Oskar Klein centre

High-Resolution Spectroscopy of Type Ia Supernovae

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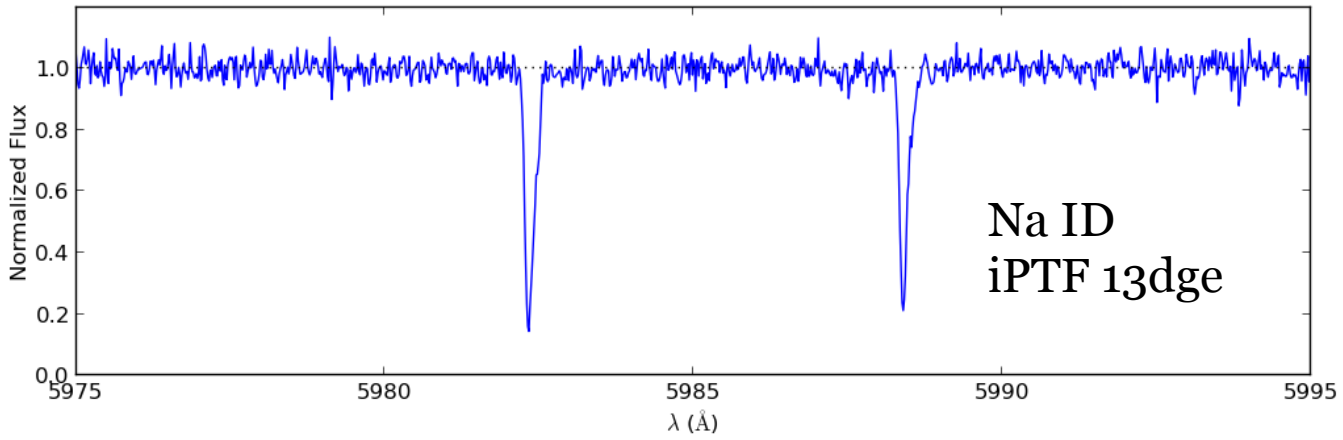
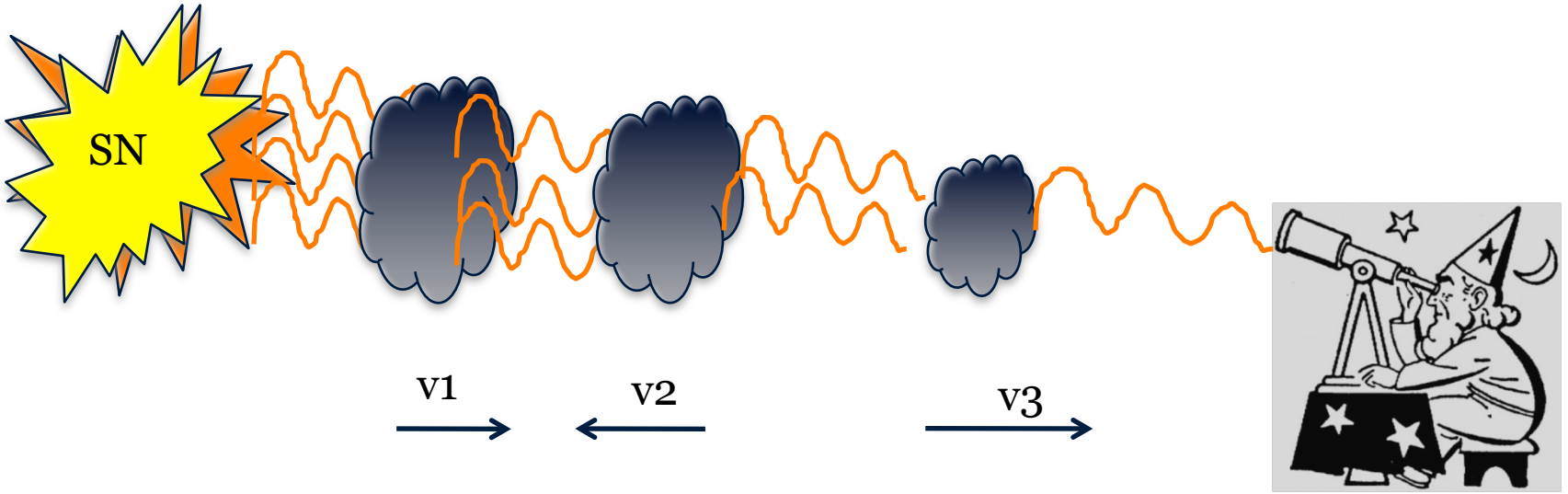
The Oskar Klein Centre

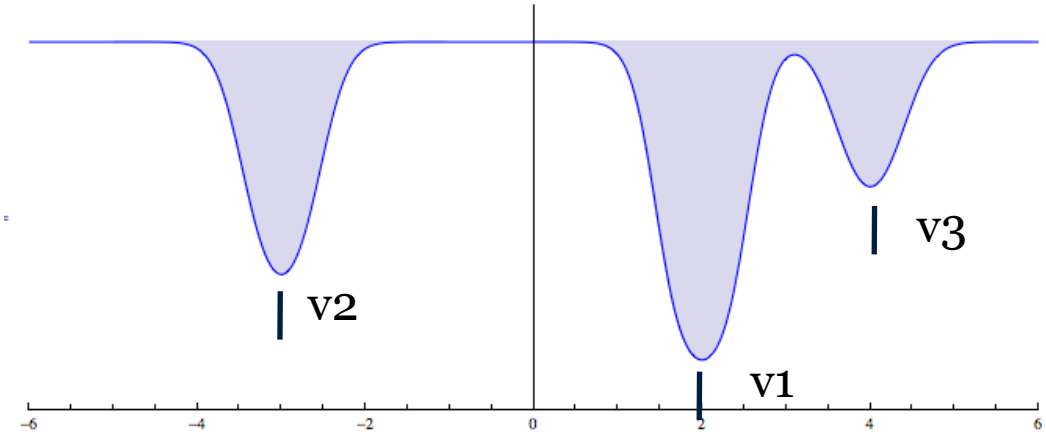
What can we see?

- SN features have high velocity dispersions
  - High resolution spectroscopy unnecessary
- Intervening matter in line of sight
  - Narrow absorption features
  - Na I D, Ca II H&K, K I, DIBs



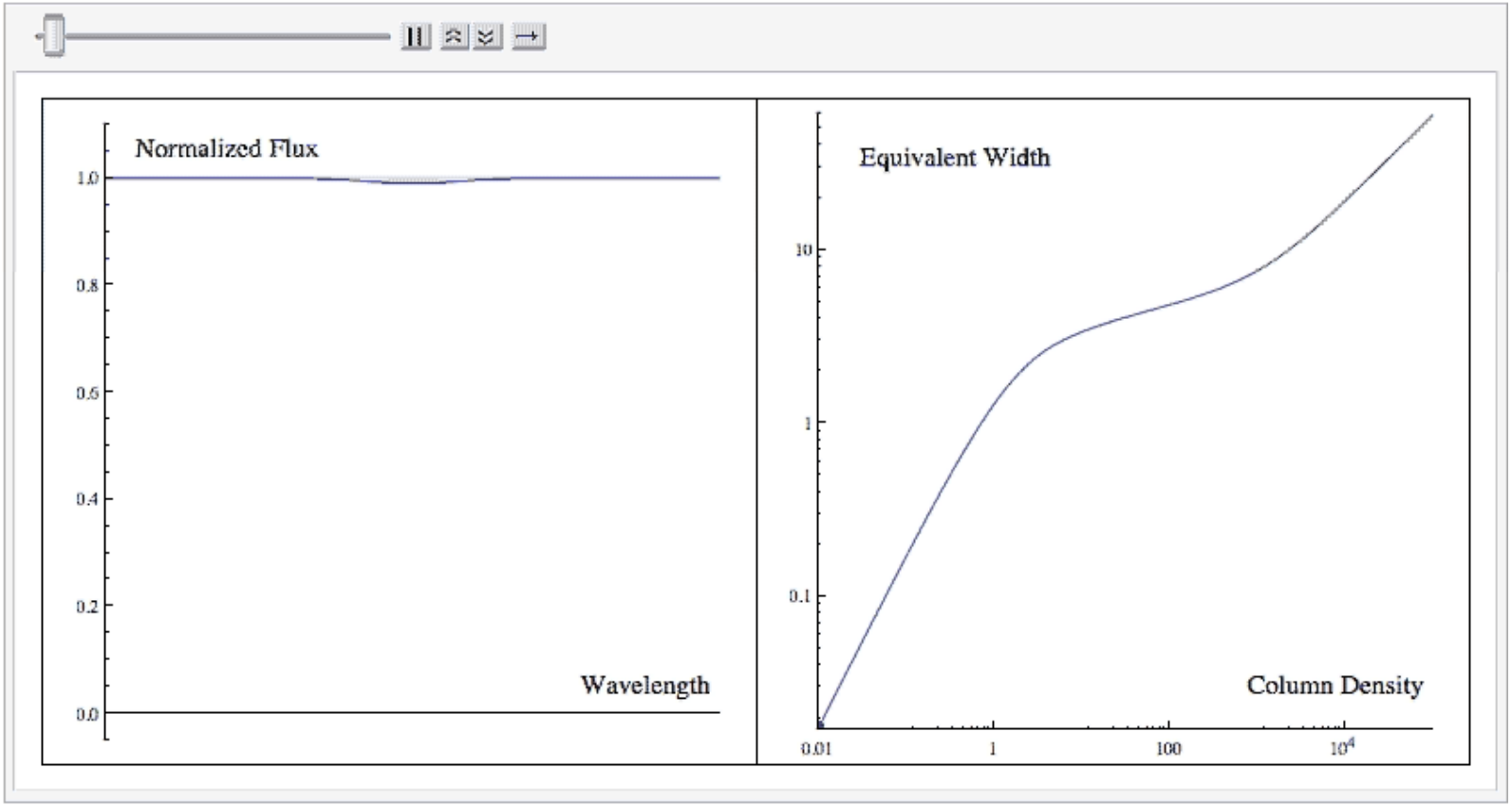
Physical description of absorption spectra



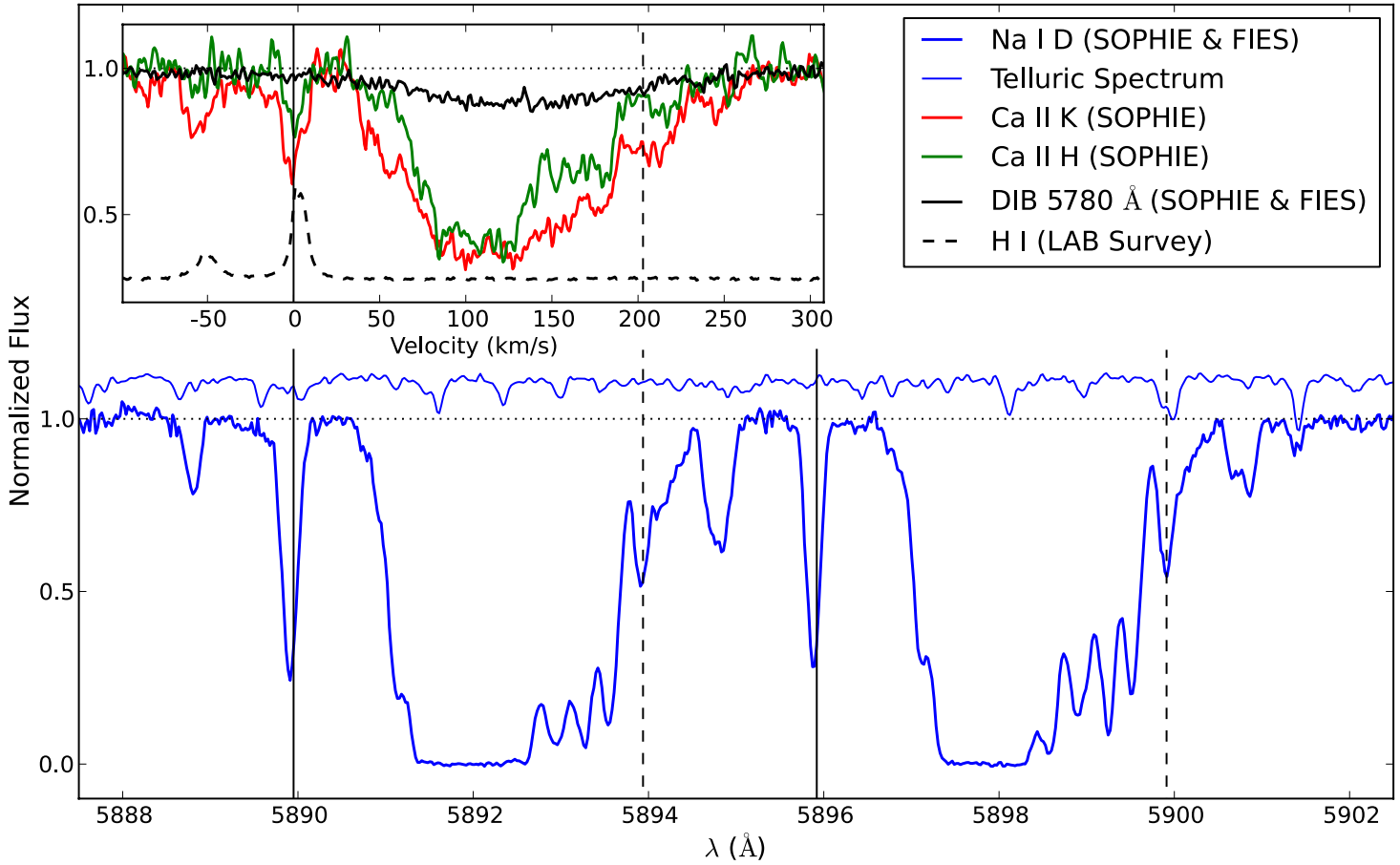


$$\sim e^{-\tau} \, , \tau_0 \propto N$$

Curve of Growth



Example SN 2014J



Goobar et al. 2014

What can we learn from the absorption lines?

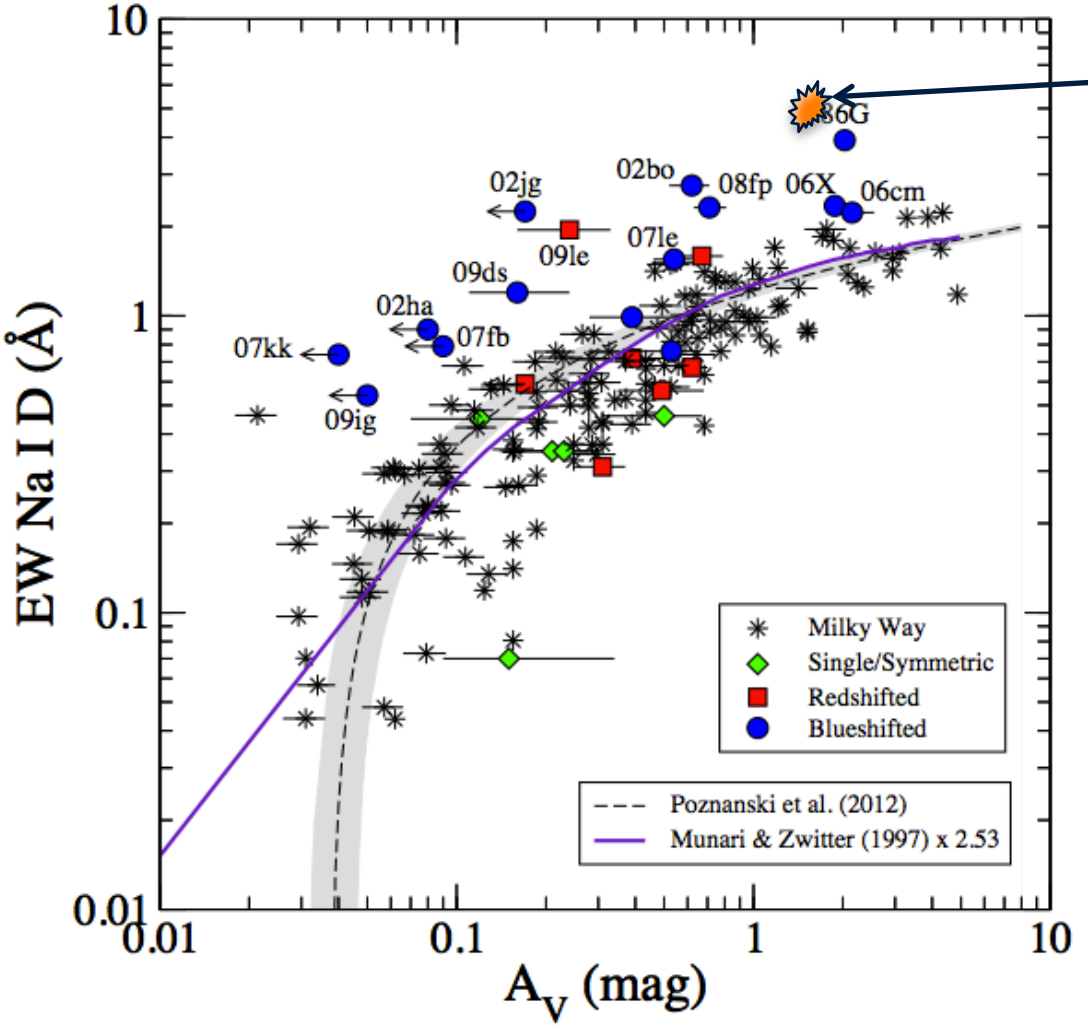
Astrophysics

- Do the profiles and the equivalent width change?
  - Geometric effects?
  - Ionization → CSM!!
- Does the progenitor have a CSM?
  - SD – CSM expected
  - DD – possibly
- Statistically more blue-shifted features (Sternberg et al. 2013)

Cosmology

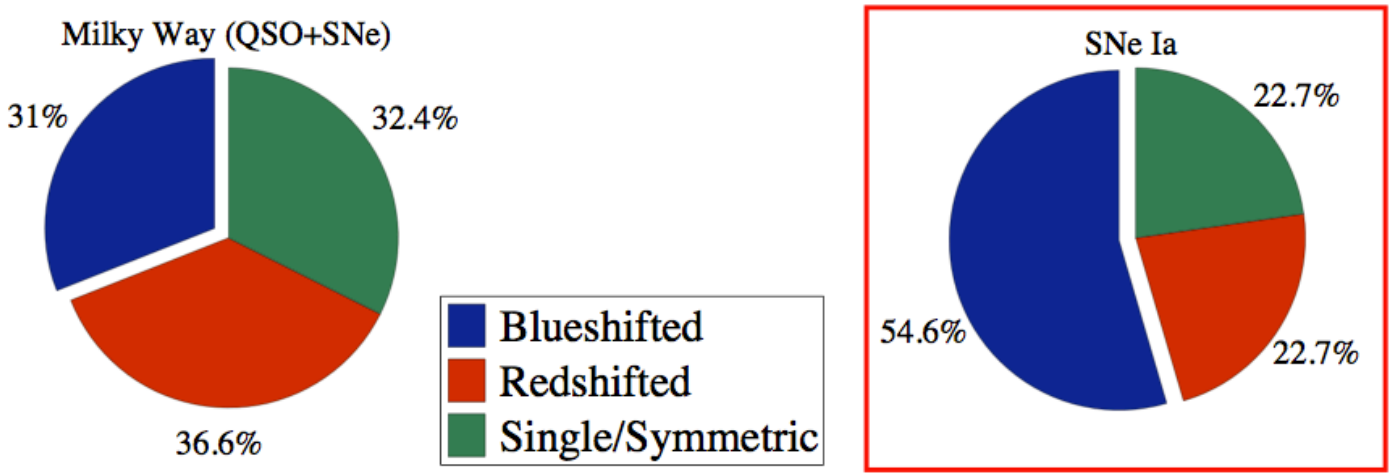
- Absorption must correlate with reddening
- But ISM composition varies
- Equivalent width of Na I D doublet is a not an ideal proxy (Phillips et al. 2013)
- Must consider all features simultaneously

Na ID as a reddening proxy?



Phillips et al. 2013

Is there Circum Stellar Matter?

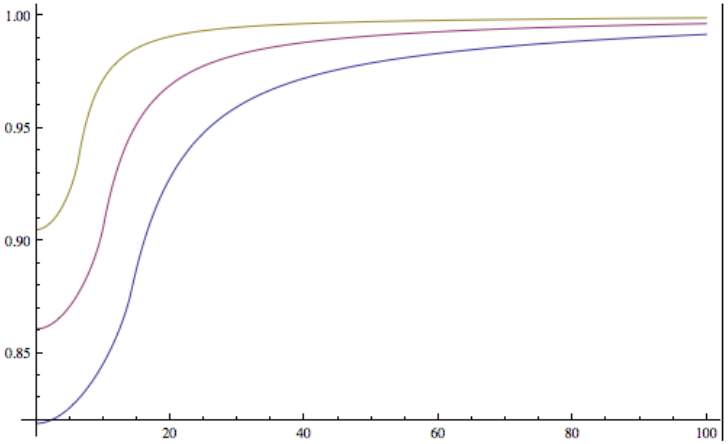


Sternberg et al. 2013

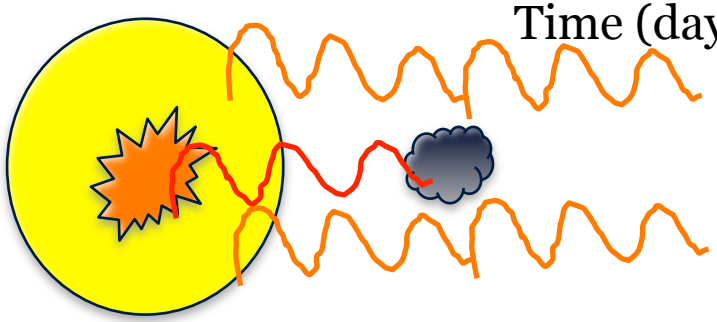
Degeneracy of Geometric and Ionization effects

Geometric effects

I/Io

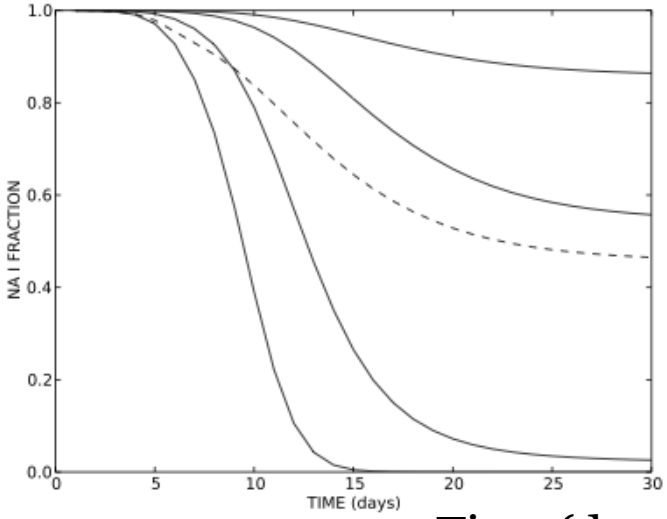


Time (days)



Ionization of CSM

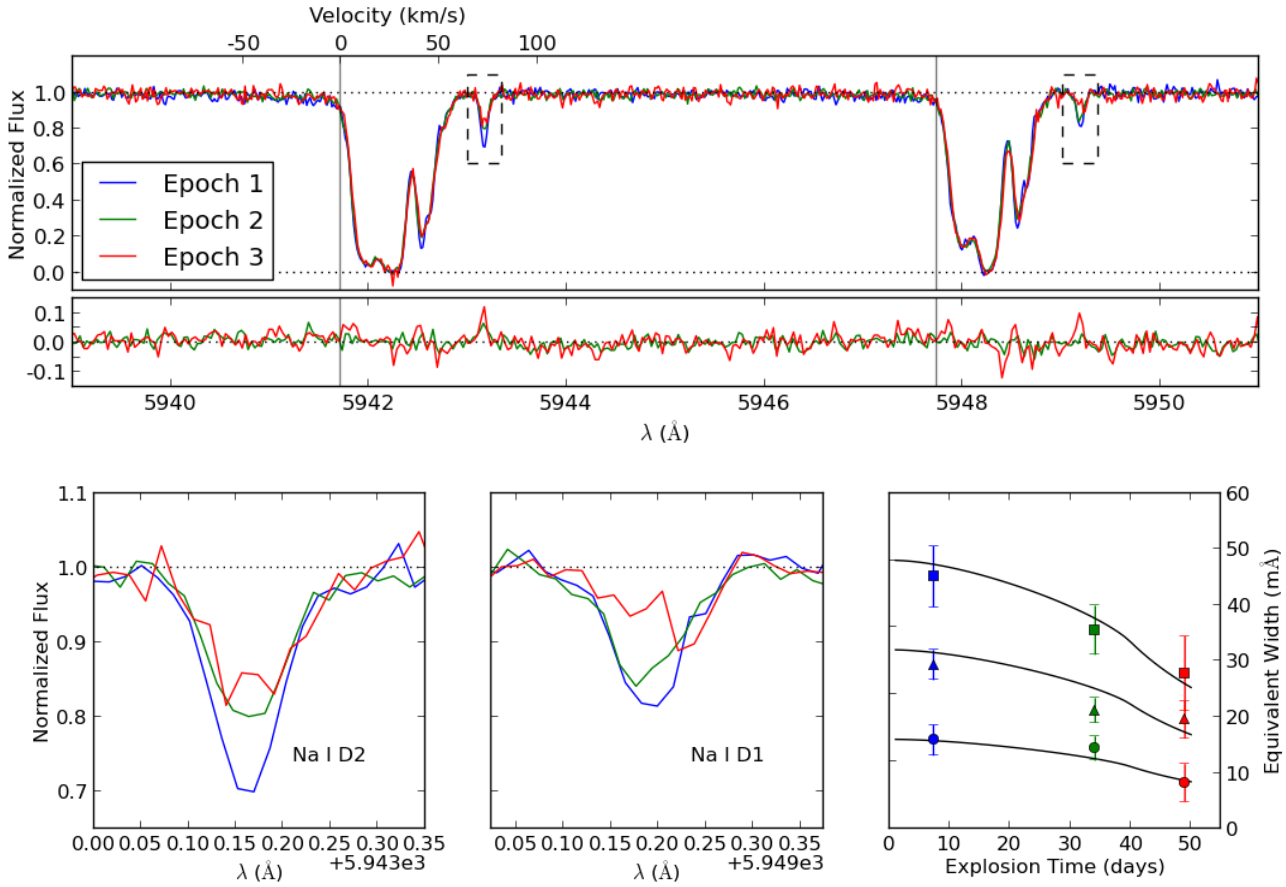
Na I Fraction



Time (days)

Borkowski et al. 2009

SN Capricciosa (SN 2013gh)



Future Goals

- Increase sample of multi-epoch (early!) high-resolution spectra
  - Are there changes apparent?
  - Can we verify/rule out the existence of a CSM?
  - What progenitor models does this favour?
- Identify useful reddening proxies
  - How do Na I D, Ca II H&K, K I, DIBs and others correlate with each other and to reddening
- VLT proposal with Assaf Sternberg

References

- Goobar et al. (2014),
- Phillips et al. (2013), ApJ, 779, 38
- Sternberg et al. (2011), Science, 333, 856
- Patat et al.
- Borowski et al. (2009), ApJ, 699, L64-67
- Image of Astronomer: http://www.supercoloring.com/pages/astronomer/