

Photometric and spectroscopic observations, and abundance tomography modeling of type Ia supernova, SN 2014J

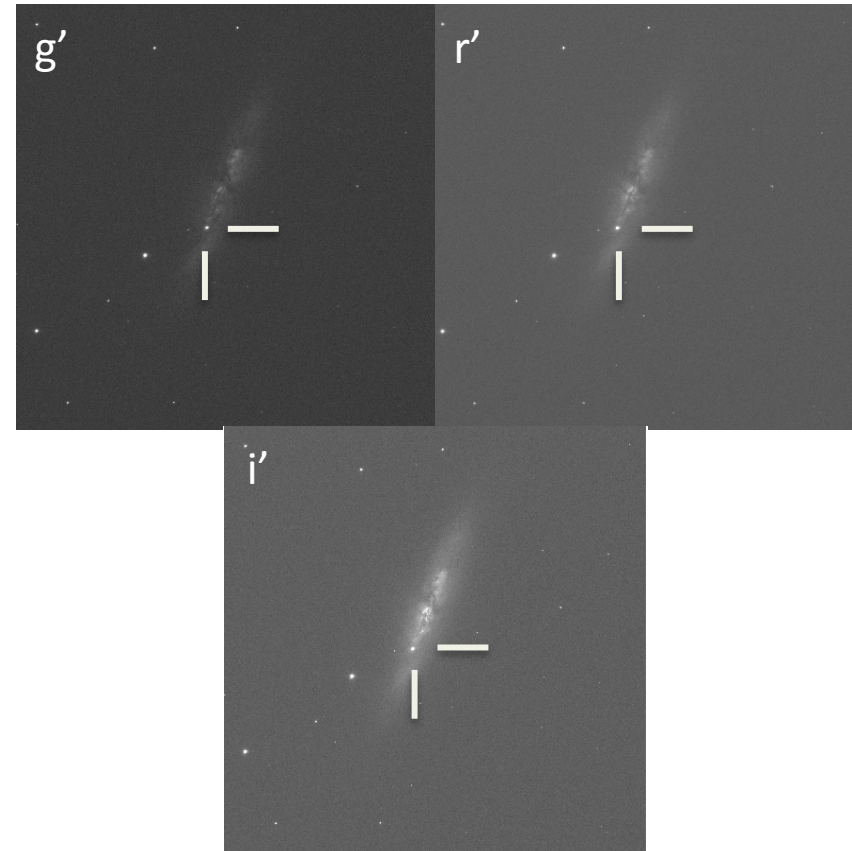
Chris Ashall

c.ashall@2013.ljmu.ac.uk

P. Mazzali, D. Bersier, S. Hachinger, S. Percival, P. James. K. Maguire

The discovery of SN 2014J

- Located in M82
- Distance ~ 3.3 Mpc
- Discovered 21/1/2014, S.Fossey, UCL observatory
- Goobar et al. (2014) –early time spectral evolution.
- Foley et al.(2014) –HST data, extinction.
- Amanullah et al. (2014)-FTZ extinction.
- Marion et al.(2014) and Tsvetkov et al. (2014).



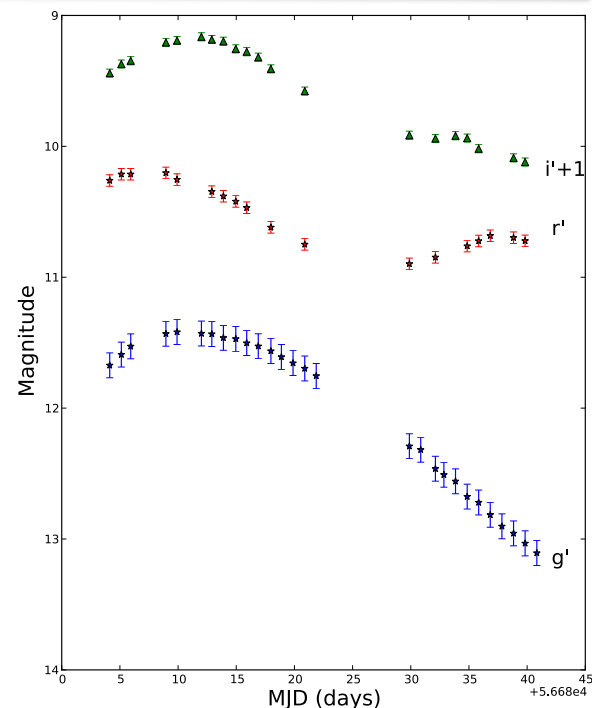
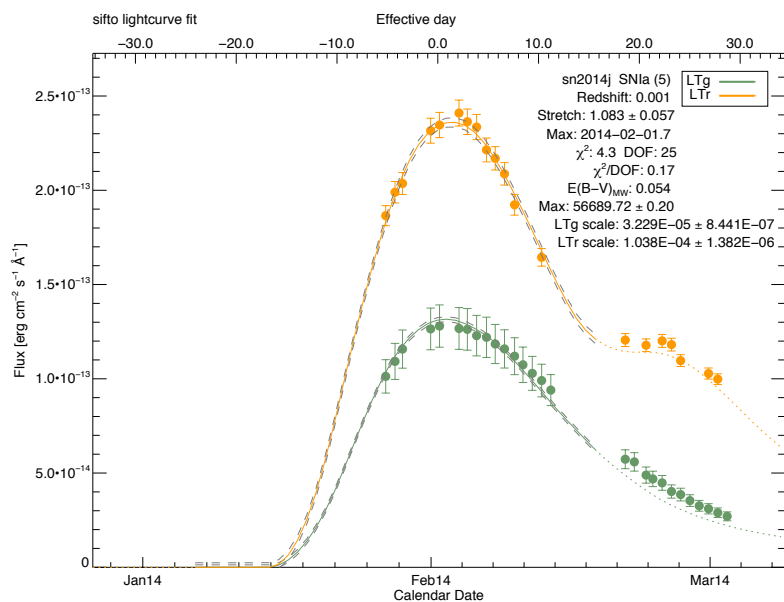
The Liverpool Telescope

- 2m fully robotic telescope, La Palma.
- IO:O- optical imaging camera FOW 10 arcmin^2 .
bands: B, V and SDSS g' r' i' z' and u' .
- FRODOspec- integral field input spectrograph
3900-5700Å 5800-9400Å.



Photometric observations

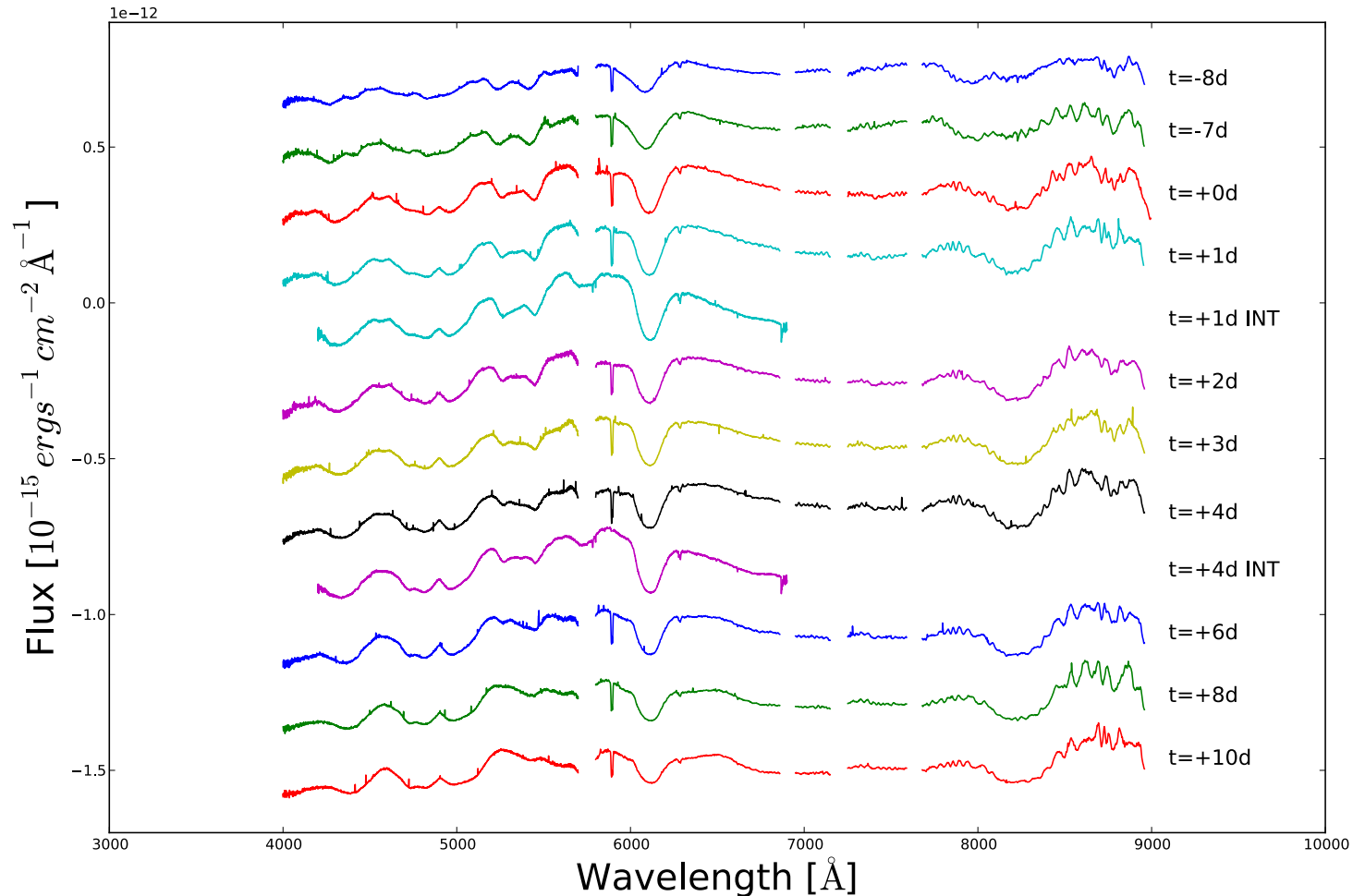
- $V_{\max} = 10.662 \pm 0.05$ (g' and r' band fitting)
- $t_{\max}(B) = 2456690.4 \pm 0.12$ (JD)
- $\Delta m_{15} \approx 0.95$ (r' band fitting)
- Rise time ~ 19 d



Foley et al. (2014):

- $t_{\max}(B) = 2,456,690.5 \pm 0.2$ (JD)
- $V_{\max} = 10.61 \pm 0.05$
- $\Delta m_{15} = 0.95 \pm 0.01$

Spectroscopic observations

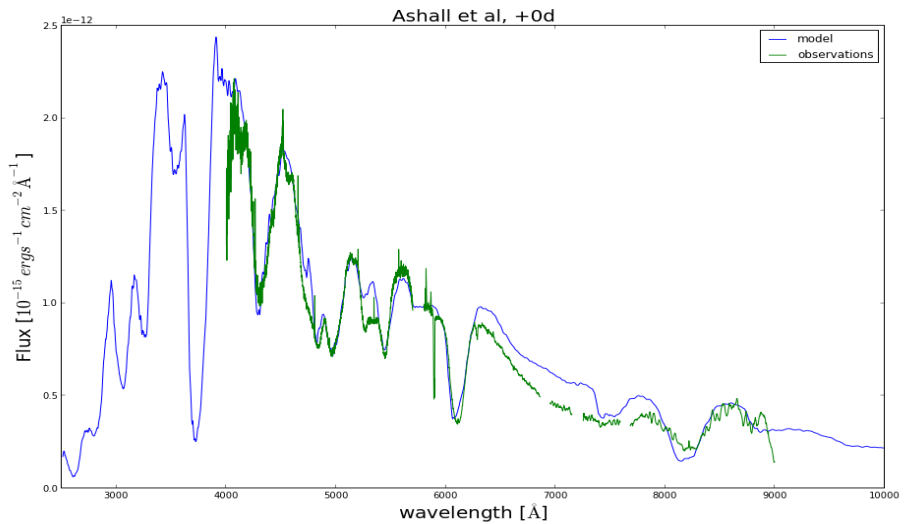
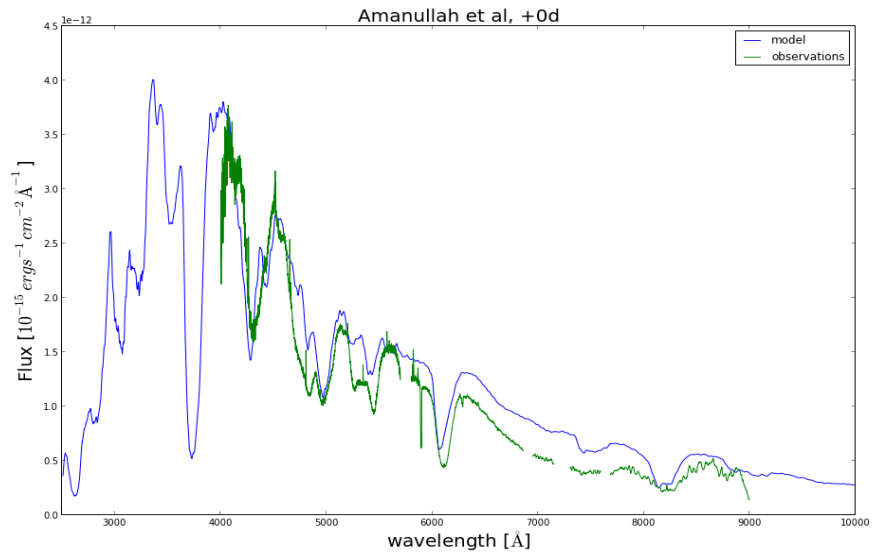
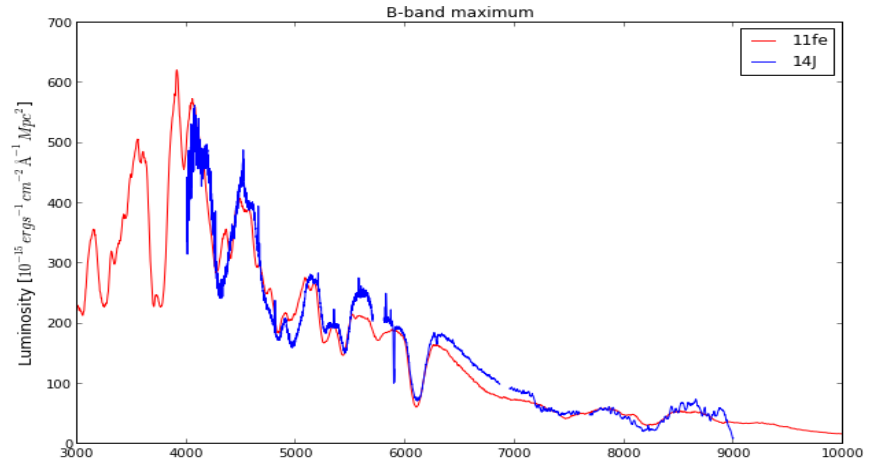
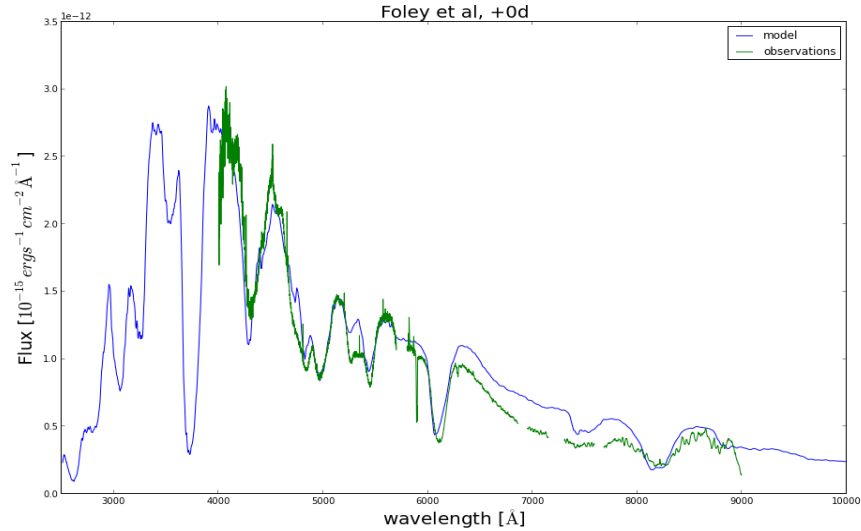


Extinction

	Amanullah et al.	Foley et al.	Marion et al.	Ashall et al.
$E(B-V)_{\text{host}}$	1.29 ± 0.02	1.24 ± 0.1	1.23	1.2
R_V	1.4 ± 0.1	1.44 ± 0.06	1.46	1.38
$E(B-V)_{\text{MW}}$	0.05	0.05	0.05	0.05
R_V	3.1	3.1	3.1	3.1
A_V	1.961 ± 0.02	1.94 ± 0.16	1.9508	1.811
A_B	3.301 ± 0.02	3.23 ± 0.19	3.23	3.061
	FTZ	CCM	CCM	CCM

- We model with the reddening value from Foley et al. using the low end of his errors.

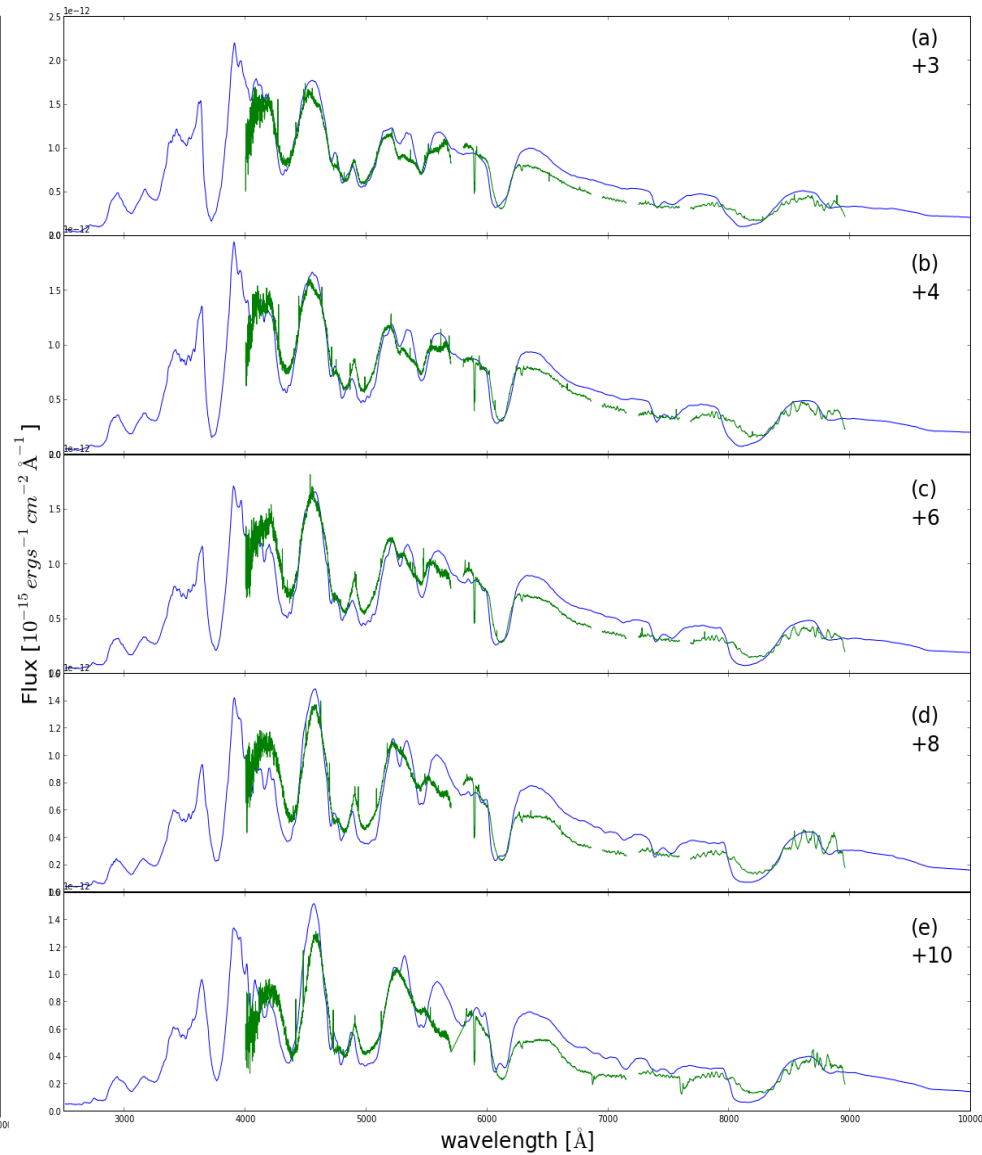
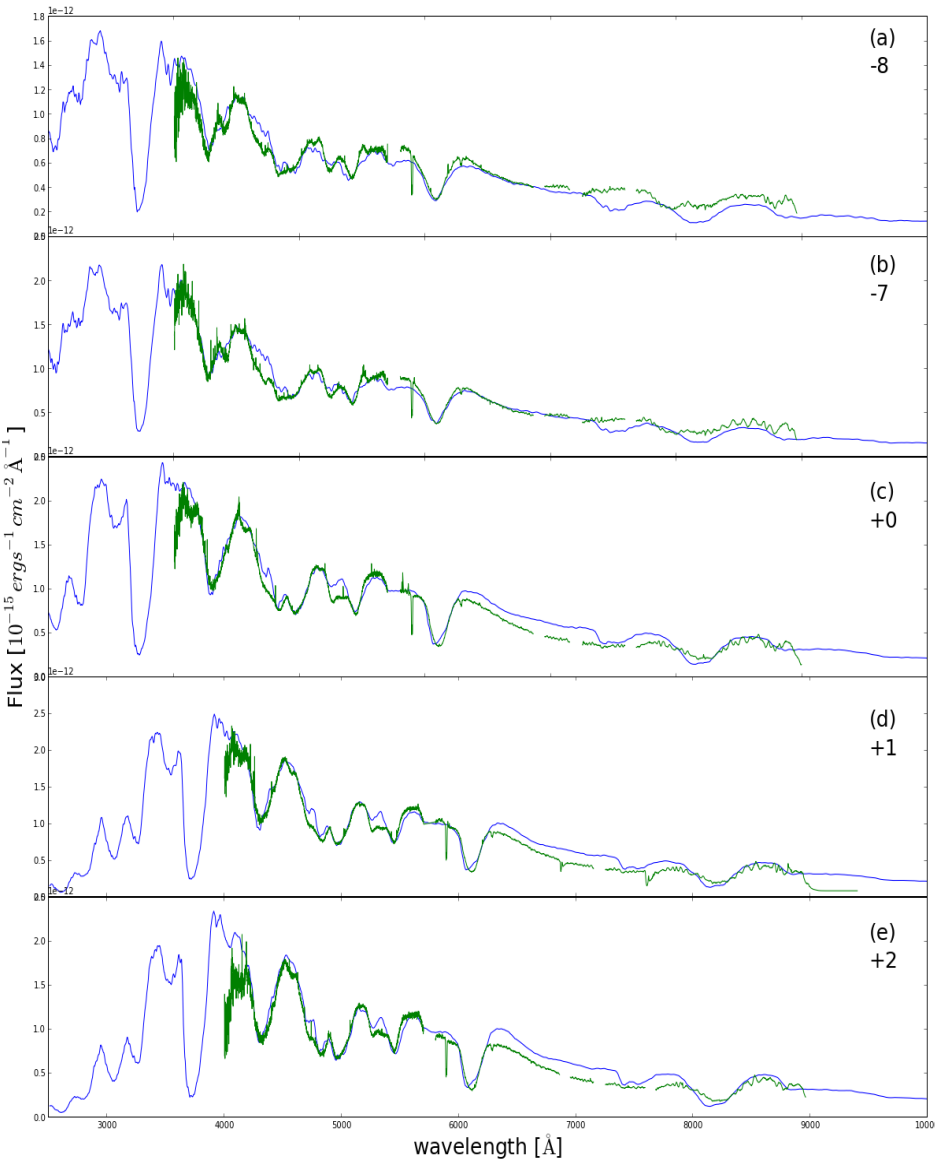
Extinction



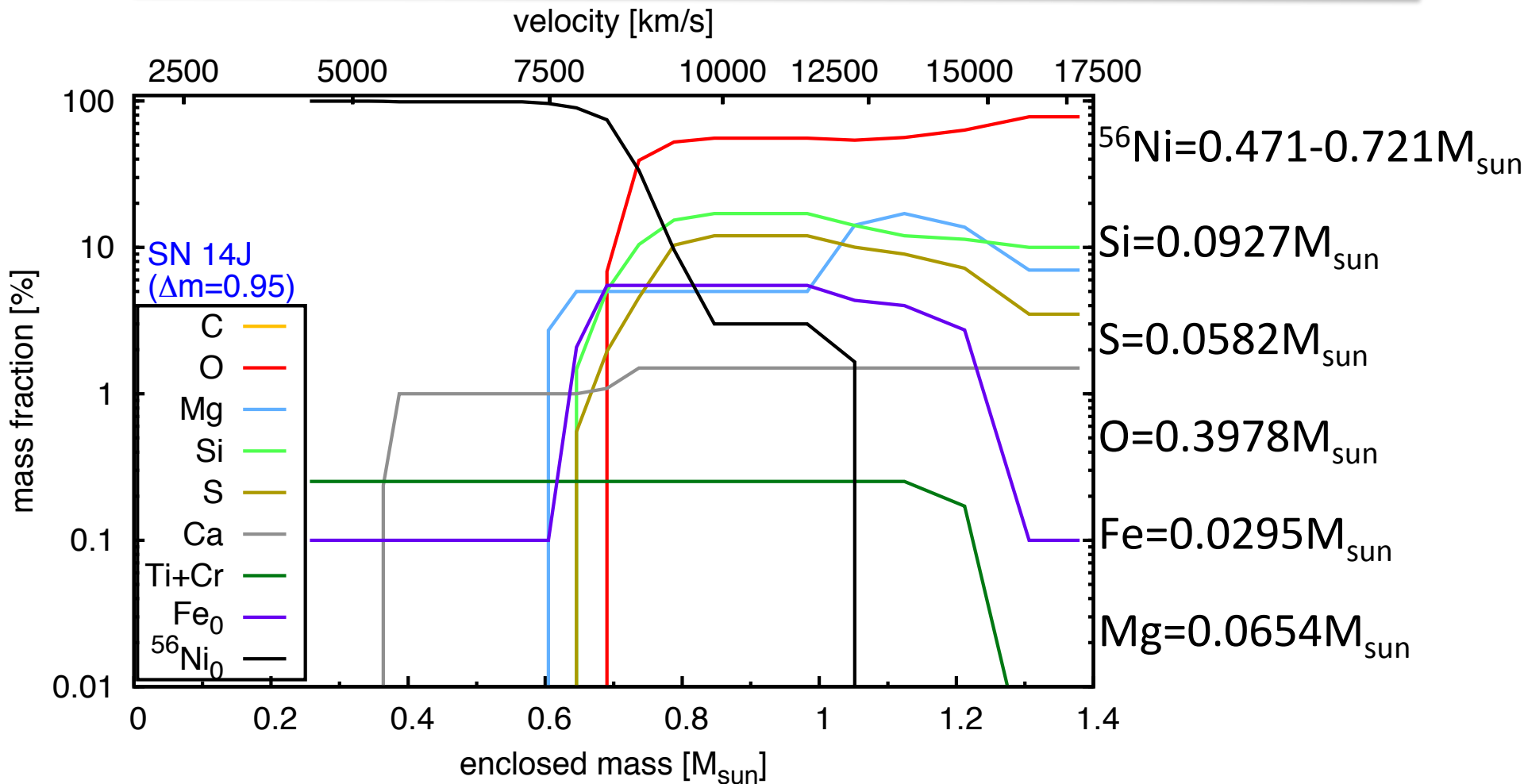
Modeling technique

- 1D MC radiative transfer code
- Model early time spectra, up to +14d
- W7 density profile
- Abundance tomography technique, $^{56}\text{Ni} \rightarrow ^{56}\text{Co} \rightarrow ^{56}\text{Fe}$
- Directly compare observed spectra with models
- Previous models the code has been used for:
11fe, 02bo, 04eo, 03du

Models



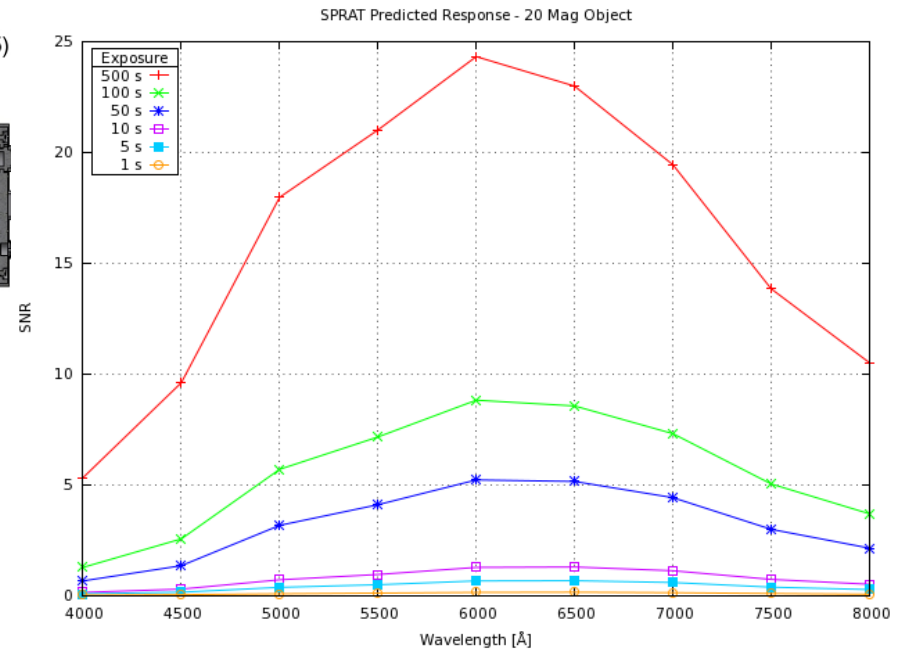
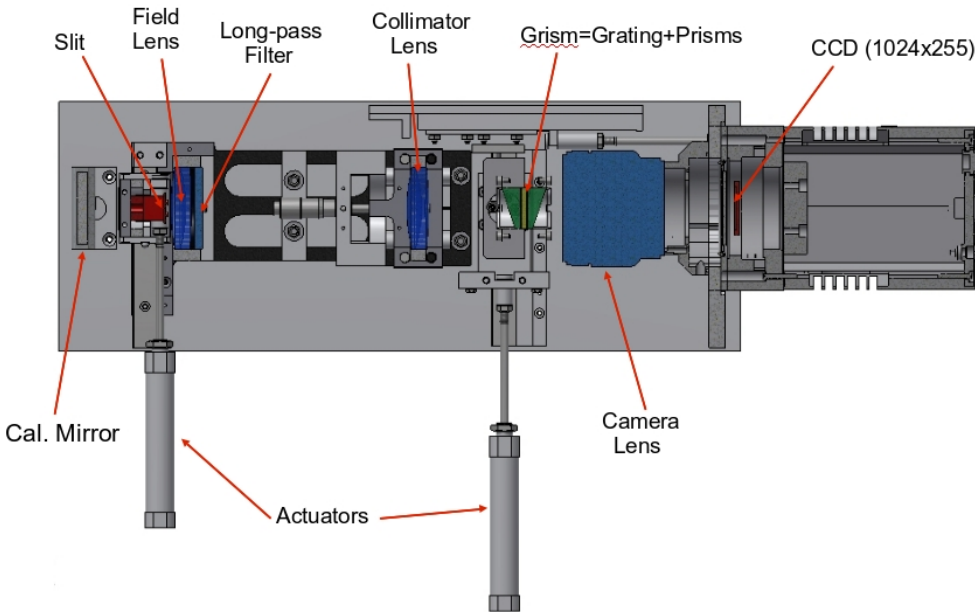
Abundance distribution



Conclusions

- W7 density profile is good at up to +2d, but we have too much absorption at later times.
- Earlier time spectra, including UV data, would be beneficial in predicting early time abundances and the correct density profile.
- Best extinction values to model are $E(B-V)=1.2$, $R_V=1.38$, $E(B-V)_{MW}=0.05$, $R_V=3.1$
- Extinction not fully correct.
- $^{56}\text{Ni}=0.471\text{--}0.721M_{\text{sun}}$, $\text{Si}=0.0927M_{\text{sun}}$, $\text{S}=0.0582M_{\text{sun}}$, $\text{O}=0.3978M_{\text{sun}}$, $\text{Fe}=0.0295M_{\text{sun}}$, $\text{Mg}=0.0654M_{\text{sun}}$.
- The abundance distribution has a large amount of ^{56}Ni out to velocities of $\sim 9000\text{km/s}$.

SPRAT

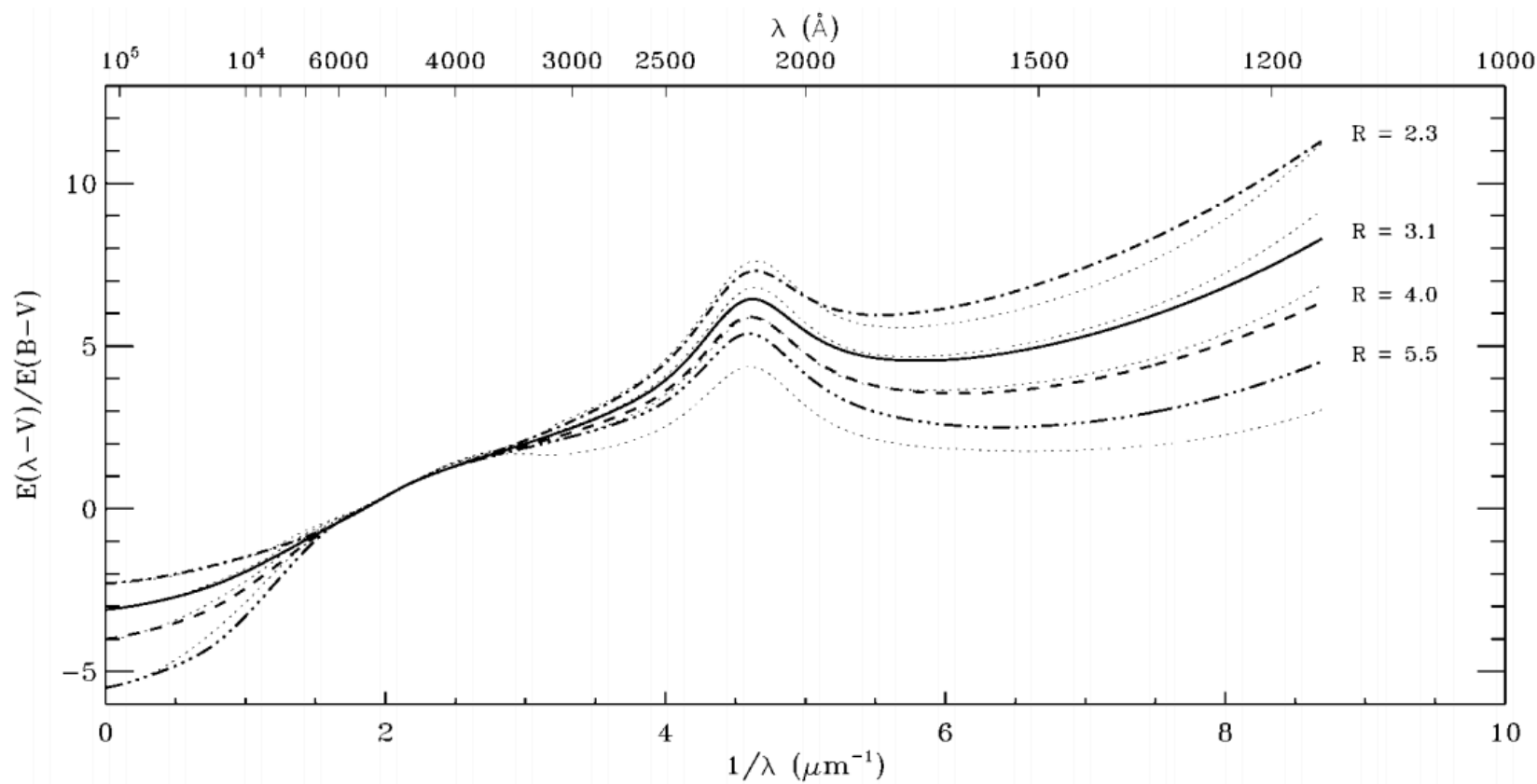


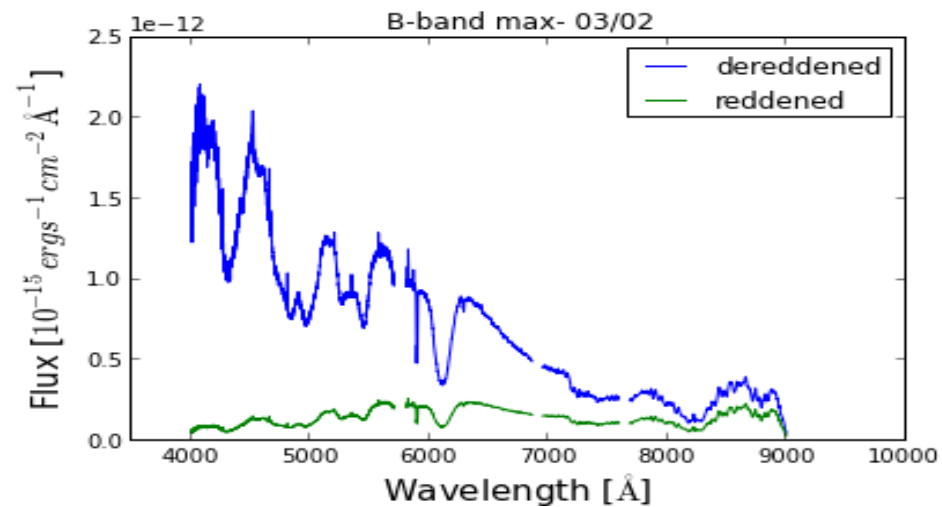
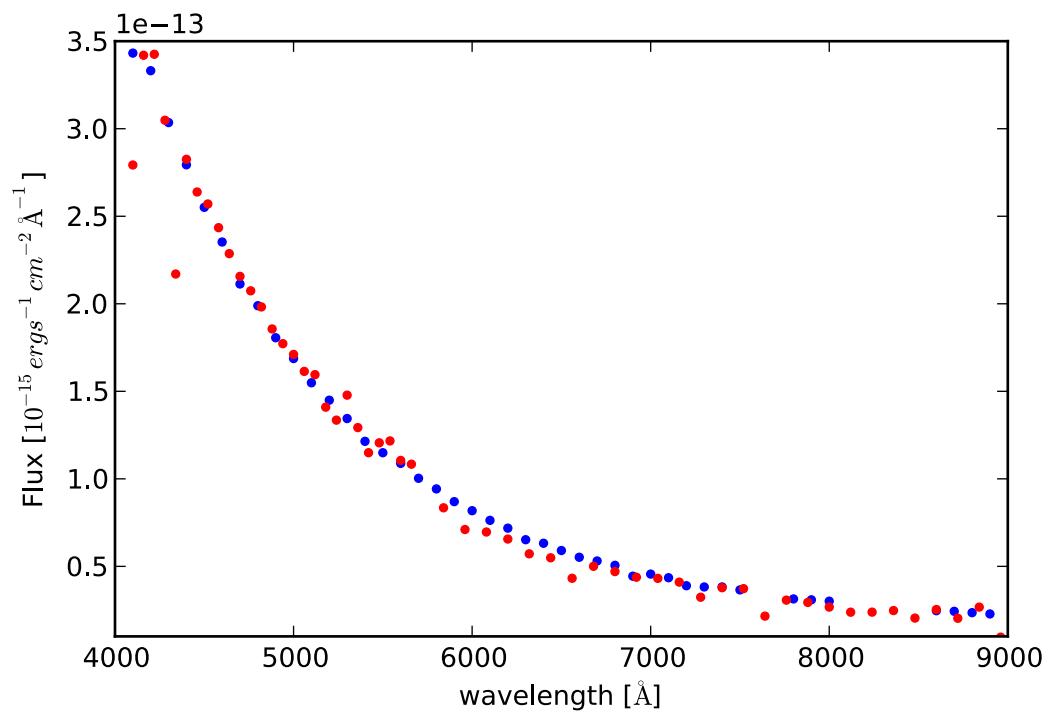
- The “Spectrograph for the Rapid Acquisition of Transients”
- It is a long-slit, low resolution spectrograph.
- 4000Å-8000Å, good S/N down to 20 Mag in 500s exposure.
- IO:I NIR optical imaging camera.

Questions?

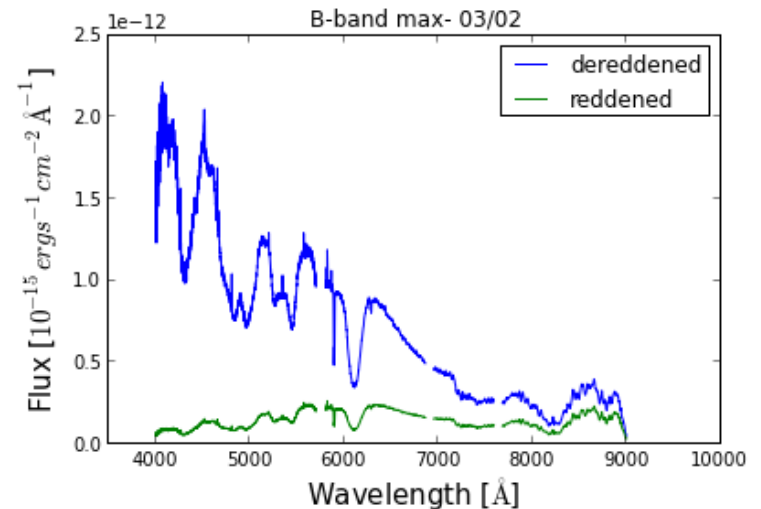
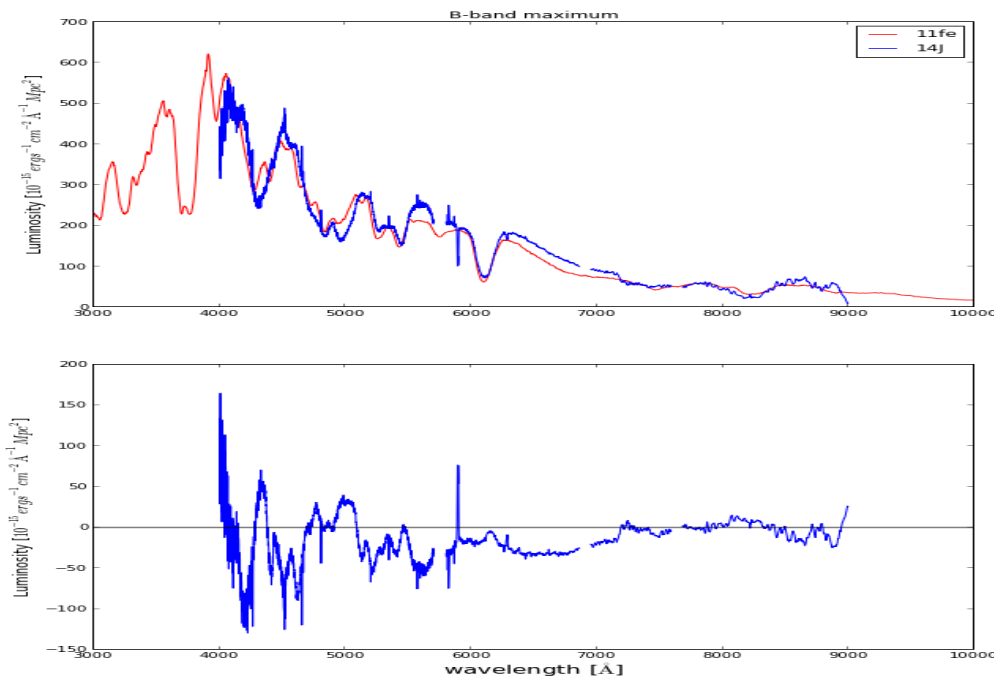
Questions?

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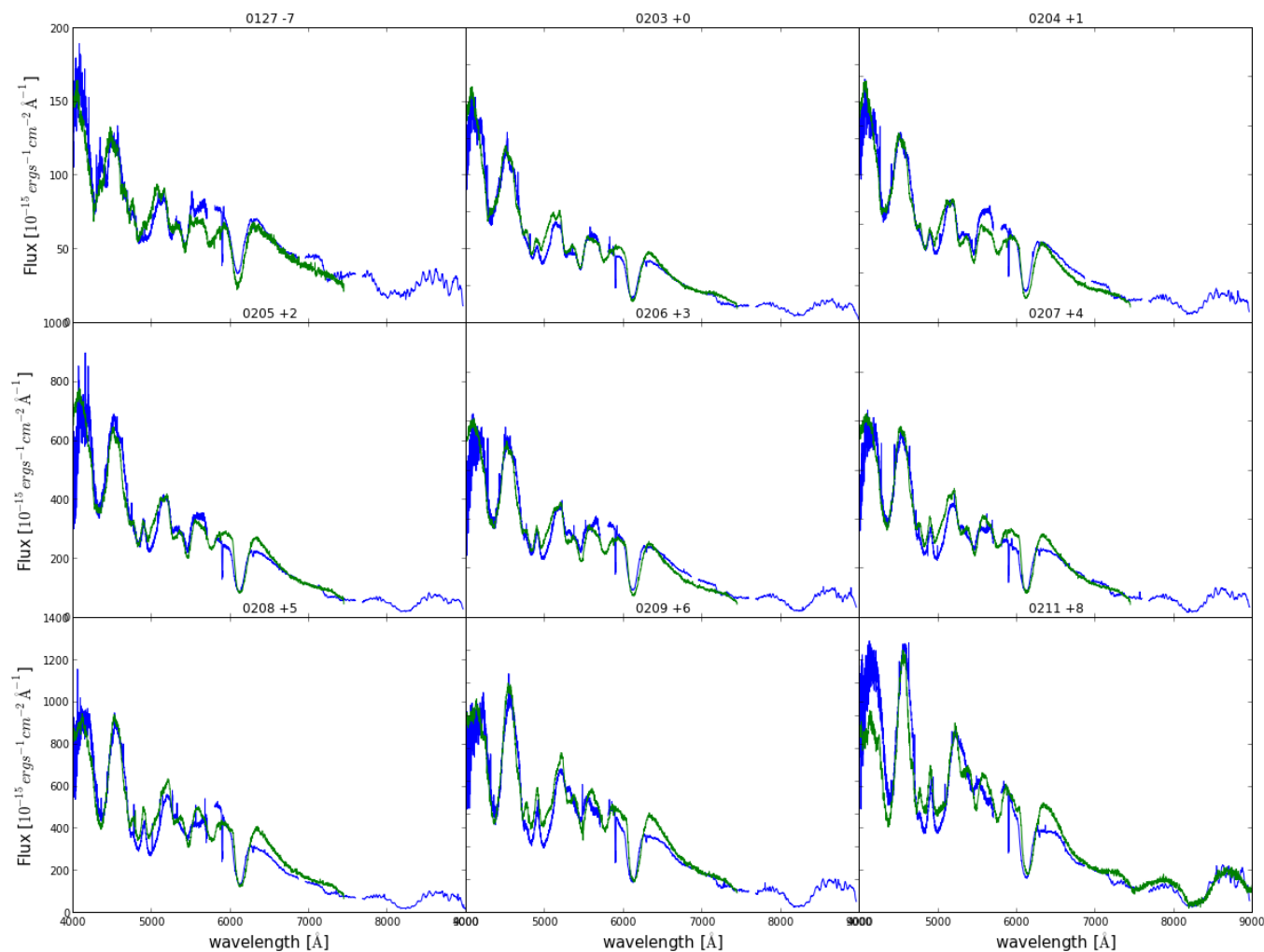




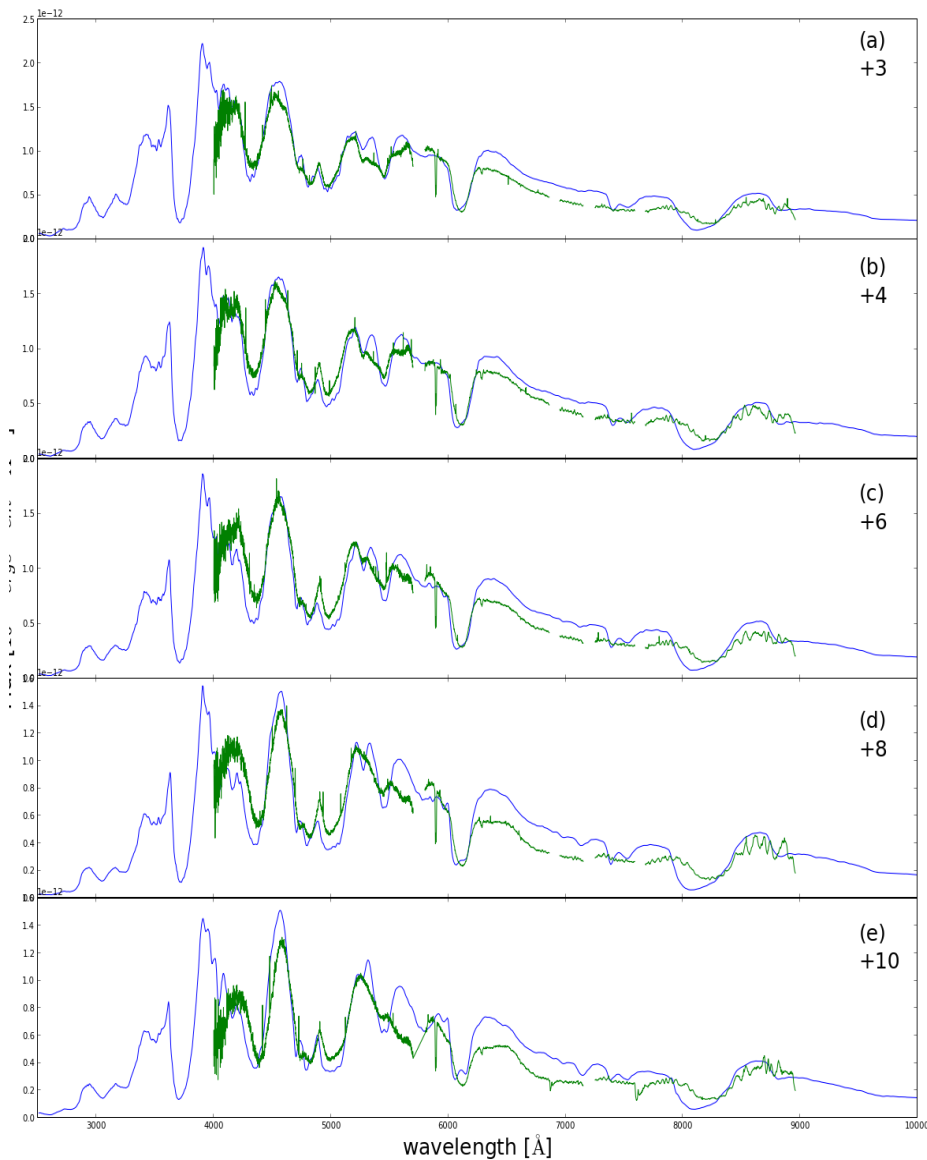
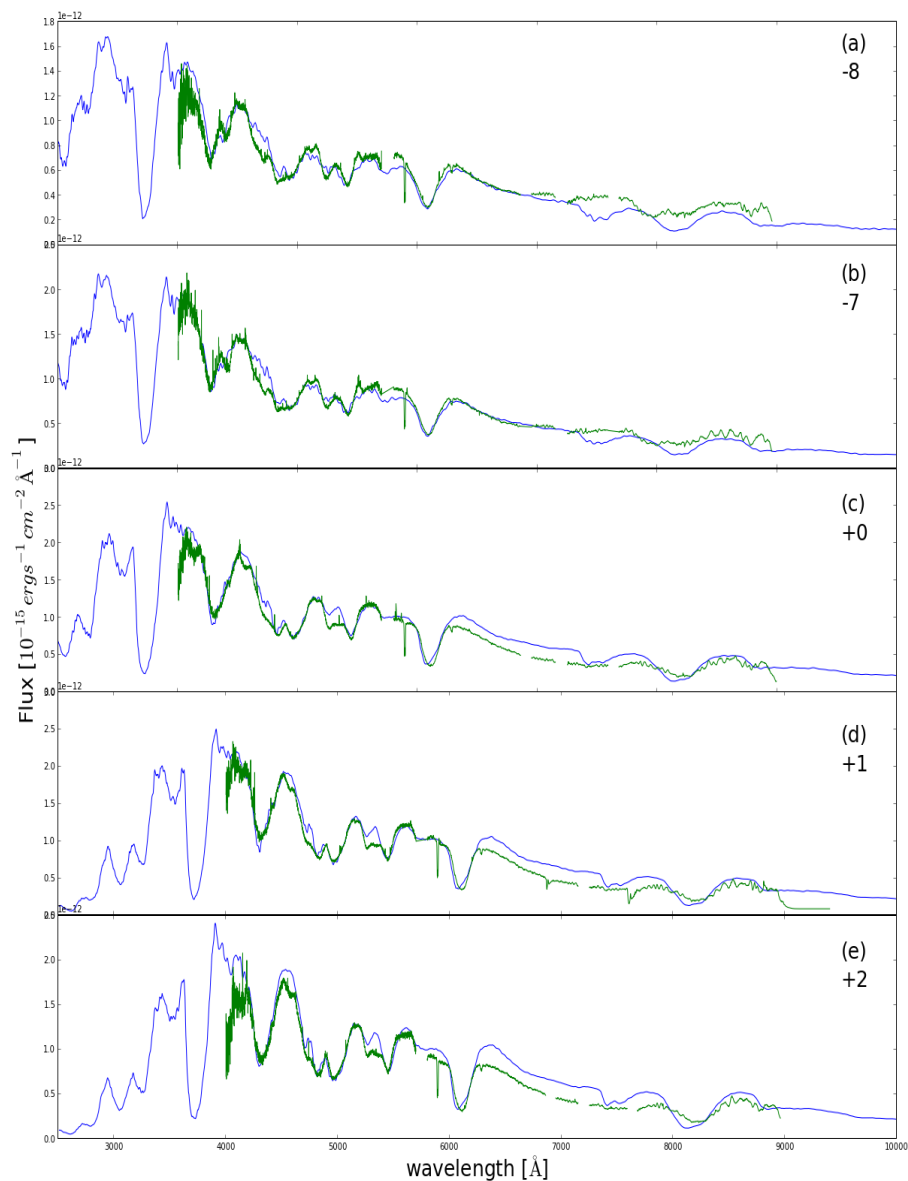
Reddening



- Comparison of 2011fe(red) to 2014J (blue),
(top) $E(B-V)=1.33$, $R_V=1.4$, $E(B-V)_{MW}=0.05$,
 $R_V=3.1$
- Plot of the residuals (bottom)



Models



Abundance distribution

