

What is DASH?

- › Fast and autonomous supernova spectral classification tool
- › Uses Deep Learning to train a matching algorithm
- › Classifies spectra into specific type and age

SN Ia: Ia-norm, Ia-91T, Ia-91bg, Ia-02cx, Ia-csm, Ia-pec

SN Ib: Ib-norm, Ibn, IIb, Ib-pec

SN Ic: Ic-norm, Ic-broad, Ic-pec

SN II: IIP, IIL, IIn, II-pec

- › Graphical interface and python library available
- › Tested successfully on
 - Operating Systems: Mac/Linux/Windows
 - Python 2.7, 3.6

Problems with current methods

- › Superfit and SNID rely on iterative template matching processes
 - Computation **time increases linearly with the number of templates**
 - Can only compare to **one template at a time** (rather than the aggregate set of each SN type)
- › Chi-squared minimisations are **slow**
- › **Not autonomous**: requires a lot of human-input

How DASH improves

› Speed

- **Autonomously** classify several spectra at once
- **Significantly faster** (example: classified 200 spectra in under 20 seconds)

› Accuracy

- DASH classifies based on **features instead of templates**
 - Uses aggregate set of templates rather than a single template
- Softmax regression probabilities

› Precision

- **More specific classification** including age and specific type

› Installation and ease of use

- Graphical interface and **python library**
- Very simple installation and use

Validation Set Performance

- › **Type:** Correct broad type (i.e. Ia, Ib, Ic, II) identified by the matching algorithm.
- › **Subtype:** Correct subtype (i.e. Ia-norm, Ib-pec, Ib-norm, etc.) identified.
- › **Type and Age:** Correct broad type and the correct age bin identified by the matching algorithm.
- › **Subtype and Age:** Correct subtype and the correct age bin identified.

Criteria	Correctly Classified
Type	99.2%
Subtype	96.0%
Type and Age	93.3%
Subtype and Age	95.7%

Results with OzDES Data

- › OzDES data from the last couple of runs at the end of 2016.
- › Matches Superfit in 100% of confirmed cases
- › Classified all 23 spectra in <10 seconds!
- › Able to classify more spectra
 - Precise likelihood measurements (from softmax regression)
 - More precise measurement (with age and specific type)

Name	Redshift	ATEL Classification	DASH		Match?
			Classification	Probability	
DES16E1de	0.292	Ia? (+2)	Ia-pec (+2 to +10)	91%	✓
DES16E2dd	0.0746	Ia (+3)	Ia-norm (+2 to +6)	89%	✓
DES16X3km	0.0542	II (+)	IIP (+6 to +10)	99.7%	✓
DES16X3er	0.167	Ia (+2)	Ia-91T (-2 to +6)	86%	✓
DES16X3hj	0.308	Ia (0)	Ia-norm (-2 to +2)	90%	✓
DES16X3es	0.554	Ia? (0)	IIP (+22 to +26)	92%	x
DES16X3jj	0.238	II? (+)	Ic-pec (-2 to 2)	37%	x
DES16C3fv	0.322	Ia (-6)	Ia-norm (-10 to +2)	99.8%	✓
DES16C3bq	0.241	Ia (+0)	Ia-norm (-2 to +6)	99.6%	✓
DES16E1md	0.178	Ia (0)	Ia-norm (-6 to +2)	99%	✓
DES16E1ah	0.149	II (+)	Ia-91T (+14 to +22)	75%	x
DES16C3ea	0.217	Ia (+)	Ia-norm (+10 to +26)	88%	✓
DES16X1ey	0.076	II (+)	IIb (+2 to +6)	38%	✓
DES16C3bq	0.237	Ia (+)	Ia-norm (-2 to +6)	97%	✓
DES16E2aoh	0.403	Ia (+)	Ia-norm (-2 to +6)	88%	✓
DES16X3aqd	0.033	IIP (+)	IIb (-6 to +2)	99%	✓
DES16X3biz	0.24	Ia (-)	Ia-norm (-14 to +2)	98%	✓
DES16C2aiy	0.182	Ia (+)	Ia-norm (-2 to +6)	99.99%	✓
DES16C2ma	0.24	Ia (+)	Ia-norm (+14 to +22)	99.2%	✓
DES16X1ge	0.25	Ia (+)	Ia-norm (+14 to +22)	99.7%	✓
DES16X2auj	0.144	Ia (0)	Ia-norm (-6 to +6)	84%	✓
DES16E2bkg	0.478	Ia (0)	Ia-norm (-2 to +6)	99%	✓
DES16E2bht	0.392	Ia (+3)	Ia-norm (-6 to +2)	58%	✓

Installation

- › `pip install astrodash`

- › For the graphical interface you will also need PyQt5
`conda install pyqt`

- › Also available open source at:
<https://github.com/daniel-muthukrishna/DASH>

Graphical Interface

DASH

Select Spectra

DES13C2acmj_SALT_20140202.t

Browse

Priors

Known Redshift 0.1137

Classify Host

Min wave 2500

Max wave 10000

Smooth 7

Re-fit with priors

Cancel

Best Matches

No.	Type	Age	Softmax Prob.	Best Match
1	la-norm	26 to 30	0.995954	la-norm 22 to 30
2	la-norm	22 to 26	0.00261576	
3	la-norm	38 to 42	0.00126771	
4	la-91T	26 to 30	0.000109286	
5	llb	34 to 38	2.42095e-05	

Redshift: 0.1137

99.86% *Reliable*

Analyse selection

Plot Template la-norm 26 to 30 No Host Host Fraction 0%

sn2008ar.lnw_28.4_No Host

Redshift 0.11

The interface displays two plots. The top plot shows a normalized spectrum with the x-axis ranging from 0 to 1. The bottom plot shows a zoomed-in view of the spectrum from 4000 to 10000 Angstroms, with the y-axis ranging from 0 to 1. The observed data is shown as a red line, and the model fit is shown as a green line.

Python Interface

```
import dash

classify = dash.Classify(filenamees, knownRedshifts)

print(classify.list_best_matches())

classify.plot_with_gui(indexToPlot=0)

dash.run_gui()
```


Use in DES

- › Can distinguish Ia and Ib?
- › Instantly check over entire sample to spot issues
 - DES15S2it (Type Ib?)
- › Confidence scores
- › Found problems on old Ia-sample set
- › New reduced cosmology sample seems okay so far. But nonetheless, DASH was able to spot the issues in the old one without a human having to iteratively check each supernova