KAEPORA

- Using a Relational Database to Investigate Spectral Diversity in a Cosmological Sample

Matt Siebert, Ryan Foley, David Jones

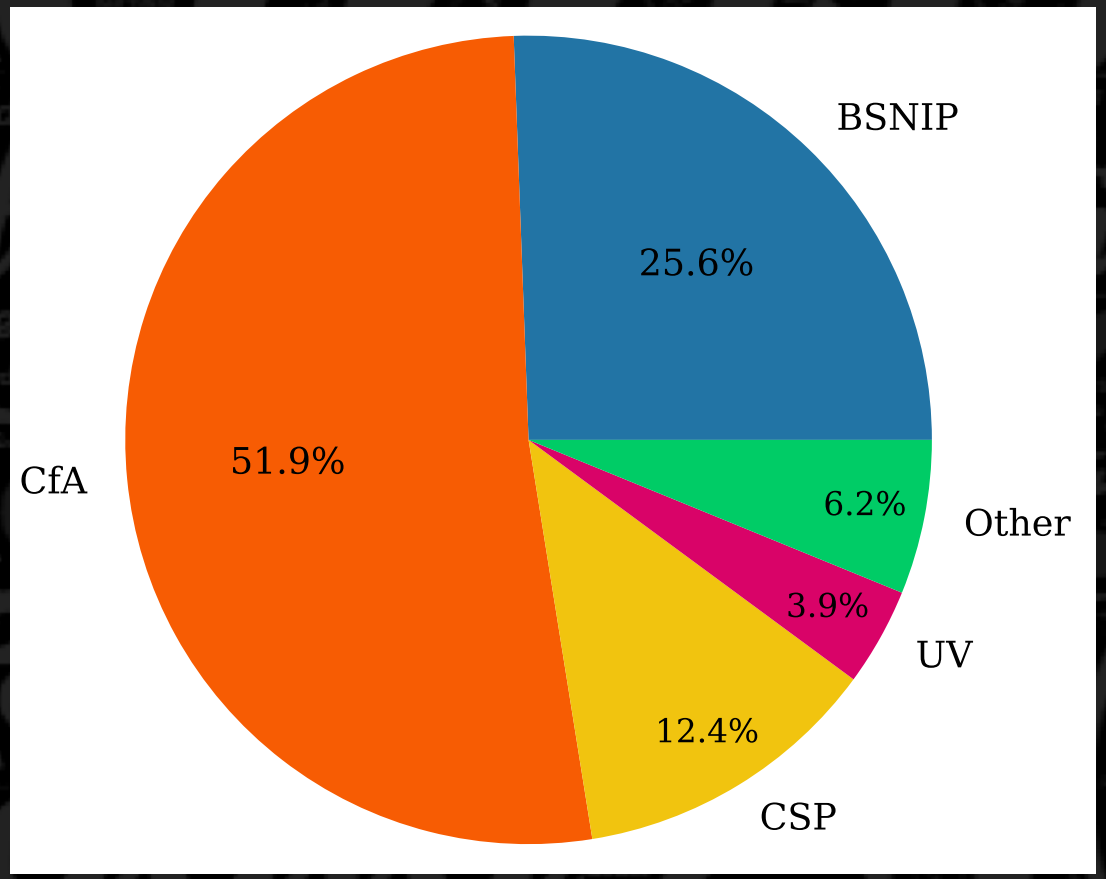
Lijiang Meeting, August 8, 2019

UNIVERSITY OF CALIFORNIA SANTA CRUZ

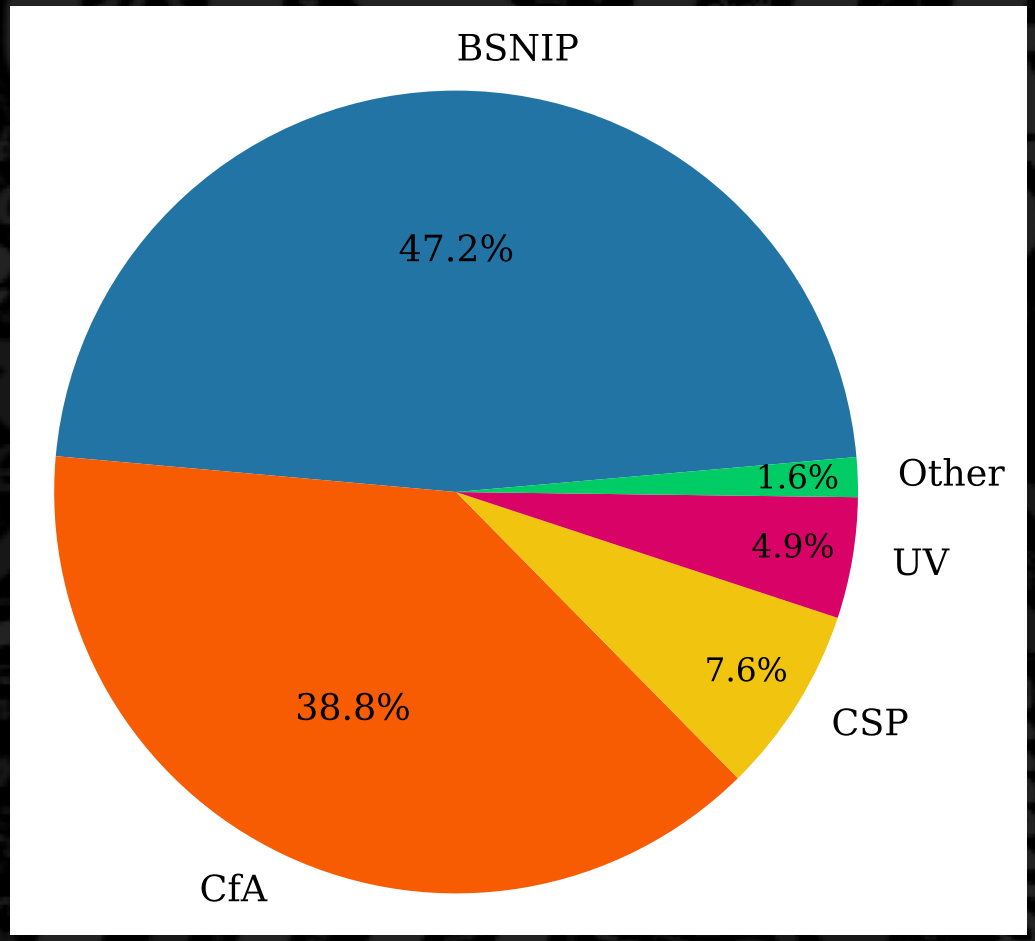
Siebert et al. 2019a

Sample Demographics

4975 Spectra

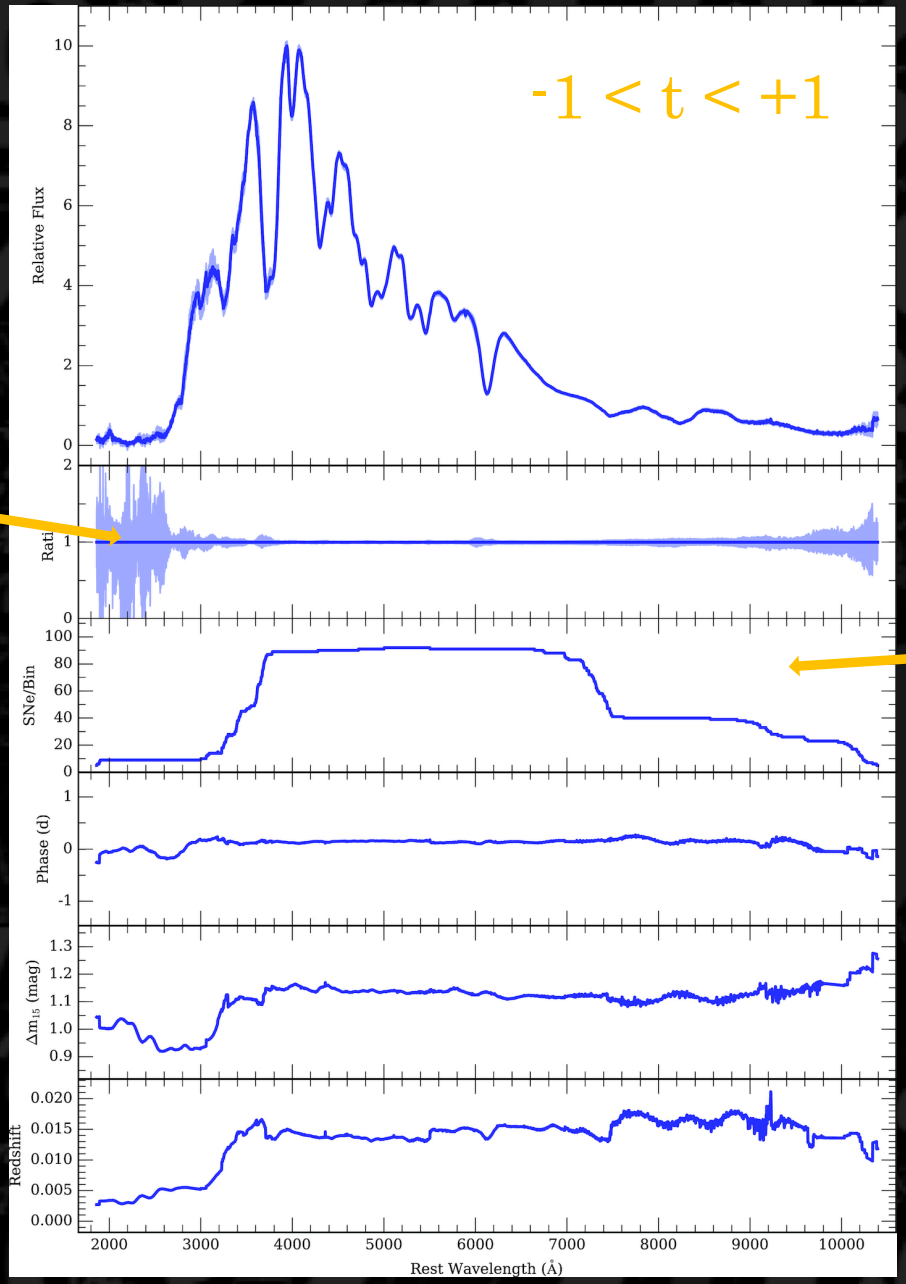


777 Supernovae



Siebert et al. 2019a

Composite Spectra



1σ Error

97 Total SNe

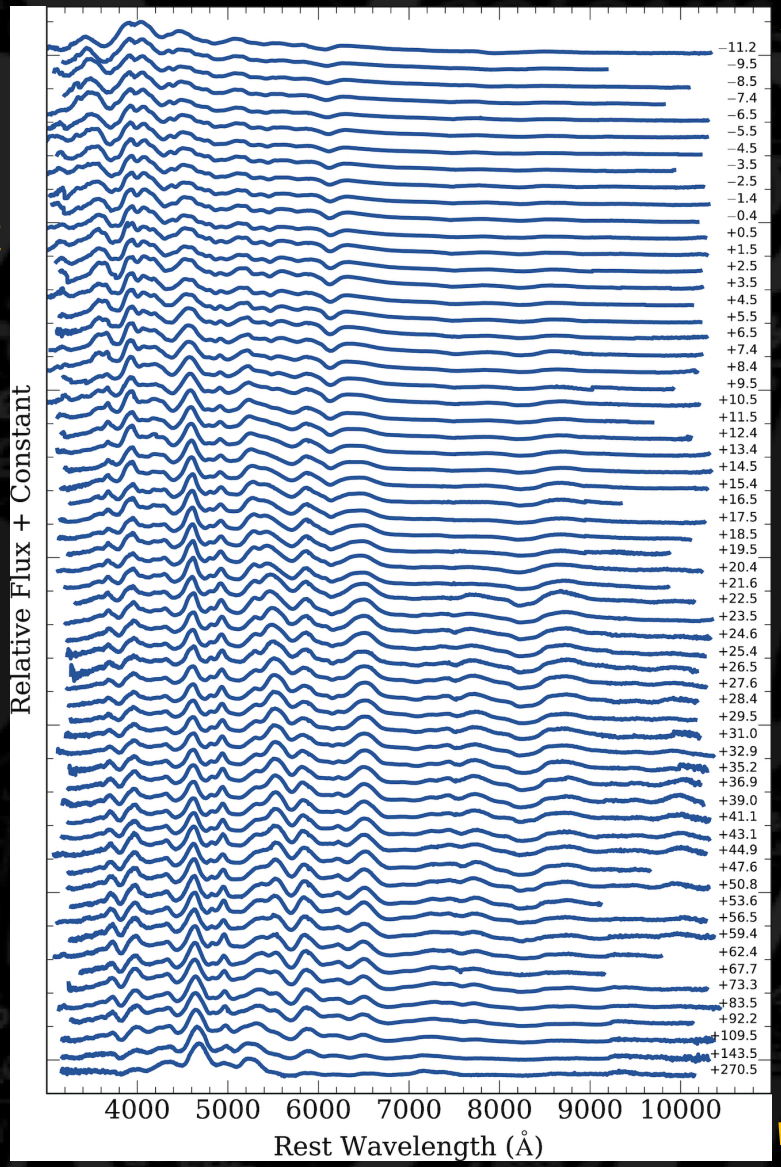
Average Properties

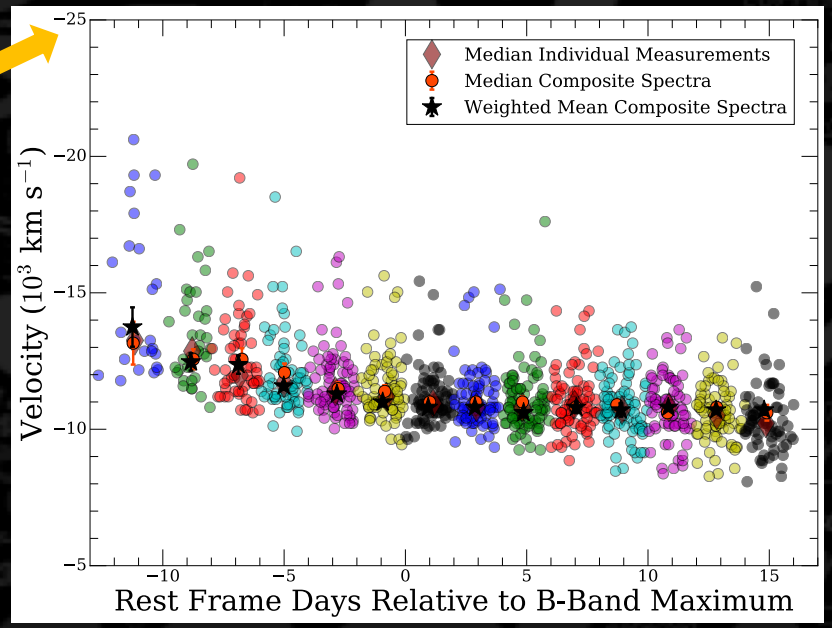
Siebert et al. 2019a

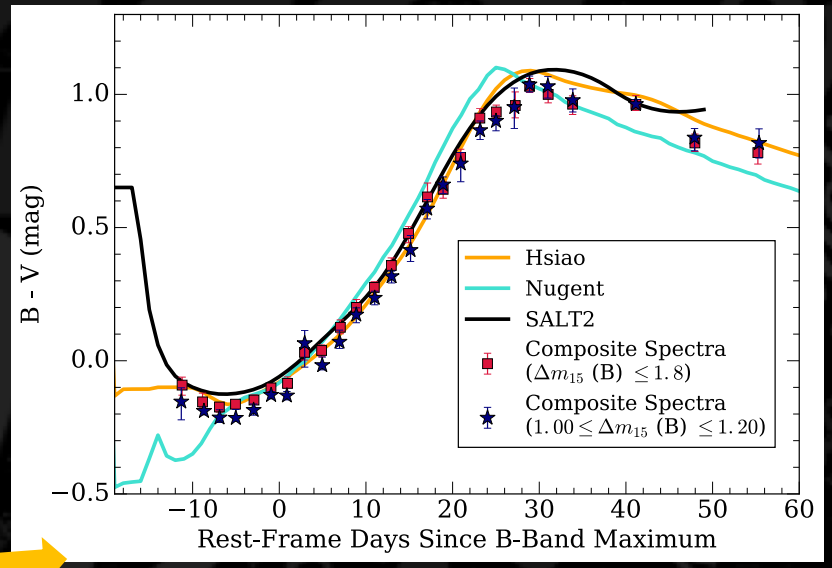
Spectral Evolution

Photospheric

Nebular







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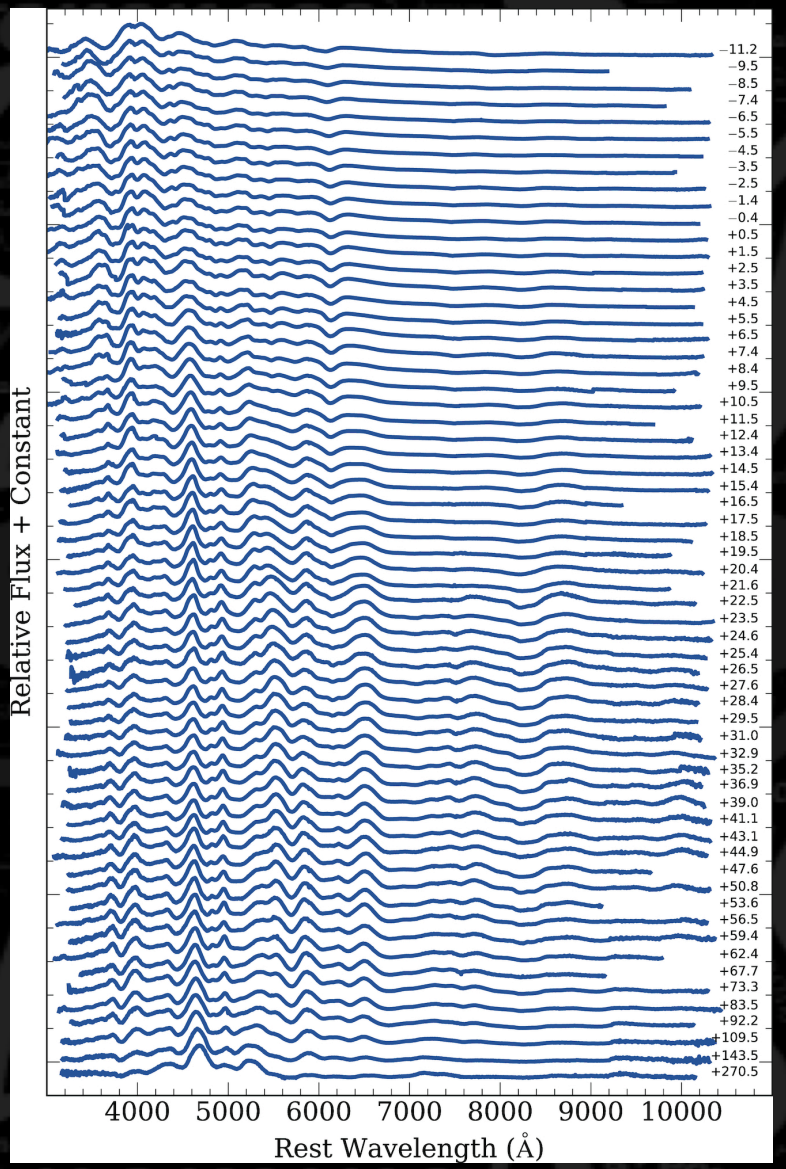
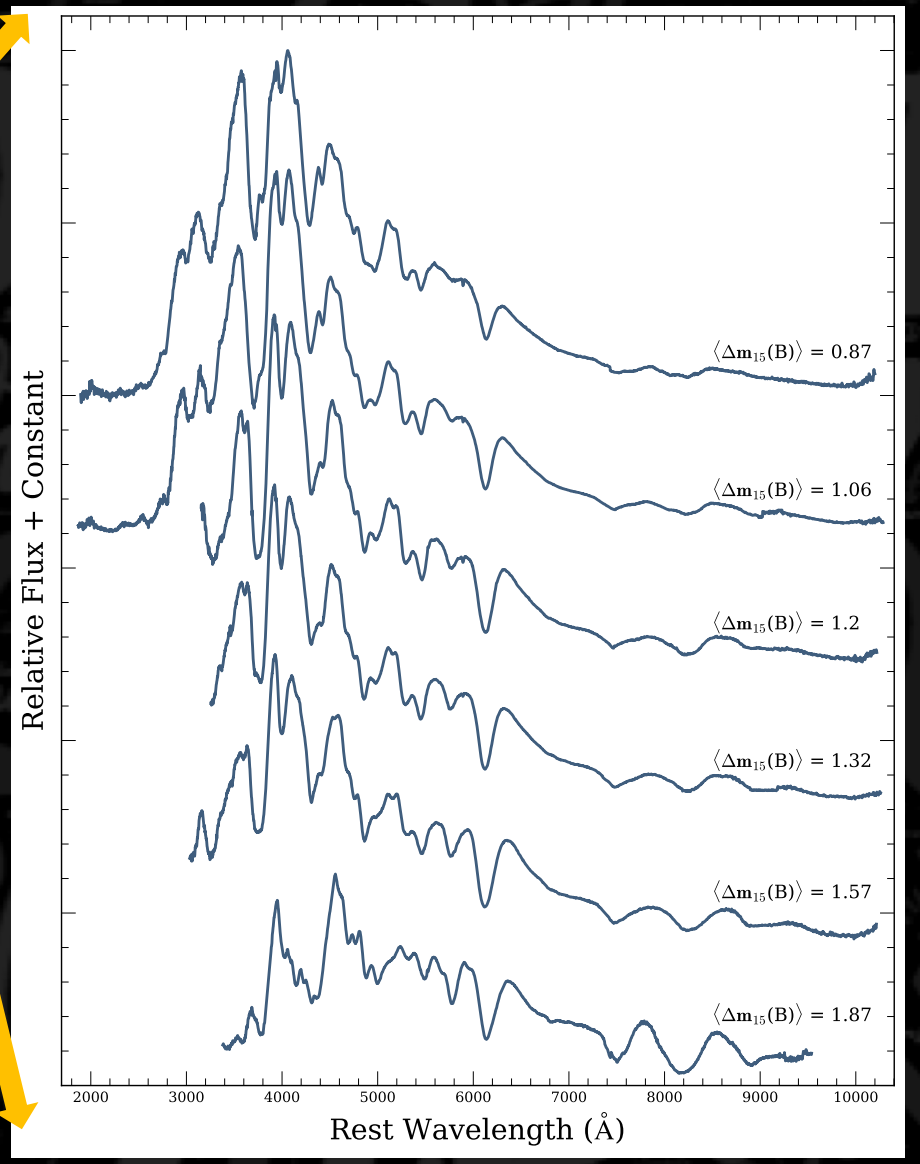
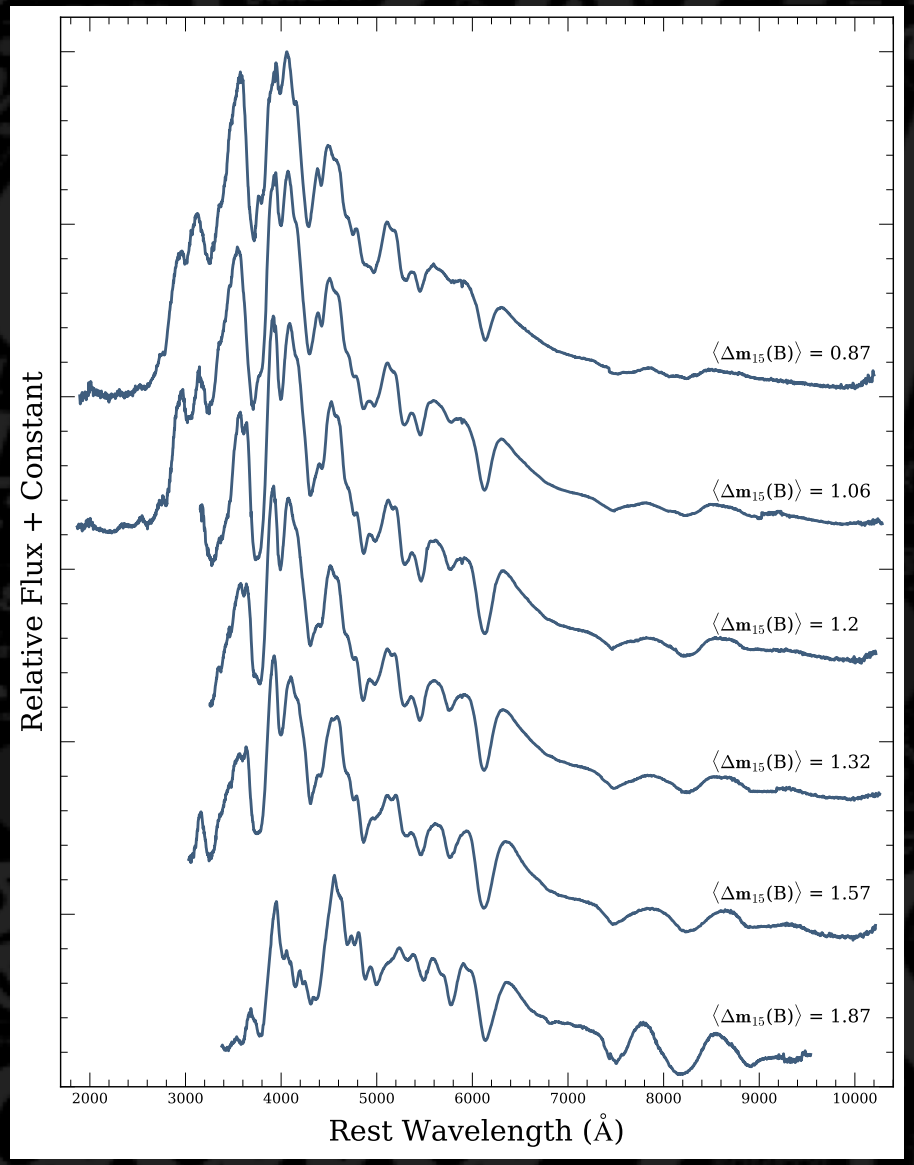
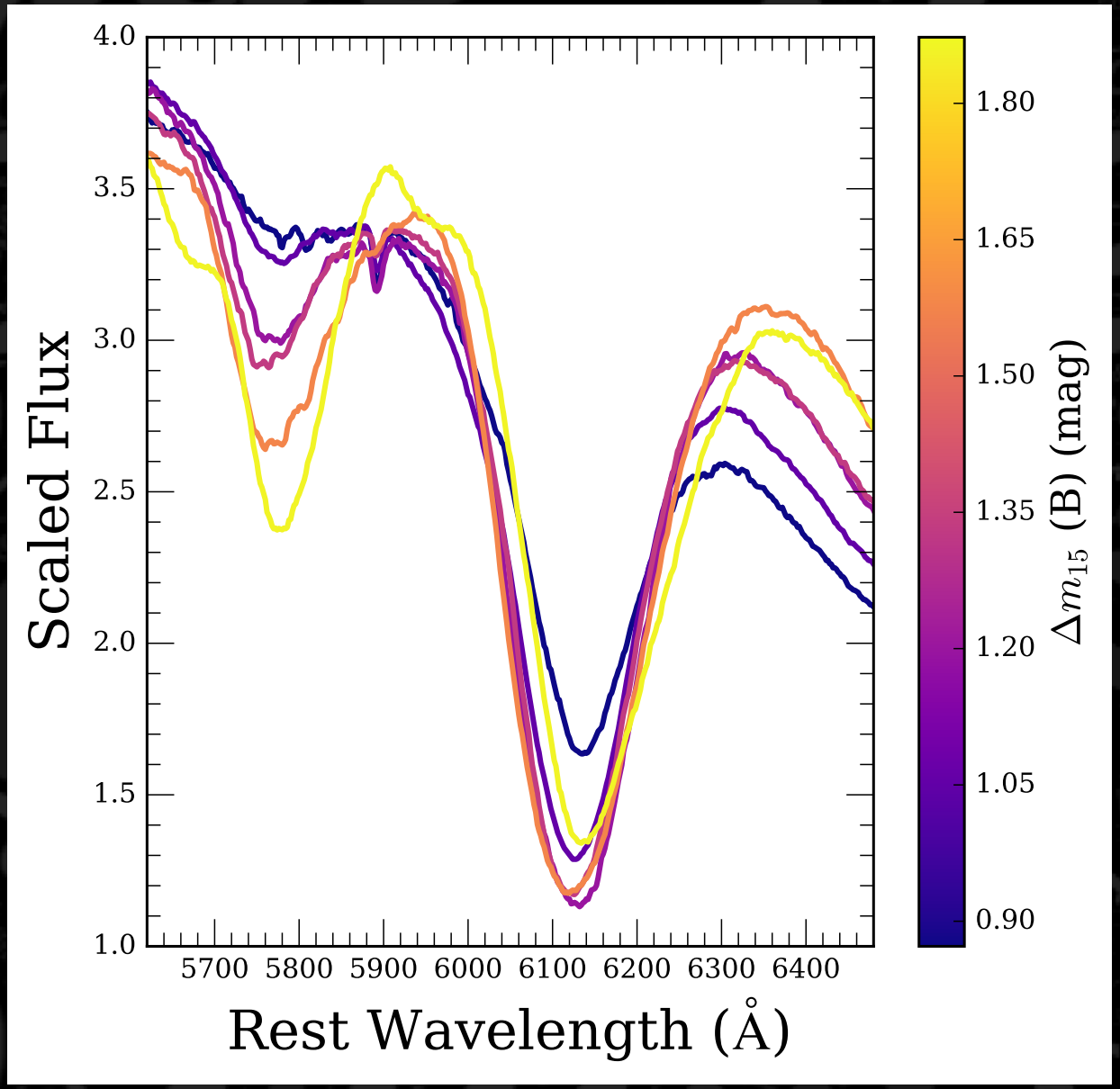
Light-Curve Shape





Siebert et al. 2019a





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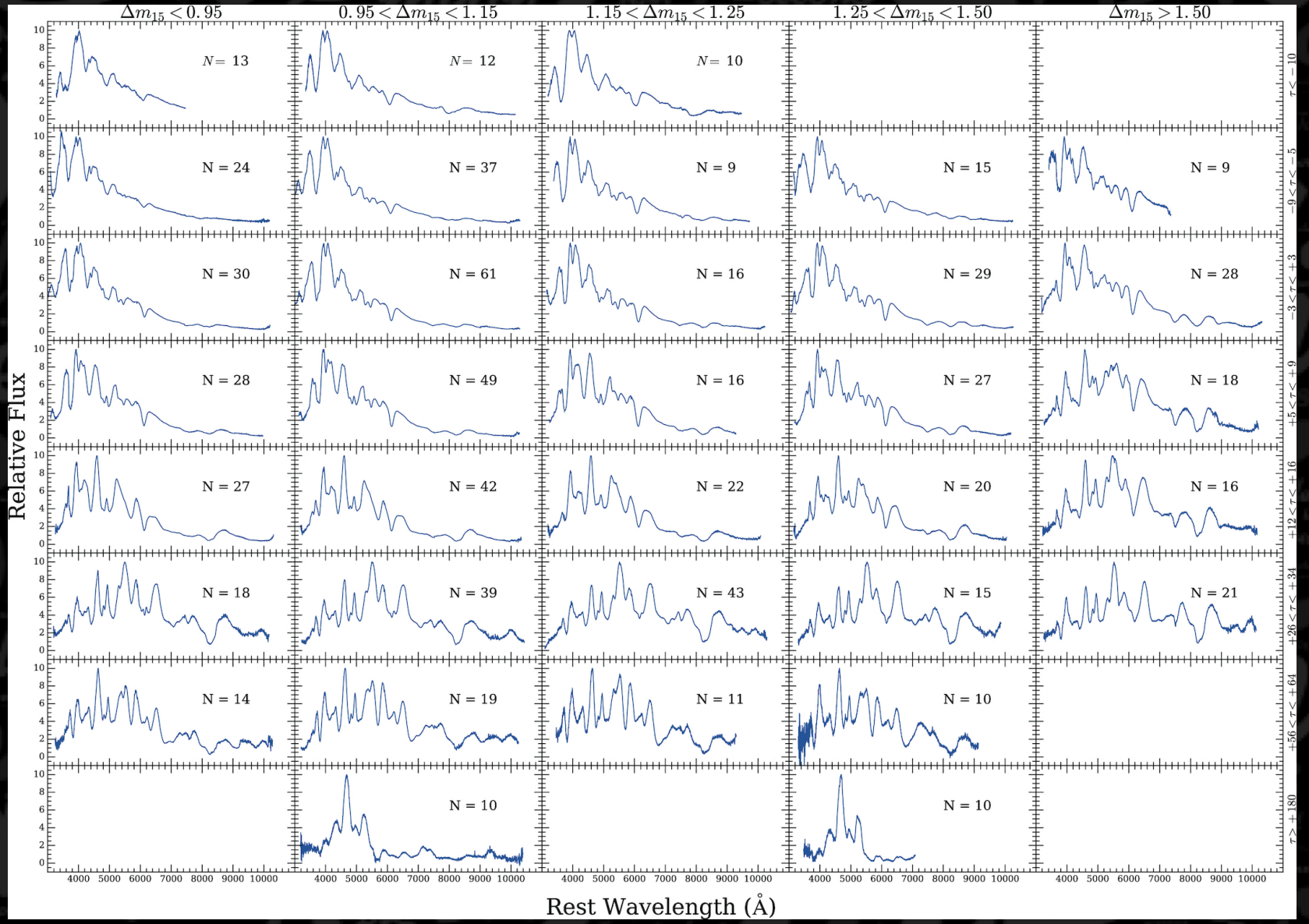
Δm_{15}

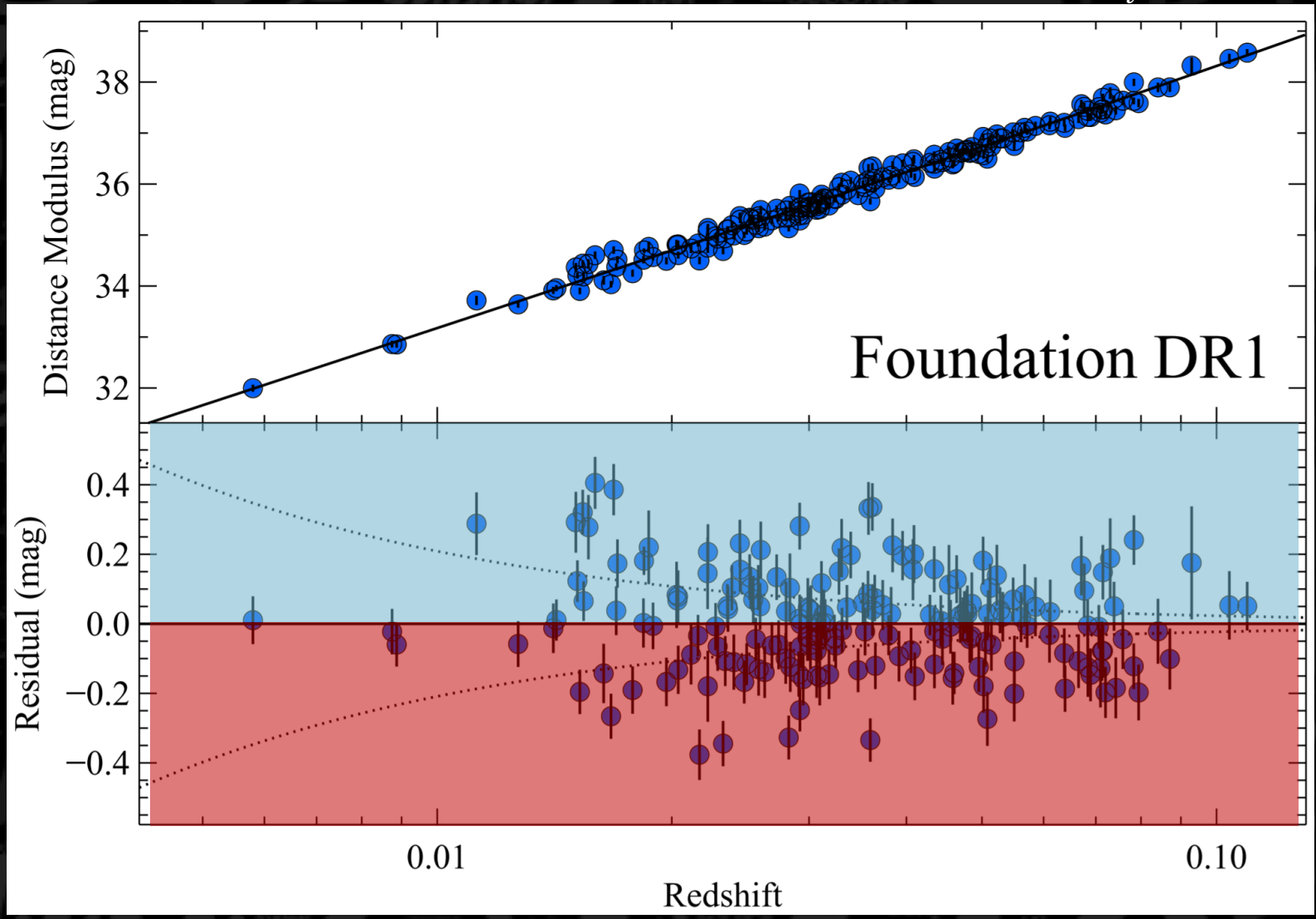
Phase



Siebert et al. 2019b in prep

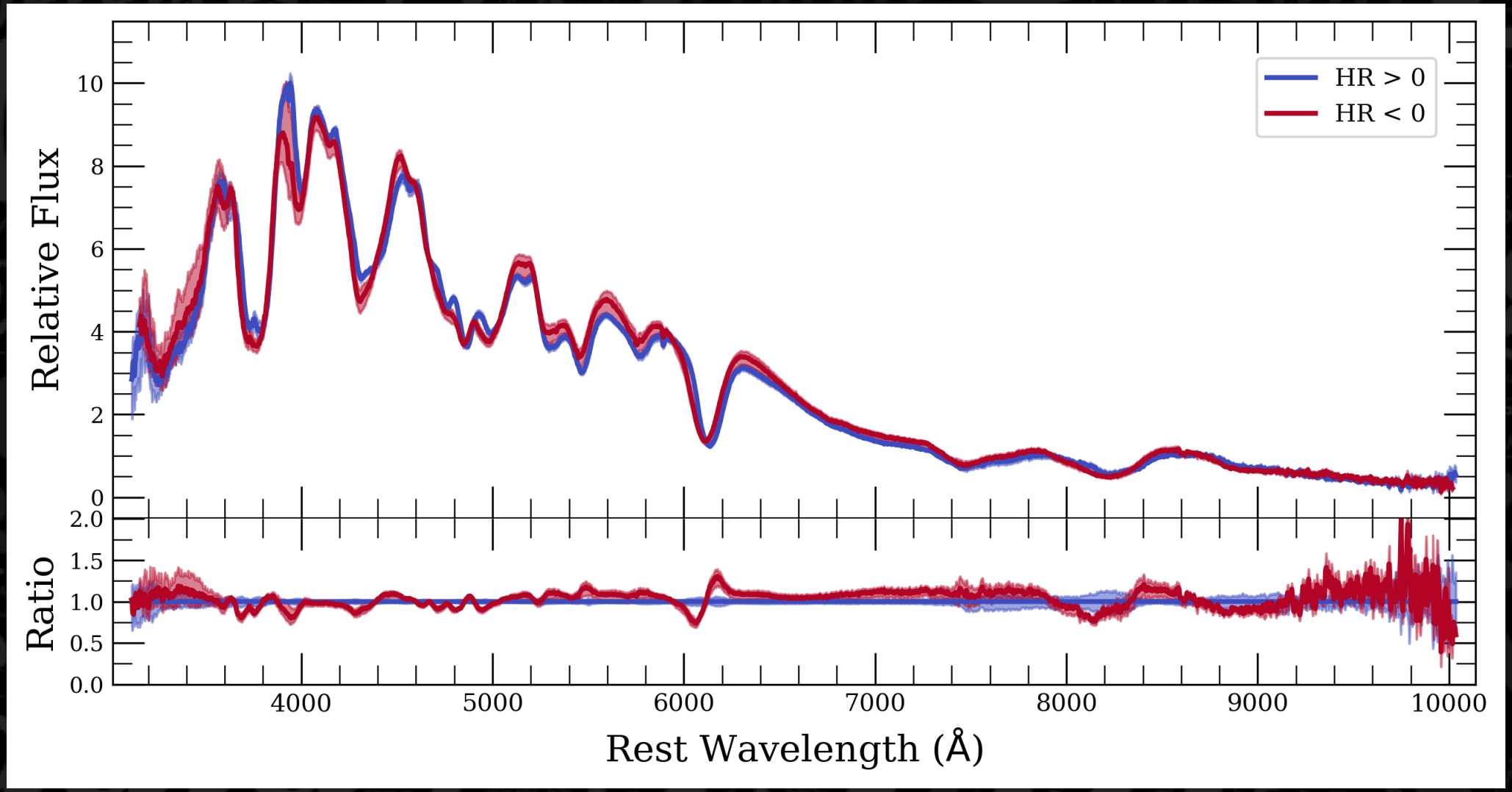
Do Spectral Properties Correlate with Hubble Residuals?

Foley et al. 2018



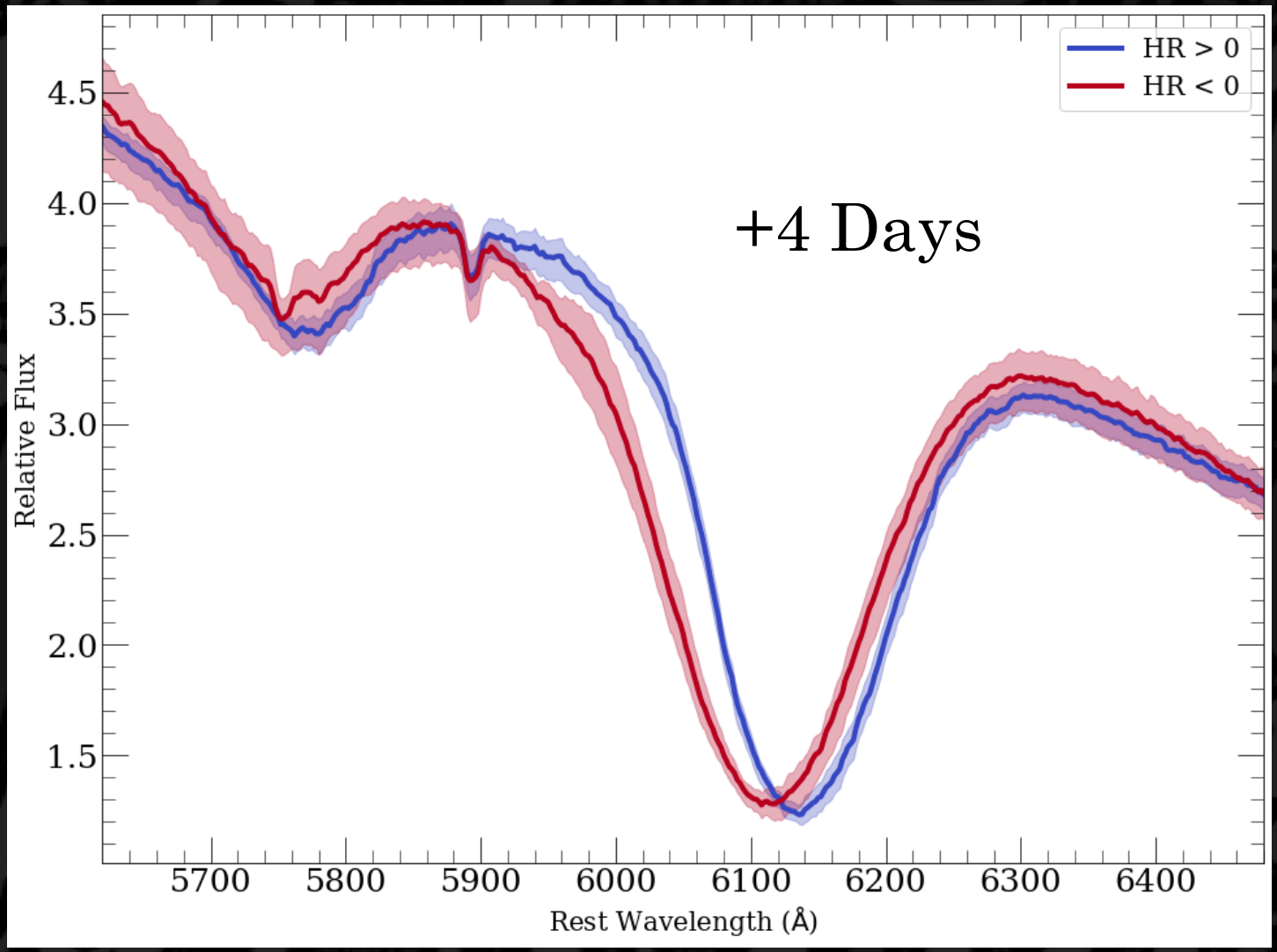
Siebert et al. 2019b in prep

+4 Day HR-binned composite spectra look very similar



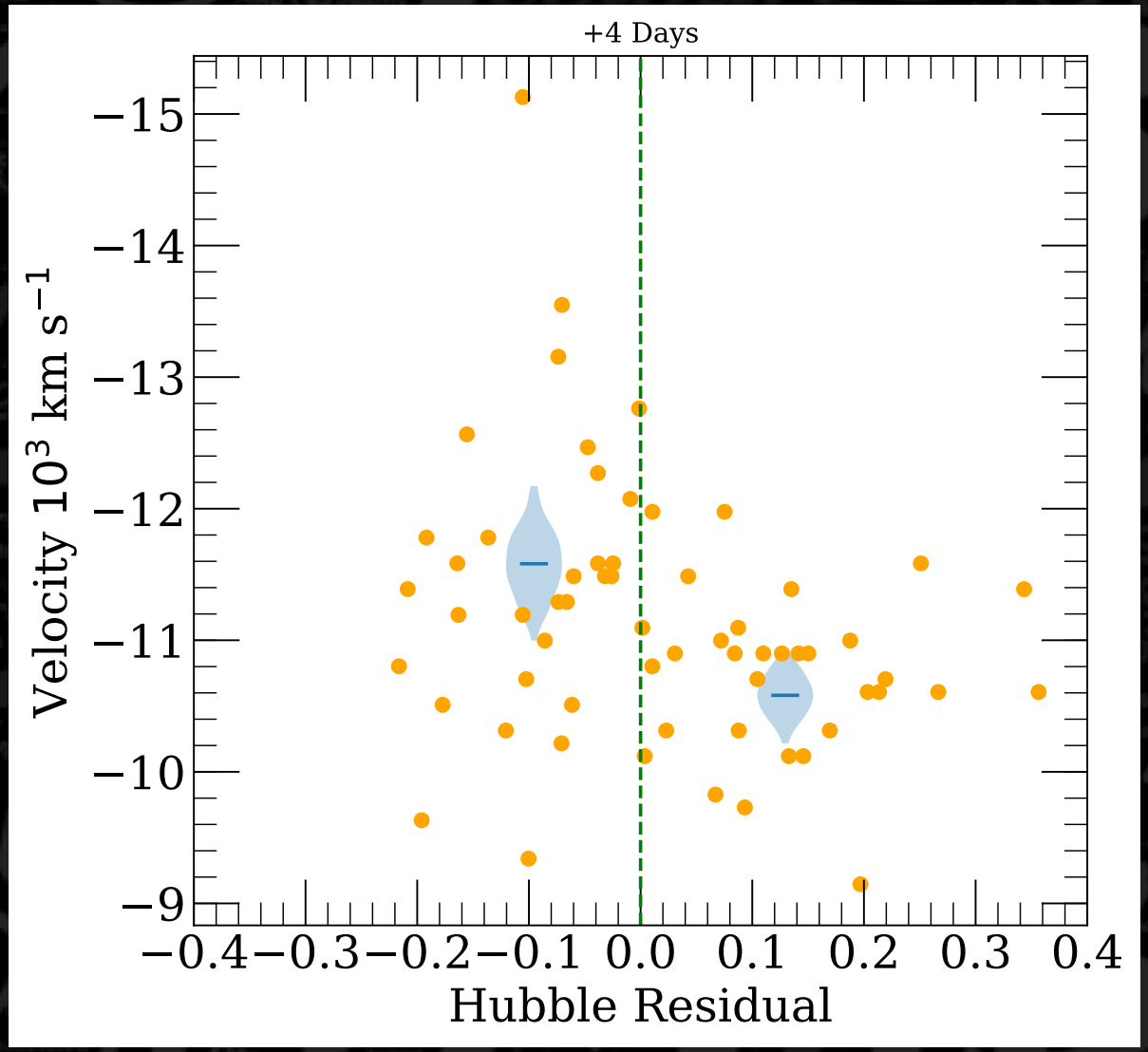
Siebert et al. 2019b in prep

SNe with HR < 0 have higher velocities



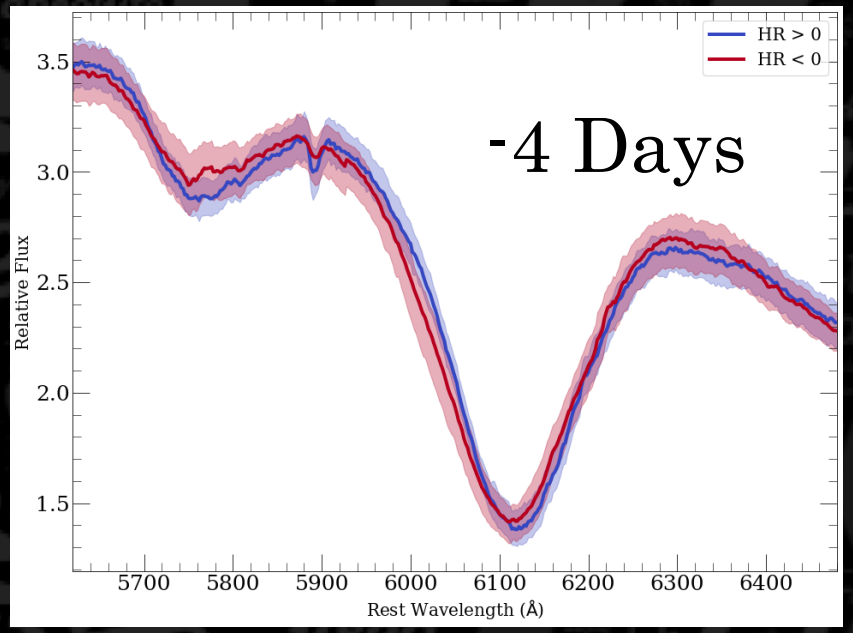
Siebert et al. 2019b in prep

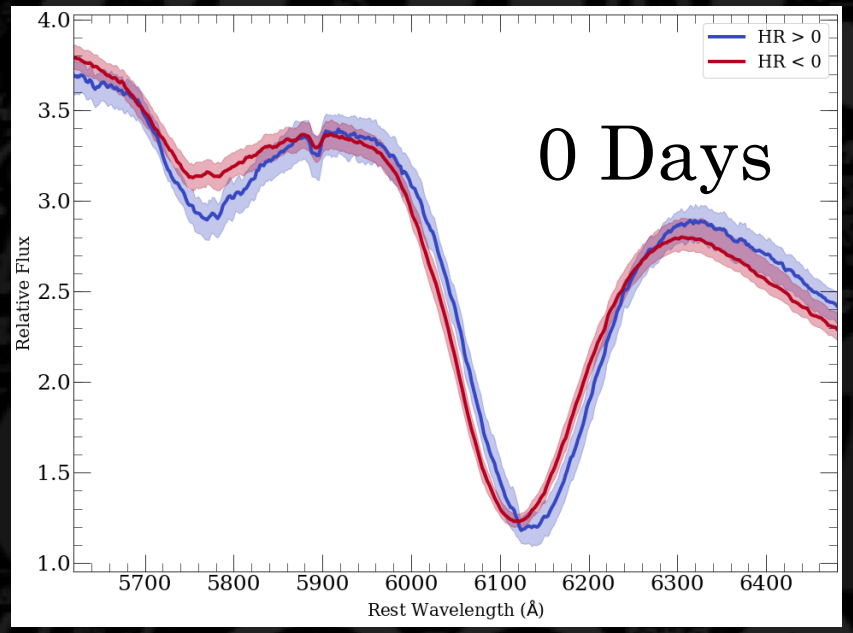
Individual Spectra

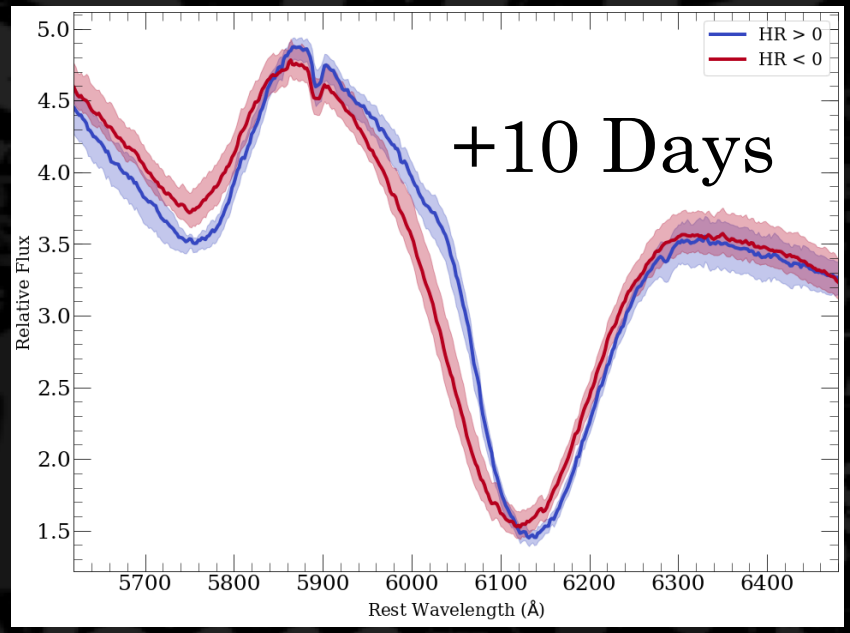


Siebert et al. 2019b in prep

Velocity Difference Present at Several Epochs







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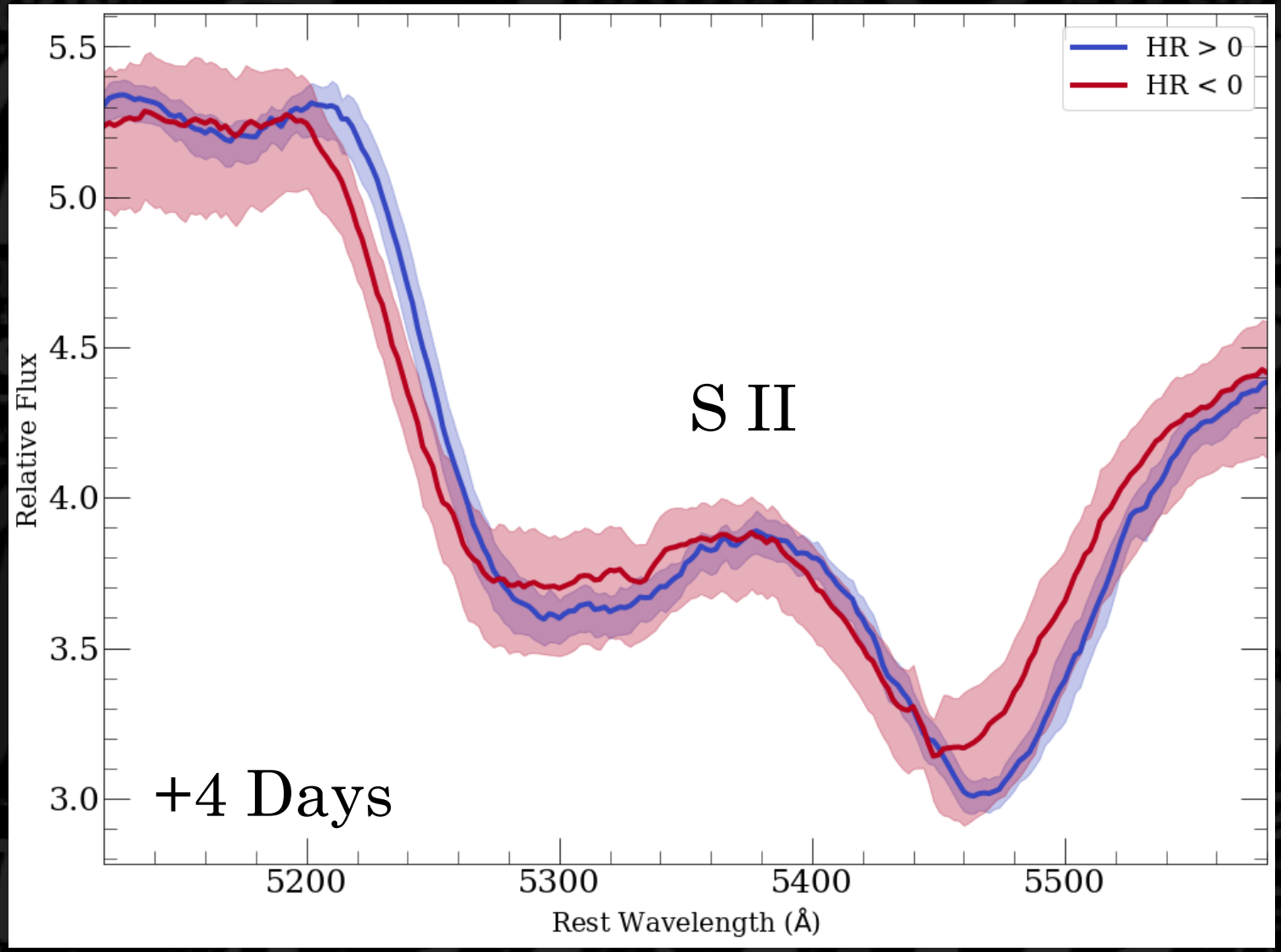
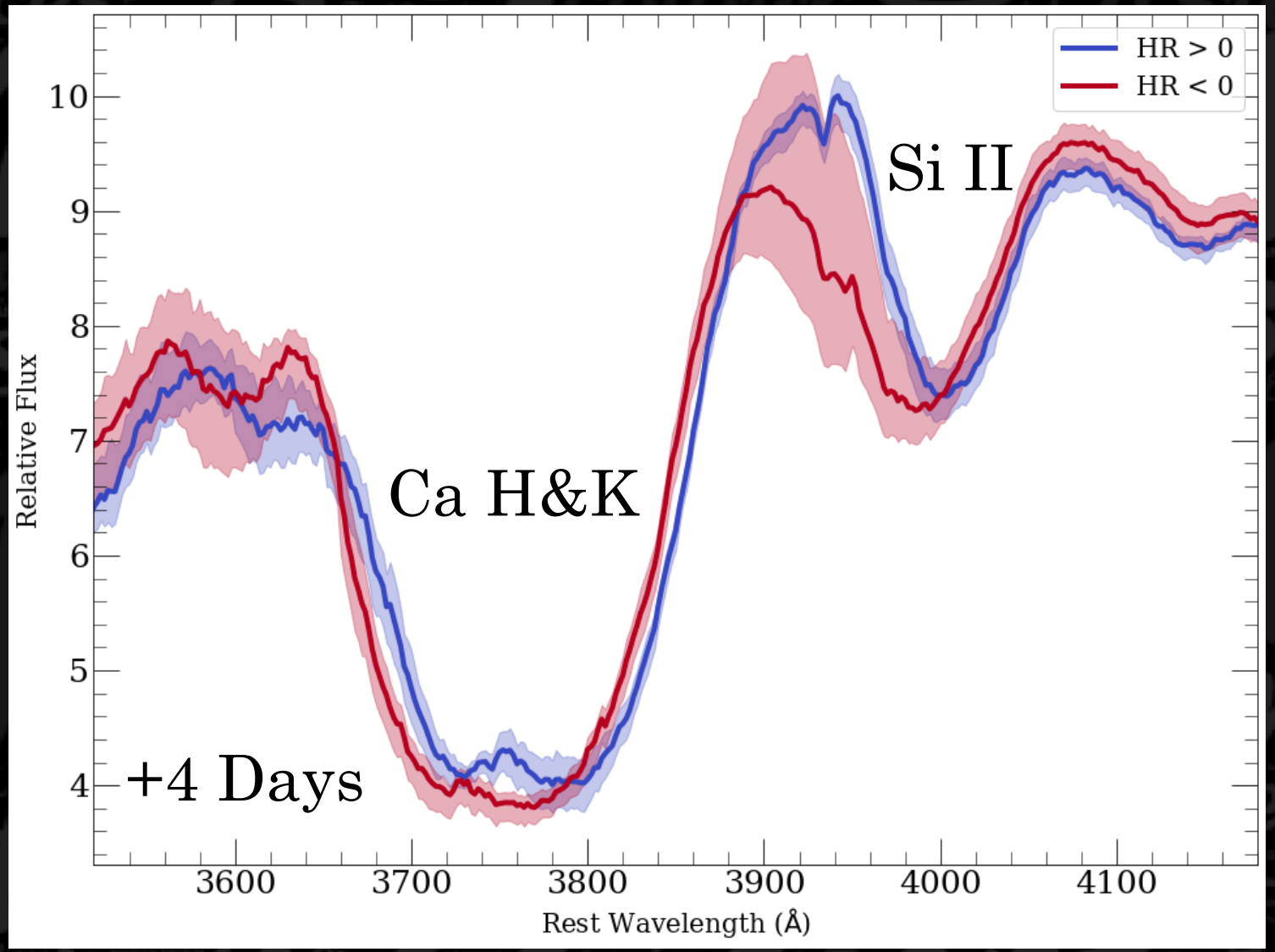
Present in Multiple Absorption Features



Siebert et al. 2019b in prep

Present in Multiple Absorption Features



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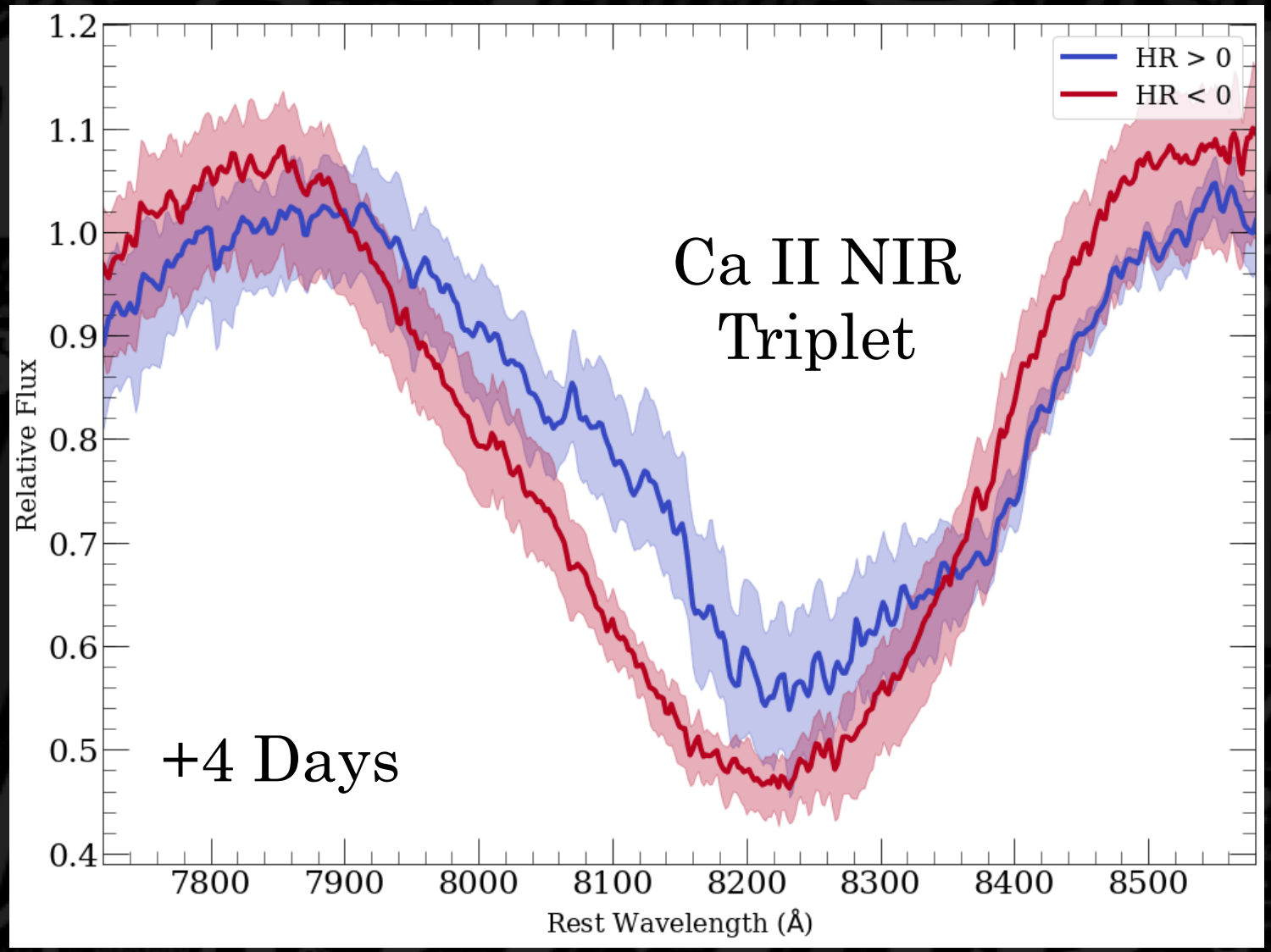
Present in Multiple Absorption Features



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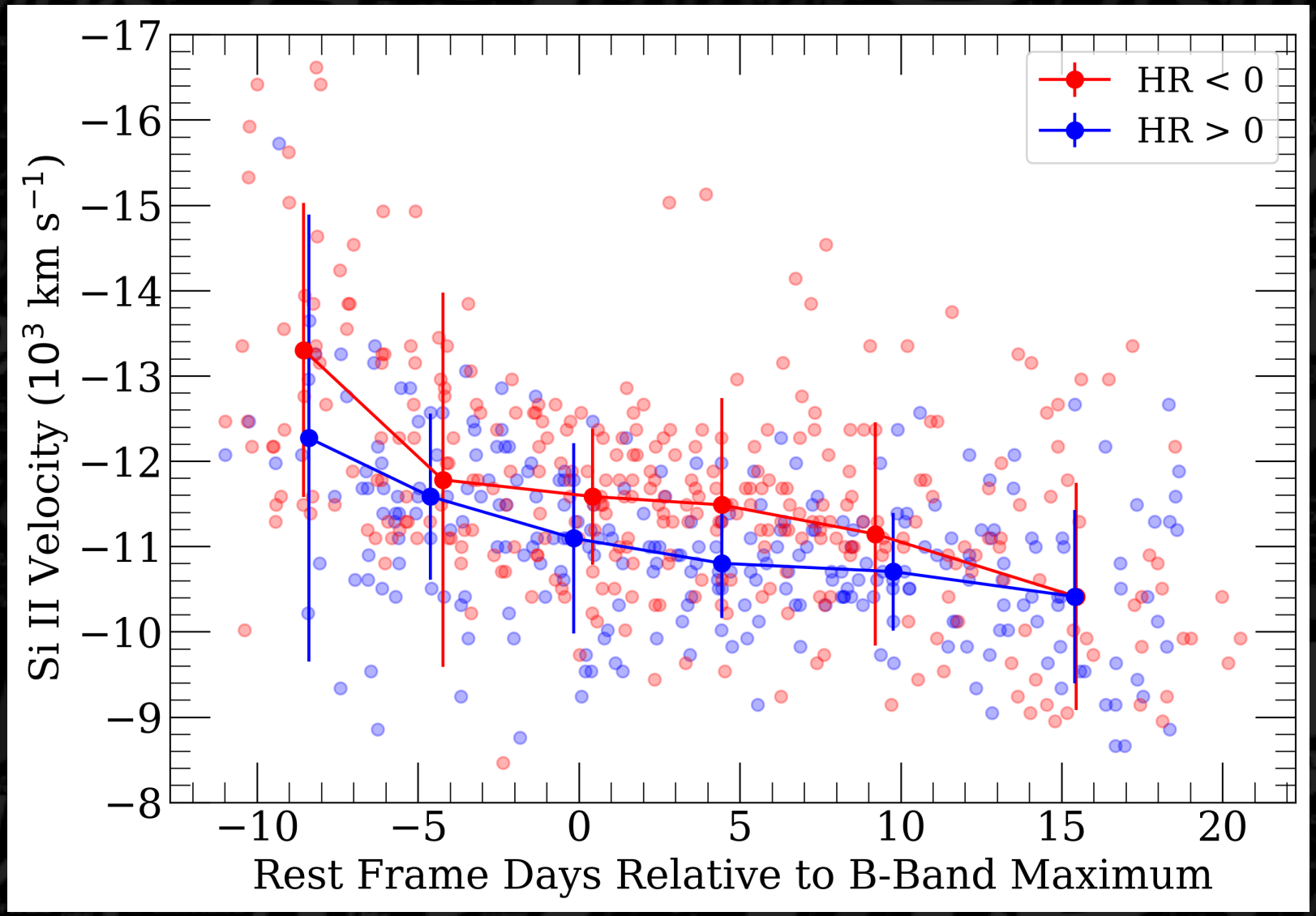
Velocity Evolution



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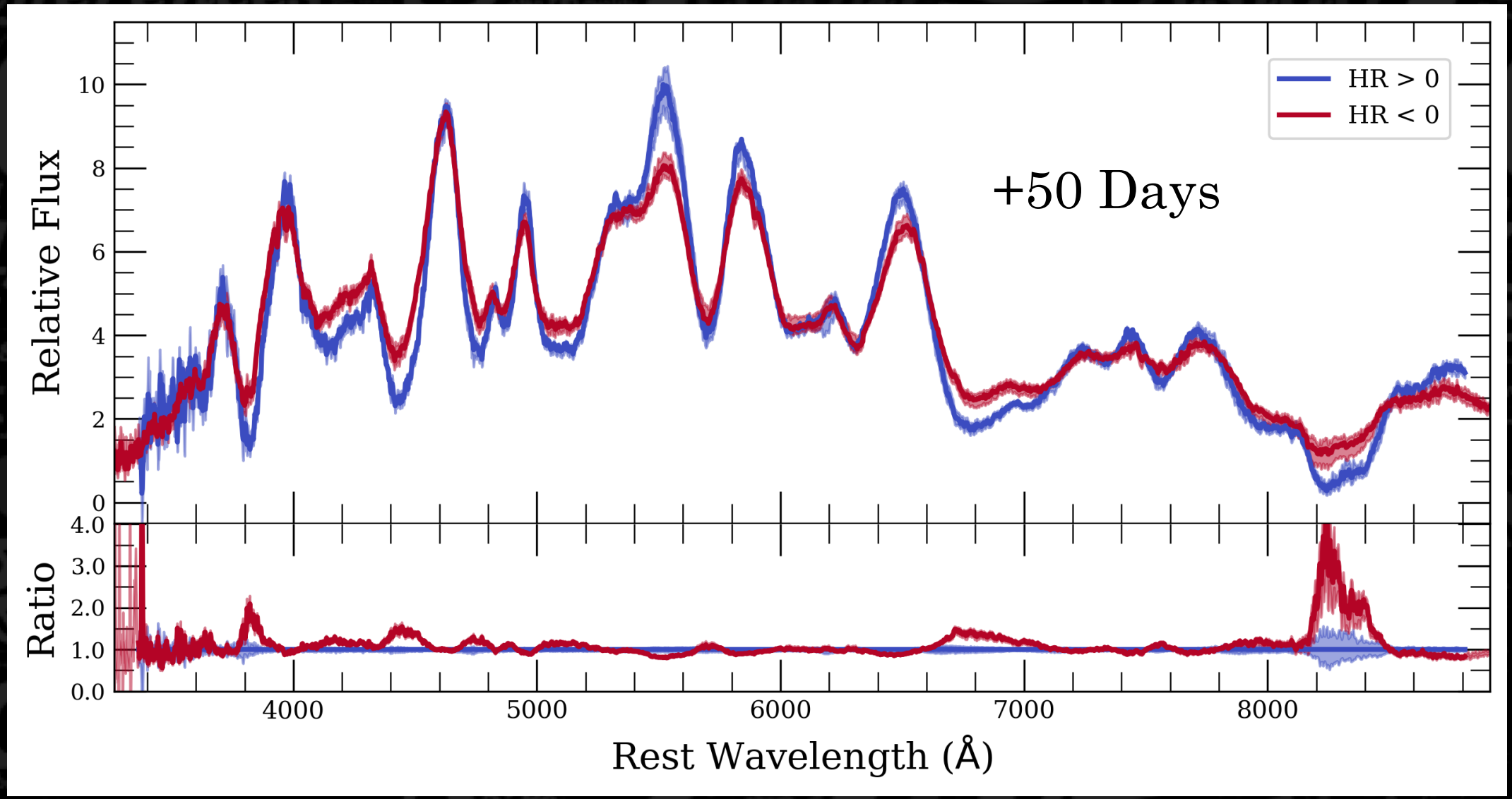
Feature Strength Difference at Later Epochs



Resources

kaepora
latest

Search docs

Getting Started
Querying the Database
Spectrum Objects
Schema
Spectral Attributes
SN Attributes
Creating Composite Spectra

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Spectrum Objects

`spec_array` now contains an array of objects that contain our homogenized spectra and all of the spectrum- and SN-specific metadata. Currently these objects are made to represent single spectra, so objects generated from the same SNe will contain some redundant SN metadata. These spectra are normalized to their maximum flux. Basic information on these objects can be viewed with:

```
for spec in spec_array_dered:
    print spec.name, spec.filename, spec.source, spec.phase, spec.wavelength[spec.x1
```

A spectrum and its variance can be plotted with:

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots(2,1)
example_spec = spec_array_dered[20]
ax[0].plot(example_spec.wavelength, example_spec.flux)
ax[1].plot(example_spec.wavelength, 1/example_spec.ivar)
plt.show()
```

Below we describe other attributes of these objects that are also queryable parameters of the database.

Schema

Spectral Attributes

Attribute	SQL Format	Description	Type
name	"SN"	SN name	String
filename	"Filename"	Filename from data source	String
source	"Source"	Data source	String
minwave	"Minwave"	Minimum wavelength of original spectrum	float
maxwave	"Maxwave"	Maximum wavelength of original spectrum	float
SNR	"snr"	Median S/N of the spectrum	float
mjd	"MJD"	Modified Julian Date of the spectrum	float
phase	"Phase"	Rest-frame days from B-Band maximum	float
ref	"Ref"	Bibtex code	String

SN Attributes

These attributes contain the most metadata. We also include (but do not list) metadata from the results of several different light curve fits. If you would like to construct a query based on these metadata please contact me.

https://kaepora.readthedocs.io/en/latest/index.html

Matt Siebert Publications Talks CV kaepora

Matt Siebert

Graduate Researcher - UCSC Department of Astronomy and Astrophysics

Santa Cruz, CA

msiebert@ucsc.edu

Github

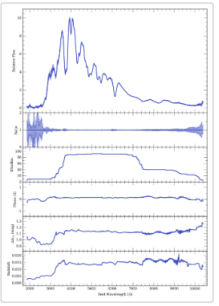
`kaepora` is an open-source relational database for Type Ia Supernova spectra. For installation and example code please visit our Read the Docs page. You can download the source code from our Github repository Below are links to download the most recent versions of the database:

kaepora_v1.db	The version used in Siebert et al. 2019

After downloading, unzip and place the '.db' file in the /data folder of the repository.

I am currently the only active developer regarding database architecture and user interaction. If you would like to contribute, please contact me and I will add you as a github collaborator. Let me know if you have suggestions for how I can improve this tool. If you have metadata that you think would be interesting to include, I am happy to help.

Composite Spectra



Below are the composite spectra presented in Siebert et al. 2019. All of these have been constructed using our "Gini-Weighting" method that is described in the paper.

Each spectrum contains 7 columns of data. They are wavelength (A), flux (arbitrary), 1σ lower bootstrap sampling error (arbitrary), 1σ upper bootstrap sampling error (arbitrary), phase (rest-frame days), $\Delta m_{15}\,(B)$ (mag), redshift, and the number of SNe per wavelength bin. At the top of each file we also include the SQL query that was used to generate the composite spectrum. Follow the link below to view the example composite spectrum from Figure 14 (right) in our paper.

siebert_example_max_light

Sets of Composite Spectra from Siebert et al. 2019

All Composite Spectra	siebert_all.tar
Phase-Binned	siebert_phase.tar siebert_phase_2day.tar
Color Curve	siebert_color_curve.tar
Maximum-Light $\Delta m_{15}\,(B)$-Binned	siebert_max_light_dm15.tar
Phase-$\Delta m_{15}\,(B)$ Grid	siebert_grid.tar

https://msiebert1.github.io/kaepora/

Conclusions

- Open source relational database for SNe Ia
  - Large amount of useful metadata
- Composite spectra are useful tools and reproduce known correlations
- HR-binned composite spectra have different velocities

Future Work

- Undergraduate research
  - Velocity, Carbon, Nebular line shifts
- Add Foundation sample
- Flux Calibration
- Other Applications
  - Sub-classification
  - SALT3 template spectra (velocity, host galaxy mass, etc.)