



The Palomar Transient Factory

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Palomar Transient Factory

A wide-angle, high cadence survey dedicated to systematically chart the transient sky.



Man Palomar 48-inch



Palomar 60-inch

for
te

| | | |
|------------|----------------|---------------|
| 2012-12-03 | P60+P60 Camera | APO+DIS |
| 2012-12-04 | P60+P60 Camera | P200+DBSP |
| 2012-12-05 | P60+P60 Camera | Lick 3-m+KAST |
| 2012-12-06 | P60+P60 Camera | |
| 2012-12-07 | P60+P60 Camera | |
| 2012-12-08 | P60+P60 Camera | Keck2+DEIMOS |
| 2012-12-09 | P60+P60 Camera | |
| 2012-12-10 | P60+P60 Camera | |
| 2012-12-11 | P60+P60 Camera | Keck1+LRIS |
| 2012-12-12 | P60+P60 Camera | |
| 2012-12-13 | P60+P60 Camera | Lick 3-m+KAST |
| 2012-12-14 | P60+P60 Camera | |
| 2012-12-15 | P60+P60 Camera | Lick 3-m+KAST |
| 2012-12-16 | P60+P60 Camera | APO+DIS |
| 2012-12-17 | P60+P60 Camera | Keck1+LRIS |
| 2012-12-18 | P60+P60 Camera | |
| 2012-12-19 | P60+P60 Camera | WHT+ISIS |
| 2012-12-20 | P60+P60 Camera | WHT+ISIS |



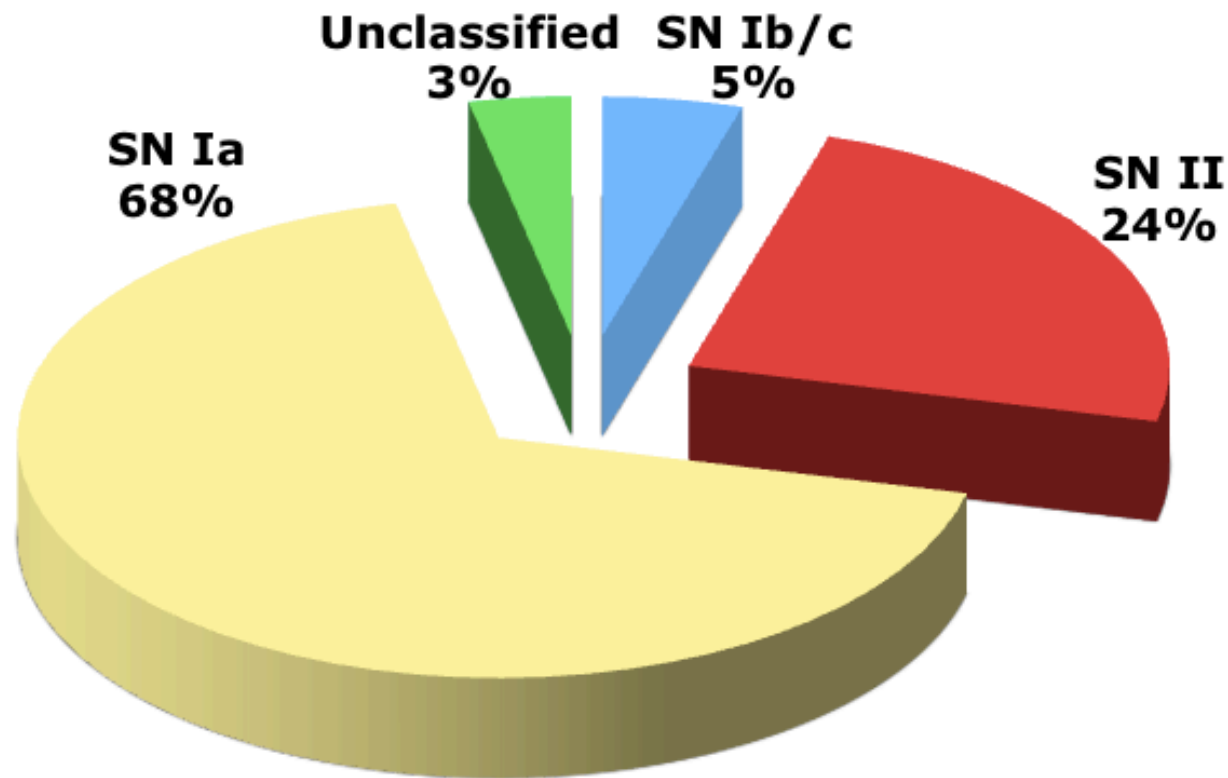
| | |
|------------------------|-----------|
| P200 | 66 |
| Keck I & II | 55 |
| WHT | 25 |
| Lick-3m | 19 |
| KPNO-4m | 18 |

Lick 3-m+KAST P200+DBSP

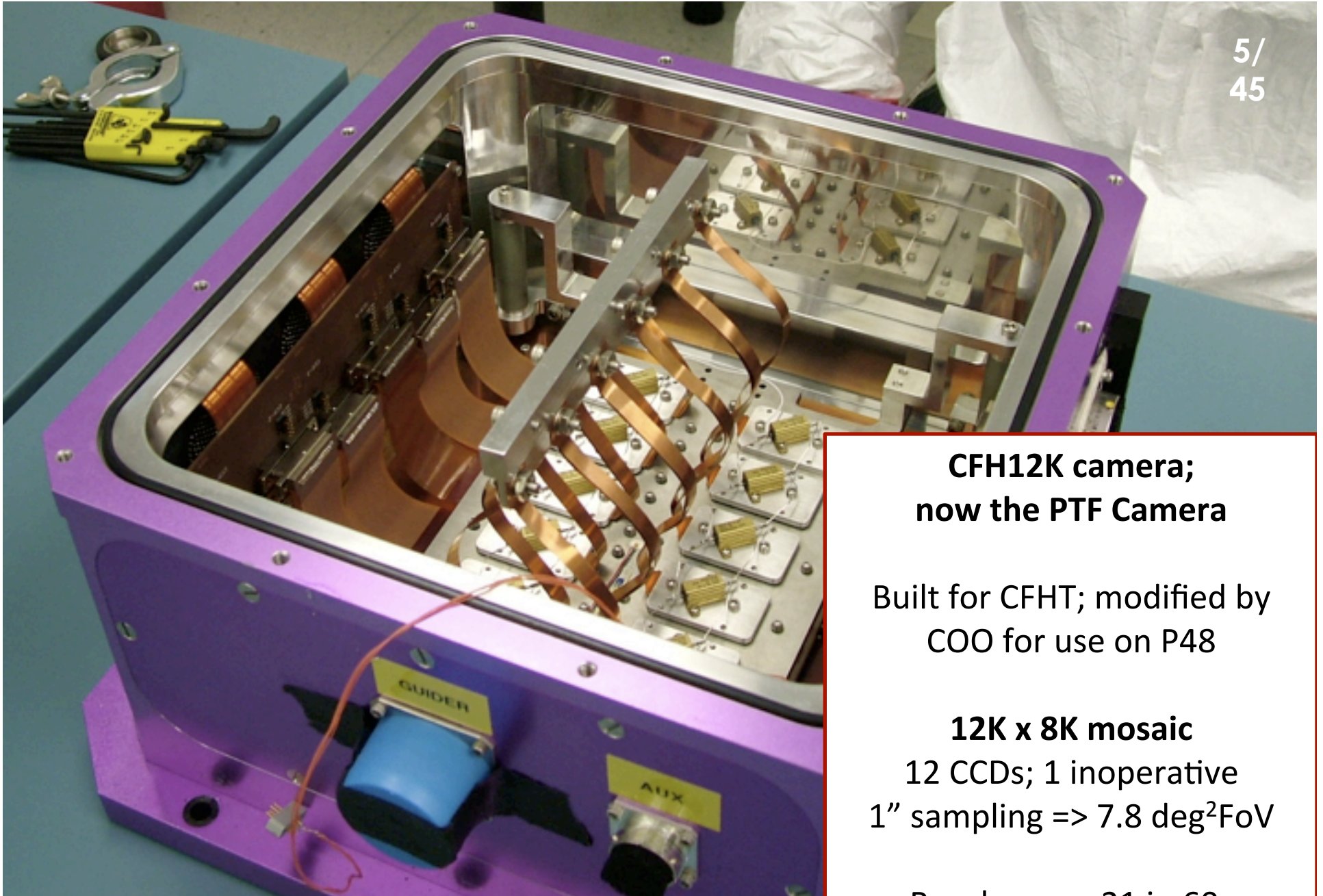




The PTF Scorecard



1771+ Discovered & Spectroscopically Classified
Extragalactic Transients

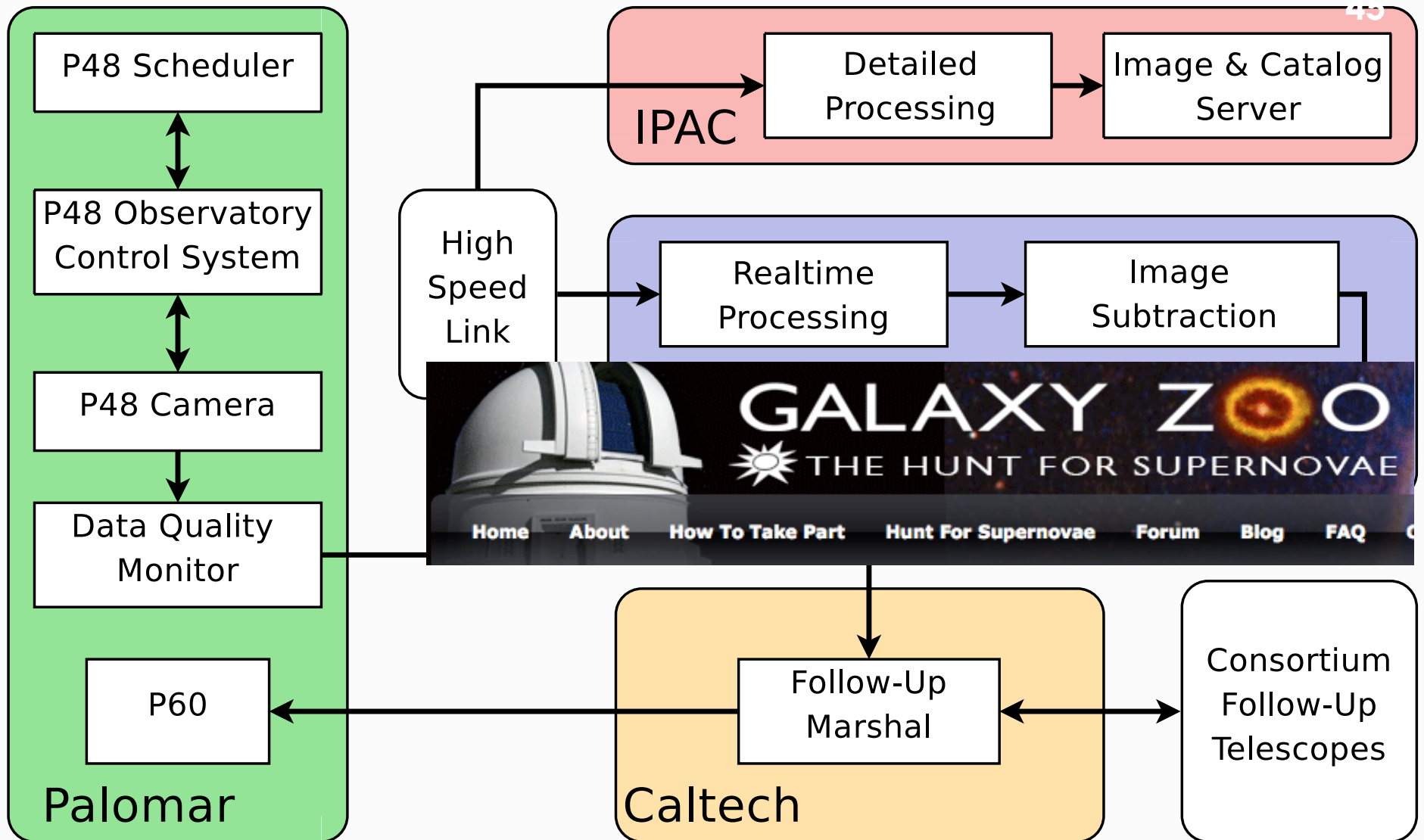


**CFH12K camera;
now the PTF Camera**

Built for CFHT; modified by
COO for use on P48

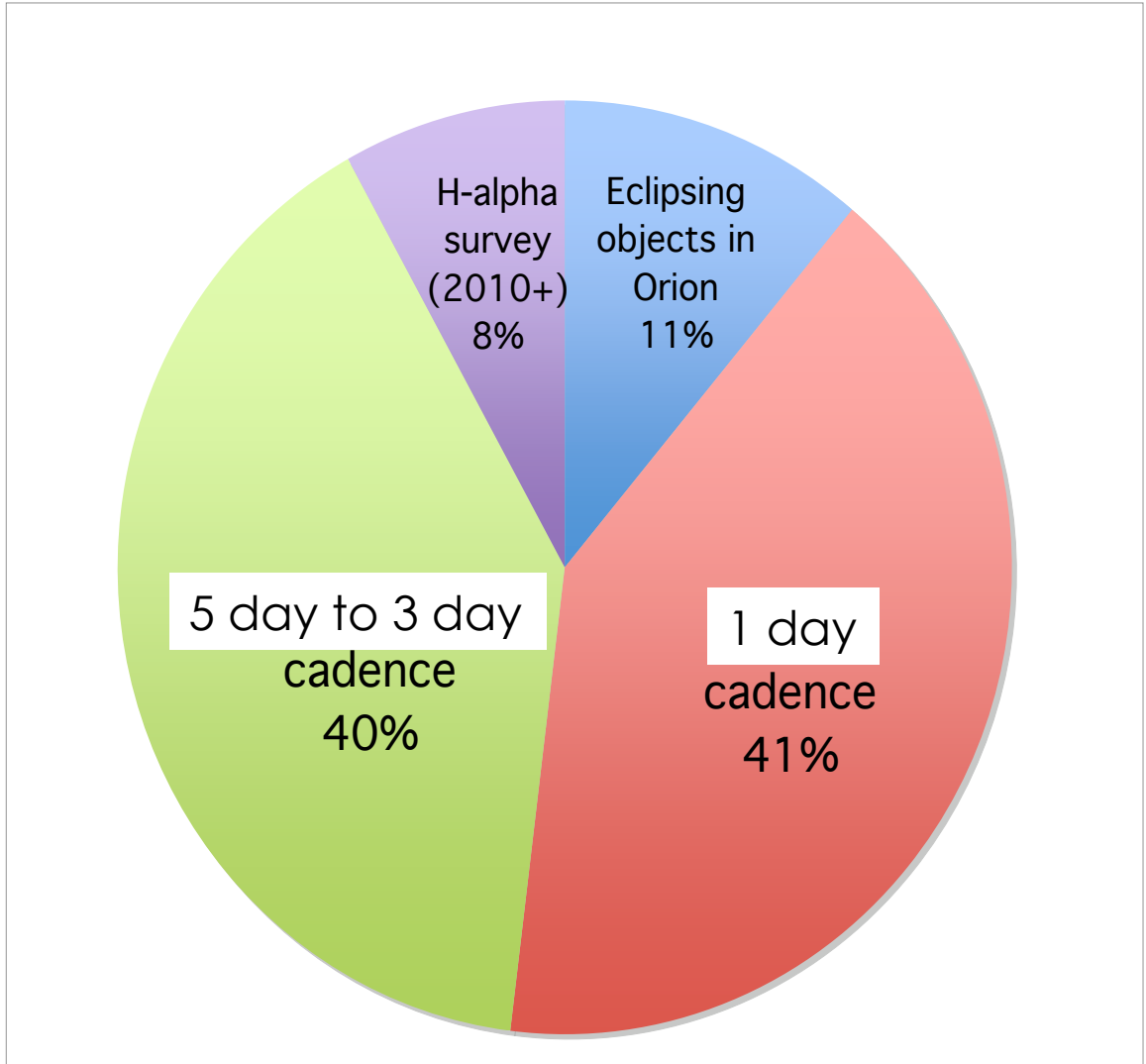
12K x 8K mosaic
12 CCDs; 1 inoperative
1" sampling => 7.8 deg²FoV

Reaches $m_R=21$ in 60s





Cadence: 5 day to 3 day to 2 day



- July 2009: Commissioned
- Rest of 2009: Station Fire

- Year 2010
Cadence of 5 day + 1 day (twice a night)
Early 2011: 1000+ SN mark

- Year 2011:
Cadence of 3 day + 1 day (twice a night)

- Year 2012:
Cadence of 2 day only (thrice a night)

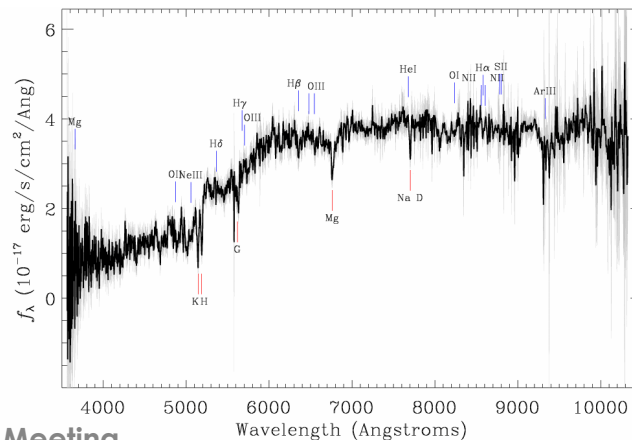
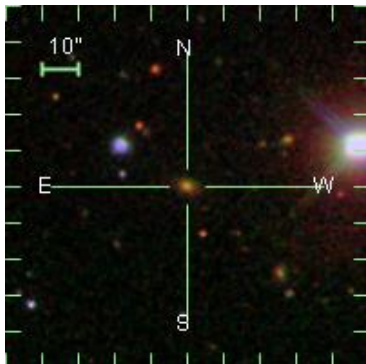
PTF + JVLA Project



Key people:
Kunal Mooley
Assaf Horesh
Gregg Hallinan

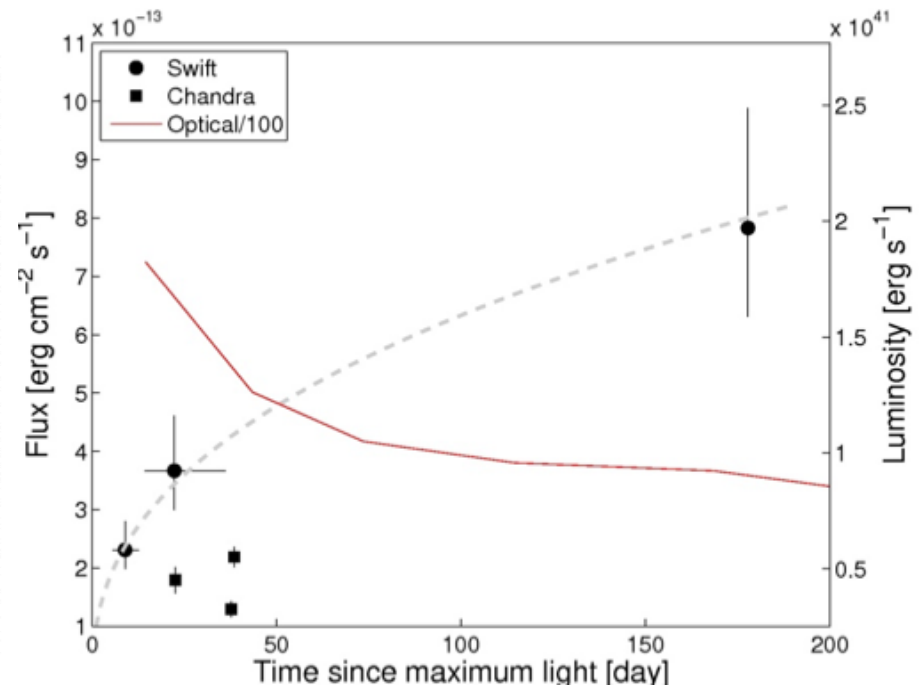
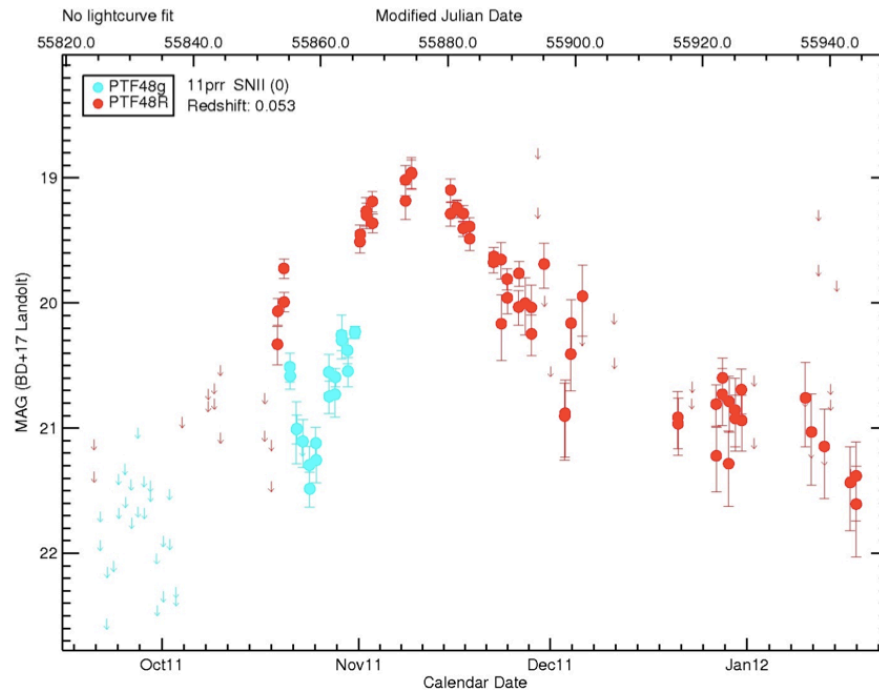
| | |
|-------------------|--|
| Coverage | 50 sq. deg |
| Freq. Band | 2-4 GHz & gR-bands |
| Cadence | EVLA: 1 wk, 1 mon, 1 yr PTF: 1 hr cadence |
| Depth | 0.4 mJy & 21 mag |

PTFS1221ab: Tidal Disruption Event?
Coincident with the nucleus of z=0.3 red galaxy





PTF + GALEX: Shock Breakout

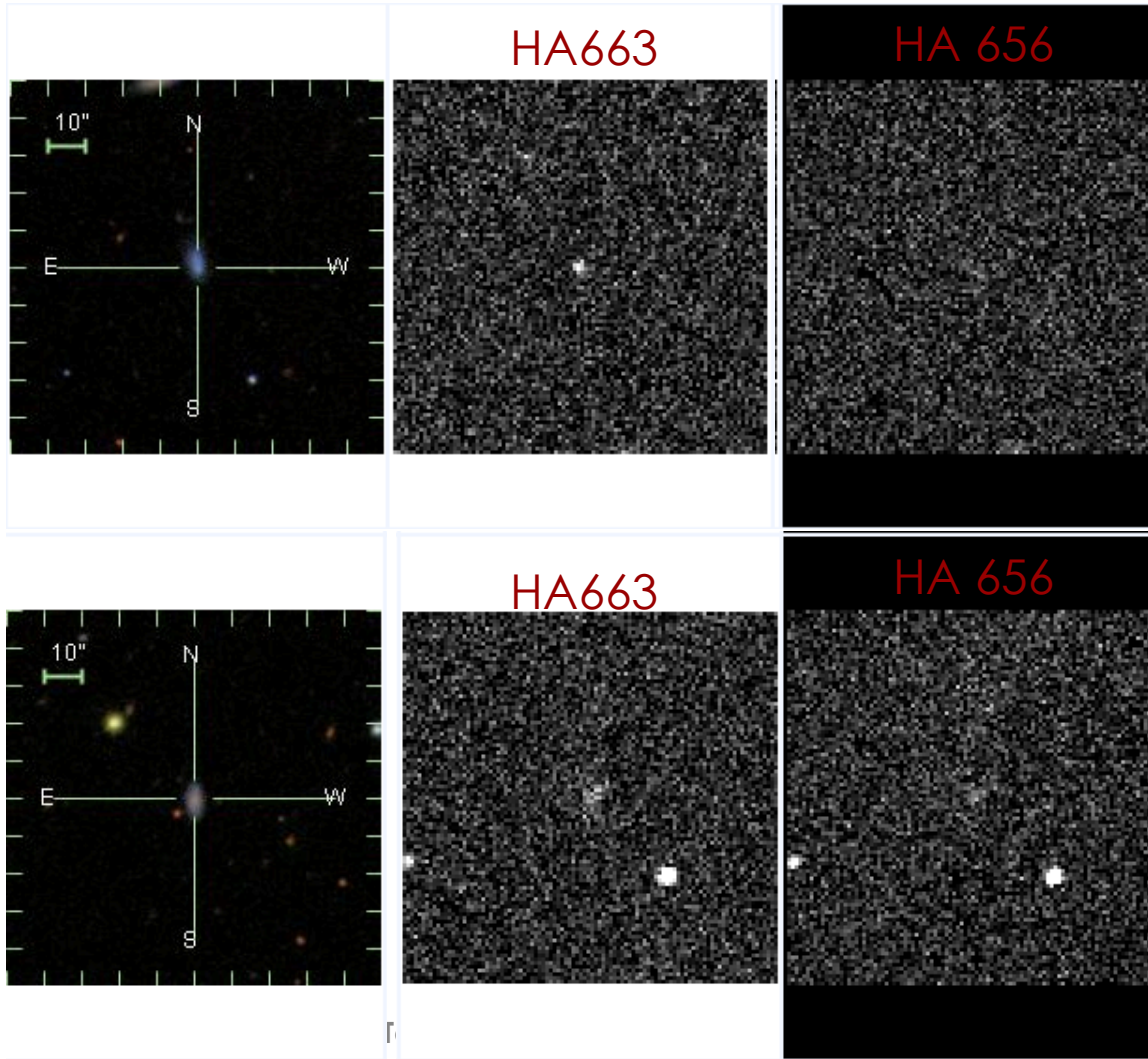


Ofek et al. 2012, Chandra et al. 2012

Dense CSM: Shock breakout several days and late-time X-rays

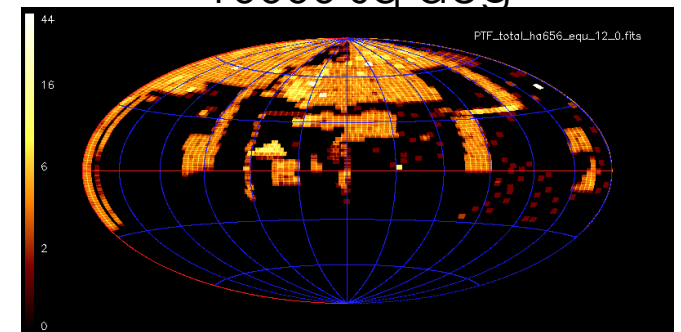
CLU: Census of Local Universe

10



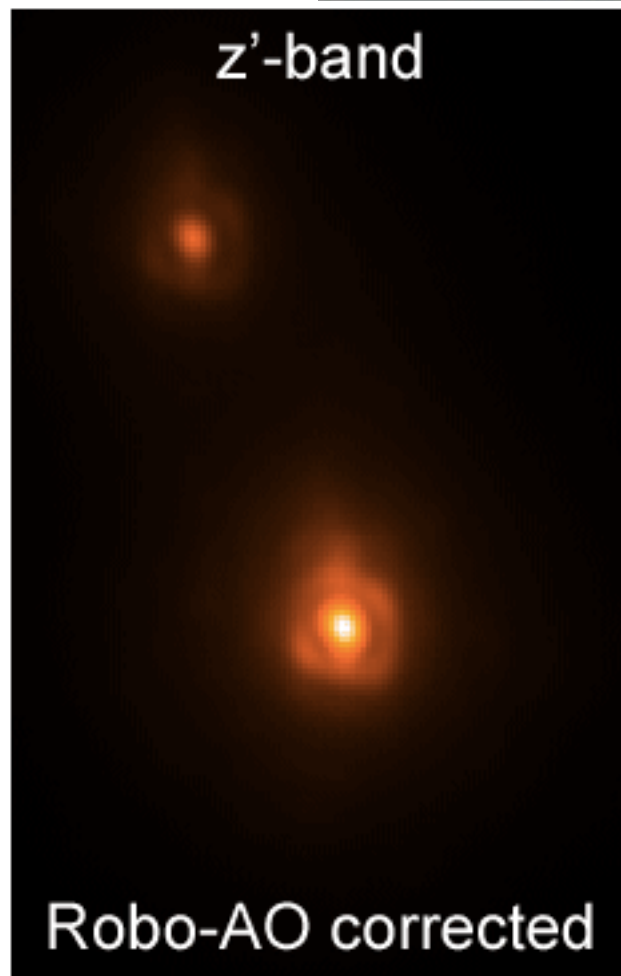
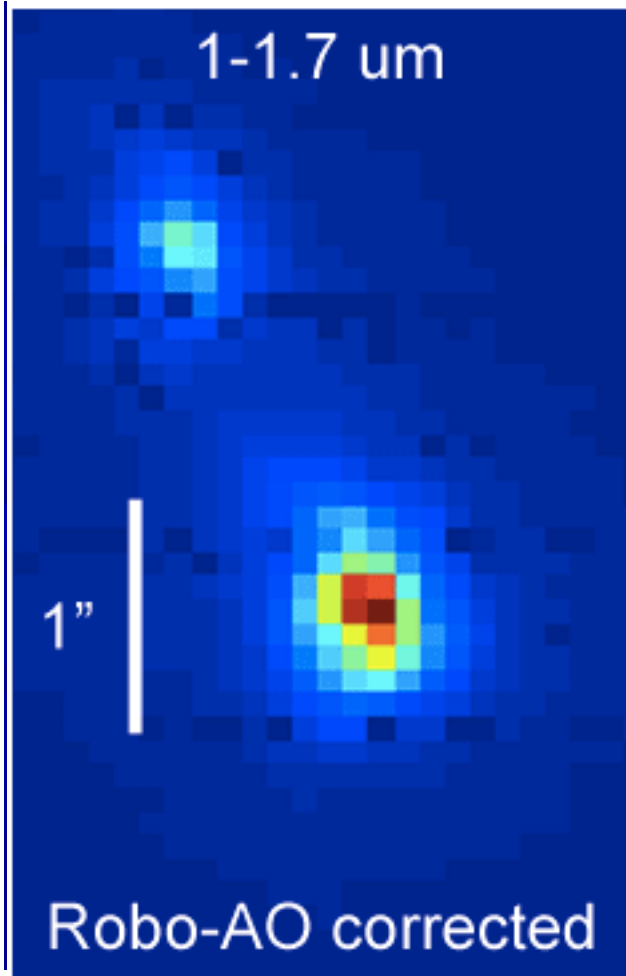
500 BOSS Spectra

10000 sq deg



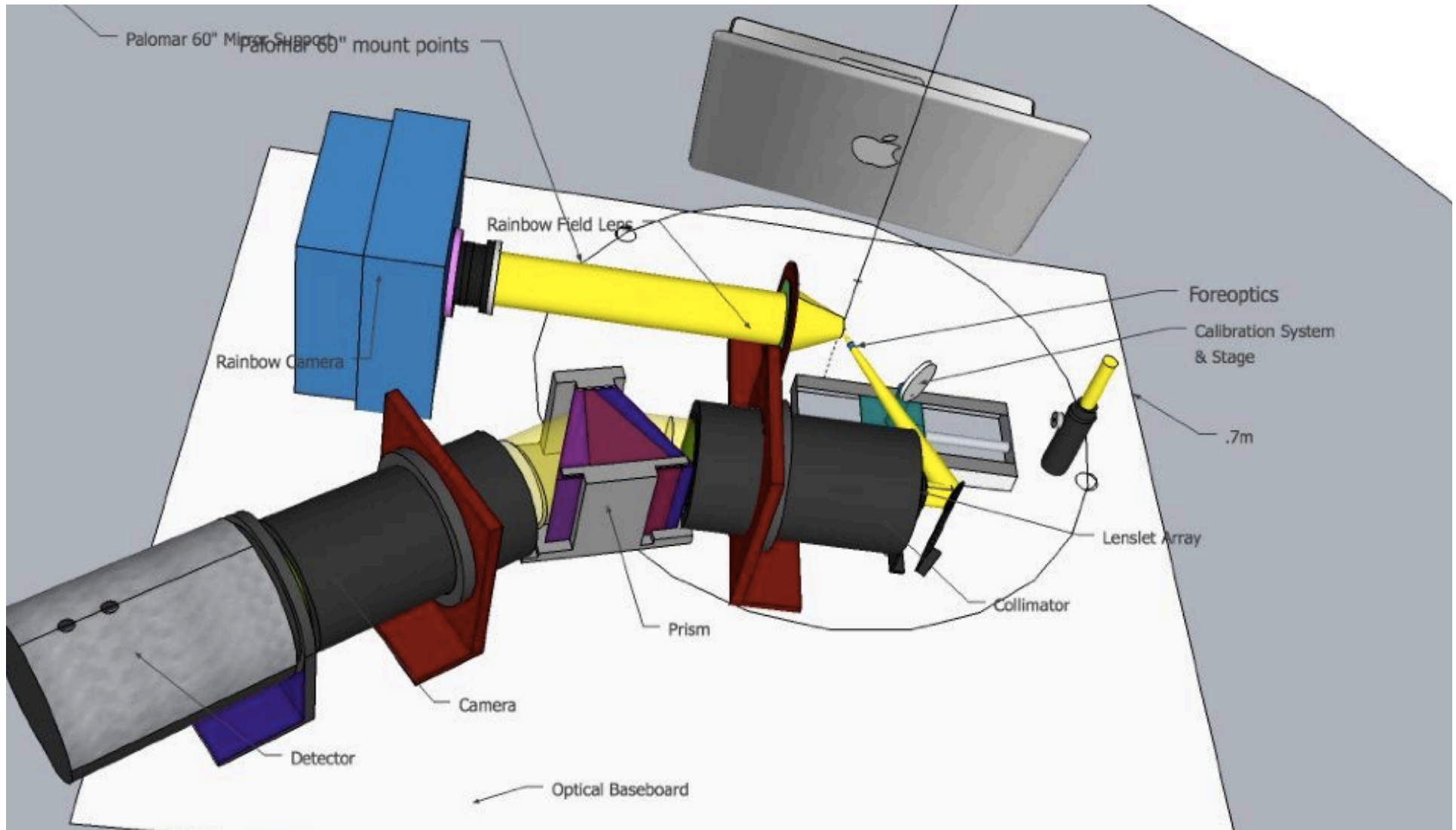
Oct 27, 2012

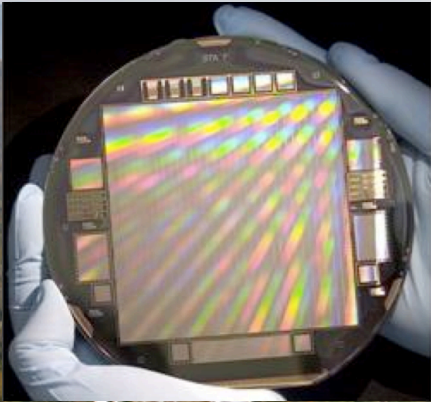
Robo-AO (PI Baranec)



SED Machine (PI Konidaris) Robotic Spectroscopy

12





P48
Discovery:
35 sq deg!
PI: S. Kulkarni



P200:
Spectroscopy



P60:
Follow-Up
The SED
Machine
PI: N. Konidaris

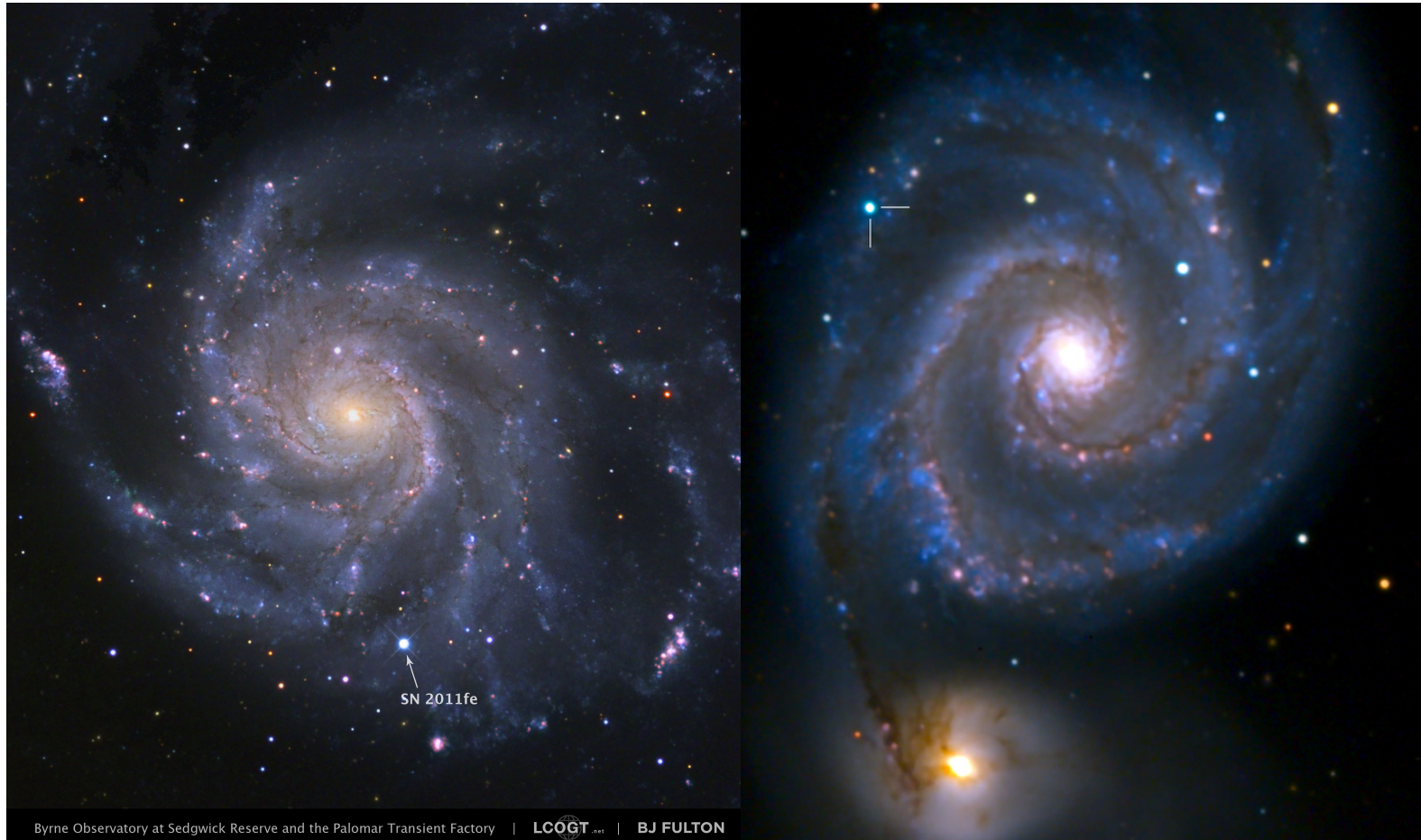


51+ PTF Papers

- 40) PTF11kx: A Type Ia Supernova with a Symbiotic Nova Progenitor, Dilday et al. 2012, submitted to Science
- 39) An early & comprehensive millimeter and centimeter wave and X-ray study of supernova 2011dh: Horesh et al., 2011 submitted to ApJ
- 38) Classical Novae in Andromeda: Light Curves from the Palomar Transient Factory and GALEX - Yi et al., 2011 submitted to ApJ
- 37) Three New Eclipsing White-dwarf - M-dwarf Binaries Discovered in a Search for Transiting Planets Around M-dwarfs - Law et al., 2011 submitted to ApJ
- 36) Calcium-rich gap transients in the remote outskirts of galaxies - Kasliwal et al., 2011 submitted to ApJ
- 35) Evidence for a compact Wolf-Rayet progenitor for the Type Ic supernova PTF 10vgv - Corsi et al., 2011 submitted to ApJ
- 34) The PTF Orion project: PTF0 8-8695, a planetary candidate transiting a T-Tauri star - van Eyken et al., 2011 submitted to ApJ
- 33) Asteroids rotation periods from the Palomar Transient Factory survey - Polishook et al., 2011 accepted to MNRAS
- 32) Implementation and testing of the first prompt search for electromagnetic counterparts to the gravitational wave transients - Abadie et al., 2011, A&A
- 31) Early radio and X-ray observations of the youngest nearby type Ia supernova PTF11kly (SN 2011fe) - Horesh et al., 2011 accepted to ApJ
- 30) Discovery of a type Ia supernova within hours of explosion in the Pinwheel galaxy - Nugent et al., 2011 Nature 480, 344
- 29) Constraints on the Progenitor System of the Type Ia Supernova SN 2011fe/PTF11kly - Li et al., 2011 Nature 480, 348
- 28) The Palomar Transient Factory photometric calibration - Ofek et al., 2011 accepted to PASP
- 27) SN 2010jp (PTF10aaxi): A jet-driven type II supernova - Smith et al., 2011 accepted to MNRAS
- 26) Automating discovery and classification of transients and variable stars in the synoptic survey era - Bloom et al., 2011 submitted to PASP
- 25) The Factory and The Beehive I. Rotation Periods For Low-Mass Stars in Praesepe - Agueros et al., 2011 ApJ 740, 110
- 24) Weird and lonely: PTF10ops - a subluminescent type Ia supernova in the middle of nowhere - Maguire et al., 2011 MNRAS, 418, 747
- 23) PTF1 J071912.13+485834.0: An outbursting AM CVn system discovered by a synoptic survey - Levitan et al., 2011 ApJ, 739, 68
- 22) PTF11eon/SN2011dh: Discovery of a Type IIb Supernova From a Compact Progenitor in the Nearby Galaxy M51 - Arcavi et al., 2011 ApJL 742, 18
- 21) The Progenitor of Supernova 2011dh/PTF11eon in Messier 51 - Van Dyk et al., 2011 ApJL 741, 28
- 20) The PTF Orion Project: Eclipsing Binaries and Young Stellar Objects - van Eyken et al., 2011 AJ, 142, 60
- 19) Hydrogen-poor superluminous stellar explosions - Quimby et al., 2011 Nature 474, 487-489
- 18) PTF10iya: A short-lived, luminous flare from the nuclear region of a star-forming galaxy - Cenko et al., 2010 submitted to MNRAS
- 17) PTF 10bzf (SN 2010ah): a broad-line Ic supernova discovered by the Palomar Transient Factory - Corsi et al., 2011 ApJ 741, 76
- 16) Real-Time Detection and Rapid Multiwavelength Follow-up Observations of a Highly Subluminescent Type II-P Supernova from PTF - Gal-Yam et al., 2010 ApJL
- 15) An extremely luminous panchromatic outburst from the nucleus of a distant galaxy - Levan et al., 2011 accepted to Science
- 14) The Subluminescent and Peculiar Type Ia Supernova PTF 09dav - Sullivan et al., 2011 ApJ 732 118S
- 13) Galaxy Zoo Supernovae - Smith et al., 2010 MNRAS 412 1309
- 12) PTF10fq: A Luminous Red Nova in the Spiral Galaxy Messier 99 - Kasliwal et al., 2011 ApJ 730 134K
- 11) Evidence for an FU Orionis Outburst from a Classical T Tauri Star - Miller et al., 2011 ApJ 730 80M
- 10) Hubble Space Telescope Studies of Nearby Type Ia Supernovae: The Mean Maximum Light Ultraviolet Spectrum and its Dispersion - Cooke et al., 2010 ApJ
- 9) PTF10nvg: An Outbursting Class I Protostar in the Pelican/North American Nebula - Covey et al., 2010, AJ, 141 40C
- 8) The Extreme Hosts of Extreme Supernovae - Neill et al., 2010 ApJ accepted
- 7) Supernova PTF 09uj: A Possible Shock Breakout from a Dense Circumstellar Wind - Ofek et al., 2010 ApJ, 724, 1396-1401
- 6) The Palomar Transient Factory Survey Camera: 1st Year Performance and Results - Law et al., 2010 SPIE 7735
- 5) Rapidly Decaying Supernova 2010X: A Candidate ".Ia" Explosion - Kasliwal et al., 2010 ApJL, 723, 98-102
- 4) Core-Collapse Supernovae from the Palomar Transient Factory: Indications for a Different Population in Dwarf Galaxies - Arcavi et al., ApJ 2010 721 777-78
- 3) The Palomar Transient Factory: System Overview, Performance and First Results - Law et al., PASP 121 1395L
- 2) Exploring the Optical Transient Sky with the Palomar Transient Factory - Rau et al., PASP 121 1334R.
- 1) The 12Kx8K CCD mosaic camera for the Palomar Transient Factory - Rahmer et al., 2008 SPIE 7014 (1.5MB pdf)



Young Supernovae

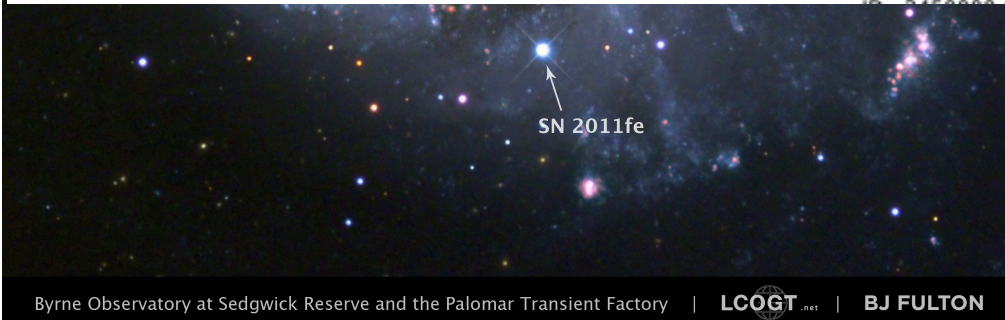
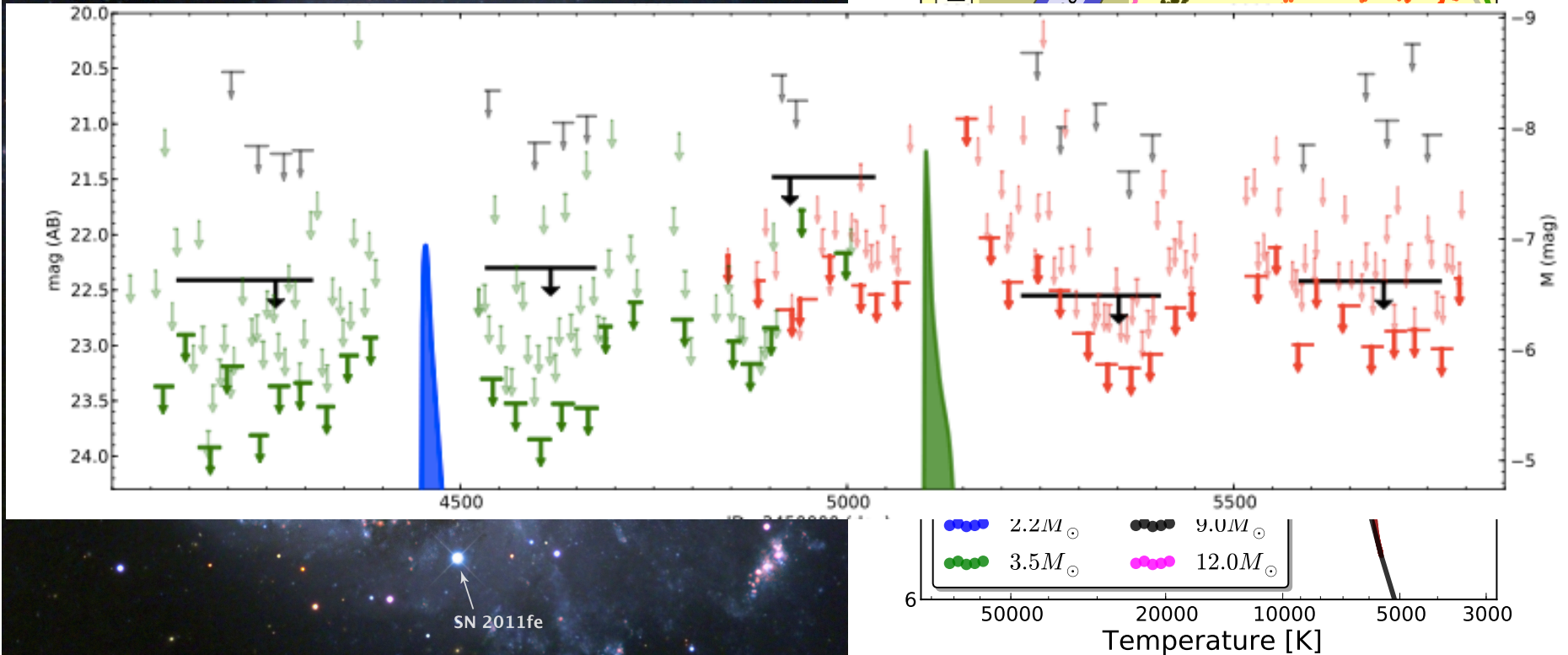
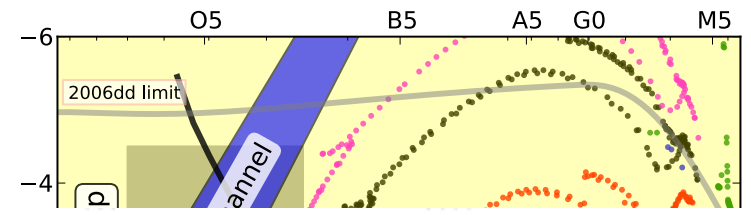


Nugent et al. 2011, Li et al. 2011
 Horesh et al. 2012, Bloom et al. 2012 + 20 more

Arcavi et al. 2011, van Dyk et al. 2011
 Horesh et al. 2012 + 14 more



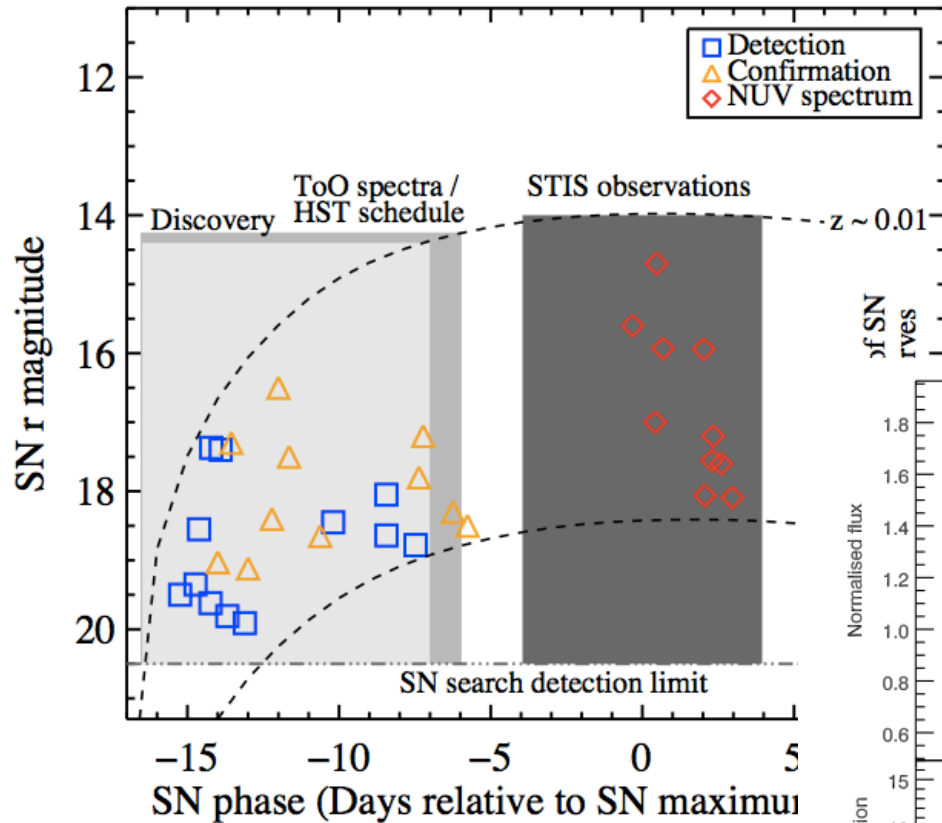
PTF11kly aka SN2011fe in M101



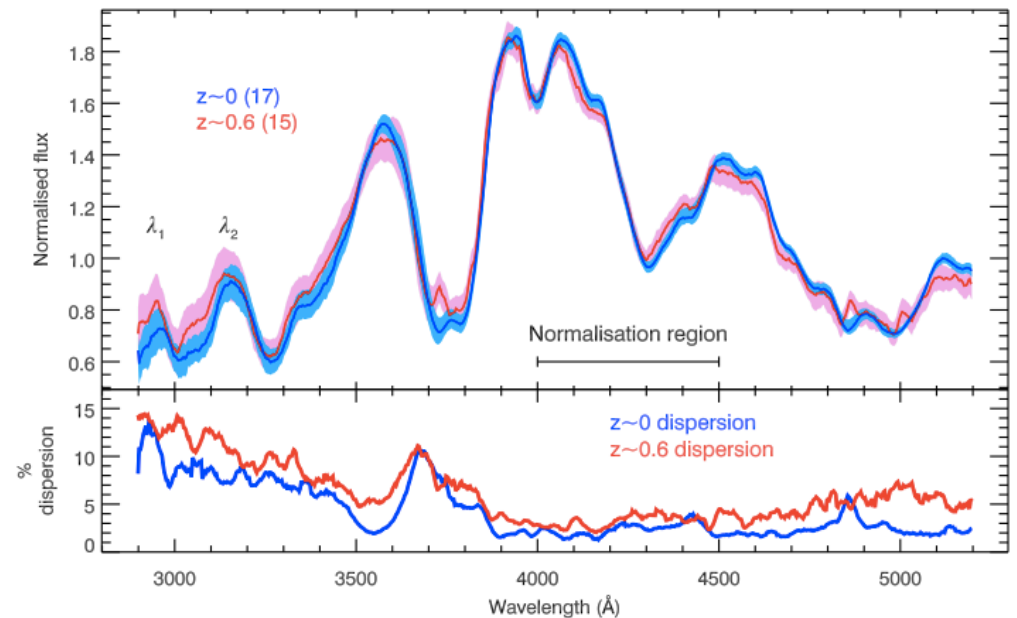
Nugent et al. 2011, Li et al. 2011, Horesh et al. 2011, Bloom et al. 2011 (+ three dozen papers)



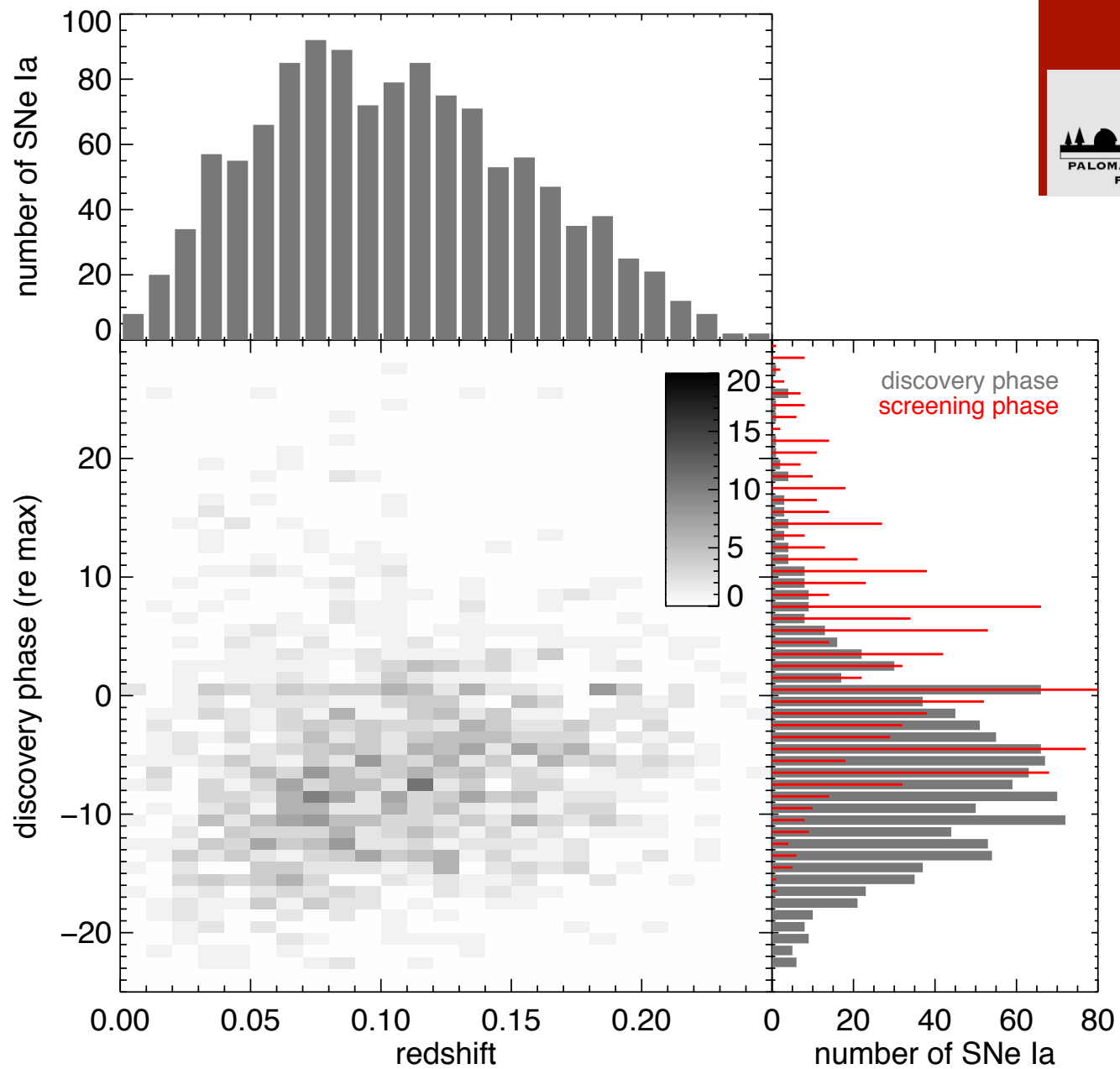
HST/STIS Type Ia program



Cooke et al. 2010, Maguire et al. 2012

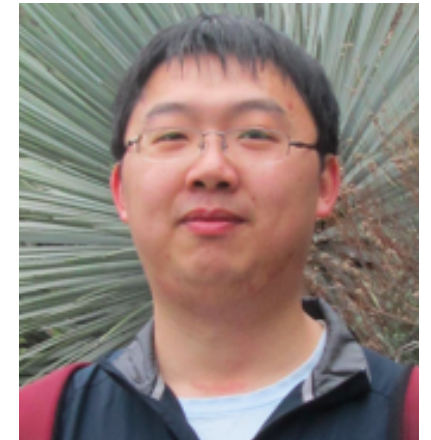
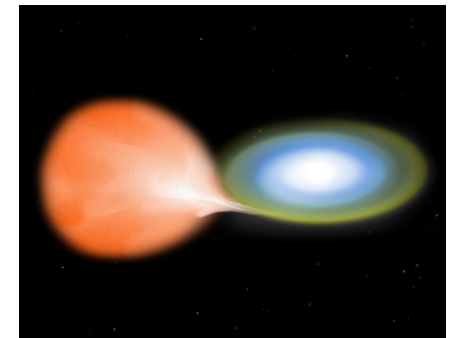


Eric Hsiao

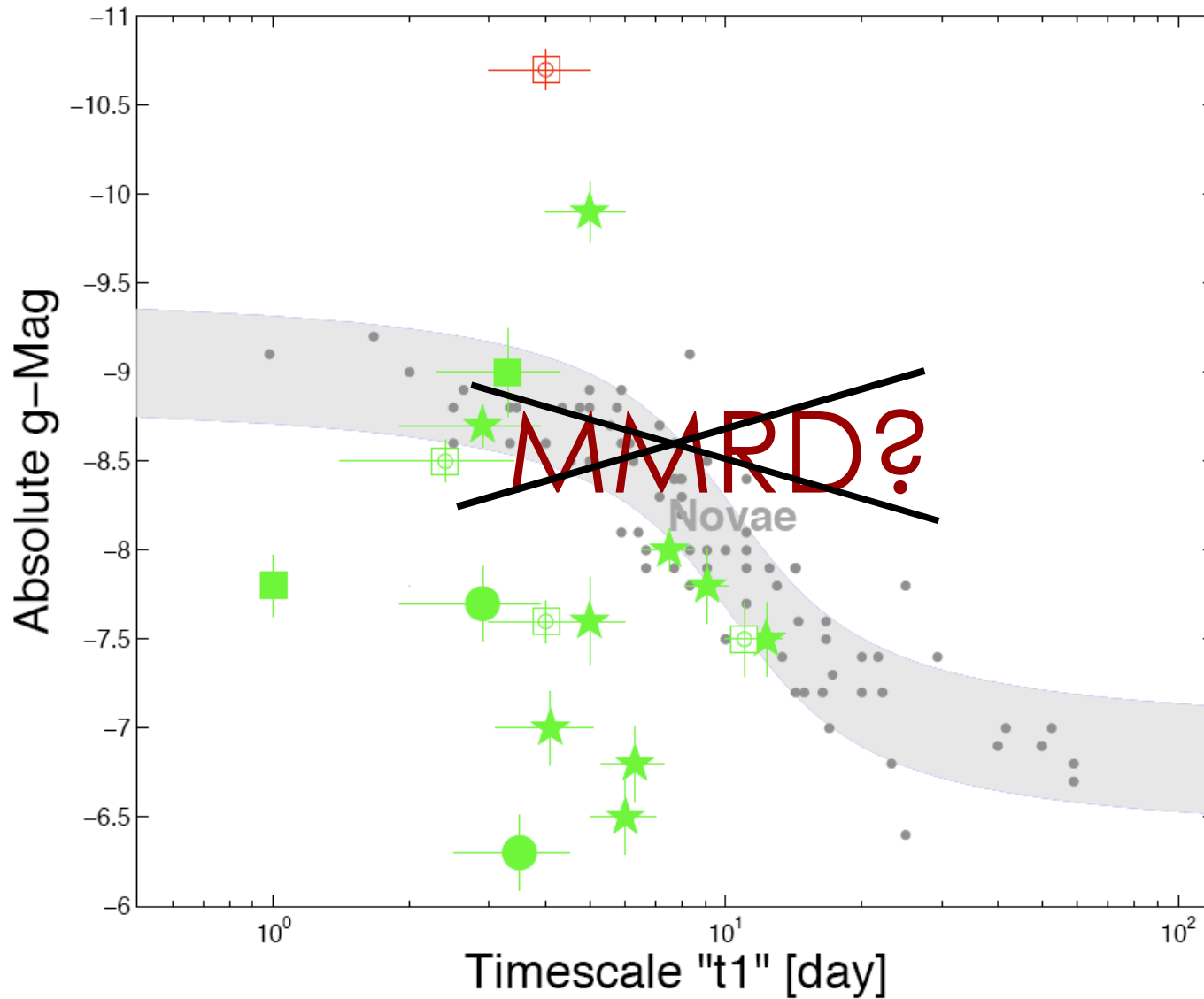


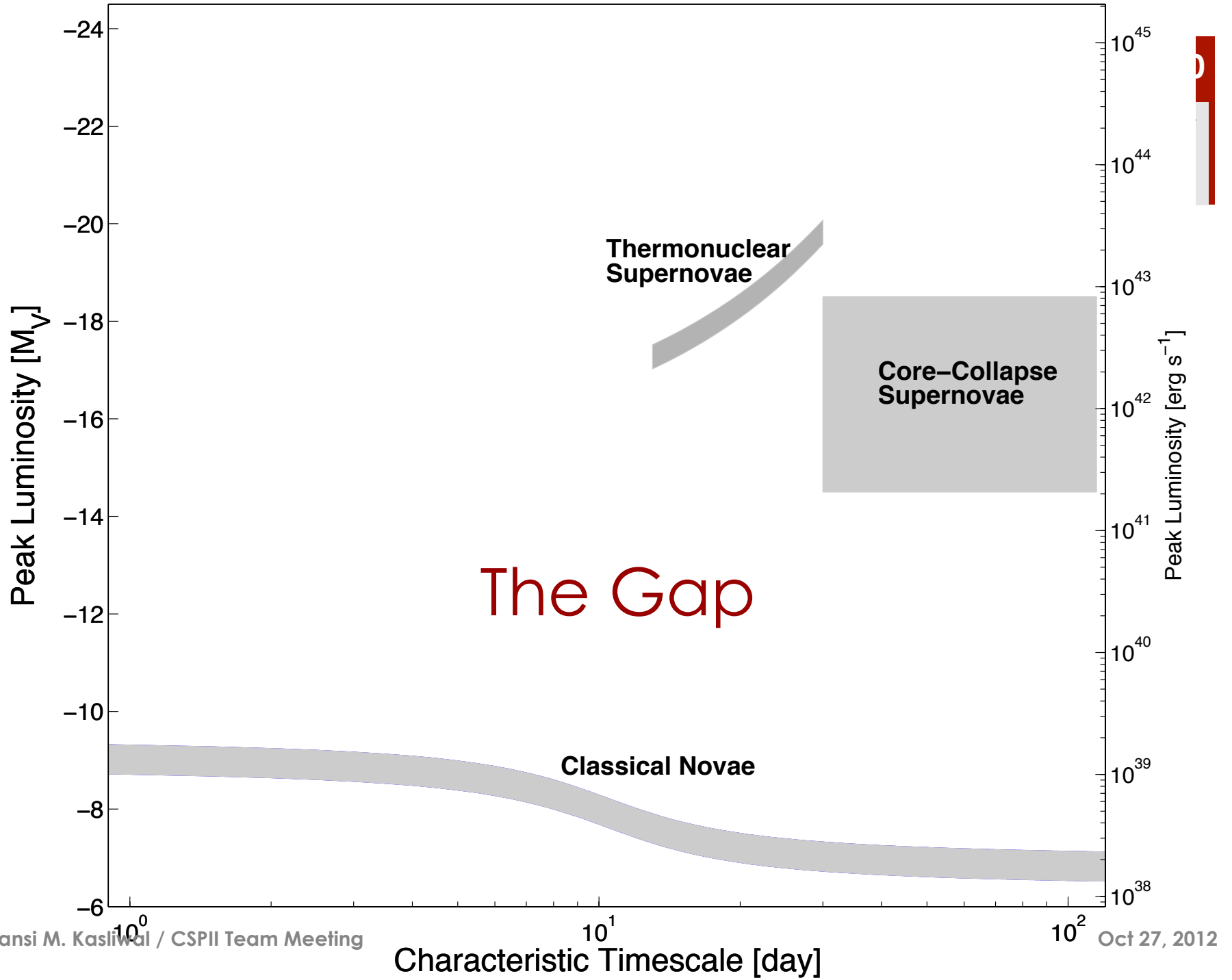
Classical Novae: Richer Physics

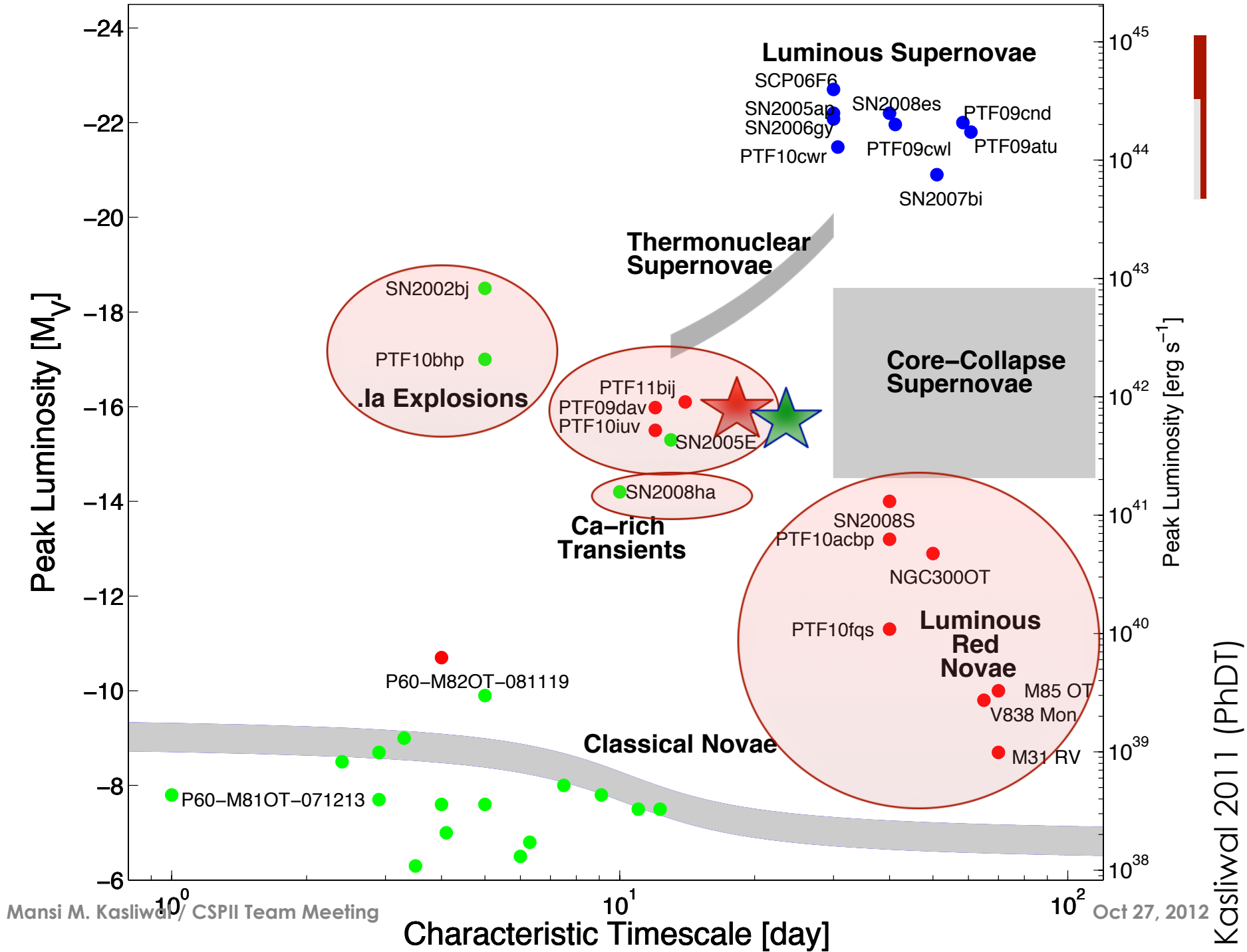
19

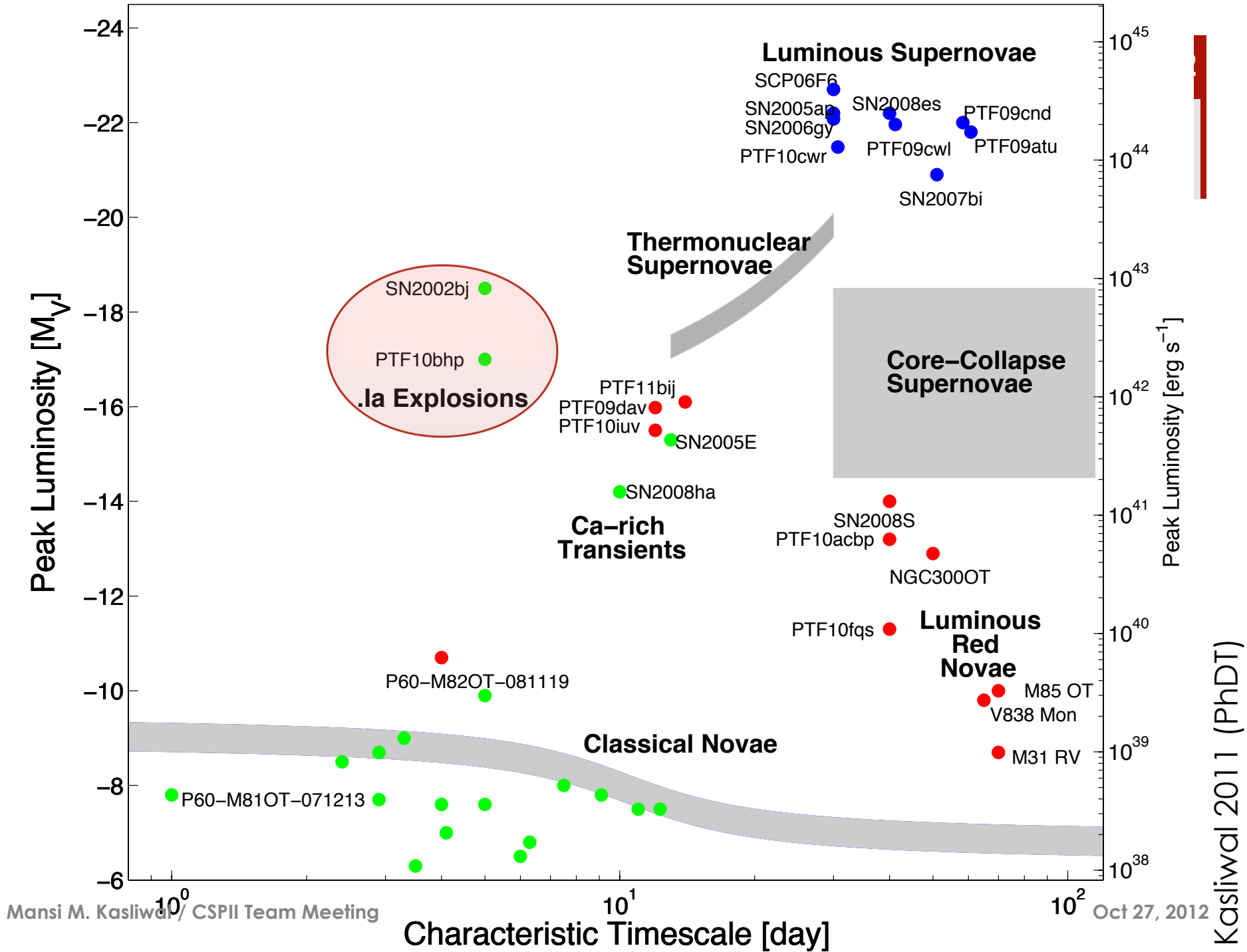


Yi Cao



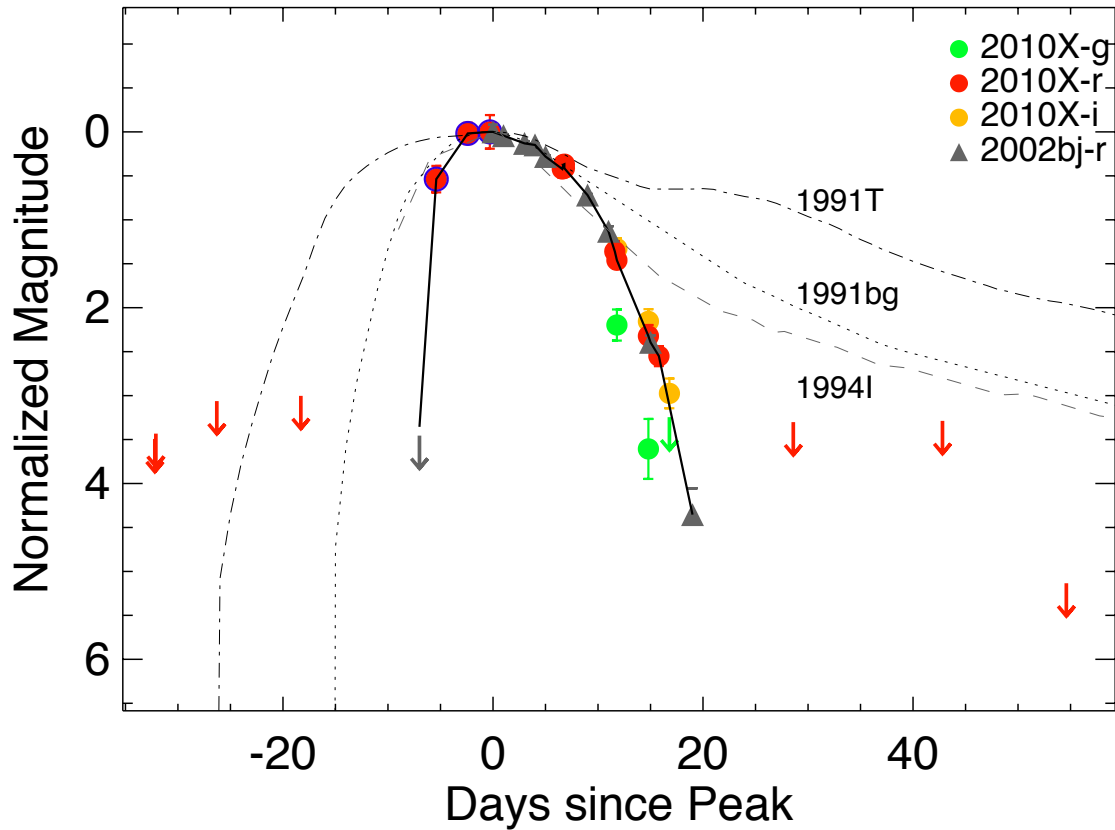




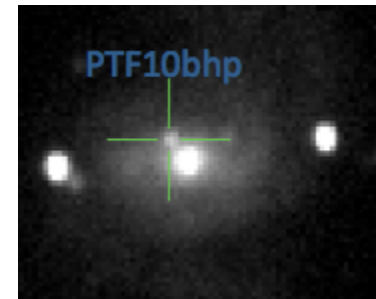


SN2002bj & PTF10bhp

23



- ★ Ephemeral
 - ◆ $\tau_r = 6$ days
 - ◆ $\tau_d = 5$ days
 - ◆ $\tau_{\text{accept}} = 5$ days
- ★ Very little ejecta: $0.16 M_{\odot}$
- ★ Early γ -ray escape

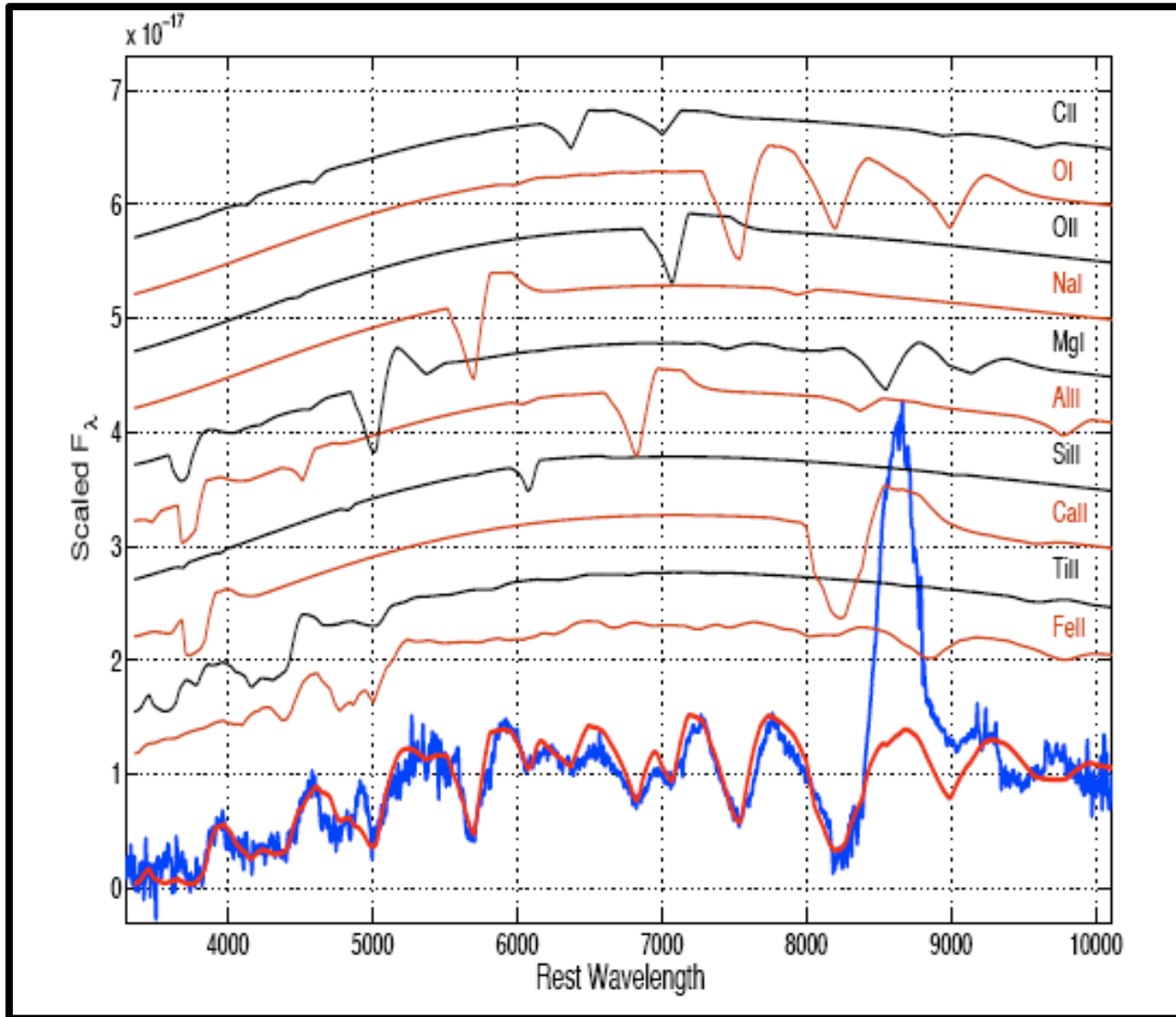


Kasliwal et al. 2010b, Poznanski et al. 2010

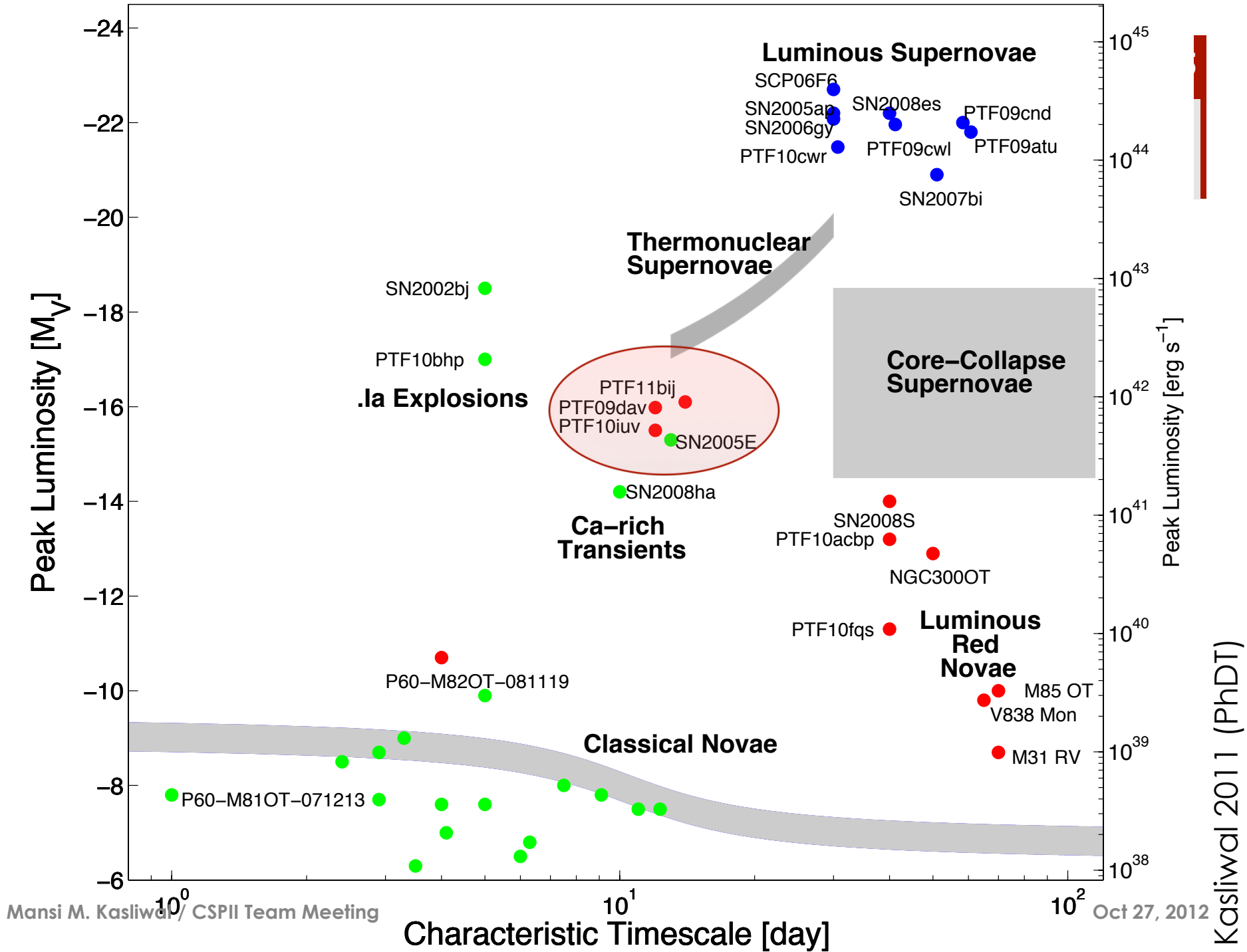
PTF10bhp: a “.Ia” explosion?



Kasliwal et al. 2010b



- ✓ Fast rise
2—10d
- ✓ Fast Decline
4—20d
- ✓ Peak Luminosity
 $0.5—5 \times 10^{42}$ erg/s
- ✓ High Velocities
 $9—13 \times 10^3$ km/s
- ✓ Ca II & Ti II in Spectr
- ✓ Non-LTE Helium
- ✓ Low Ejecta Mass



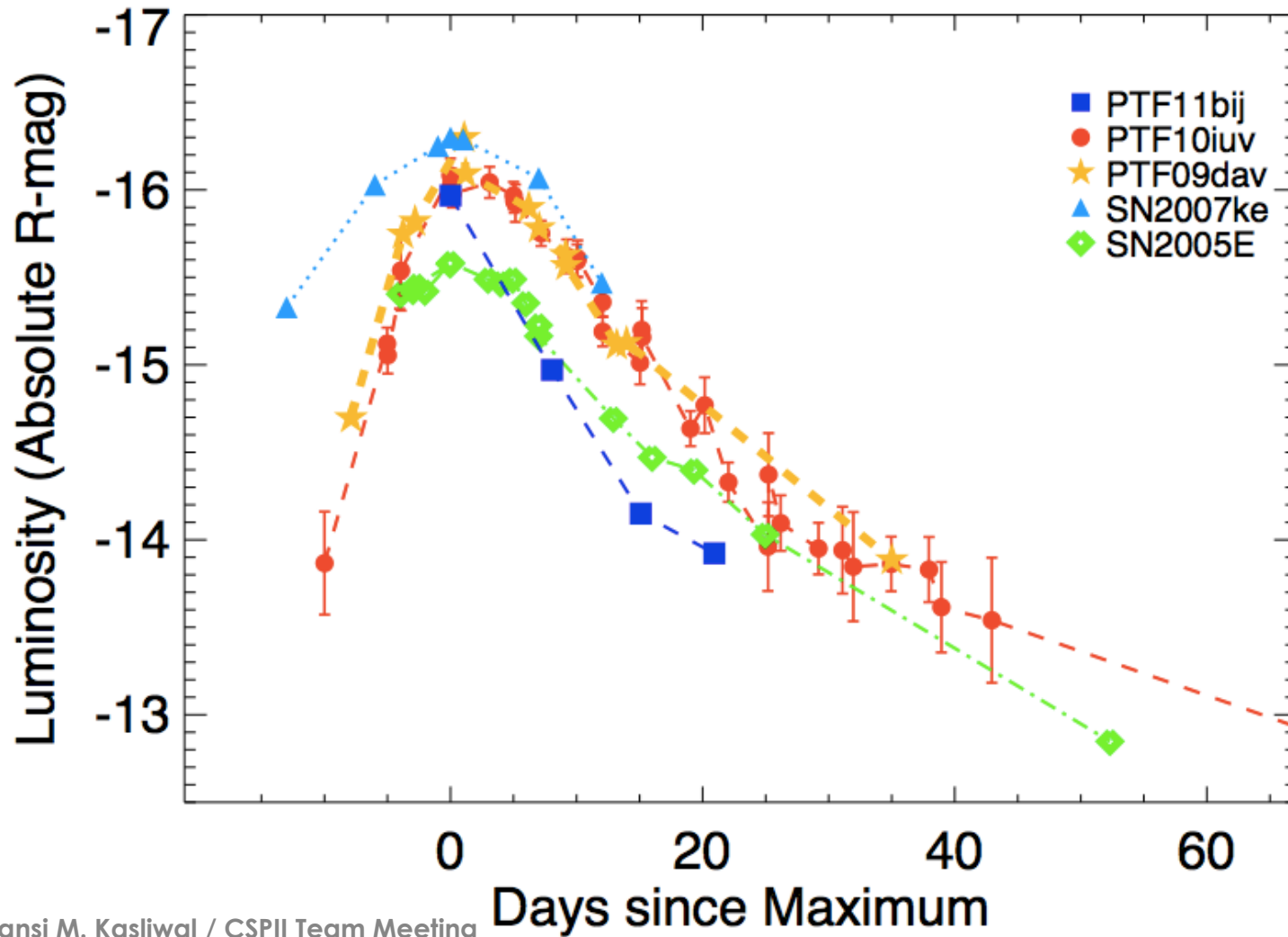


Characteristics of this Class

1. Peak luminosity in the gap (-14 to -16)
2. Fast Rise and Decline (12 to 15 days)
(i.e. Ejecta Mass 0.4 to 0.7 M_{sun})
3. Photospheric Velocities ($\sim 10,000$ km/s)
4. Early evolution into nebular phase (~ 3 months)
5. Nebular spectra dominated by Calcium Emission
(Remote Locations?)

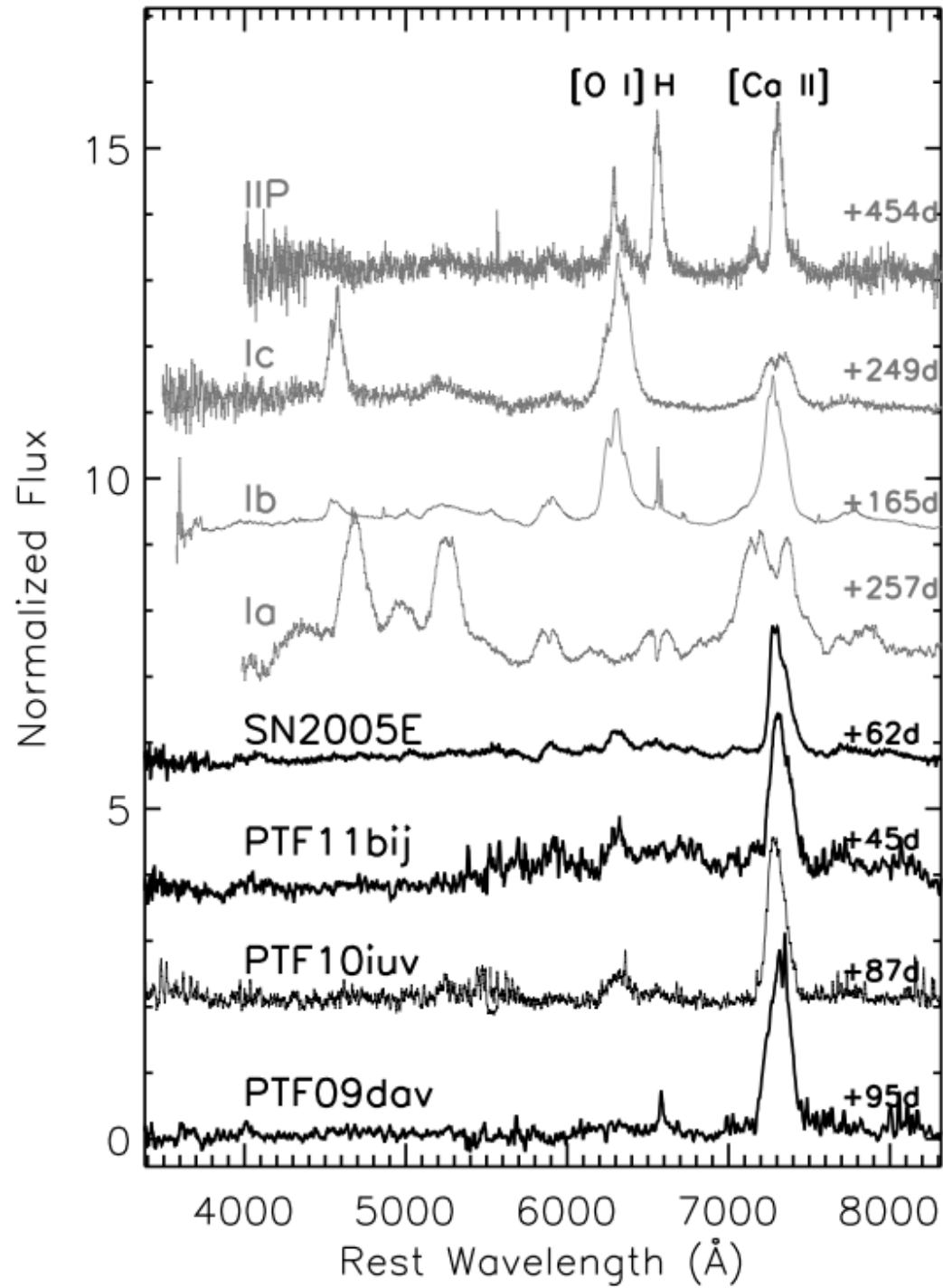


Light Curves



Kasliwal et al. 2012

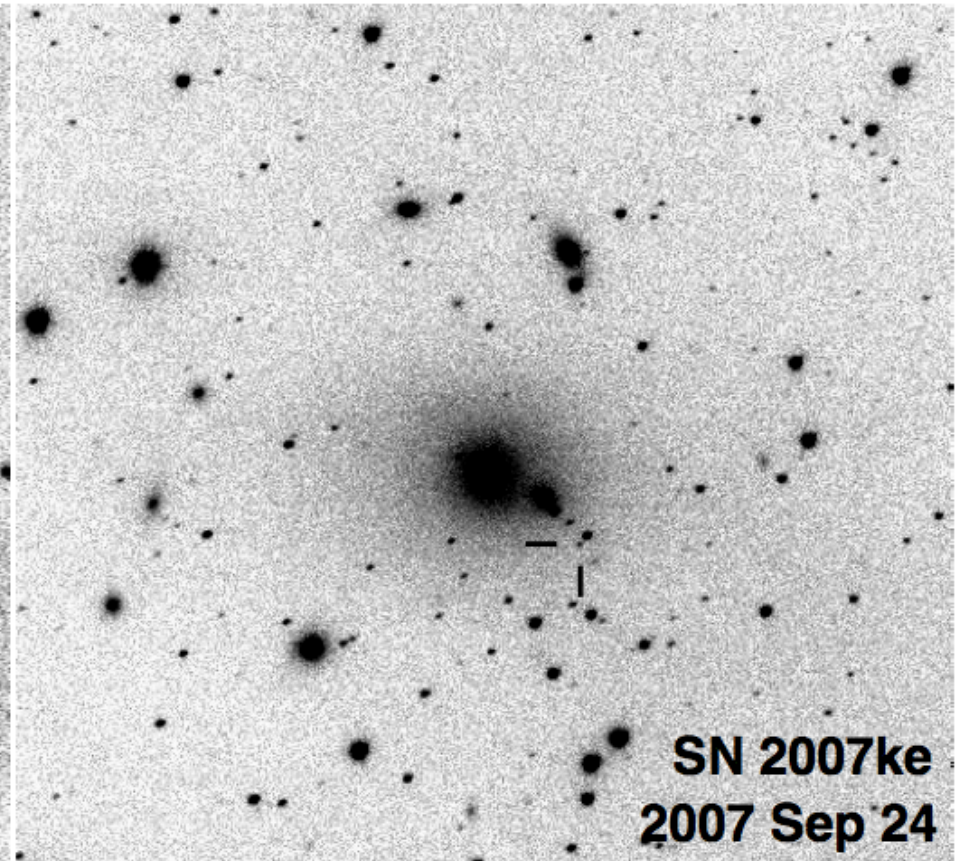
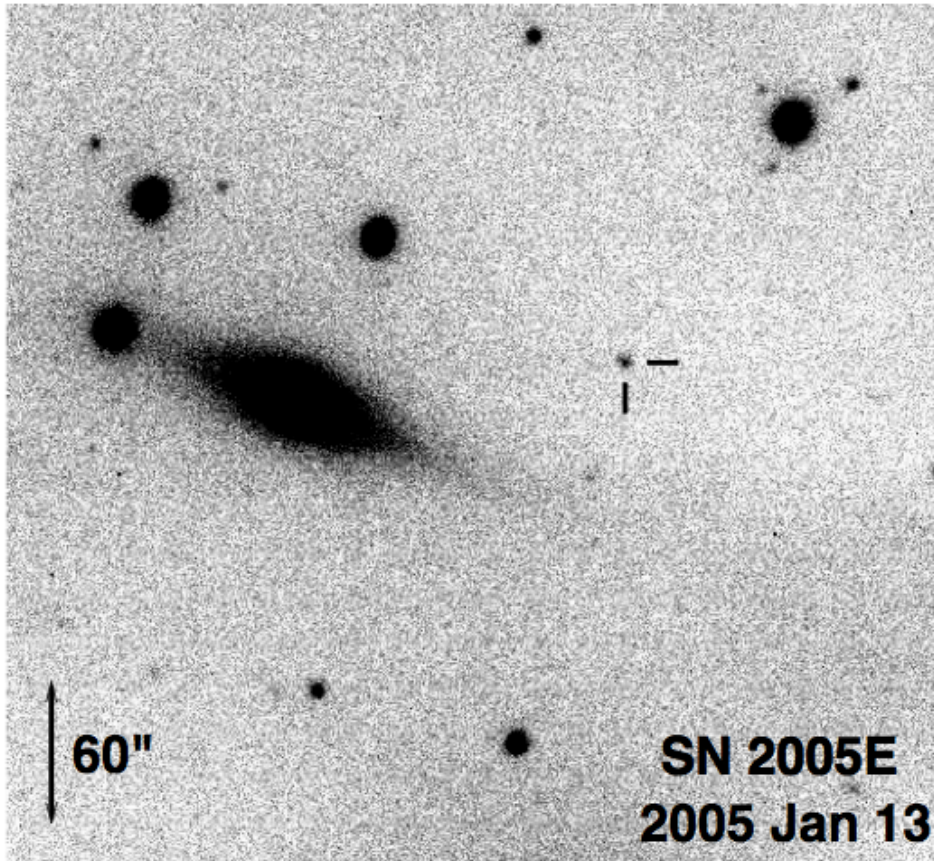
Nebular Spectra



Kasliwal et al. 2012



SN2005E & SN2007ke

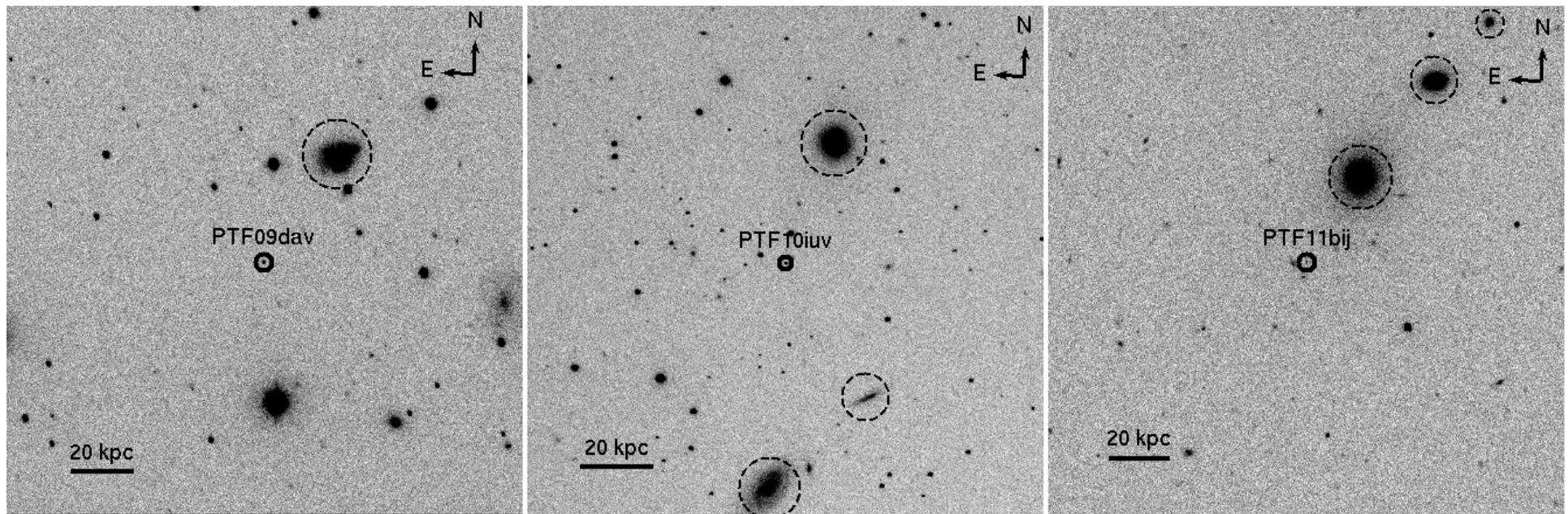


Perets et al. 2010



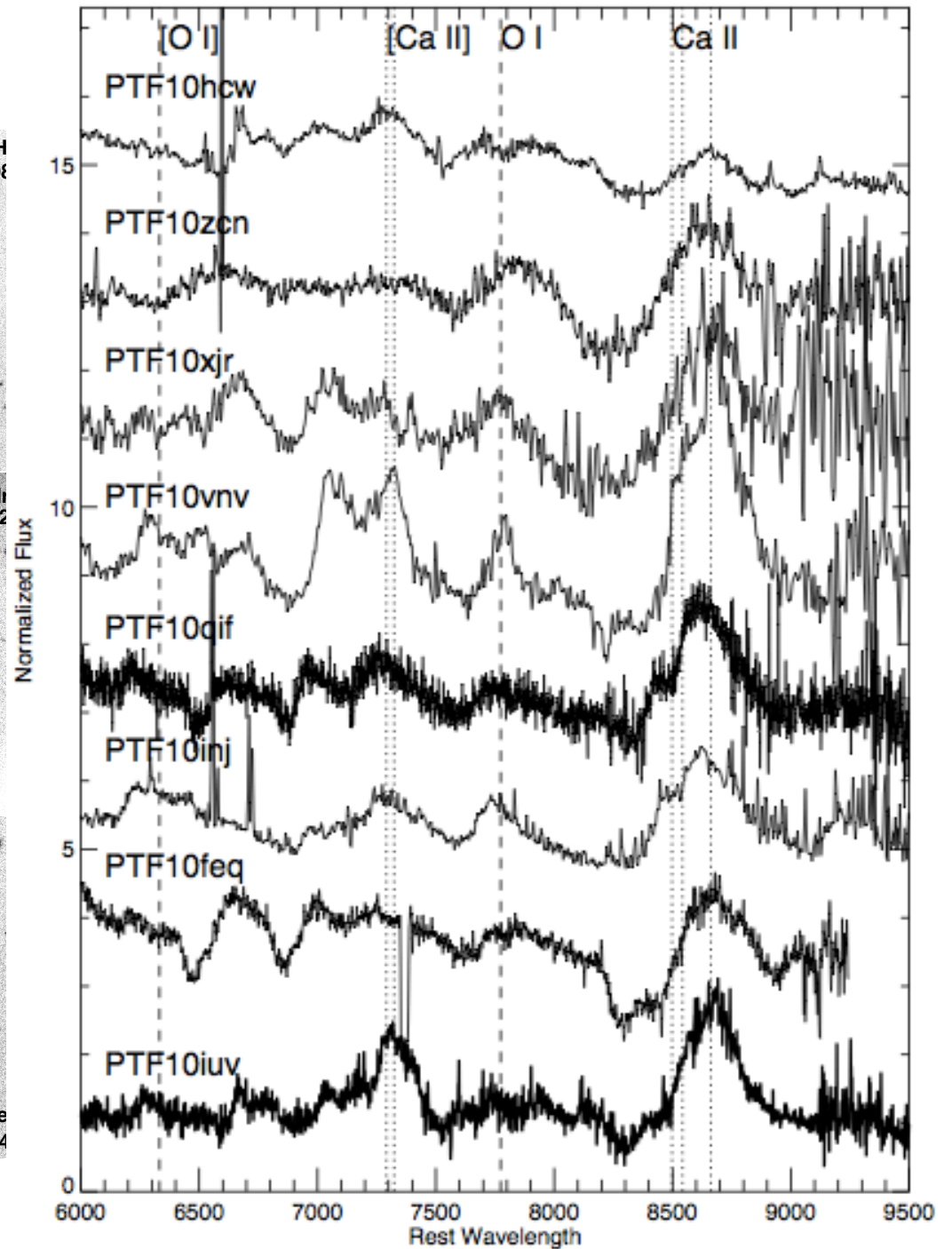
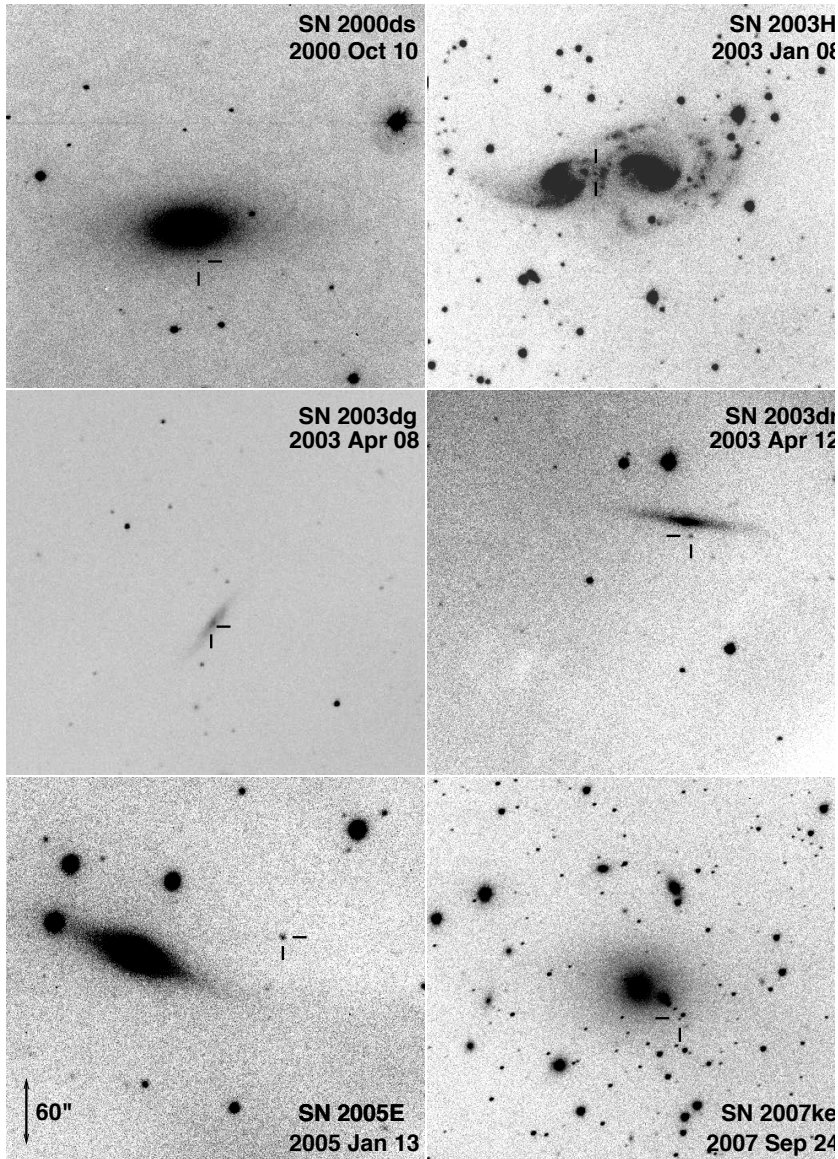
PTF09dav, PTF10iuv & PTF11bij

White Dwarf or Massive Star Explosion?



Sullivan et al. 2011, Kasliwal et al. 2012

Any in the disk?



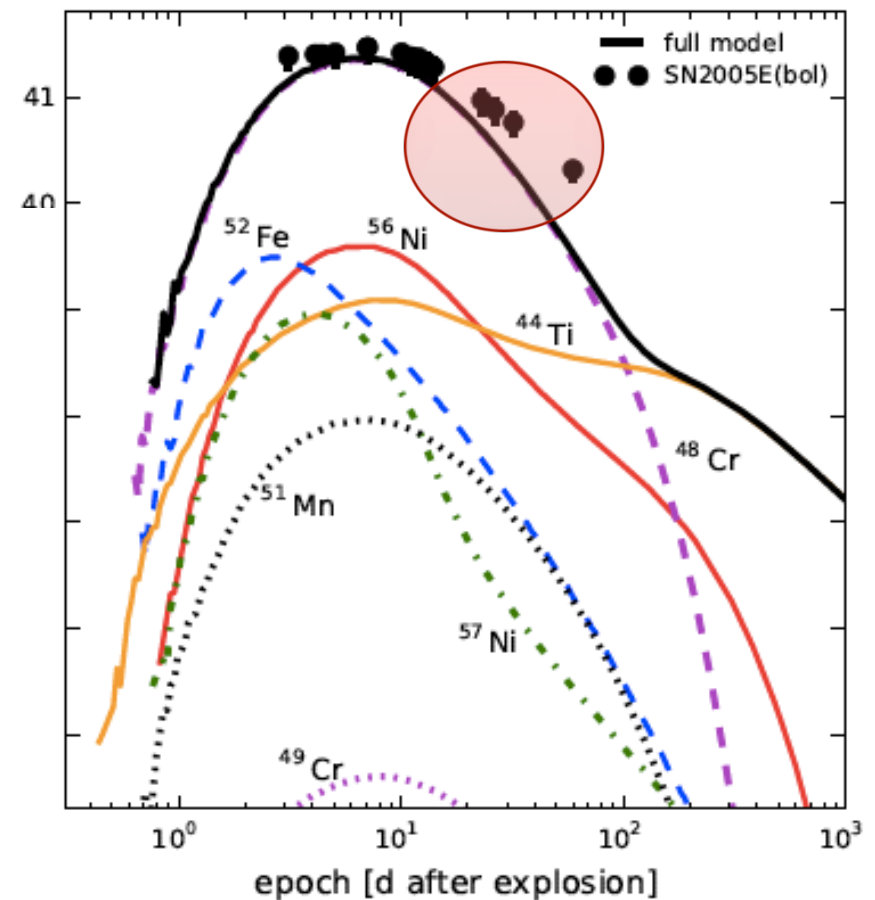
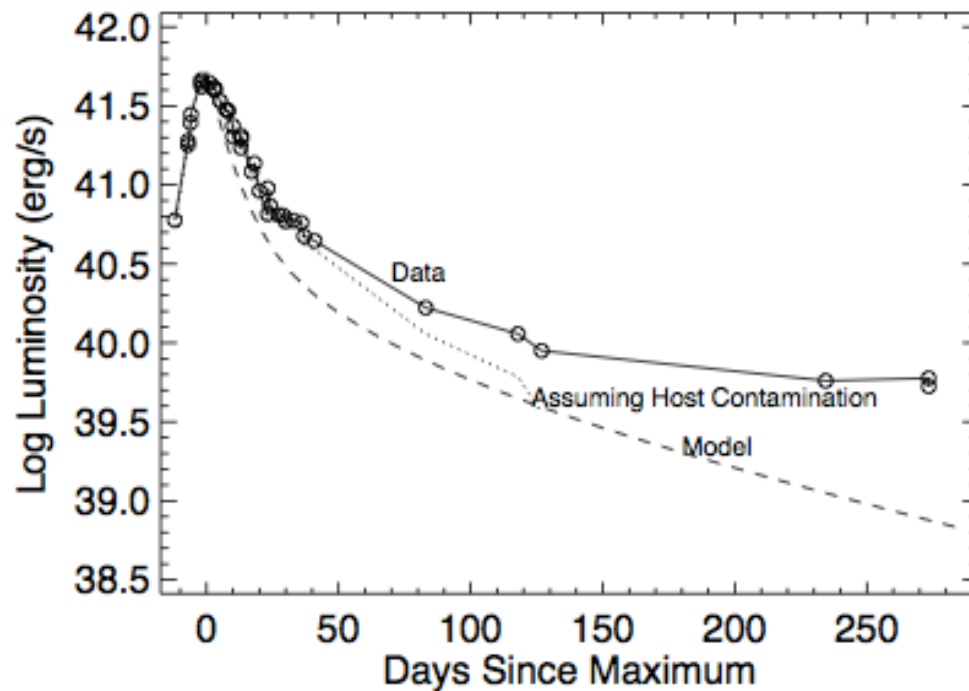


White Dwarf?

- Pro: Location
- Con: Location, Hydrogen, Ejecta

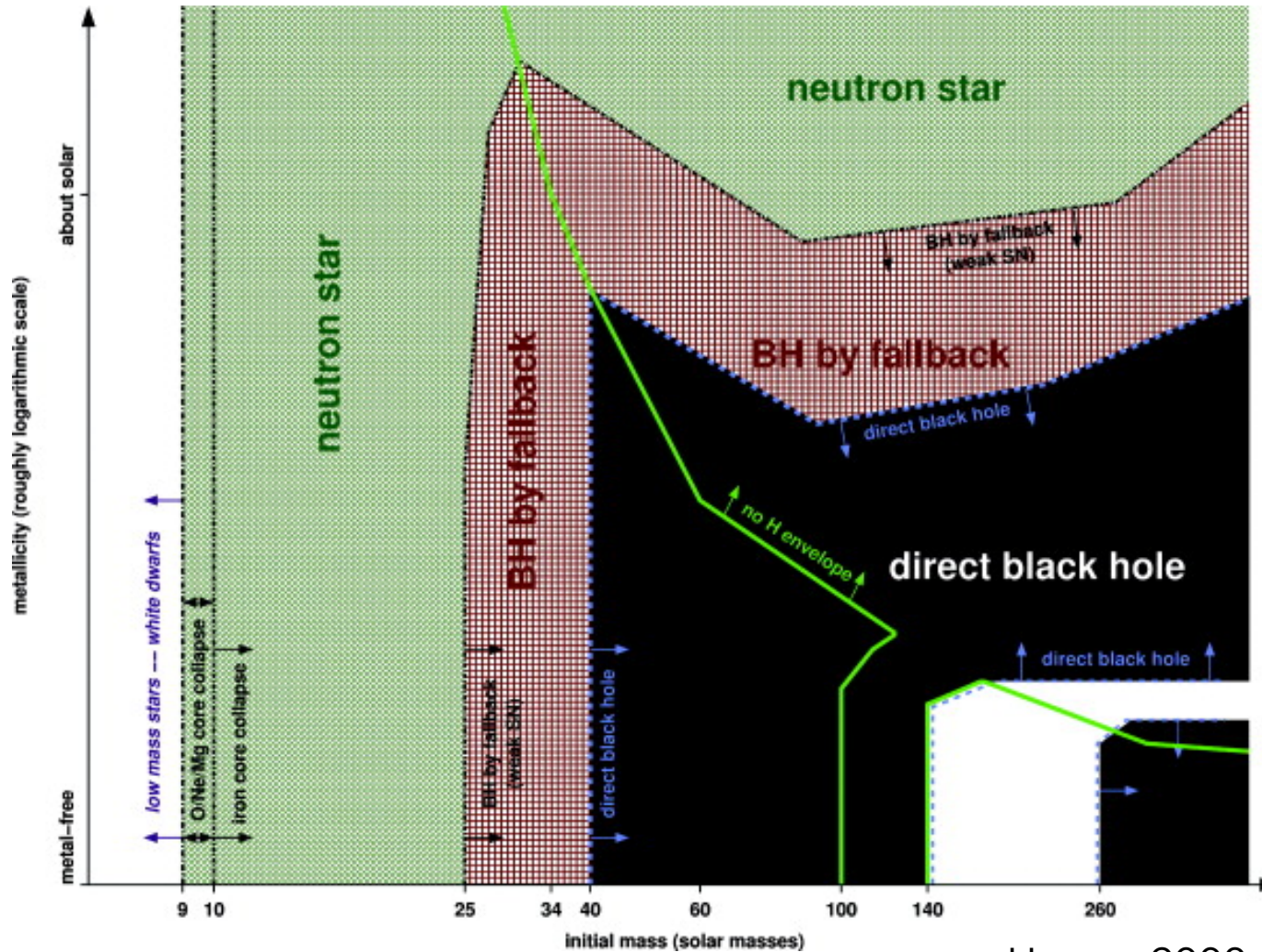
Waldman et al. 2010

Kasliwal et al. 2012

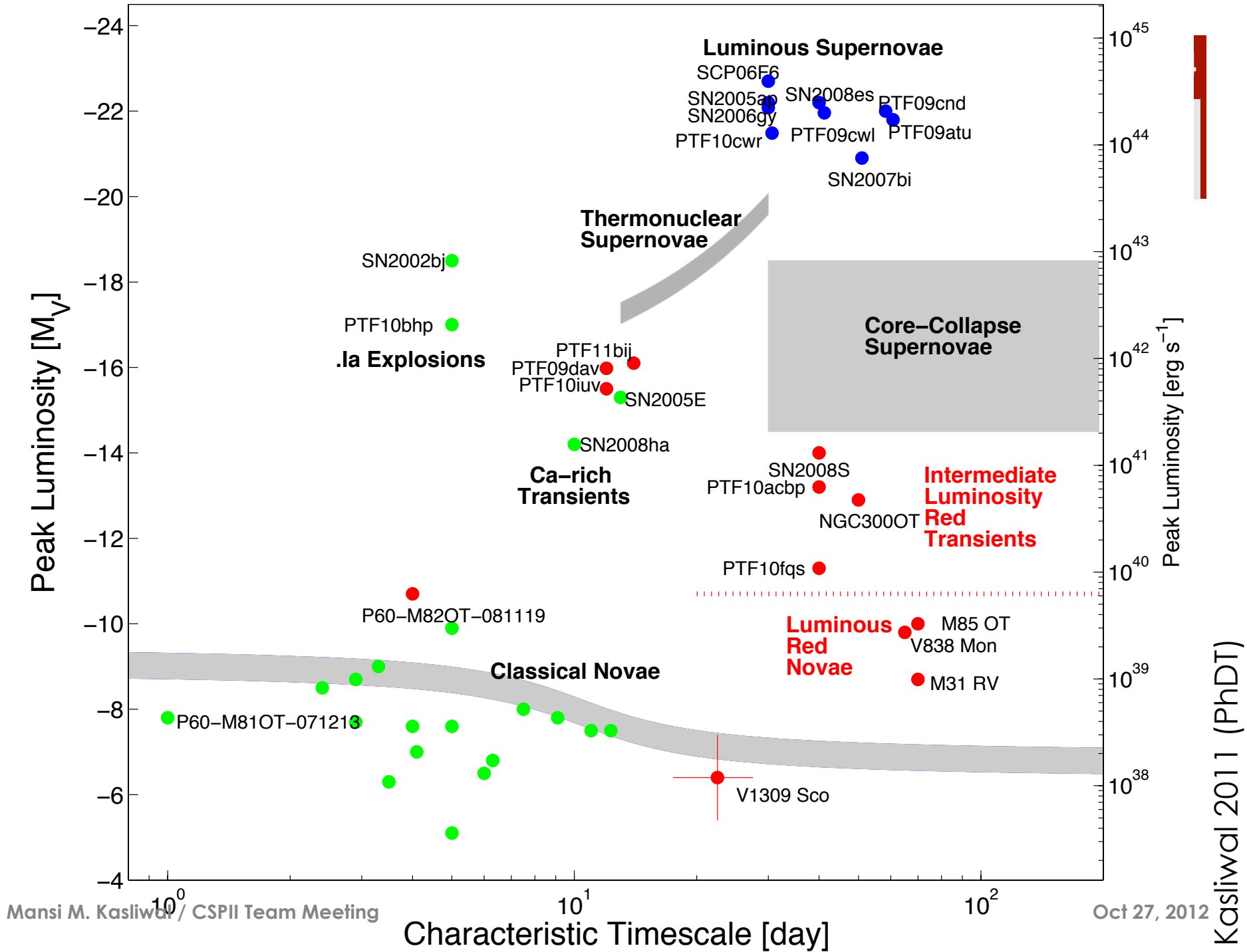




Massive Star?



- Pro:
 - Low Metallicity
 - Low Rates
 - Hydrogen
- Con:
 - Rest of IMF?



Thank You

