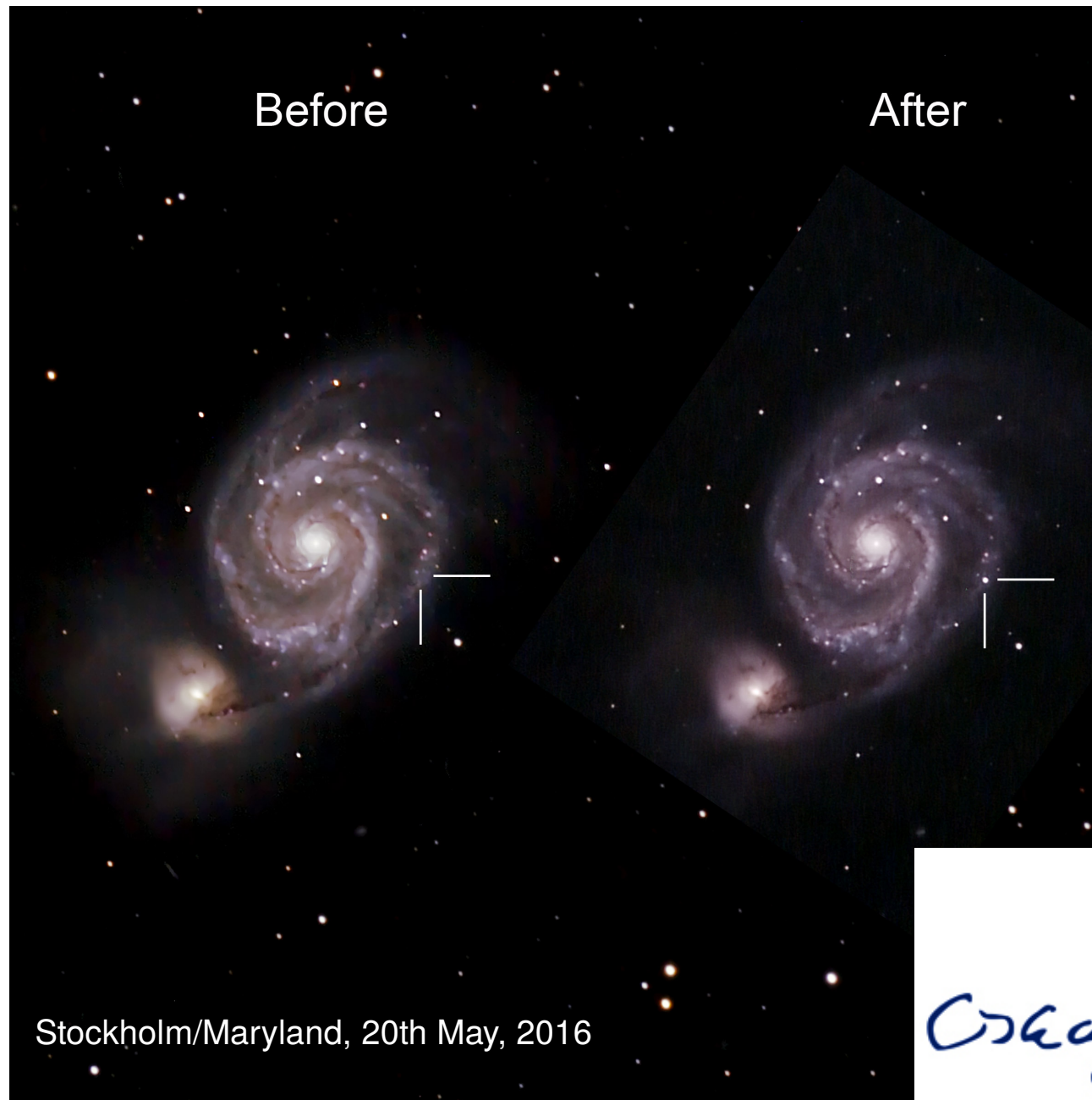


# Core-collapse supernovae at the Department of Astronomy at Stockholm University



Stockholm/Maryland, 20th May, 2016



# Who's Who? - Core-collapse SN group

Prof:

Claes Ingvar Björnsson,  
Claes Fransson,  
Peter Lundqvist,  
Jesper Sollerman



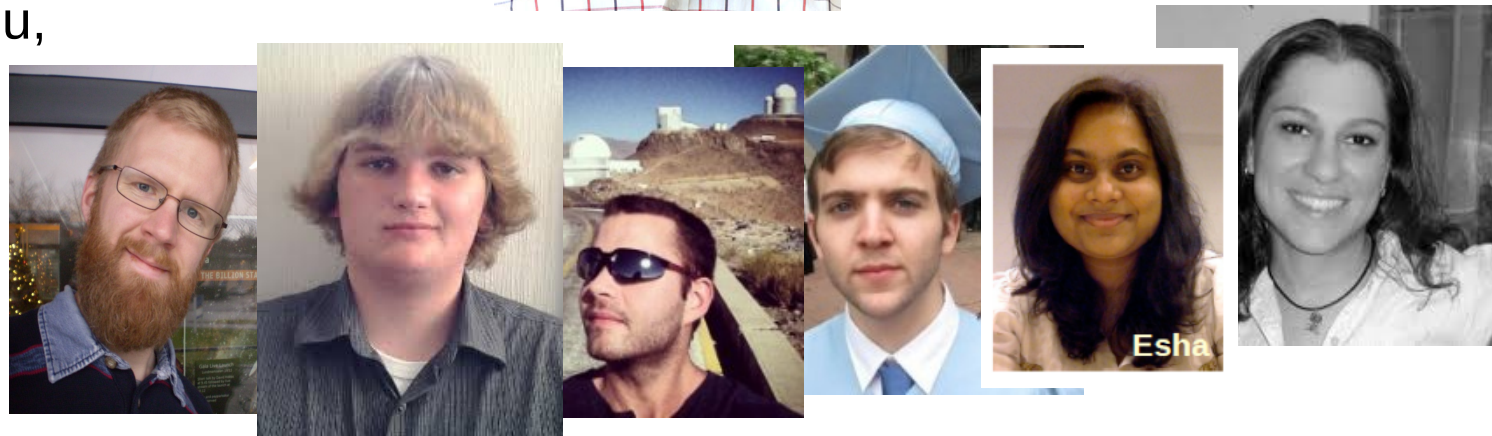
Postdocs:

Mattias Ergon,  
Rupak Roy,  
Francesco Taddia



PhD:

Michiel Bustraan,  
Christoffer Fremling,  
Emir Karamehmetoglu,  
Esha Kundu,  
Katia Migotto,  
Anders Nyholm



# SN group

Prof:

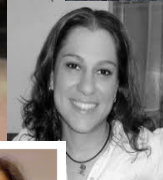
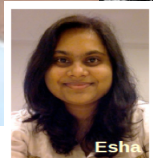
Claes Ingvar Björnsson,  
*Claes Fransson*,  
Peter Lundqvist,  
**Jesper Sollerman**

Postdocs:

Mattias Ergon,  
**Rupak Roy**,  
**Francesco Taddia**  
*Markus Kromer*

PhD:

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**Anders Nyholm**



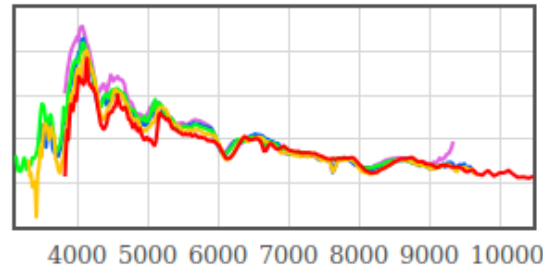
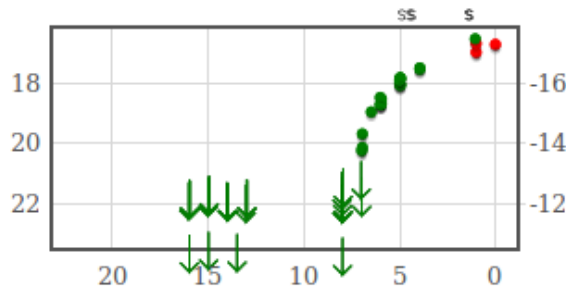
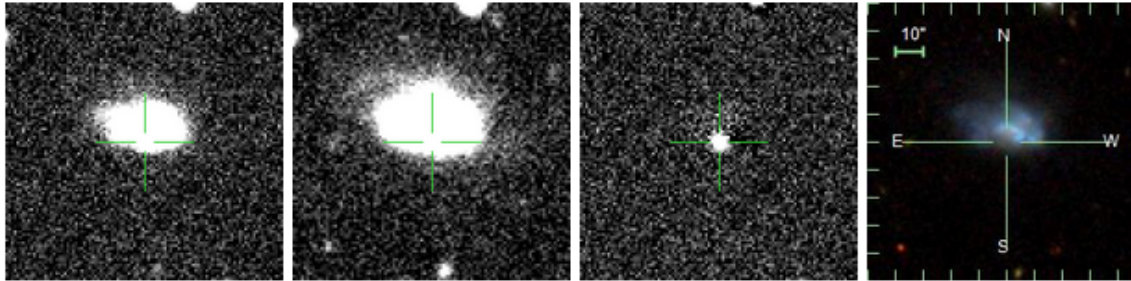


NEW

REF

SUB

SDSS



$r = 16.7$  (0.0 d) | Upload New Photometry

$z = 0.0149$  | Upload New Spectroscopy  
DM (approximate) = 34.00



- [w](#)
- [PyMP](#)
- [MPChecker](#)
- [Extinction](#)
- [Variable Marshal \(Search\)](#)
- [ADS](#)

### CROSS REFERENCES

[ATel 9049](#): IPTF discovery of a young Type Ia supernova: IPTF16auf *T. Petrushevskaya et al., 2016 May 13*

### COMMENTS

[2016 May 14 avishay \[Info\]](#): AT 2016ccz: <https://wis-tns.weizmann.ac.il/object/2016ccz>

[2016 May 13 tanja \[SDSS\\_specz\]](#): 0.0150

[2016 May 13 ftadd \[Info\]](#): NOT triggered for tonight

[2016 May 13 tanja \[classification\]](#): SN Ia

[2016 May 13 ycao \[Info\]](#): We missed this object in the previous two nights because all RB scores at both NERSC and IPAC did not meet our scanning thresholds. At IPAC,  $rb \sim 0.3$ . At NERSC,  $rb2 \sim 0.3$ ,  $rb4 \sim 0.3$ ,  $rb5 \sim 0.5$ .

[2016 May 13 lair \[Info\]](#): LCOGT Triggered (phot and spec)

[2016 May 13 raphael \[Info\]](#): first detection is within an hour from last non-detection!

[2016 May 13 anders \[Info\]](#): Did not see this in the scanning pages when scanning May 11 & May 12.

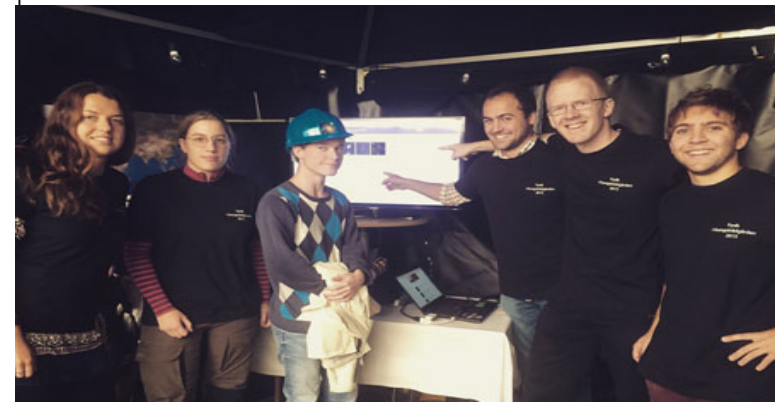
[2016 May 13 ftadd \[Info\]](#): triggering gemini

[2016 May 13 raphael \[Info\]](#): Good limits two days ago

[2016 May 13 raphael \[Info\]](#): via NED

[2016 May 13 raphael \[redshift\]](#): 0.0149

[2016 May 13 raphael \[type\]](#): Transient





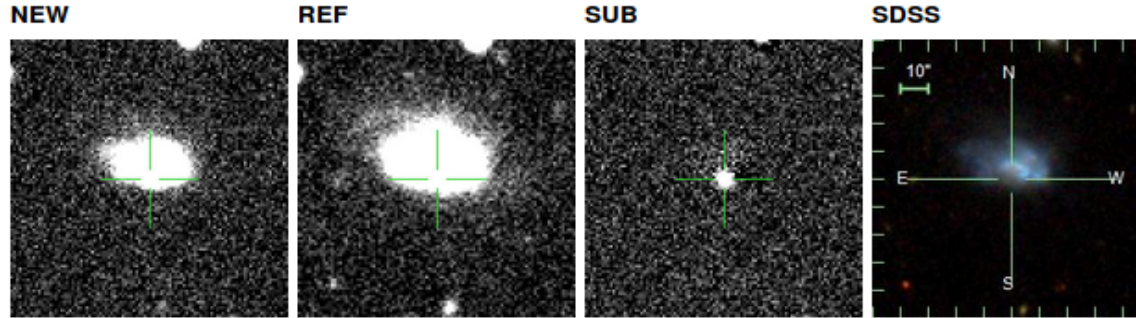
# 16auf SN Ia

14:31:09.26 +27:14:09.8  
217.788598 +27.236051

View another



OVERVIEW PHOTOMETRY SPECTROSCOPY OBSERVABILITY FINDING CHART NERSC EXAMINE IPAC EXAMINE



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**2016 May 13 raphael [redshift]:** 0.0149

**2016 May 13 raphael [type]:** Transient

Add a Comment:

GMT+02	mån 9/11	tis 9/12	ons 9/13	tors 9/14	fre 9/15
08:00	08:00 – 09:00 Emir scanning (backup Anders)		08:00 – 09:00 Christoffer scanning (backup Rupak)		
09:00		08:30 – 09:30 Anders scanning (backup Semeli)		08:30 – 09:30 Laura Scanning (backup Raphael)	
10:00				10:00 – 11:00 SN theory meeting (every 2 weeks)	
11:00			10:30 – 12:00 SN group meeting Lead Jesper		10:30 – 11:30 Astronomy seminar
12:00					
13:00		13:00 – 14:00 OKC seminar		13:00 – 14:00 Extreme Object meeting Lead Jesper	
14:00					
15:00			15:00 – 16:00 Scanner meeting Lead Jesper	15:00 – 16:00 AlbaNova Colloquium	
16:00					
17:00					
18:00					
19:00					
20:00			20:00 – 21:00 ZTF phoneconf		
21:00					

# Which core-collapse supernovae are we mainly interested in?

1) **Stripped-envelope core-collapse SNe:** Type Ibc/I Ib. These supernovae lack hydrogen (sometimes even helium), which was stripped away from the progenitor star by either a companion star or strong winds.

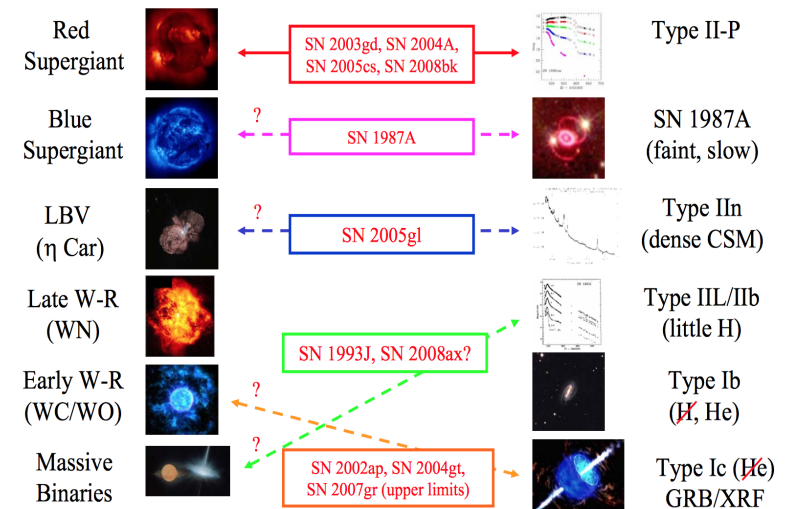
2) **Circumstellar-interacting supernovae** (Type IIn, Ibn, Ia-CSM). These are supernovae whose ejecta interact with the material ejected by the progenitor system before collapse.

3) Other **new or rare and peculiar SN events:** e.g., 1987A-like supernovae.

-----  
We can study:

- a) Single objects;
  - b) Large SN samples;
  - c) SN environments.
- 

The Progenitor – SN Map



# Stripped-envelope supernovae (Type Ib/c & IIb)

## Observations:

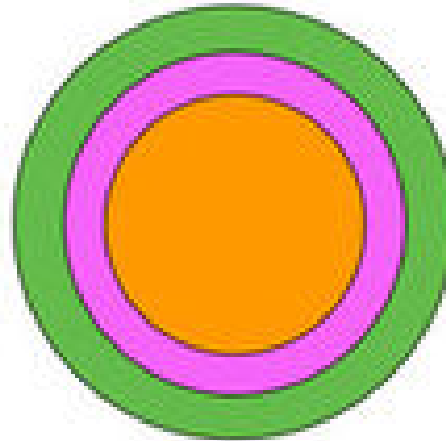
### Single events:

IIb/Ib)  
SN 2011dh (Ergon),  
PTF12os (Fremling),  
iPTF13bvn (Fremling),

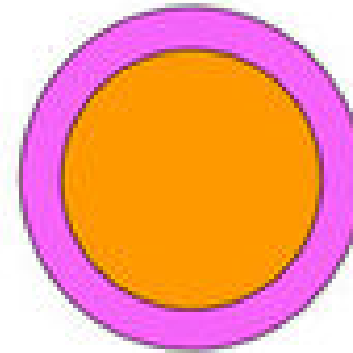
Ic)  
SN 2012aa (Roy),  
iPTF15dtg (Taddia).

### Samples:

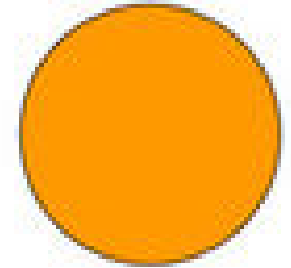
SDSS (Taddia),  
CSP (Taddia),  
iPTF (Karamehmetoglu, Fremling, Taddia)



**Type II**  
H and He shells



**Type Ib**  
He shell only  
no H shell



**Type Ic**  
no H nor He  
shells

SN 2011dh  
(PTF11eon)

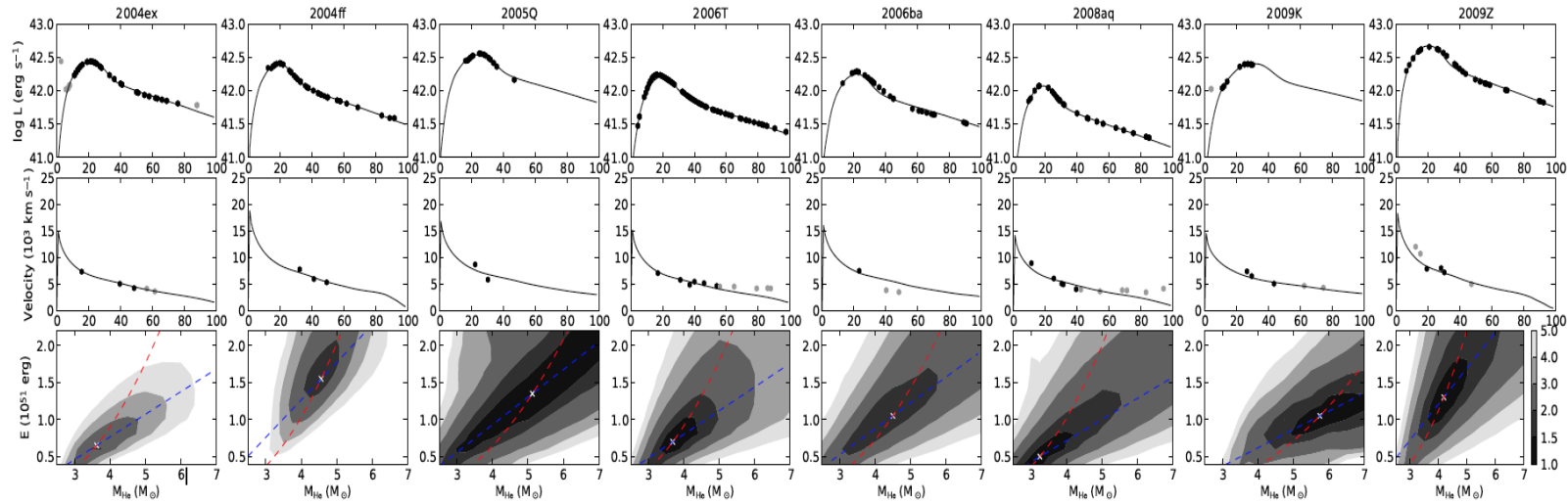


Ergon et al. 2014, 2015



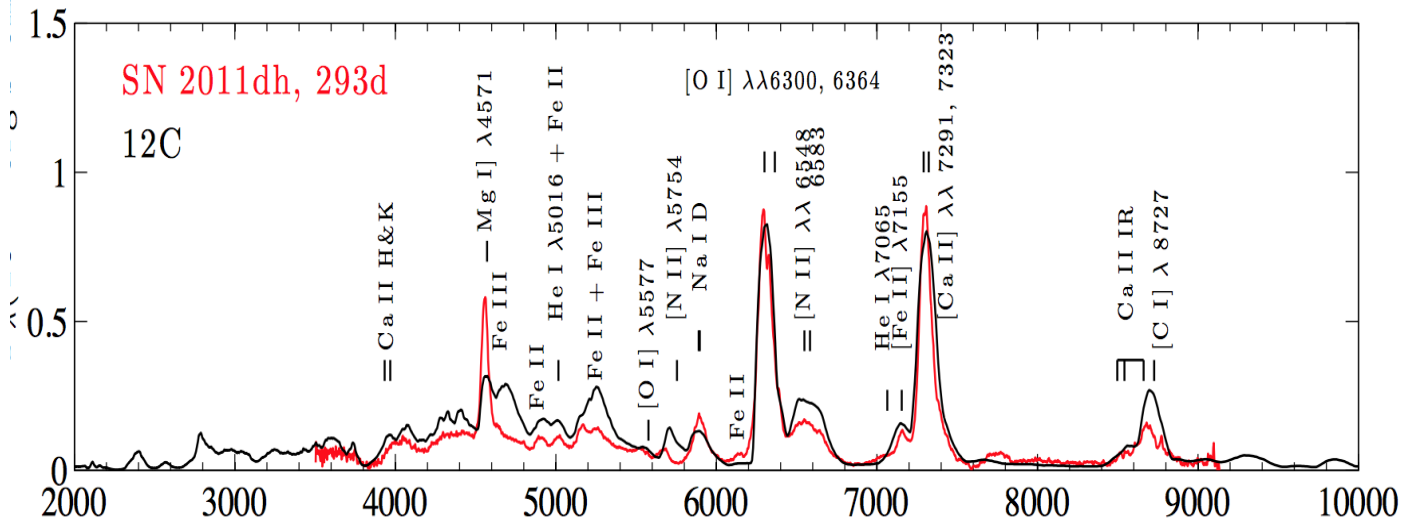
# Modeling of SNe IIb

## Photospheric phase modeling



Ergon et al. in prep.

## Late-time spectral line formation in Type IIb supernovae, with application to SN 1993J, SN 2008ax, and SN 2011dh



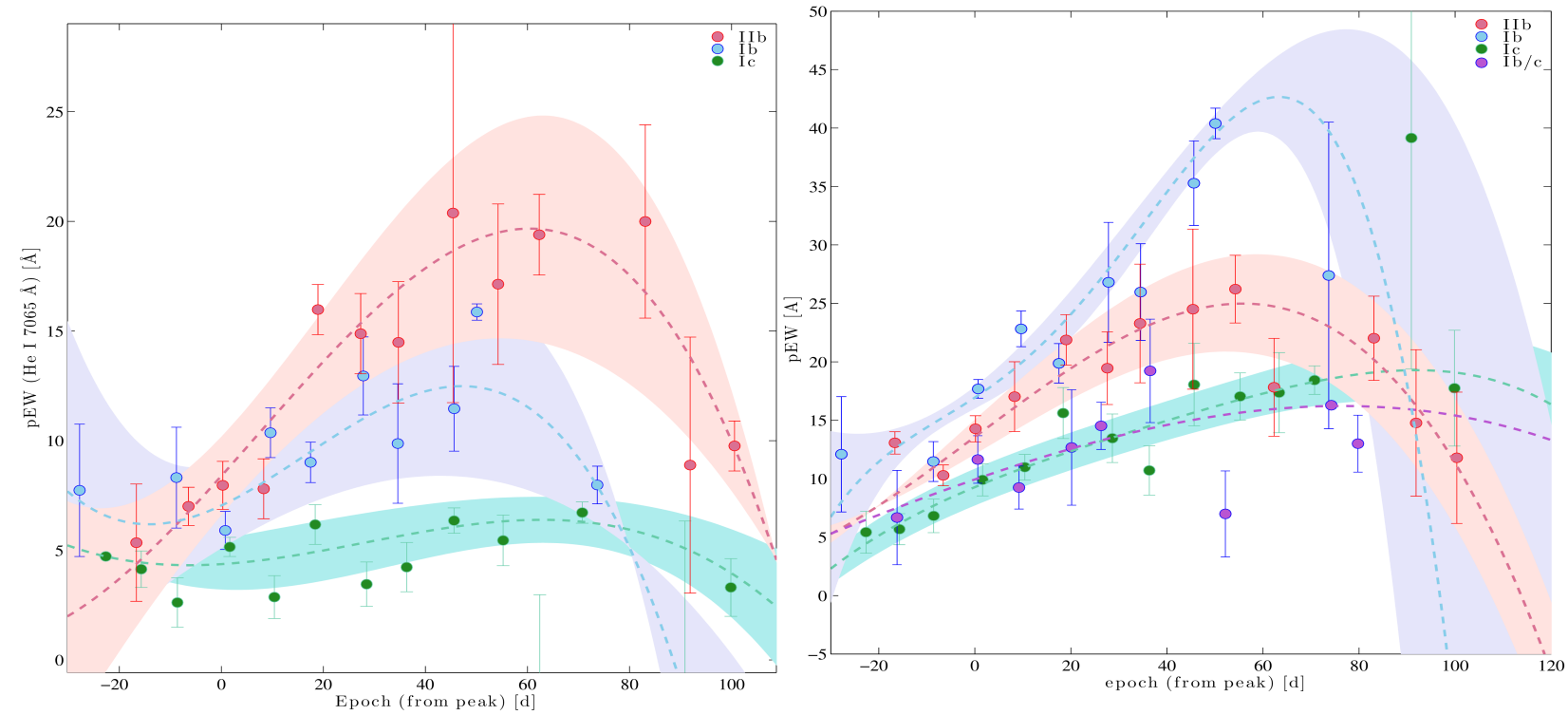
Jerkstrand, Ergon, Smartt, Fransson et al. 2015



# Stripped-envelope SNe

7065

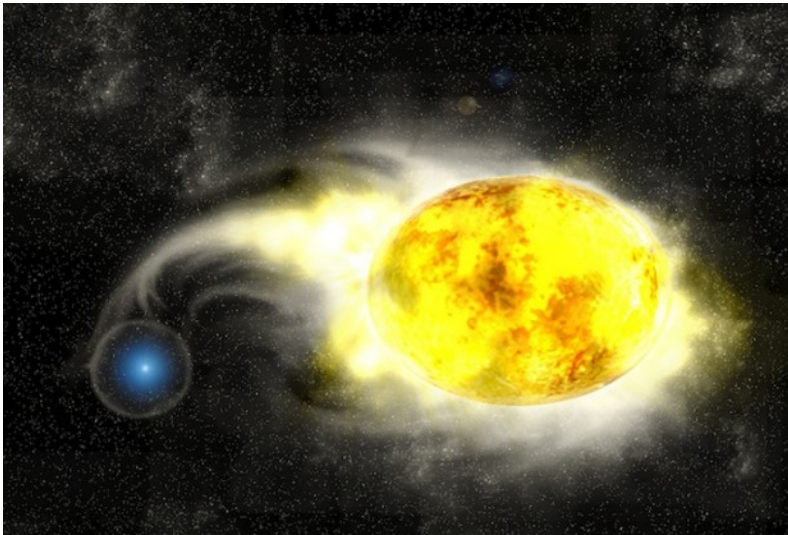
5876



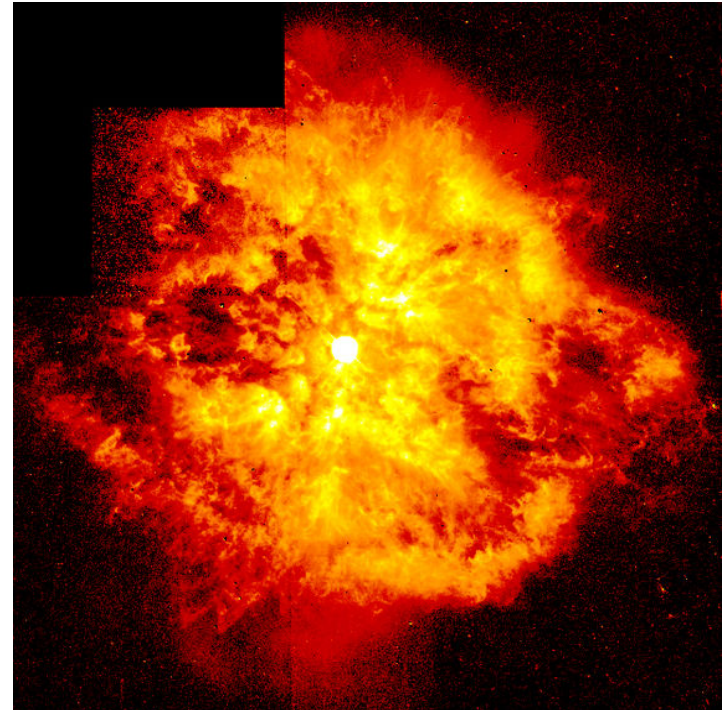
Fremling et al. 2016+, to be submitted

## Type Ib/c & IIb SN progenitors

Low ejecta mass, low-oxygen mass,  
Most of them are probably from  
binaries?

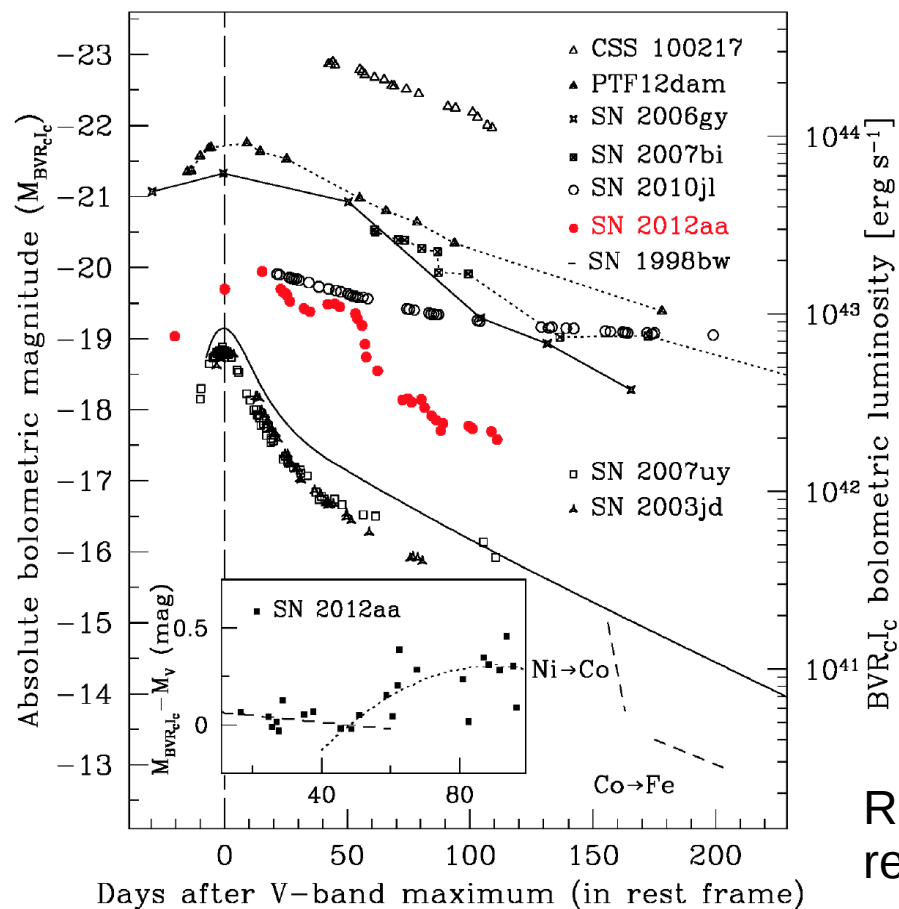
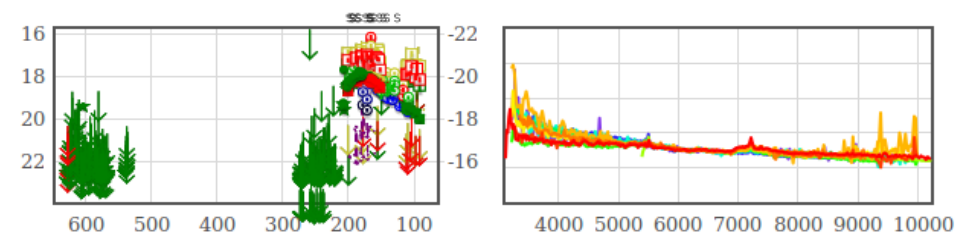
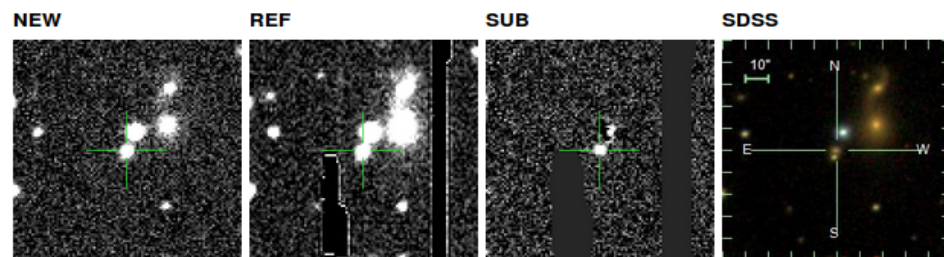


We now have some events that  
appear with broader light curves  
or higher velocities, probably  
from single stars?



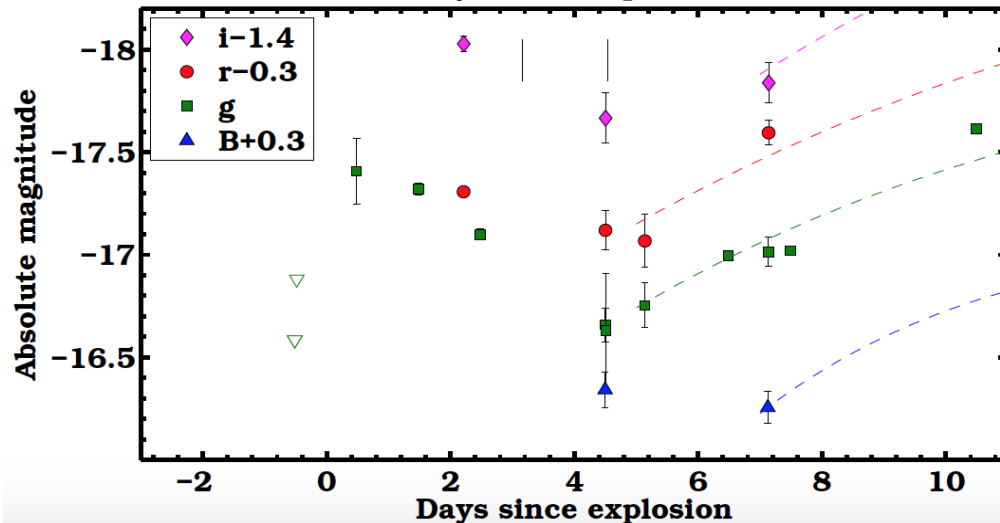
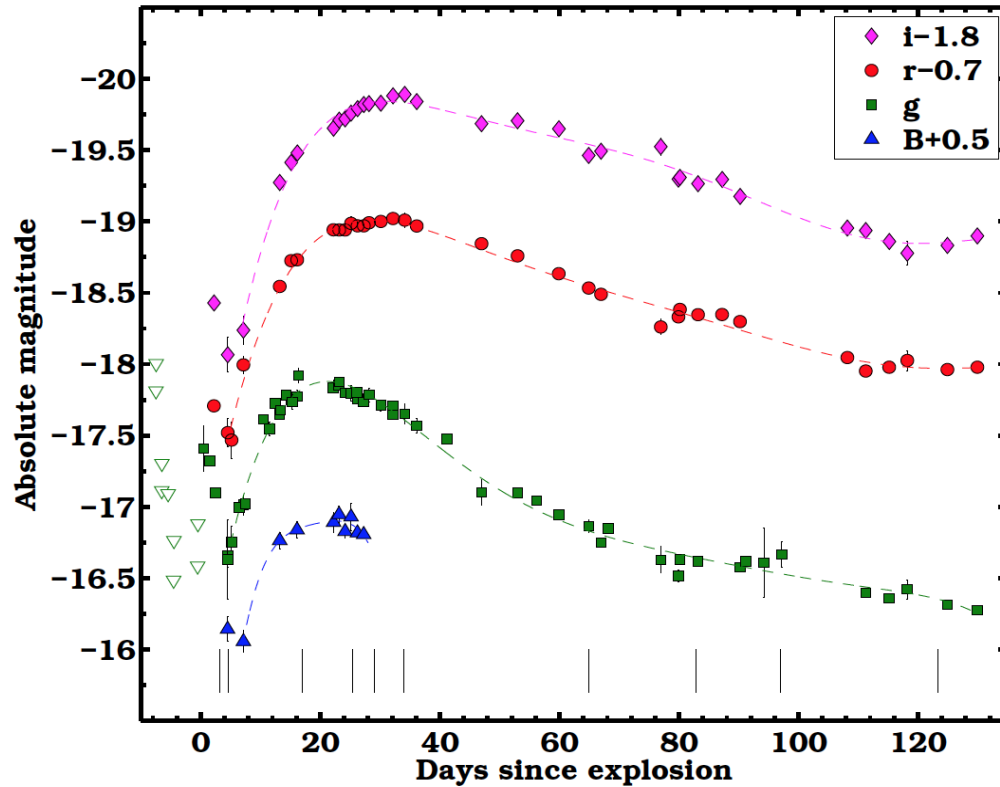


## SN 2012aa - a transient between Type Ibc core-collapse and superluminous supernovae



Roy et al. 2016, re-submitted

# iPTF15dtg: a double-peaked Type Ic Supernova from a massive progenitor

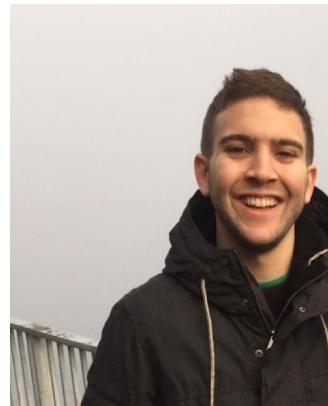
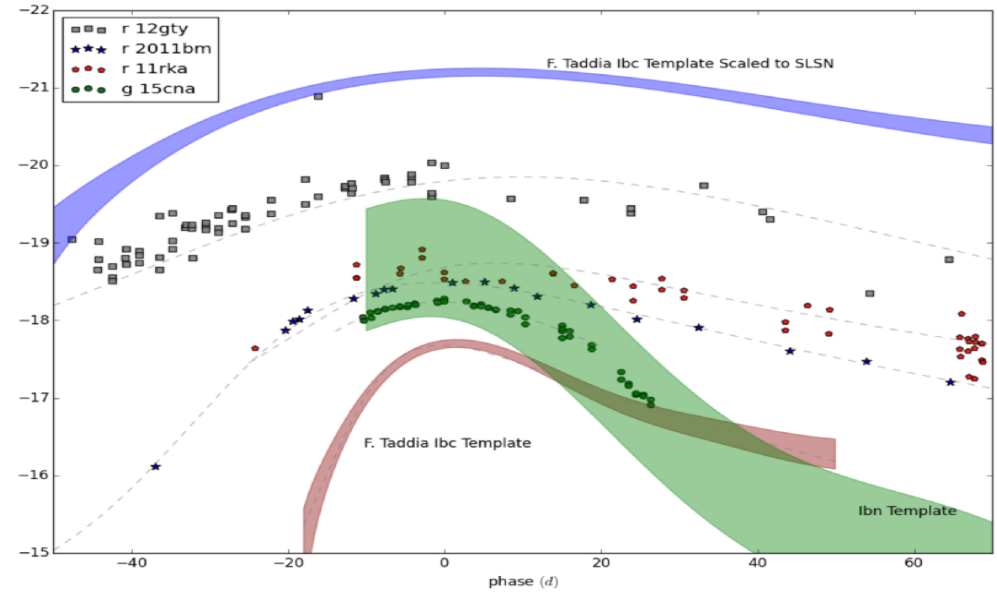
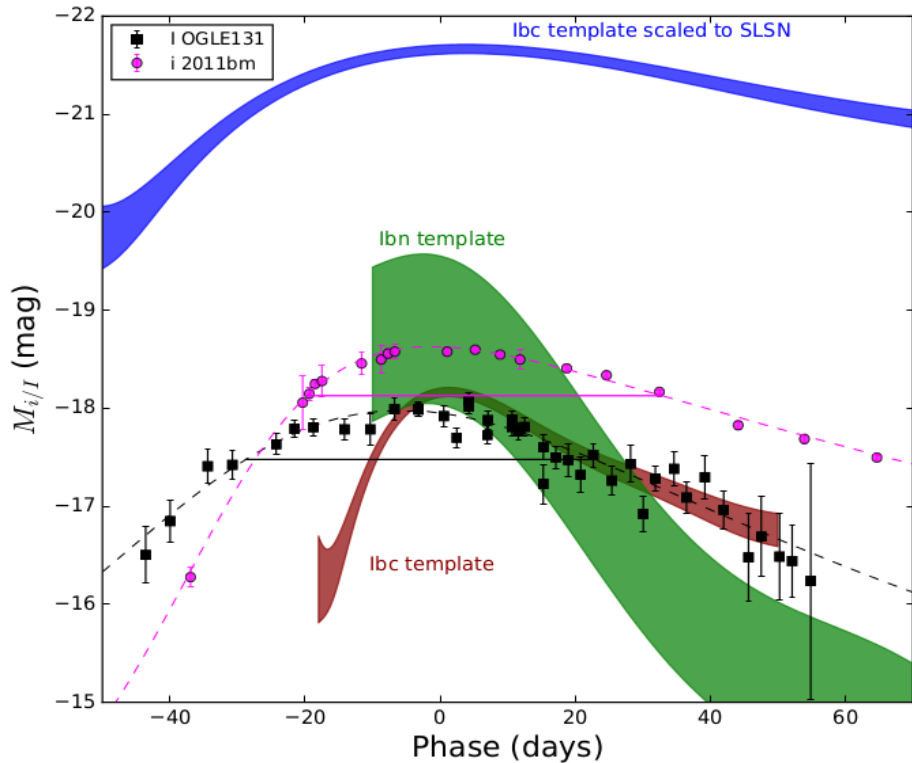


This is the first spectroscopically normal SN Ic with a detected early cooling phase!

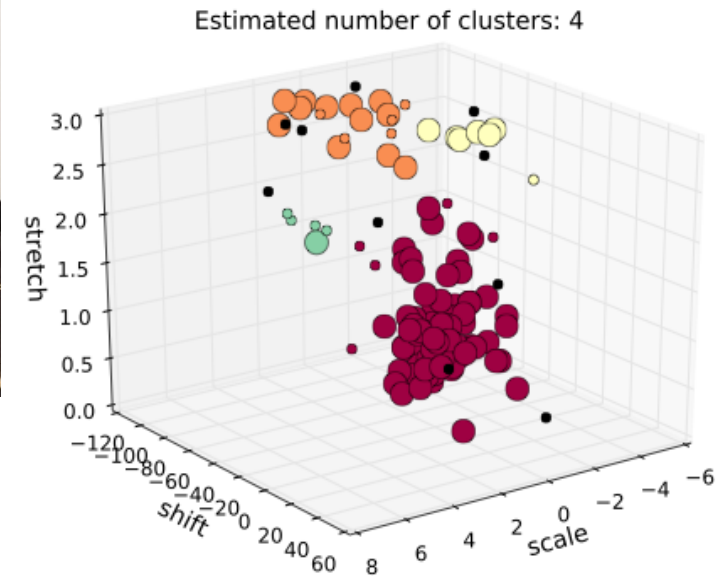
Taddia et al. 2016, re-submitted

# OGLE131 - a long-rising Type Ibc supernova from a massive progenitor

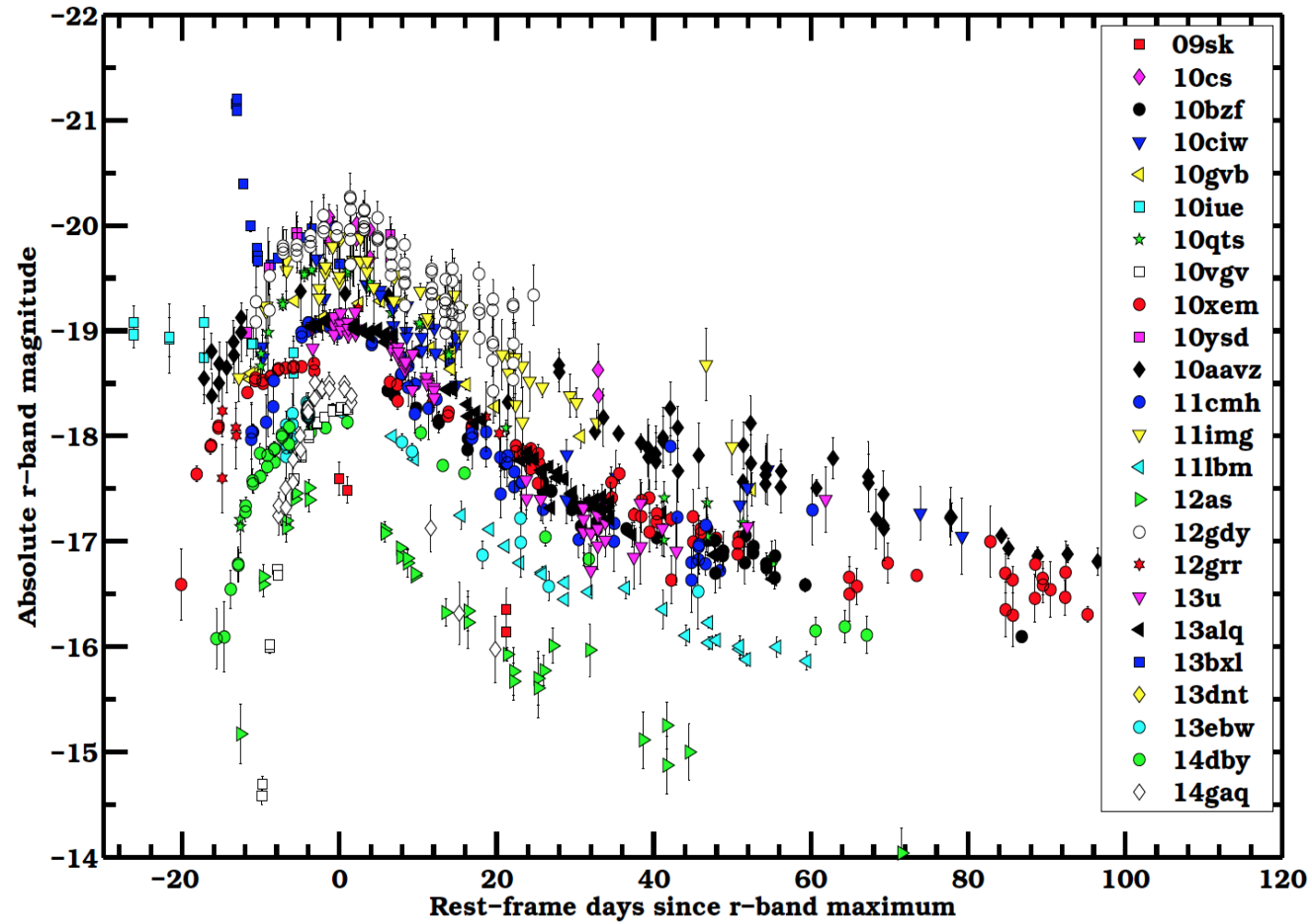
E. Karamahmetoglu et al.: OGLE-2



Karamahmetoglu et al. 2016+



# Type Ic Broad-Lined Supernovae from (i)PTF

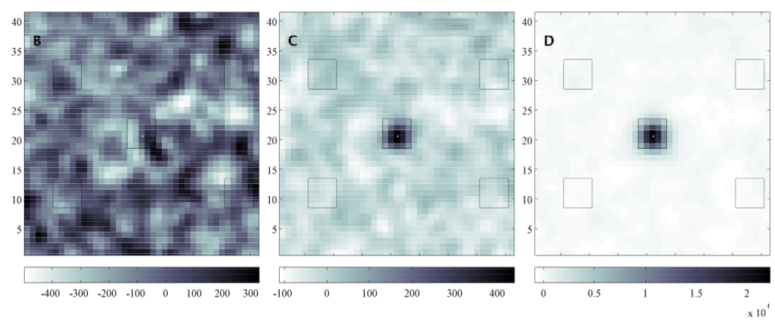
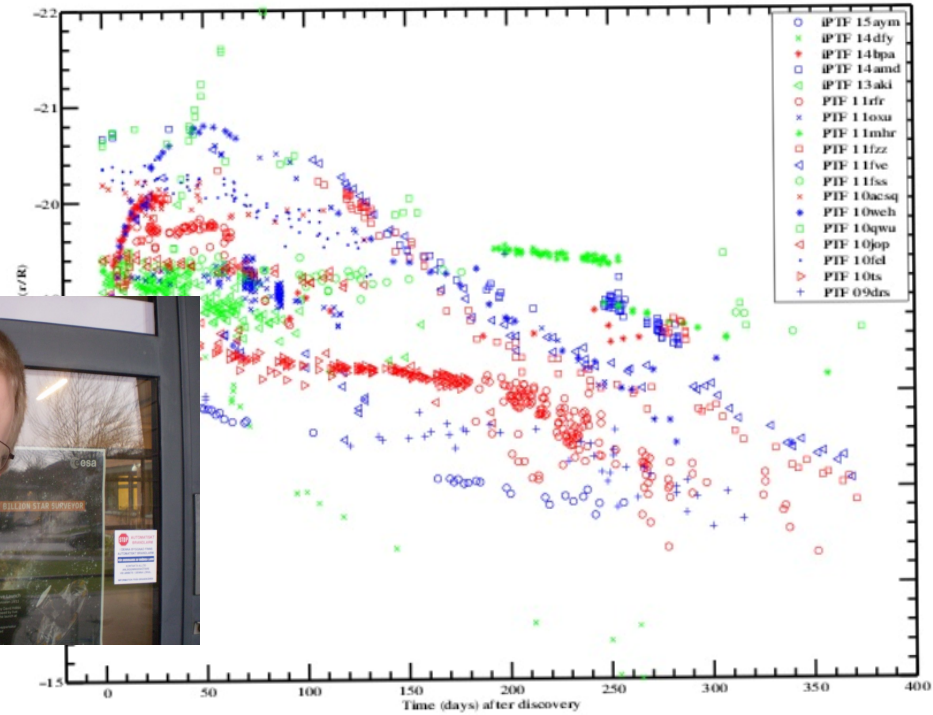
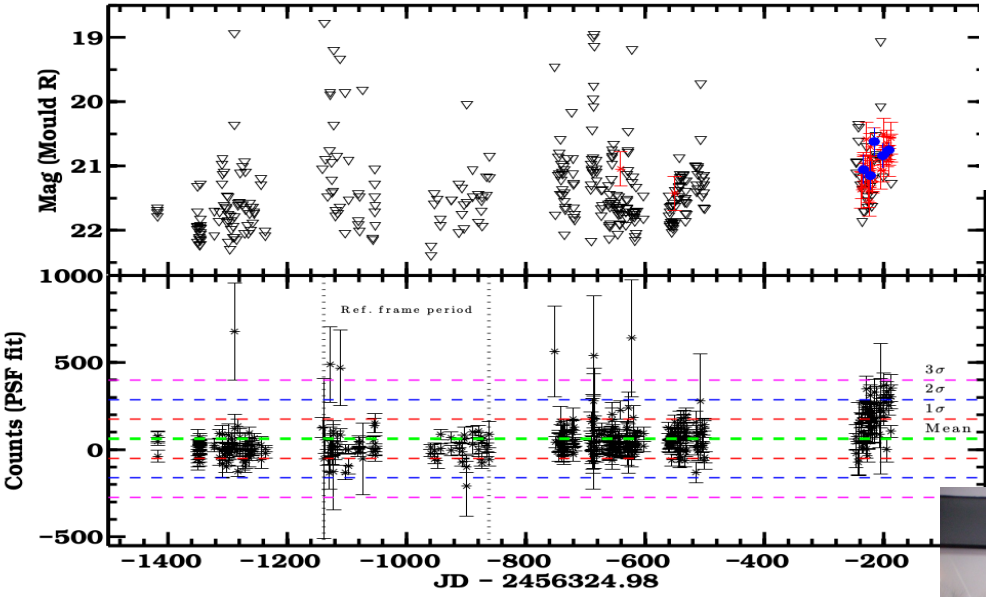
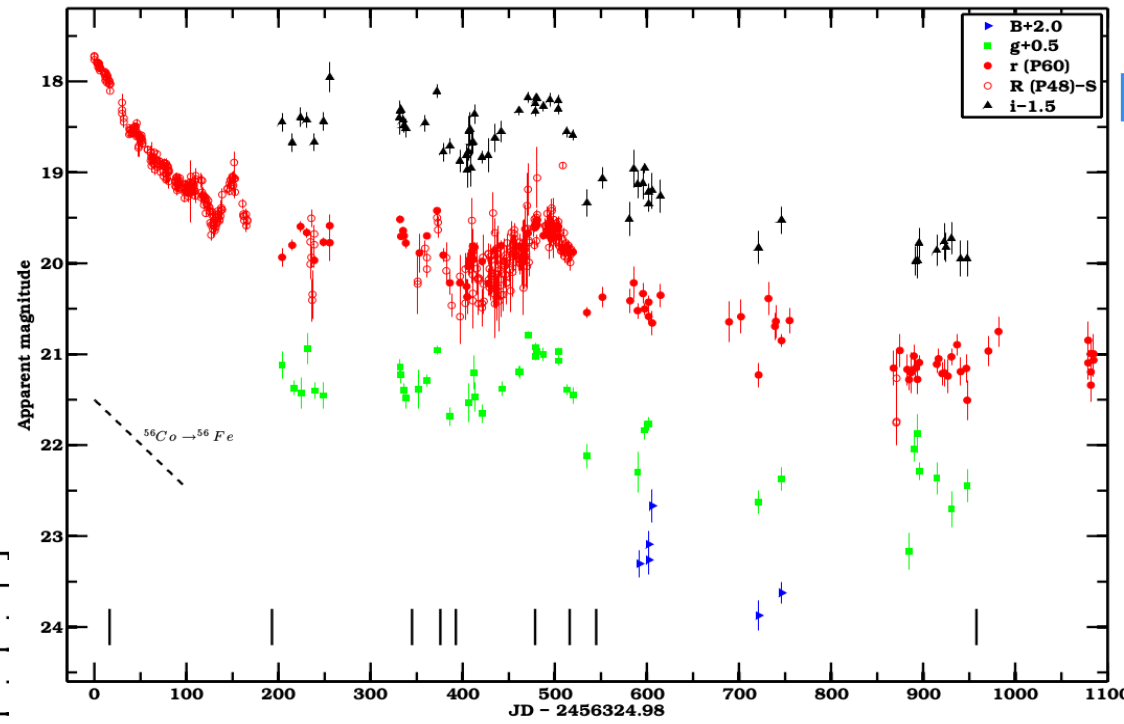


l Absolute  $r$ -band magnitudes, after (host+MW) extinction correction and k-correction.

Taddia et al. 2016, to be submitted



# The bumpy light curve of SN iPTF13z - A peculiar IIn supernova during 1000 days

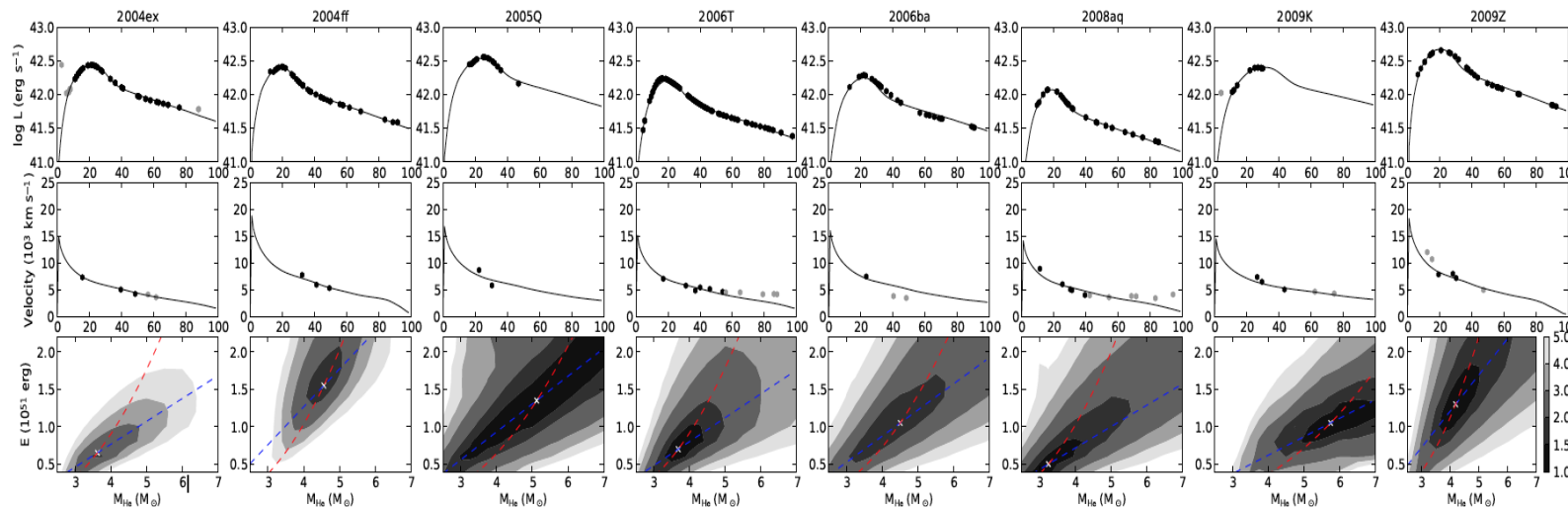


Nyholm et al.  
2016, in prep.

# Modeling of SNe IIb

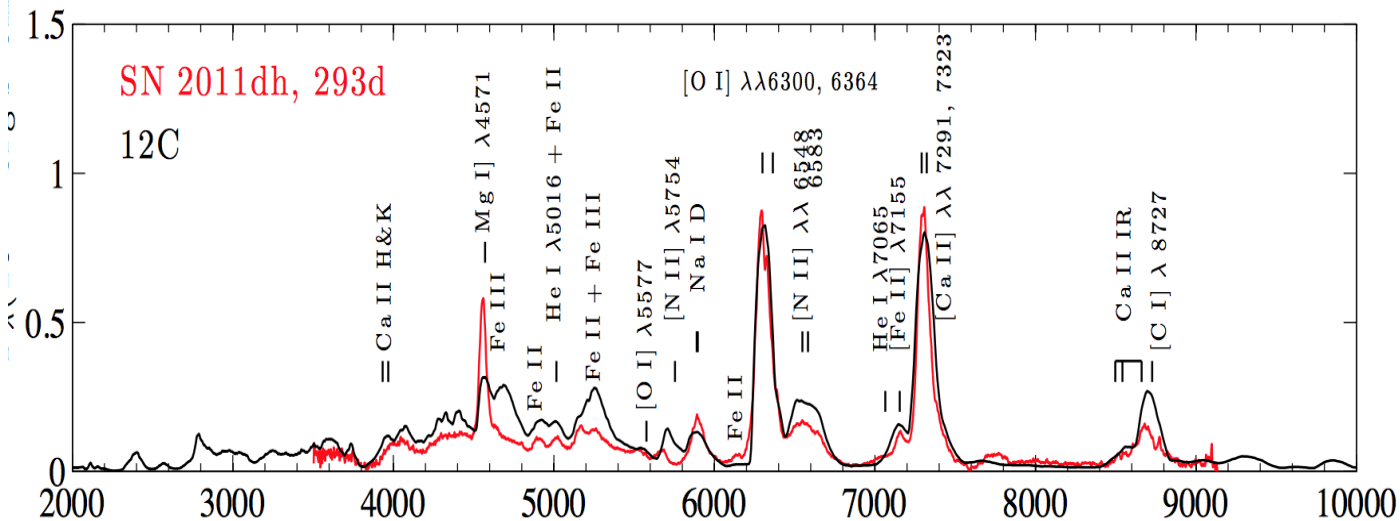


## Photospheric phase modeling

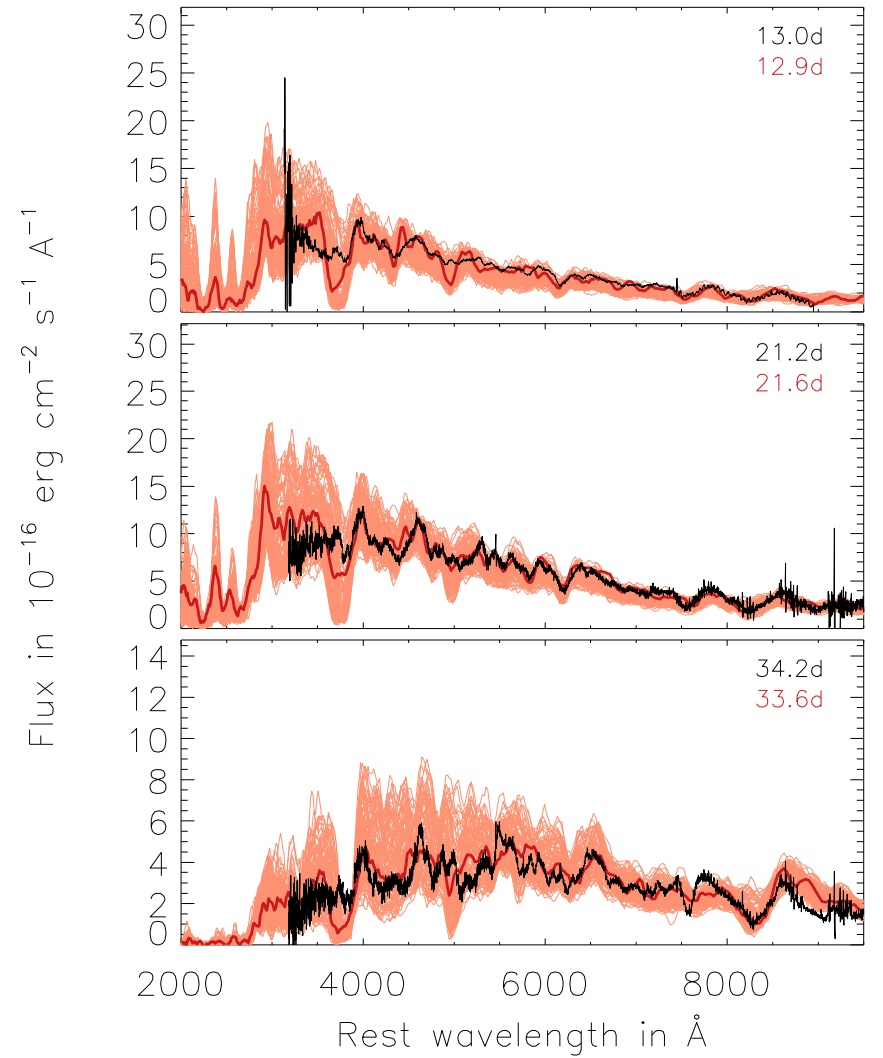
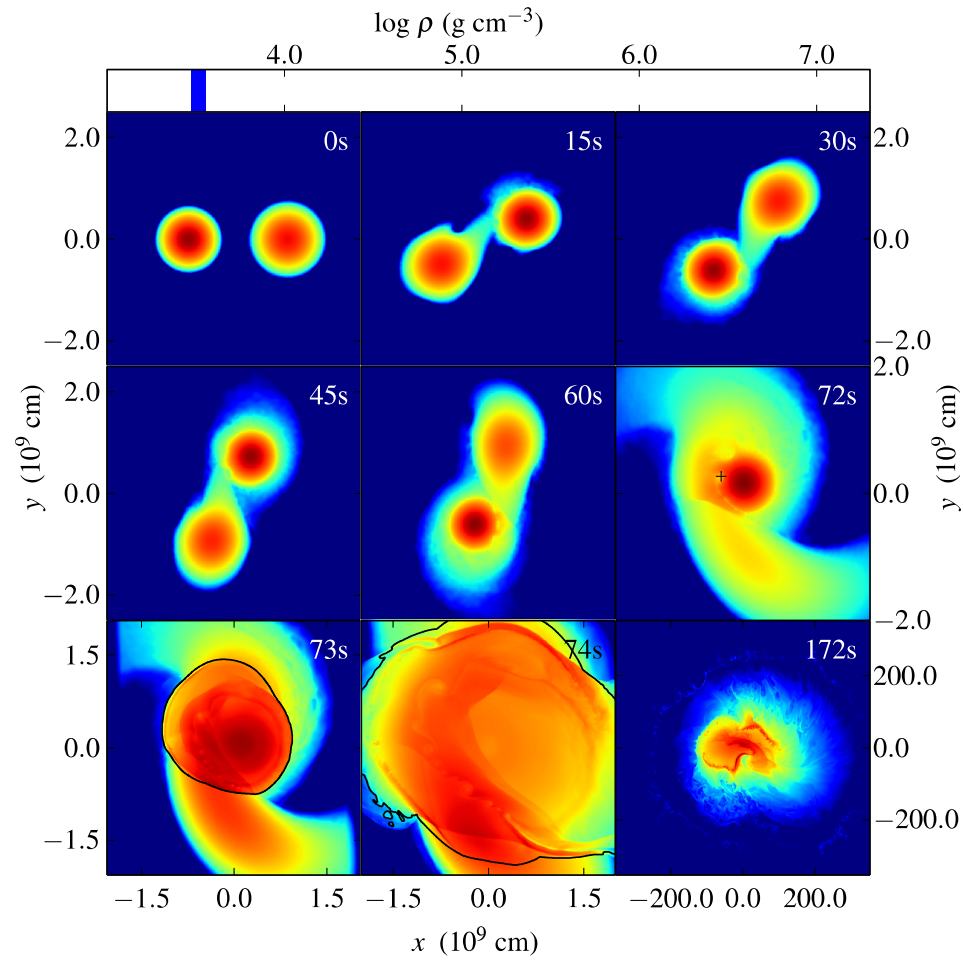


Ergon et al. in prep.

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Jerkstrand, Ergon, Smartt, Fransson et al. 2015



Kromer+ 2016