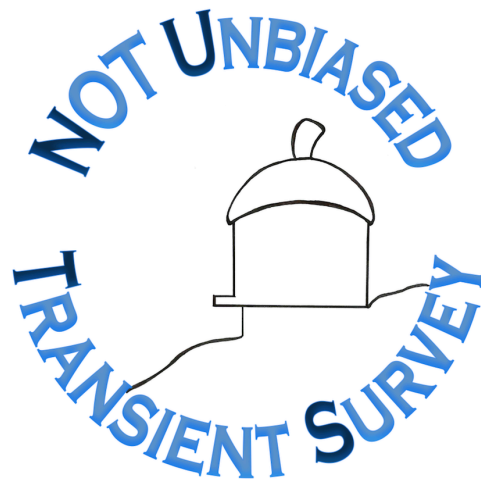


# The Carnegie Supernova Project

## NUTS, narrow-lined Type IaX supernova and CO formation in SN 2016adj

Maximilian Stritzinger  
Aarhus University  
Denmark  
[max@phys.au.dk](mailto:max@phys.au.dk)

VILLUM FONDEN

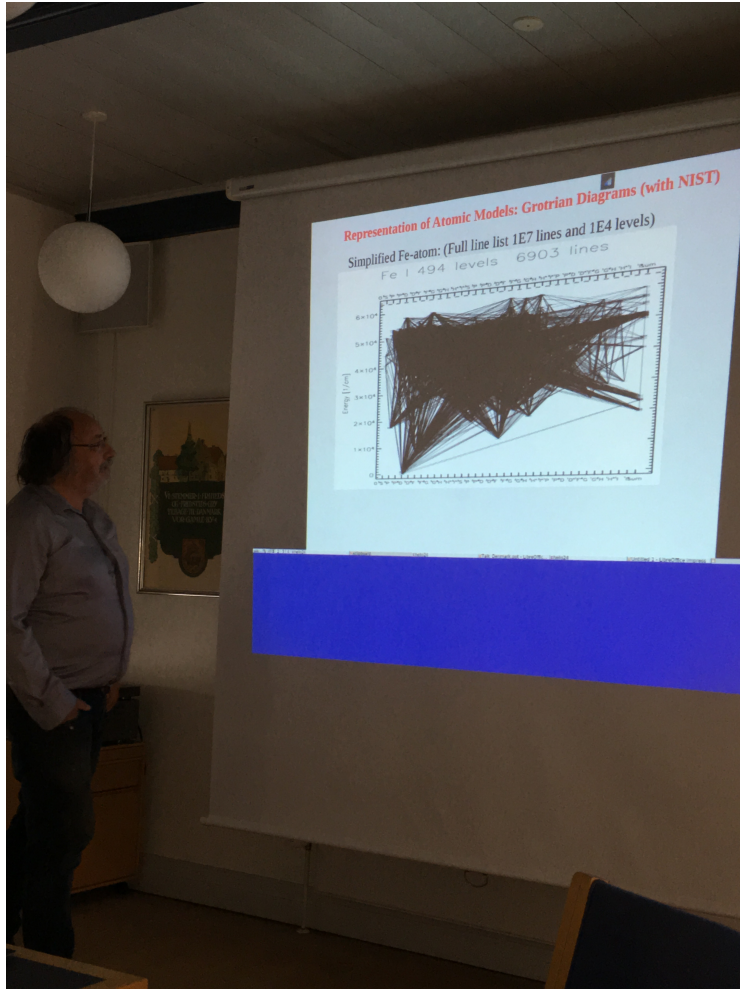


# CSP 2017 summer trip to Europe

## Sandberg Gods



# Peter determine his favorite line transition





# NOT Un-biased Transient Survey

3 year follow-up program on the NOT

PIs: S. Mattlia, MS., P. Lundqvist

Italian PI: A. Pastorello;

*also* M. Fraser, N. Elias Rosa, S. Dong

Node structure:

Aarhus/Beijing, Stockholm/Tuorla,  
Warsaw, Padua, Belfast, Nijmegen

Additional facilities: Asiago, GTC, Swift,  
+ ASAS-SN

- Young supernovae
- Peculiar supernovae

→ ASAS-SN/Gaia/MUSSES/DLT40+....

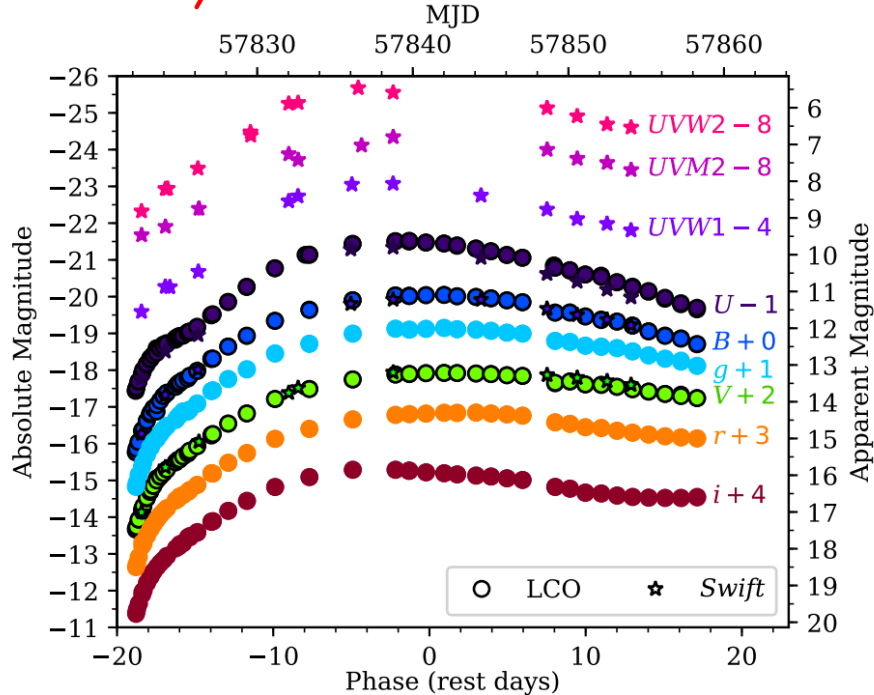
All Members (NOT-TRANSIENTS@JISCMAIL.AC.UK)

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juanauh@UTU.FI	Jussi Harmanen
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E.Kankare@QUB.AC.UK	Erkki Kankare
zkostrze@ASTROUW.EDU.PL	Zuzanna Kostrzewa
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francesco.taddia@ASTRO.SU.SE	Francesco Taddia
ftadd@ASTRO.SU.SE	Francesco Taddia
gterreran01@QUB.AC.UK	Giacomo Terreran
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T.Wevers@ASTRO.RU.NL	Thomas Wevers
wyrzykow@GMAIL.COM	Lukasz Wyrzykowski
sheng.yang@OAPD.INAF.IT	Sheng Yang

# Recent SNe Ia results

SN 2017cbv

Binary Interaction?

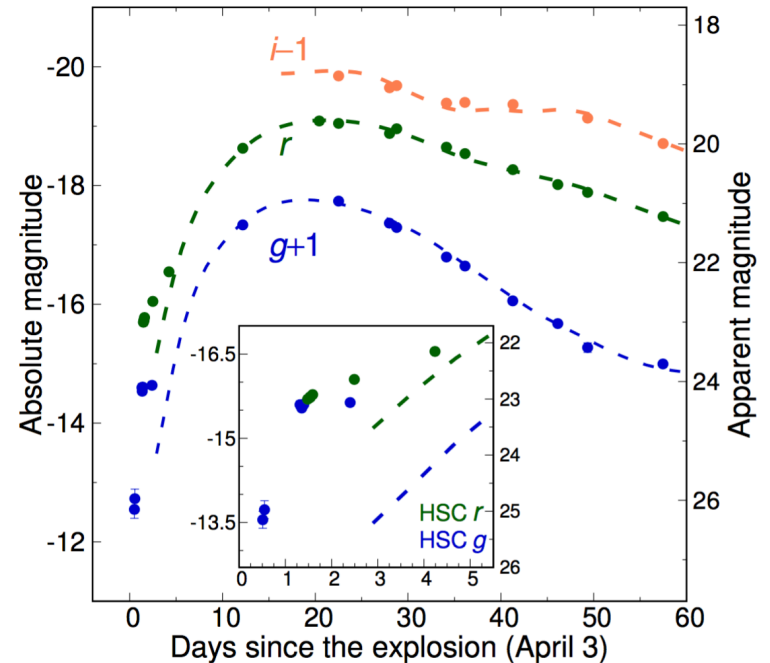


Hosseinzadeh et al. 2017, ApJL  
(makes use of Danish Swift time)

ASAS-SN paper in the works Shappee?

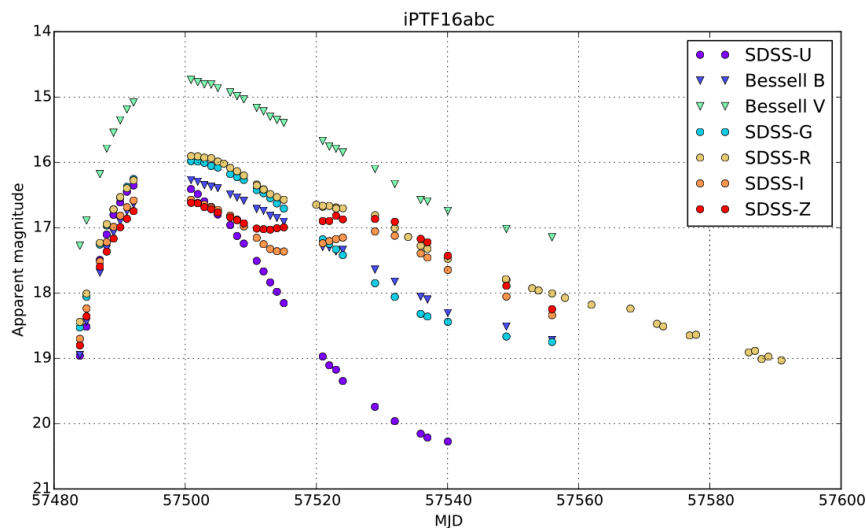
SN 2016jhr

Helium Shell Double Detonation?



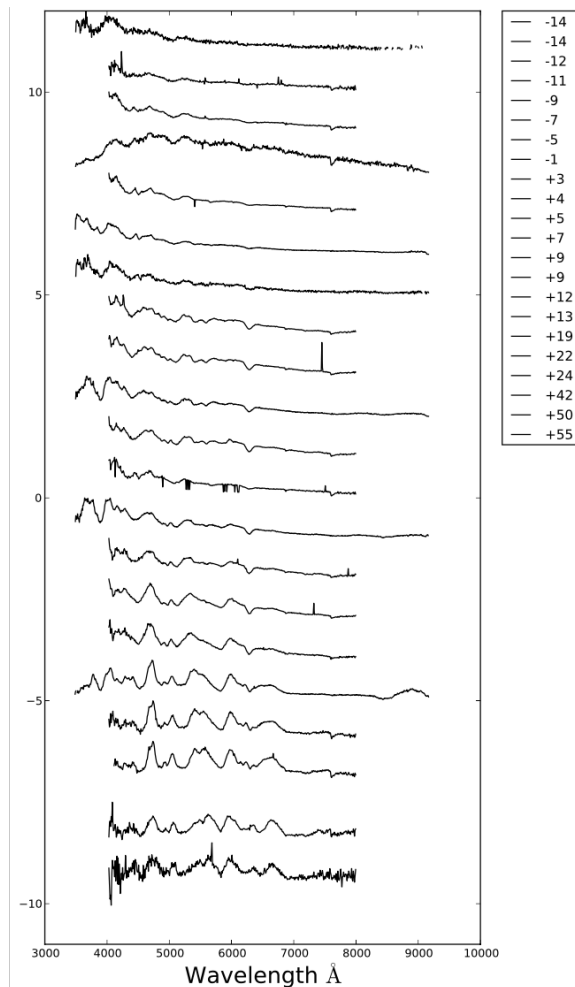
Jiang et al. 2017, Nature  
(makes use of a NUTS images)

# NUTS follow-up of (numerous) young/peculiar SNe Ia

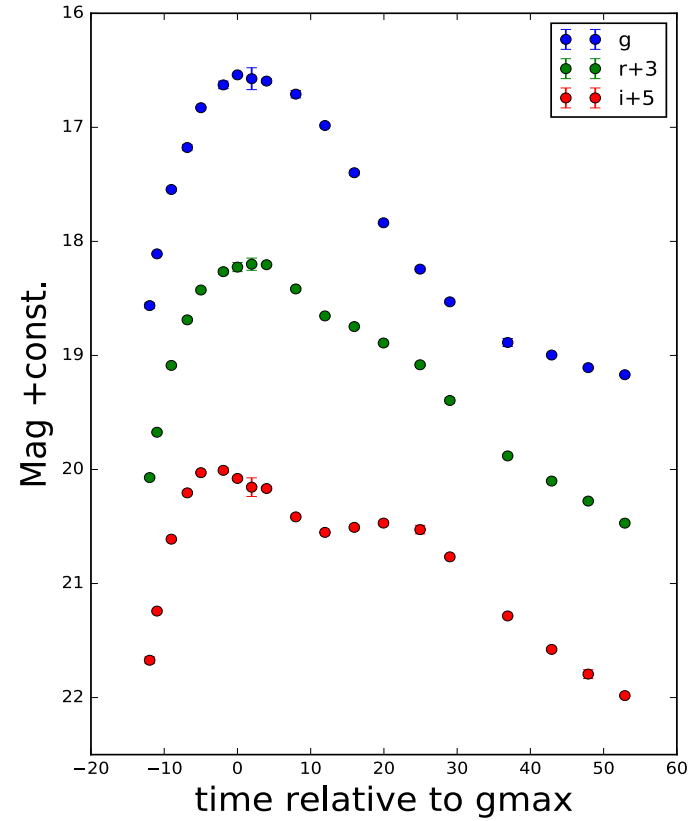
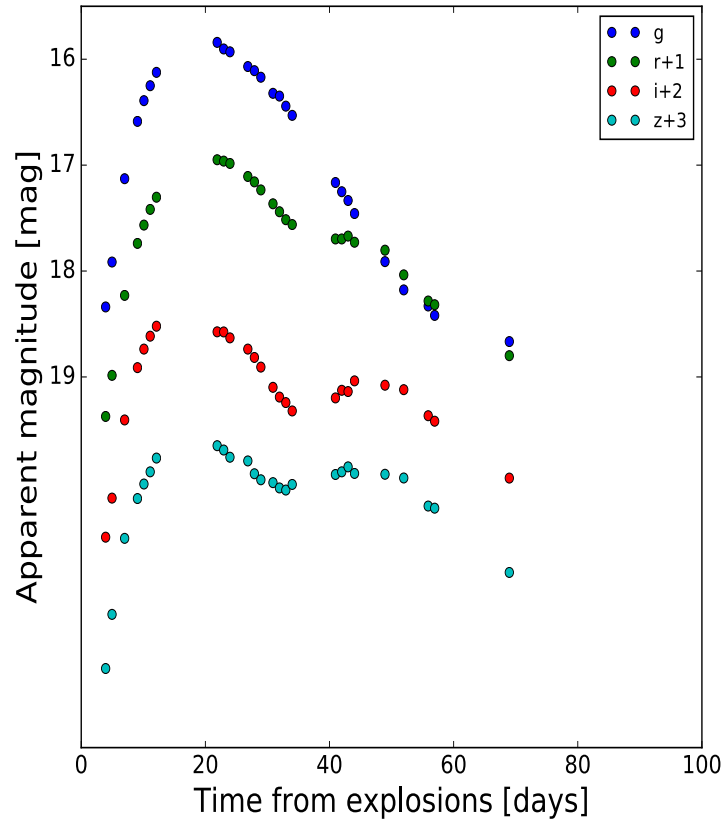


*Courtesy of C. Ashall & S. Holmbo*

*Wondering what DLT40 are doing with objects of overlap?*



# Liverpool Telescope

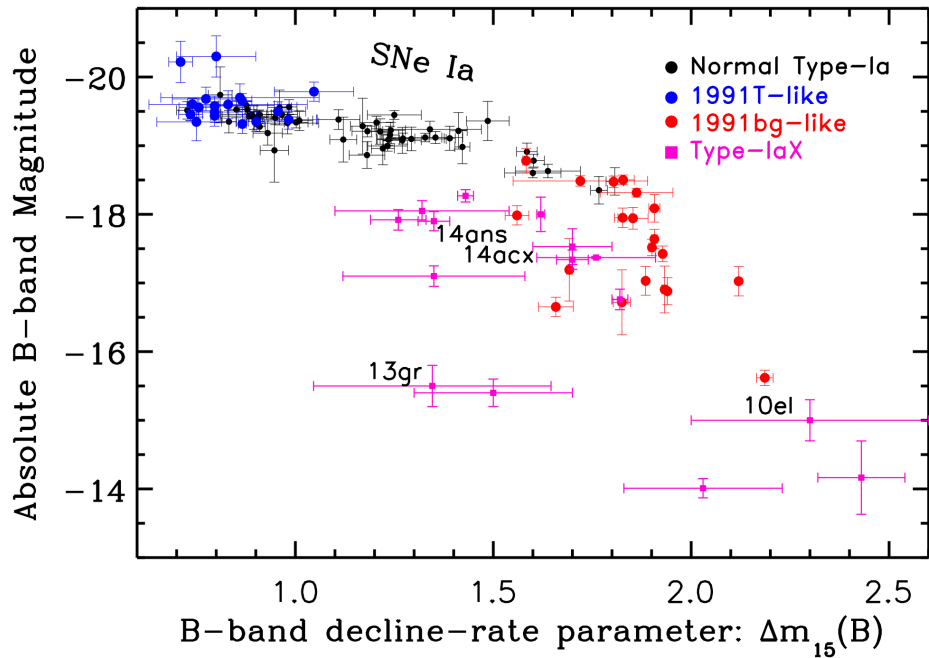


*Courtesy of C. Ashall & S. Holmbo*



# CSP-II Type IaX supernovae

Unpublished 2010el, 2013gr,  
PTF 14ans, LSQ 14acx, 2015H



- Hot spectra with signatures of Fe II and Fe III

- Range of peak luminosities

- IME & other Fe-group elements

- Velocities ranging between a few to 10 thousand km/s

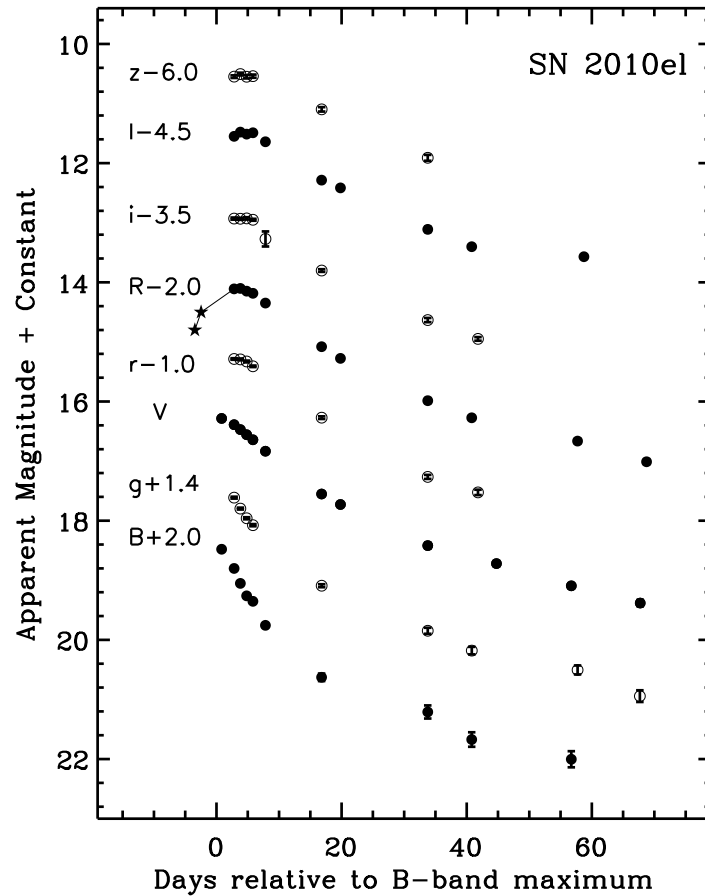
- evidence for *layered structure*

Stritzinger et al. 2015 →

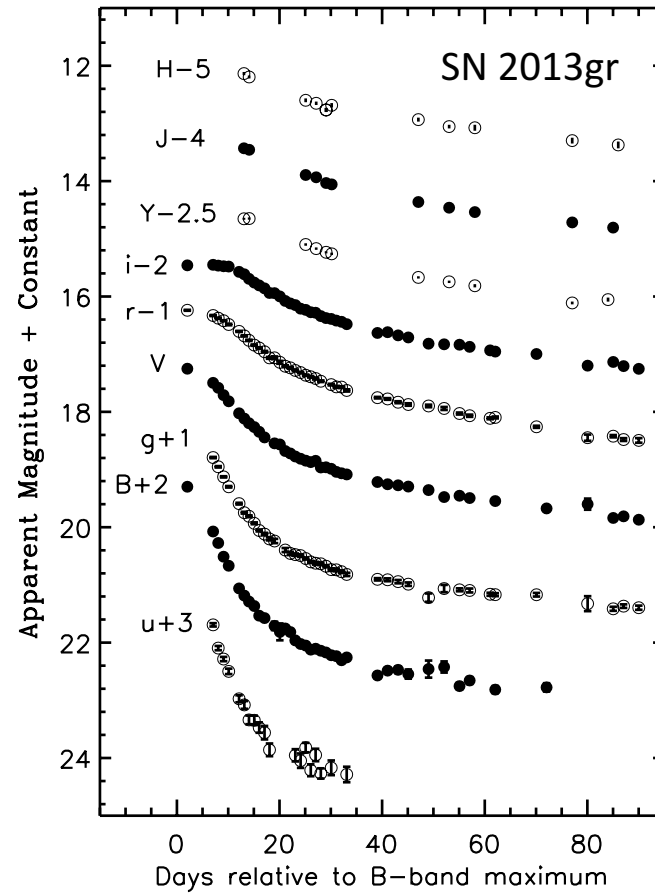
Barnabas, Tamas, Kromer et al. 2017

# Photometry of Type IaX 2010el & 2013gr

CHASE

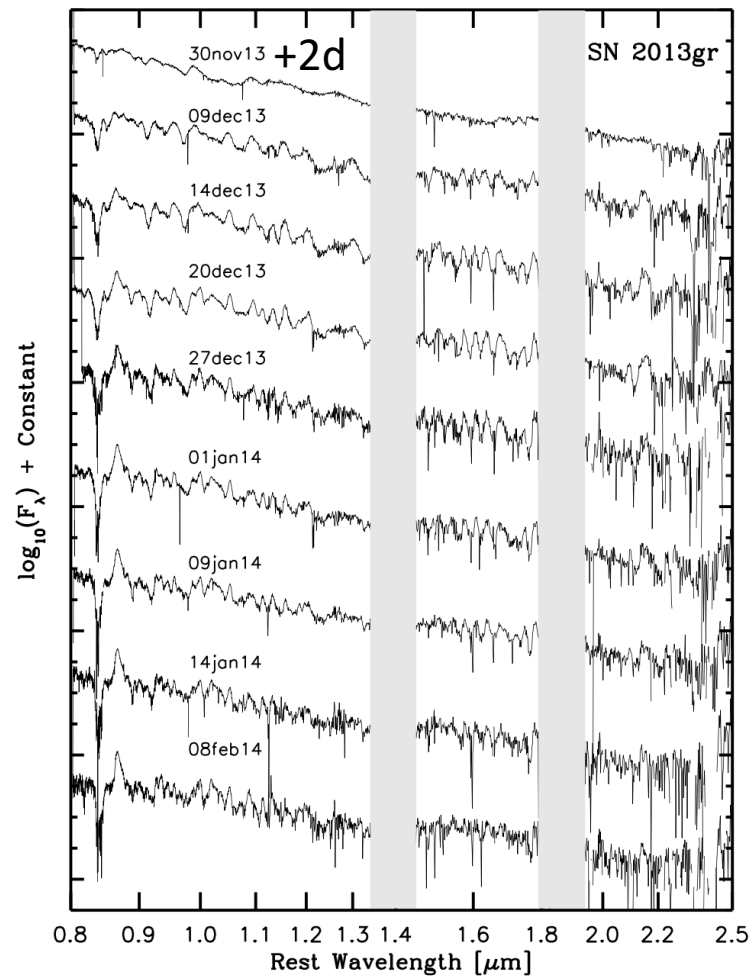
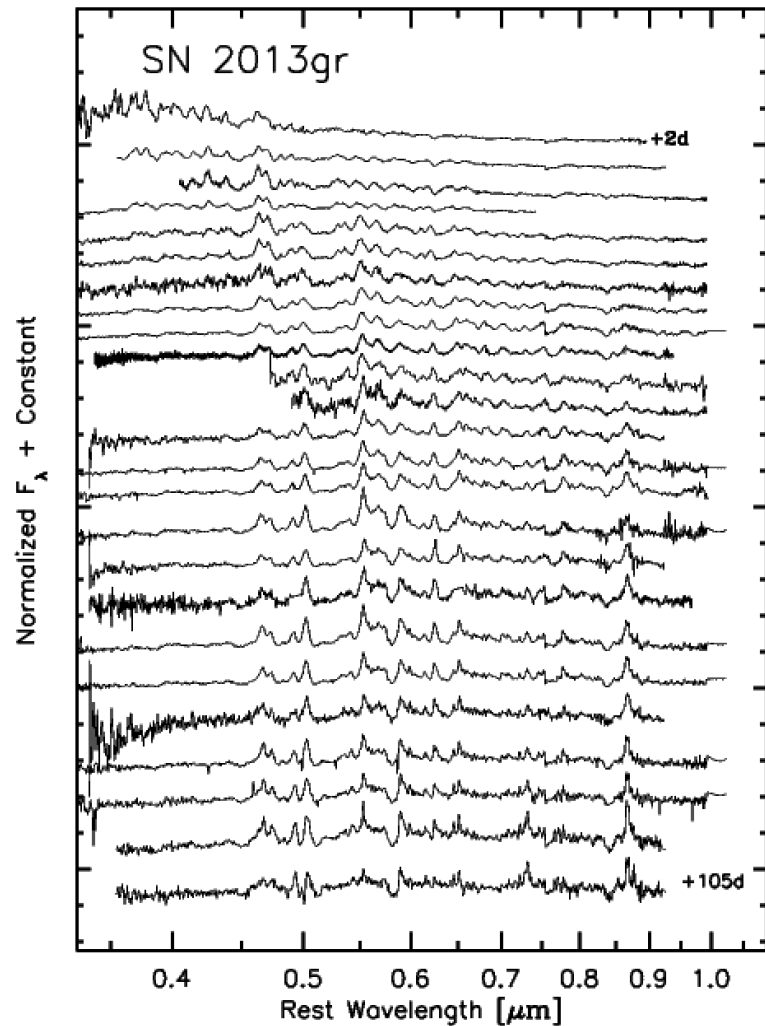


CSP2, also around LCO-GT+

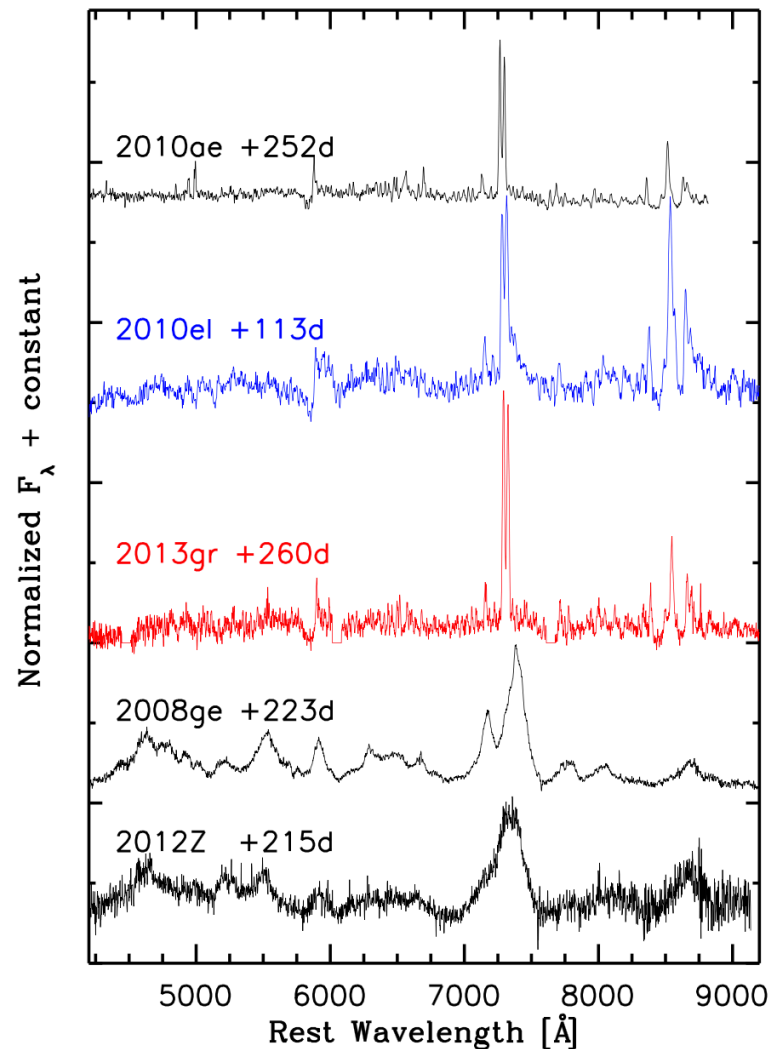
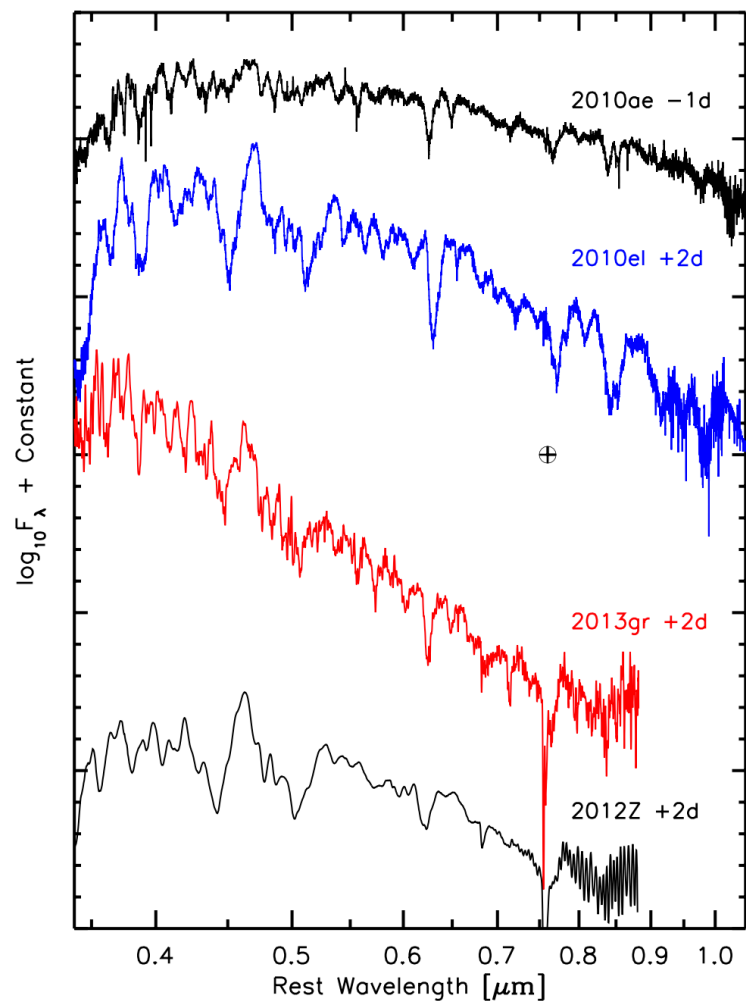


LCO-GT photometry, Dave filter functions?

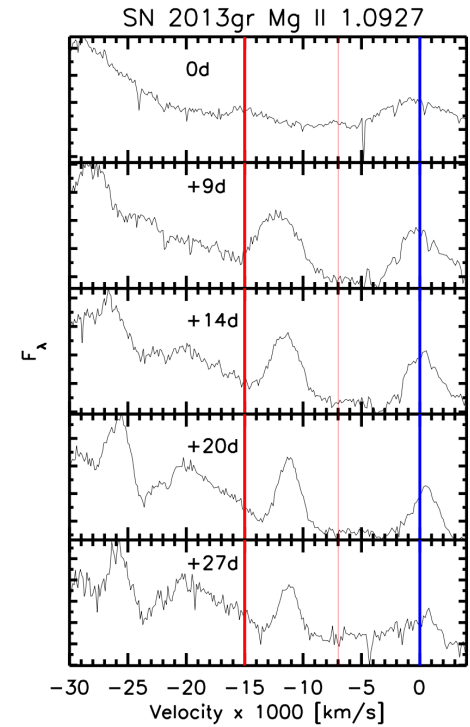
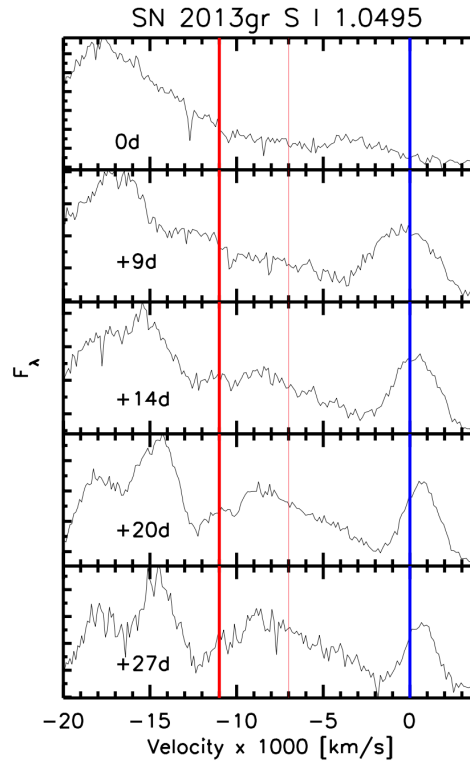
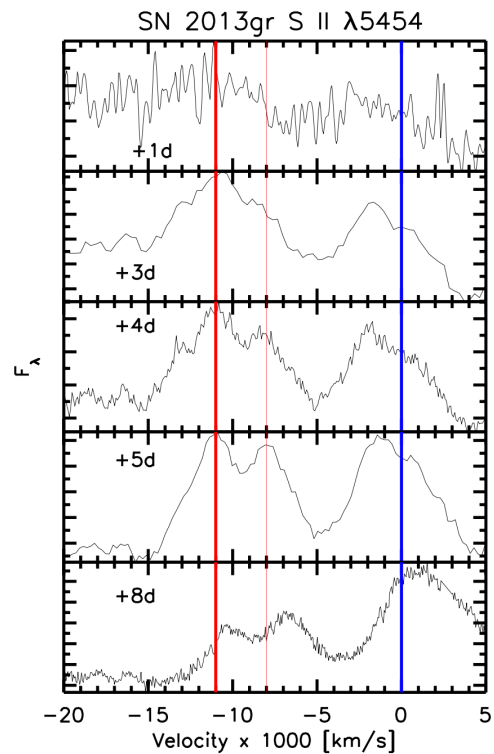
# Spectroscopy of SN 2013gr



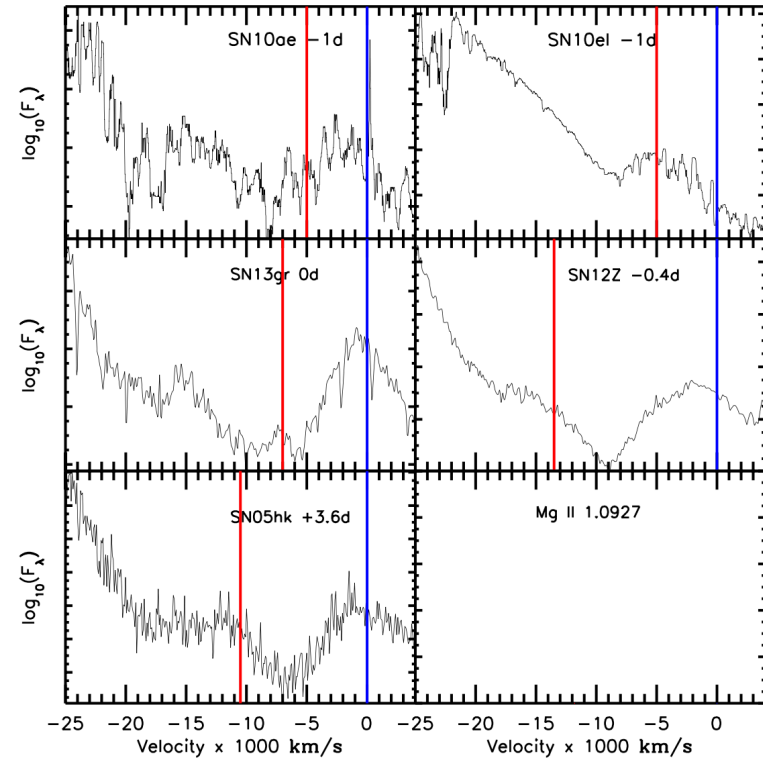
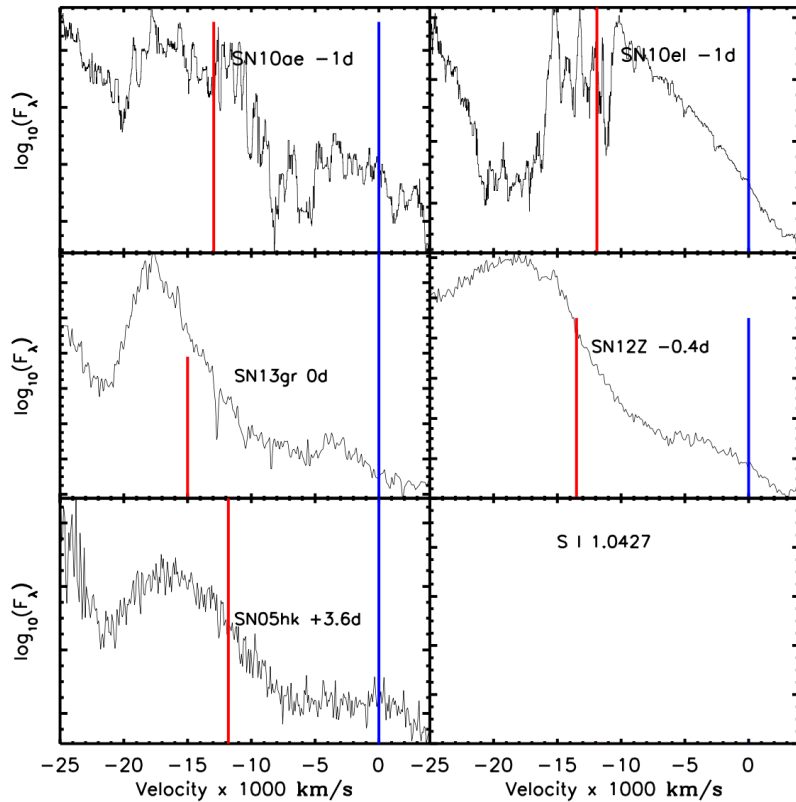
# Comparison of early and late spectra



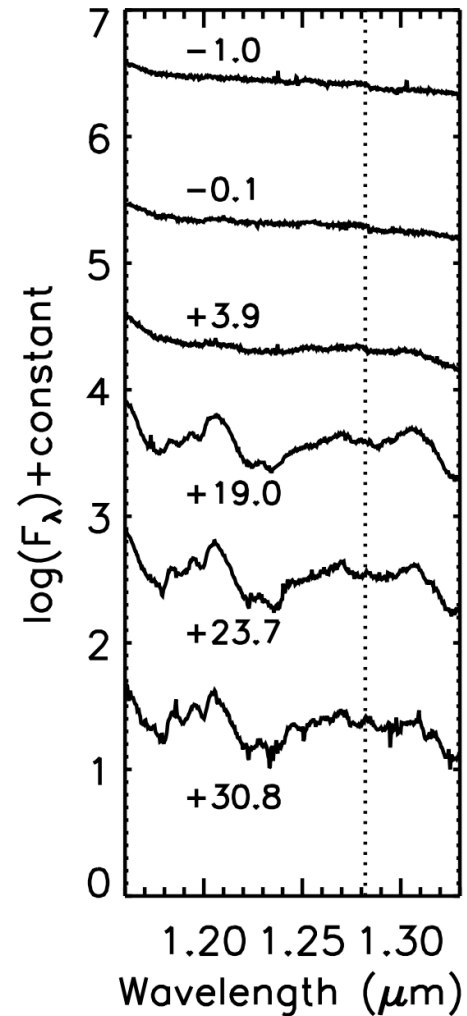
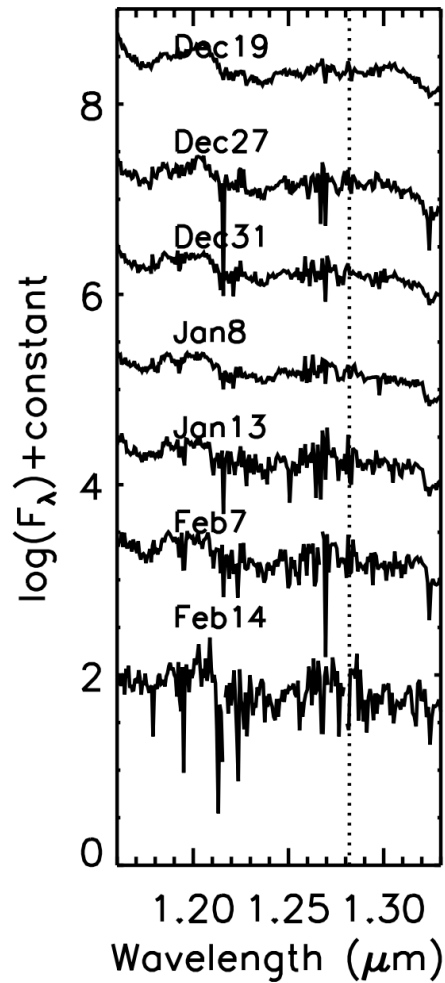
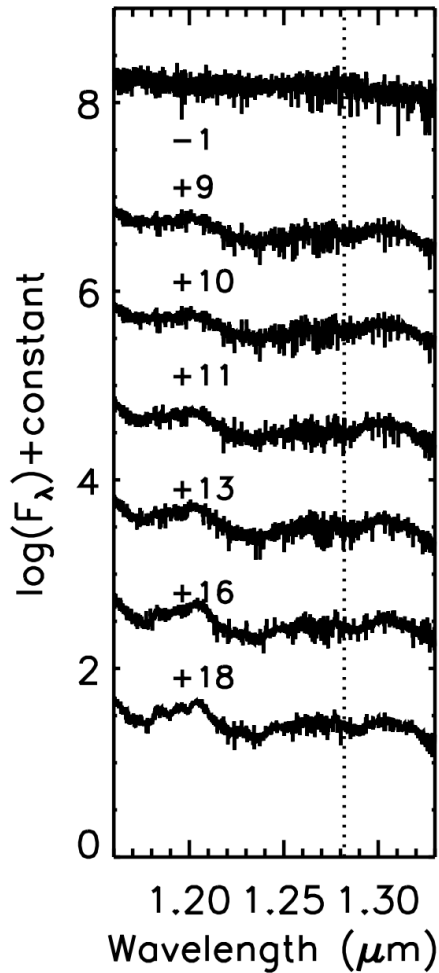
# Preliminary efforts: lines lots of lines



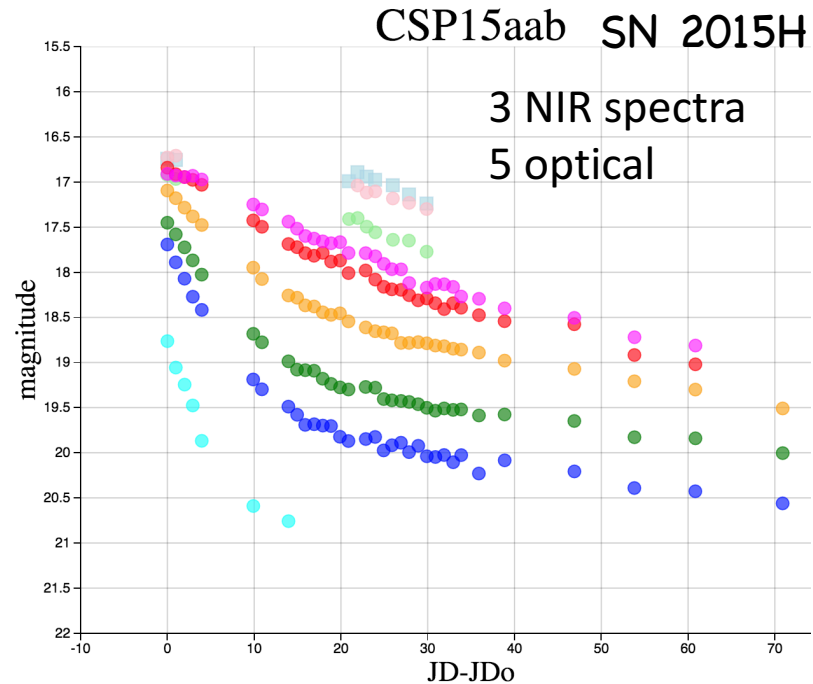
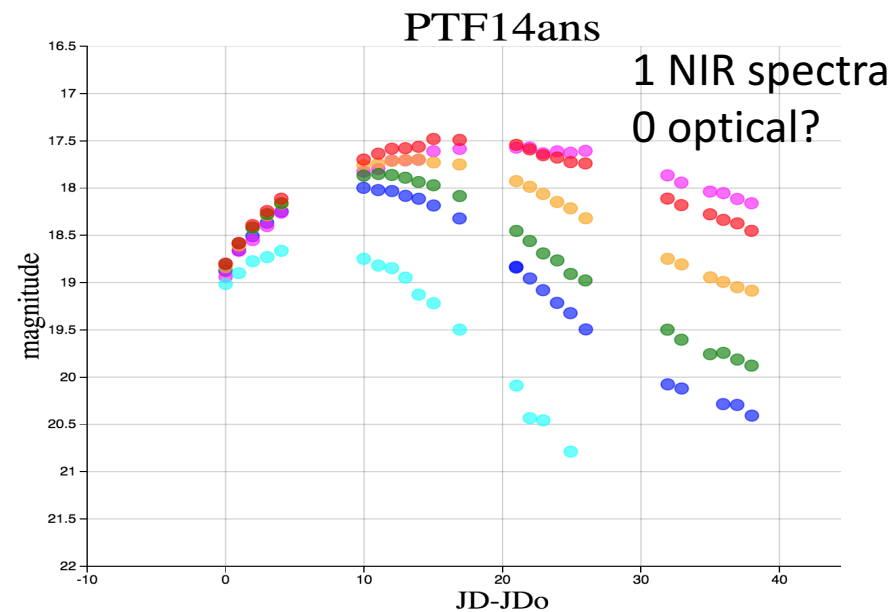
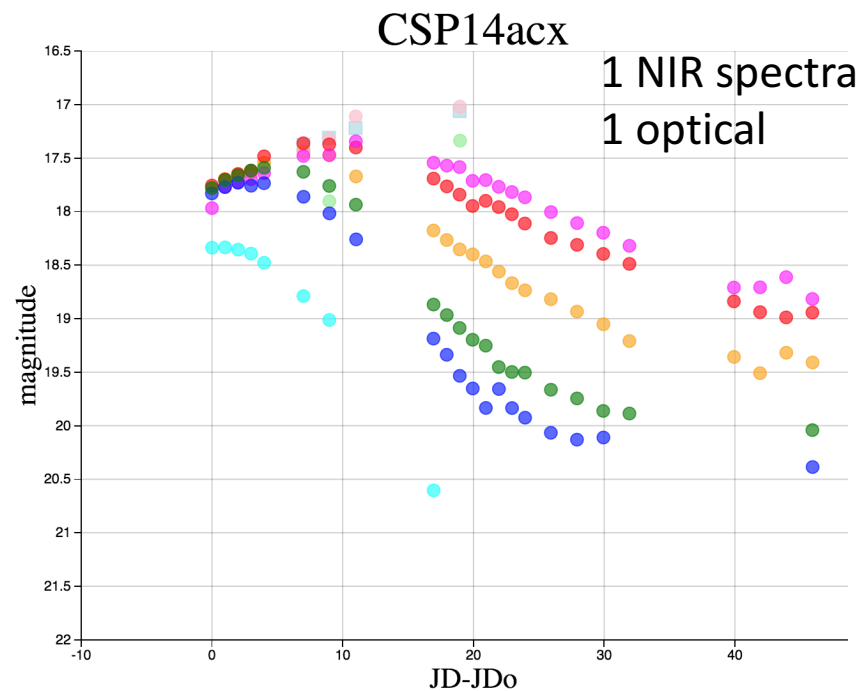
# Preliminary efforts: layered structure?



# Preliminary efforts: Search for $\rho$ -beta



# Light curves CSP-II:



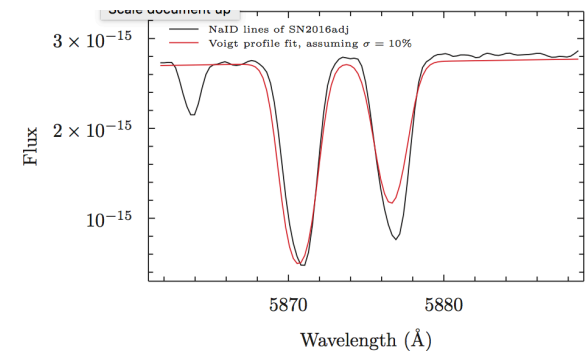
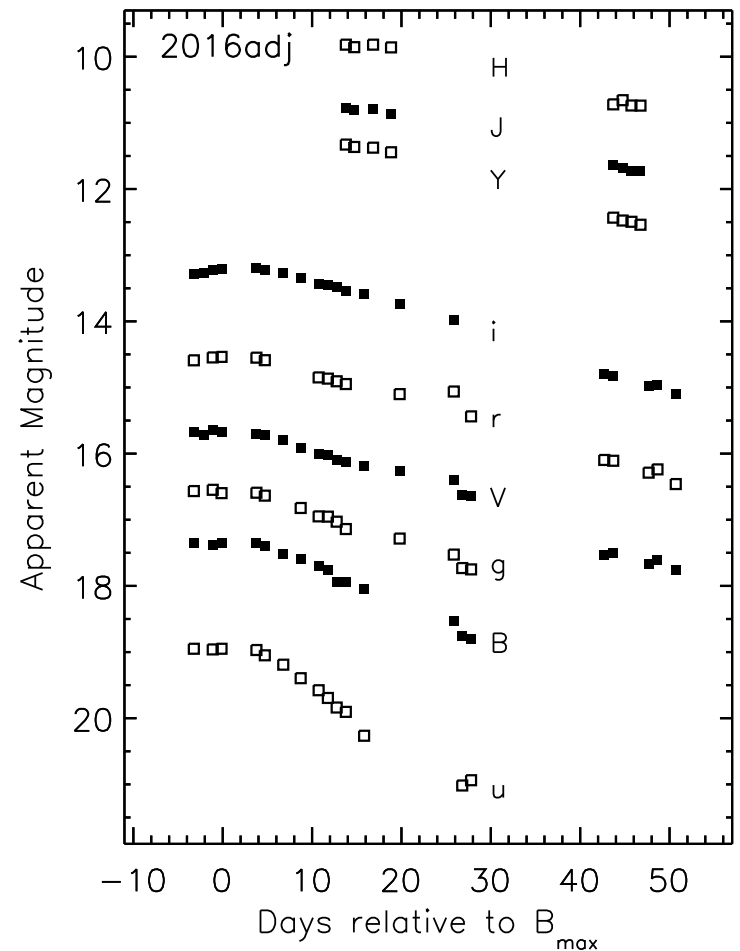
- Modeling efforts underway+CO cooling
- Abundance tomography (C. Ashall).



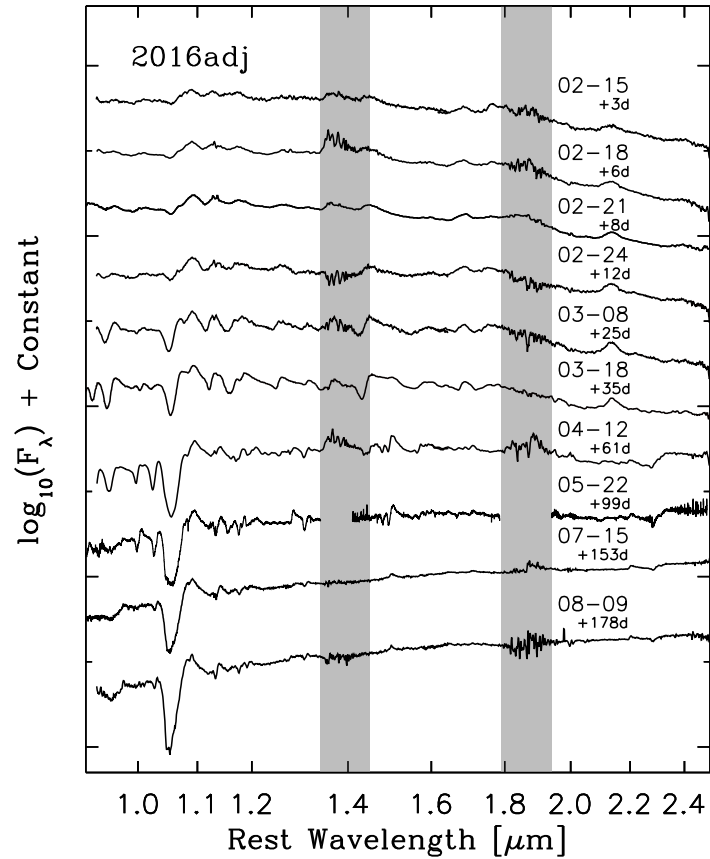
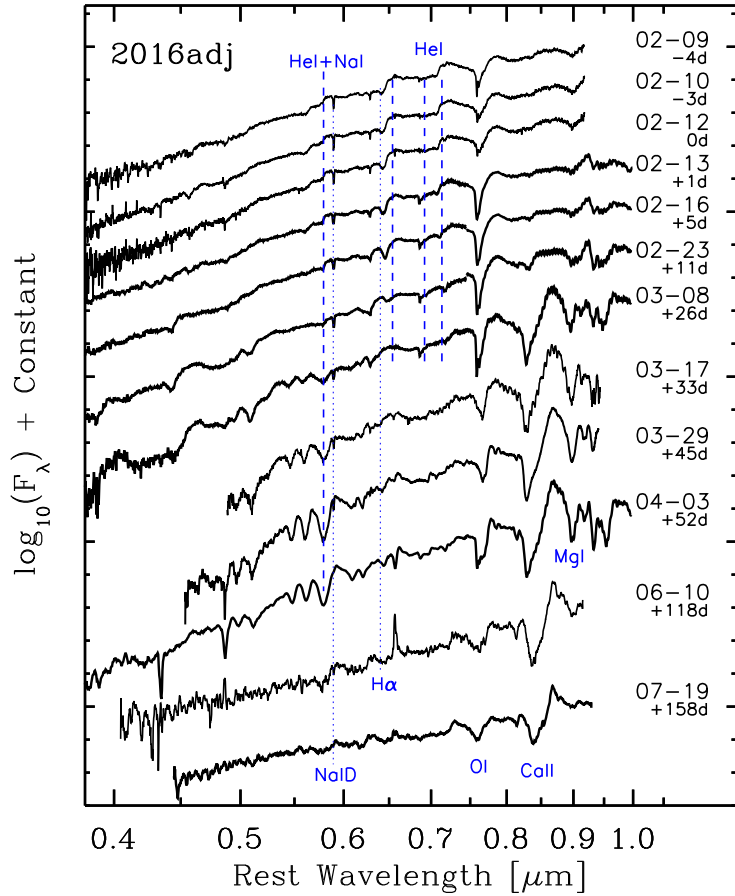
# SN 2016adj



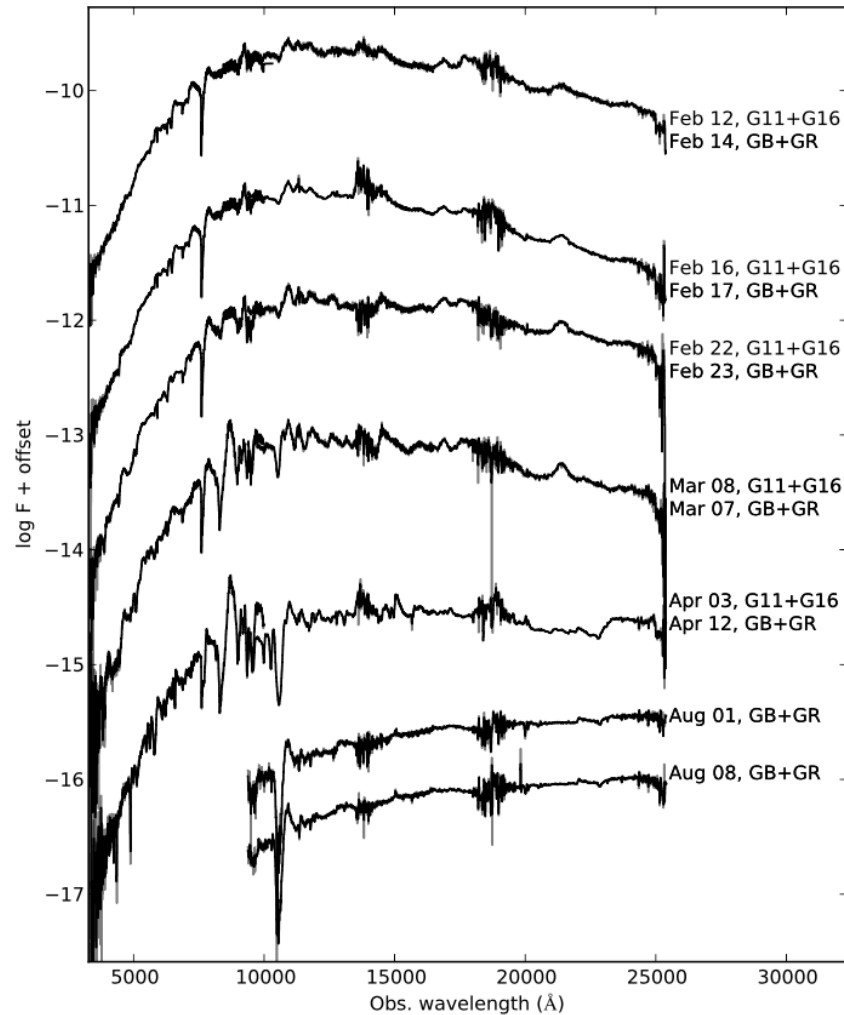
- Highly reddening SN Ib/IIb
- HST observations by Sugerman & Lawrence (2016, ATel #8890) contain evidence of a light echo related to a ring of dust located 105-125 pc away
- DIB @ 578-nm implies  $A_V \approx 3.0^{+1.9}_{-1.2}$  mag
- Adopting SBF distance  $M_V = -19.6$  mag



# SN 2016adj

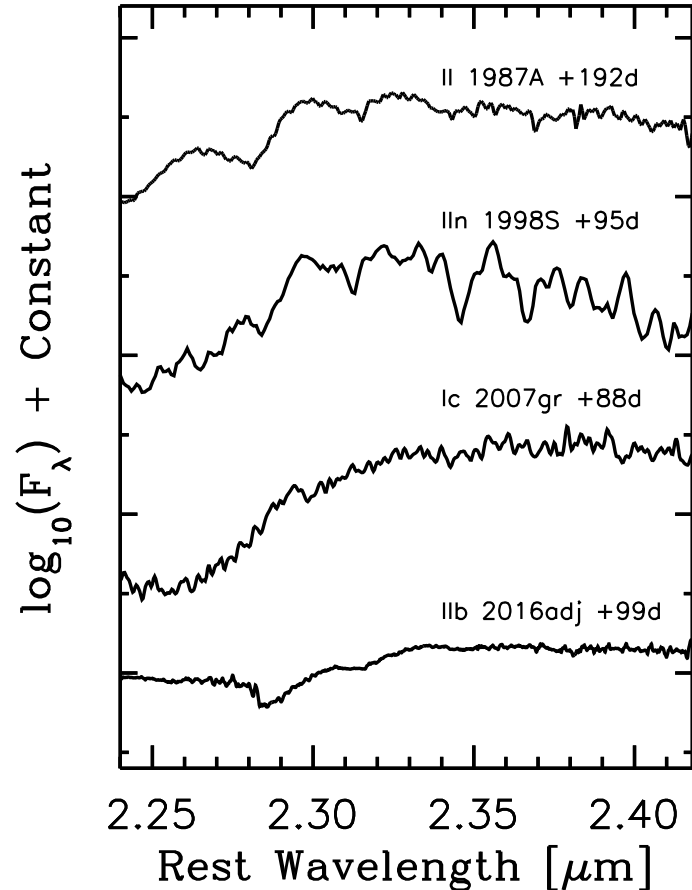
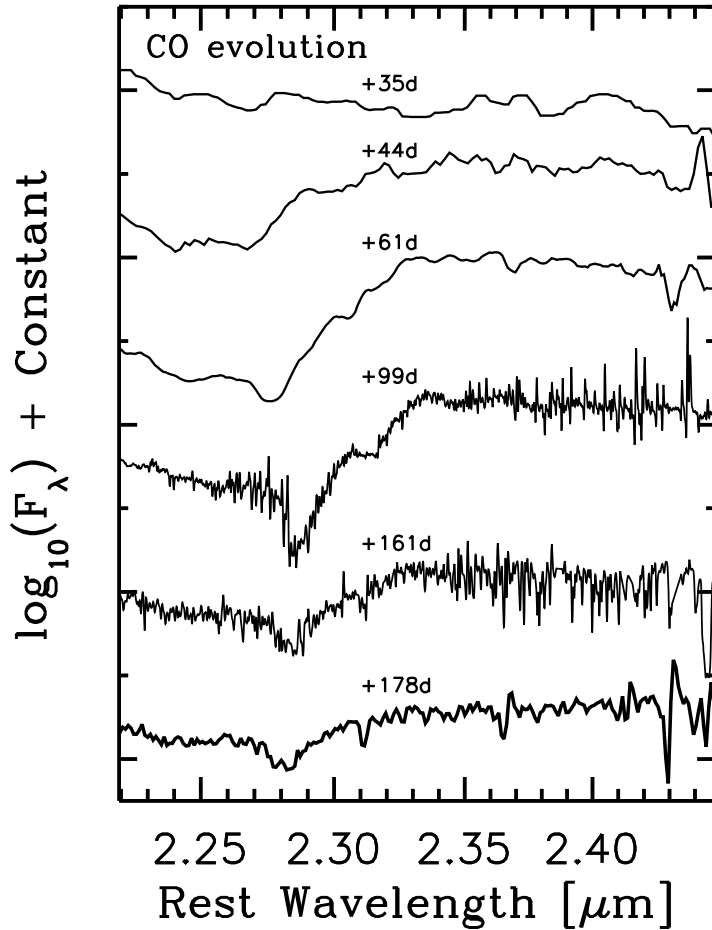


# SN 2016adj



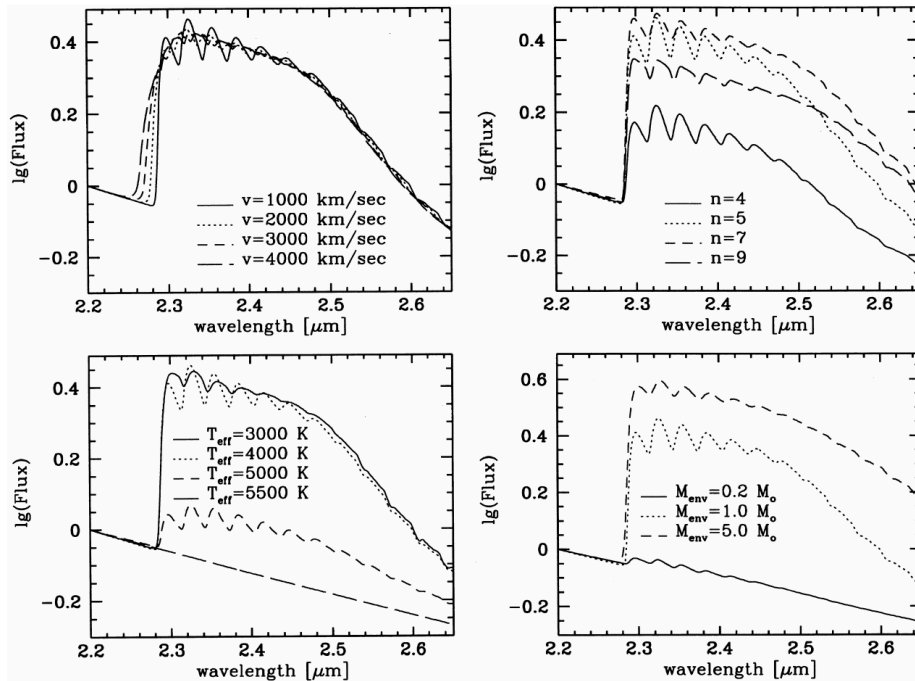
- Spectral type?
- Line ID to be sorted through, e.g., Mg II/Mg I, C or no C?
- Constrain light echo emission
- Infer reddening law via comparison to minimally reddened spectral template

# Carbon Monoxide (CO)



Late X-shooter spectra (2017) contain no evidence of CO [needs checked]  
IRTF spectrum obtained post +160d?

# CO model comparison: TBD



Gerardy et al. (2000)

- Enable an estimation of the temperature, mass and velocity of CO
- Probe He mixing in ejecta

## ADDITIONAL EFFORT:

- Reddening
- MUSE data (Steve Schulze)
- ALMA CO mapping

- CSP-I SE SN spectroscopy paper
  - SN 2013gy early phase paper
  - CSP SNe IaX III.
  - SN 2016adj
- 
- CSP-II low-luminosity SNe Ia
  - CSP-II SE SN
  - CSP-II SNe IIn w/ Moriya-san

# NTE: NOT Transient Explorer

- Medium resolution optical/NIR imager/spectrograph
- Rapid response mode for fast transients  
< 2 minutes

