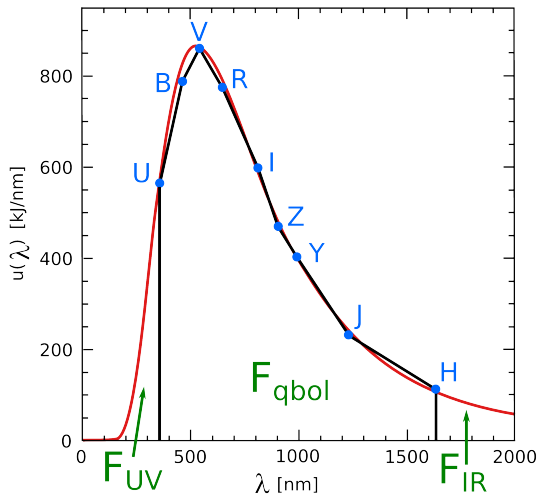
- Quasi-bolometric



SuperBoL: Techniques

Techniques:

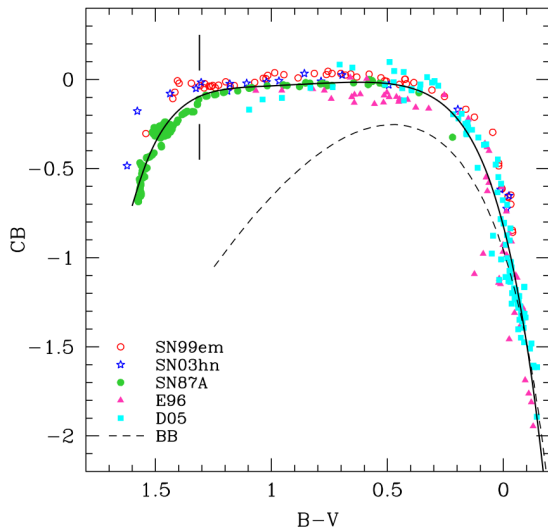
- Quasi-bolometric
- Direct Integration



SuperBoL: Techniques

Techniques:

- Quasi-bolometric
- Direct Integration
- Bolometric Correction

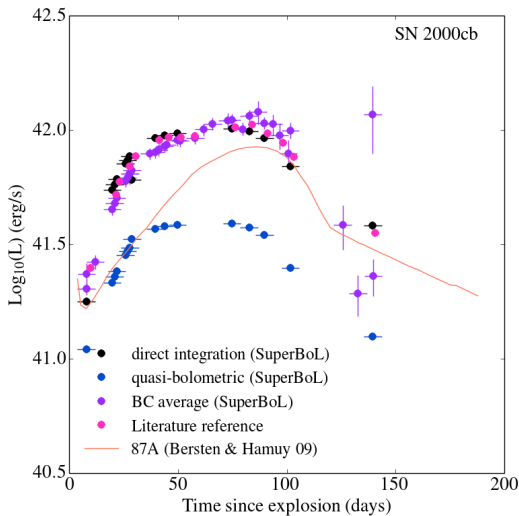


(Bersten & Hamuy, 2009)

SuperBoL: Outputs

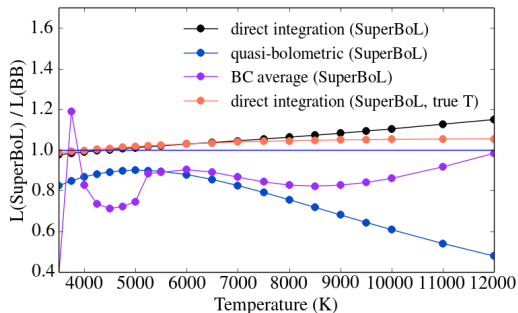
Techniques:

- Quasi-bolometric
- Direct integration
- Bolometric correction



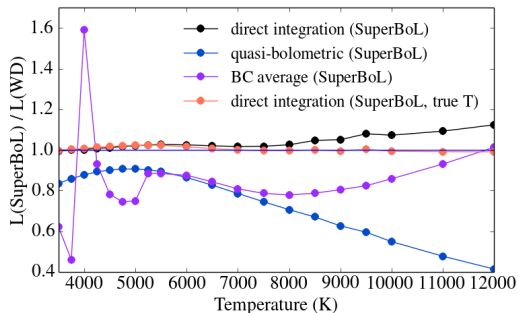
SuperBoL: Validation

- Blackbody models
 - Generate blackbody spectra of known luminosity
 - Take synthetic photometry
 - Run photometry through SuperBoL
 - Compare luminosities



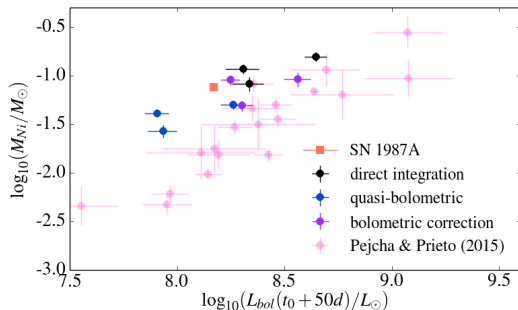
SuperBoL: Validation

- White Dwarf models
 - Use WD models of known luminosity
 - Run photometry though SuperBoL
 - Compare luminosities



Paper I: Results

- Nickel mass - peak luminosity relation
 - Systematic differences from previously published relations
 - Under-luminous for a given M_{Ni} ?
 - Over-produced ^{56}Ni for a given L_{bol} ?



Paper I: Results

- Need more information about the progenitors
 - Mass, explosion energy, initial radius
- Need way of testing the bolometric techniques
 - Synthetic spectra from PHOENIX
 - Calculate synthetic photometry
 - Run photometry through SuperBoL

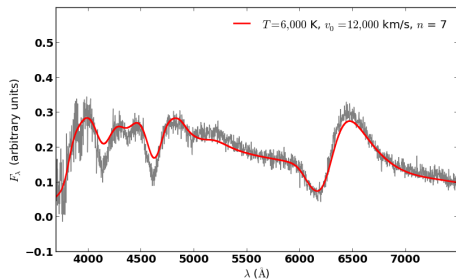
Bands	L_{qbol} 10^{41} (erg/s)	L_{D} 10^{41} (erg/s)	L_{BC} 10^{41} (erg/s)
VRI	—	—	6.18
BVR	—	—	12.52
UBV	—	—	12.52
BVRI	3.49	8.36	8.62
UBVR	3.78	9.15	12.52
UBVRI	4.88	8.76	8.62
UBVRIJHK	7.25	8.36	8.62
L_{bol} (PHOENIX)		11.08	

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PHOENIX: A Supernova In a Box

- PHOENIX provides the full SED of a supernova of known bolometric luminosity
 - This can be used to test the different bolometric luminosity techniques
- Allows us to fix bolometric luminosity and make grids of other parameters. One less parameter really helps

SN 2000cb



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SuperBoL: Next Steps

For SuperBoL v1.0.0:

- Modular
- Extensible
- Multiple I/O options
 - AstroCatalogs
(<http://sne.space>)
- Cross-platform testing
- Documentation: User guide

Goal: AJ Software paper Fall 2017



INSTRUMENTATION, SOFTWARE,
LABORATORY ASTROPHYSICS, AND
DATA

Data from the Web

- Open Supernova Catalog
 - Photometry
 - Spectra
- astroquery: IRAS dust extinction map
- Needed: magnitude-flux conversion for different filters

How does it work with weirdo objects?

GW170817

- Easy access to photometry thanks to <http://kilonova.space>
- Preliminary quasi-bolometric lightcurve from development version of SuperBoL
- No interpolation for missing data, just averaging repeated observations

GW170817 Optical Counterpart

