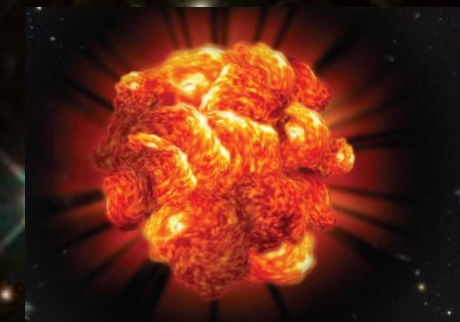
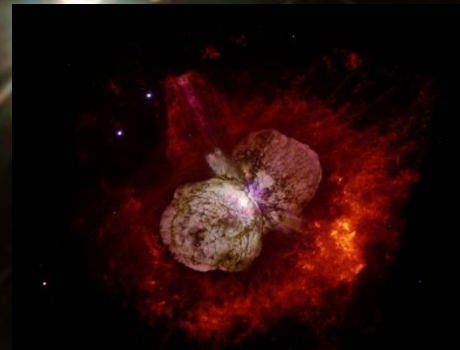


The fate of the most massive stars

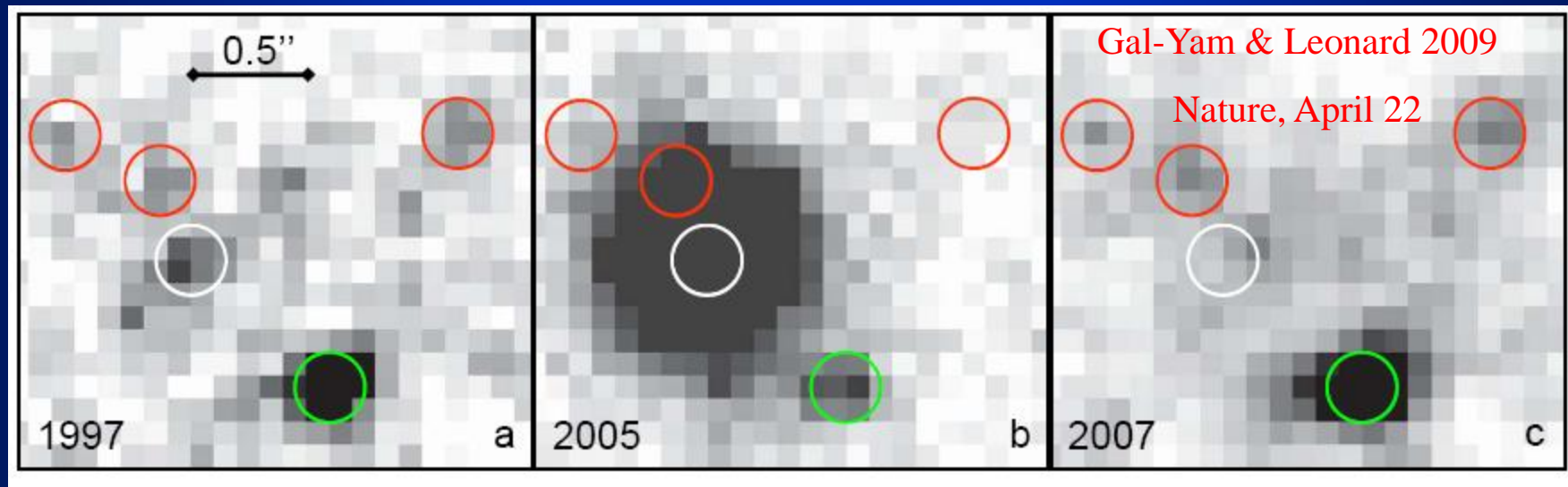
Introducing the Palomar Transient Factory



Avishay Gal-Yam,
Weizmann Institute of Science
Paris 2010

SNe IIn from very massive stars (LBVs)

* Direct detection of the progenitor of SN 2005gl: $L \sim 10^6$ solar



* In accord with works by Kotak, Smith, Trundle, ...

* May involve the pulsational pair instability (PPSN; Woosley et al. 2007; Smith et al. 2009; Miller et al. 2009)

Pair Instability Supernovae (PISNE)

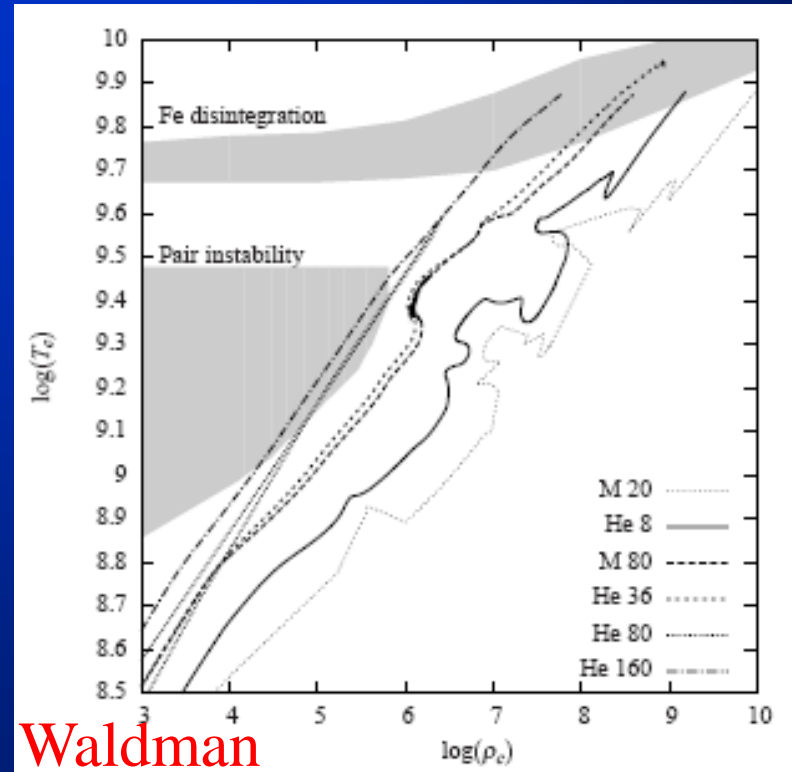
(Barkat, Rakavi & Sack 1967 ; Heger & Woosley 2002; Waldman 2008 ...)

* Helium cores above ~ 50 solar masses become pair unstable

* In these low-density high-T cores, $\gamma\gamma \rightarrow e^+e^-$ wins over oxygen ignition, heat is converted to mass and implosion follows

* Inertial oxygen ignition leads to explosion and full disruption

* “This is a uniquely calculable process” (Heger & Woosley 2002); “this is a trivial calculation” (Barkat 2009); “Pretty neat homework problem” (Gal-Yam 1996)



“Smoking gun”:

Core mass > 50 solar

SN 2007bi=SNF20070406-008

(PTF “dry run”)

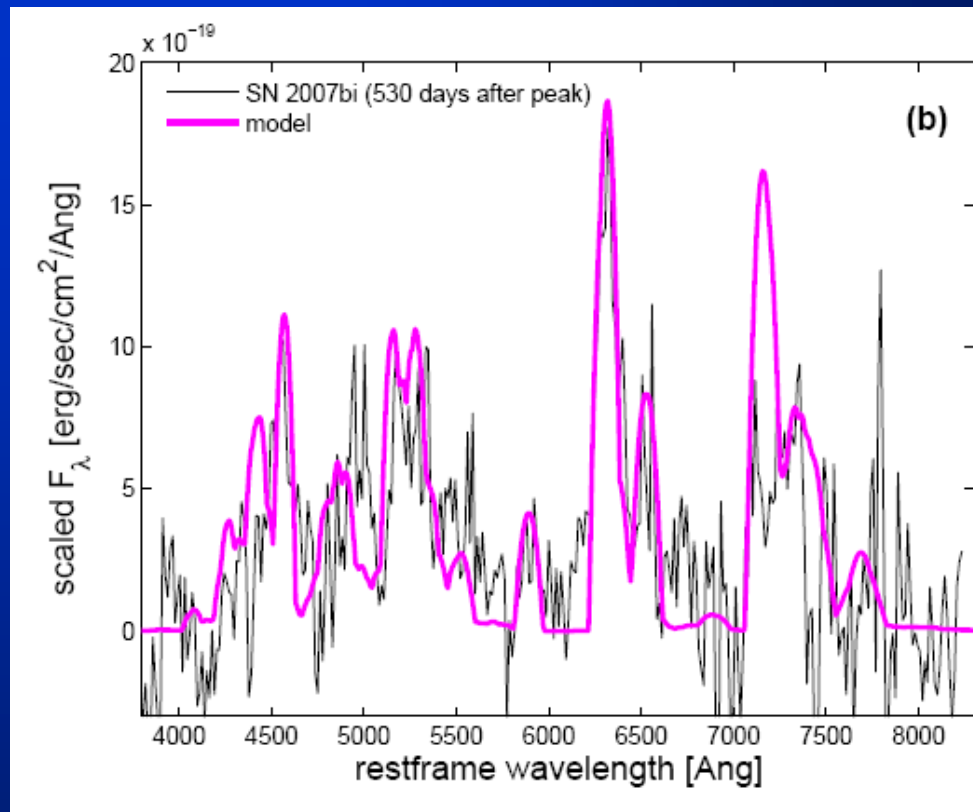
* Type Ic SN. No interaction, no dust, $v=12000$ km/s

* Luminous peak (-21.3), slow rise (~77 days), ^{56}Co decay

* Ejected mass ~100 solar, $E_k \sim 1e53$ (scaling), 4-11 solar masses of ^{56}Ni

* Well-fit by models (Kasen)

* Nebular spectra: 4-6 solar mass of ^{56}Ni ; >50 solar total (Mazzali), consistent with 98bw



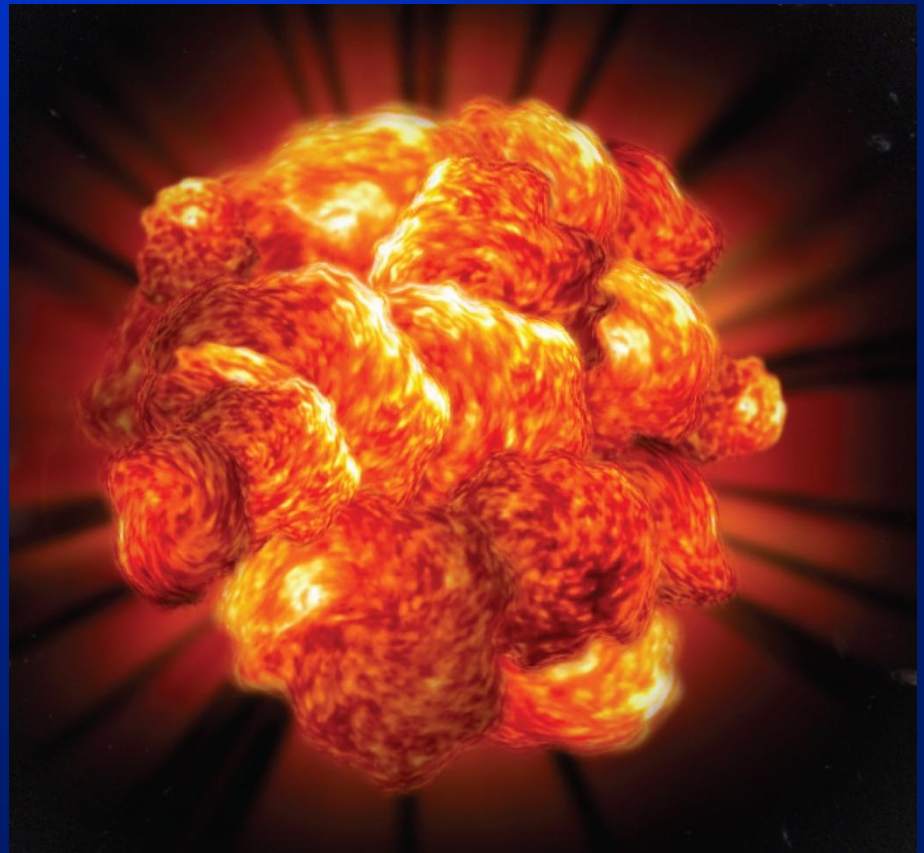
Core mass > 50 robustly established;

Gal-Yam et al. 2009, also Young et al. 2009

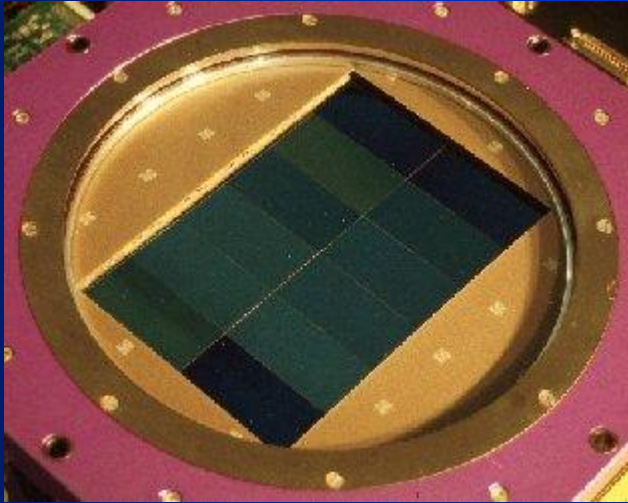
Implications

(Gal-Yam et al. 2009)

- * A helium core ~ 100 solar detected at $Z \sim \text{SMC}$
- * Mass loss models are key
- * PISNe happen locally, Universally, models are $\sim \text{ok}$
- * Dwarfs have stars above Galactic limit (>200 solar, probably)
- * Hydrogen efficiently removed (pulsations?)



And now: news from The Palomar Transient Factory

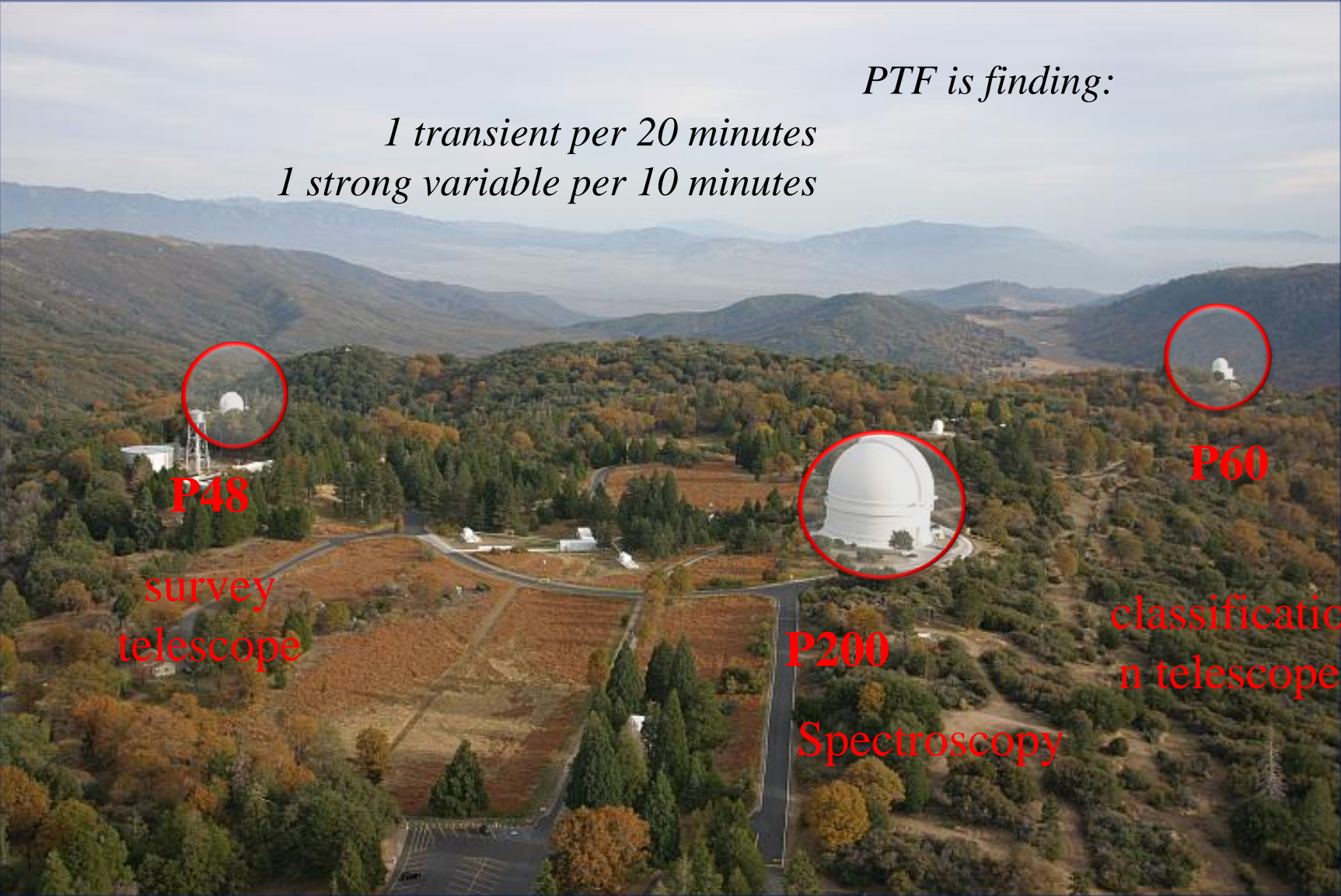


There is nothing like searching, if you want to find something.
You usually find something, if you search,
but it is not always quite the something you were after.

Thorin Oakenshild

PTF is finding:

*1 transient per 20 minutes
1 strong variable per 10 minutes*



P48

survey
telescope



P200

Spectroscopy

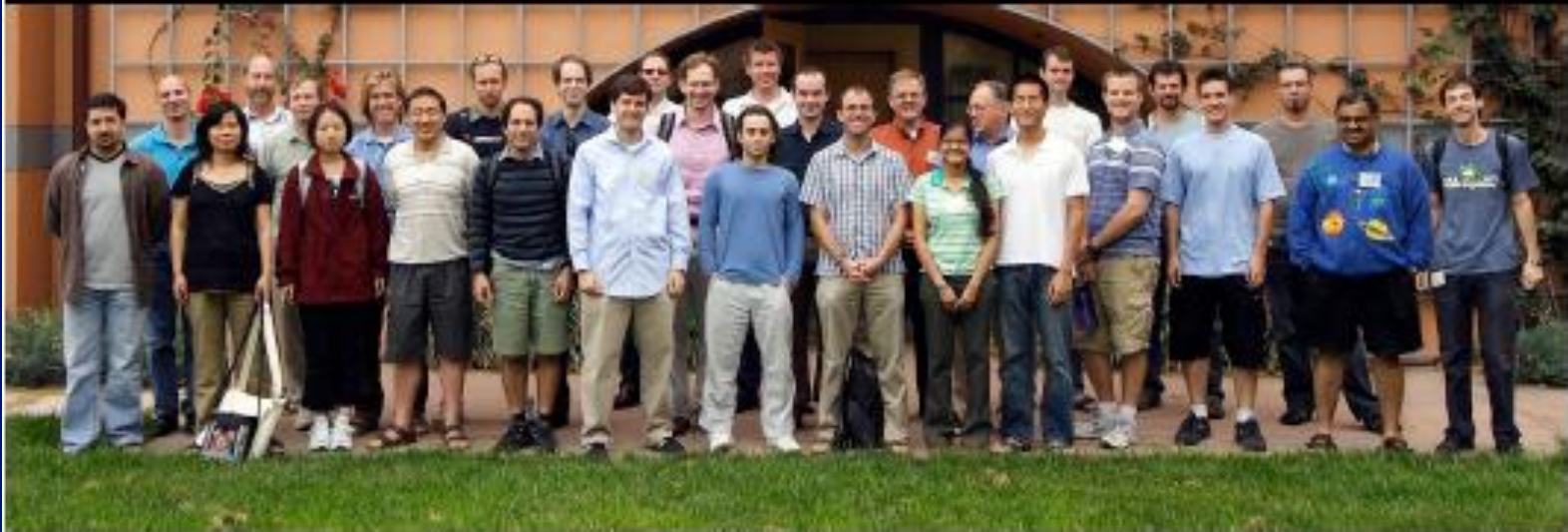


P60

classification
telescope

Thanks

PTF collaboration



Caltech, LCOGT, Berkeley, LBL, IPAC, Columbia, Oxford, Weizmann



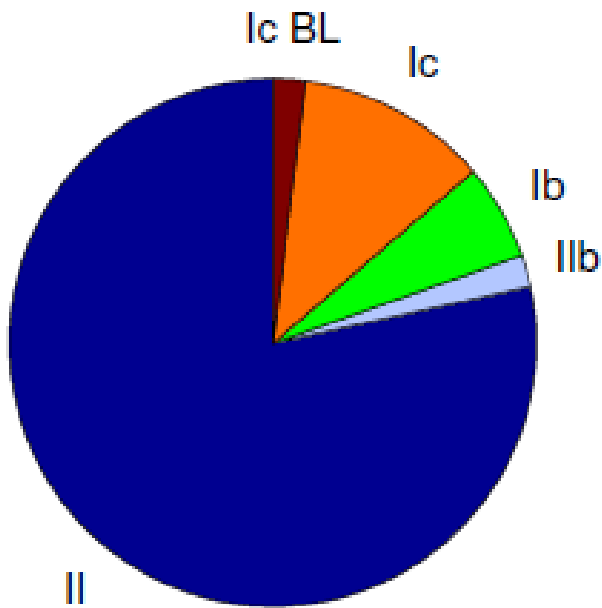
The Core-Collapse Key Project



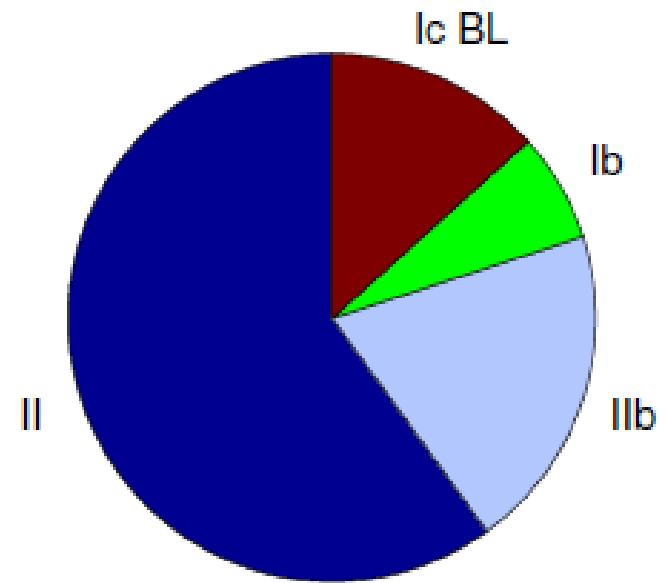
- Study the population of CC SNe
- Focus on dwarf galaxies
- New types?
- Very early events

Supernovae: dwarf vs. giant hosts

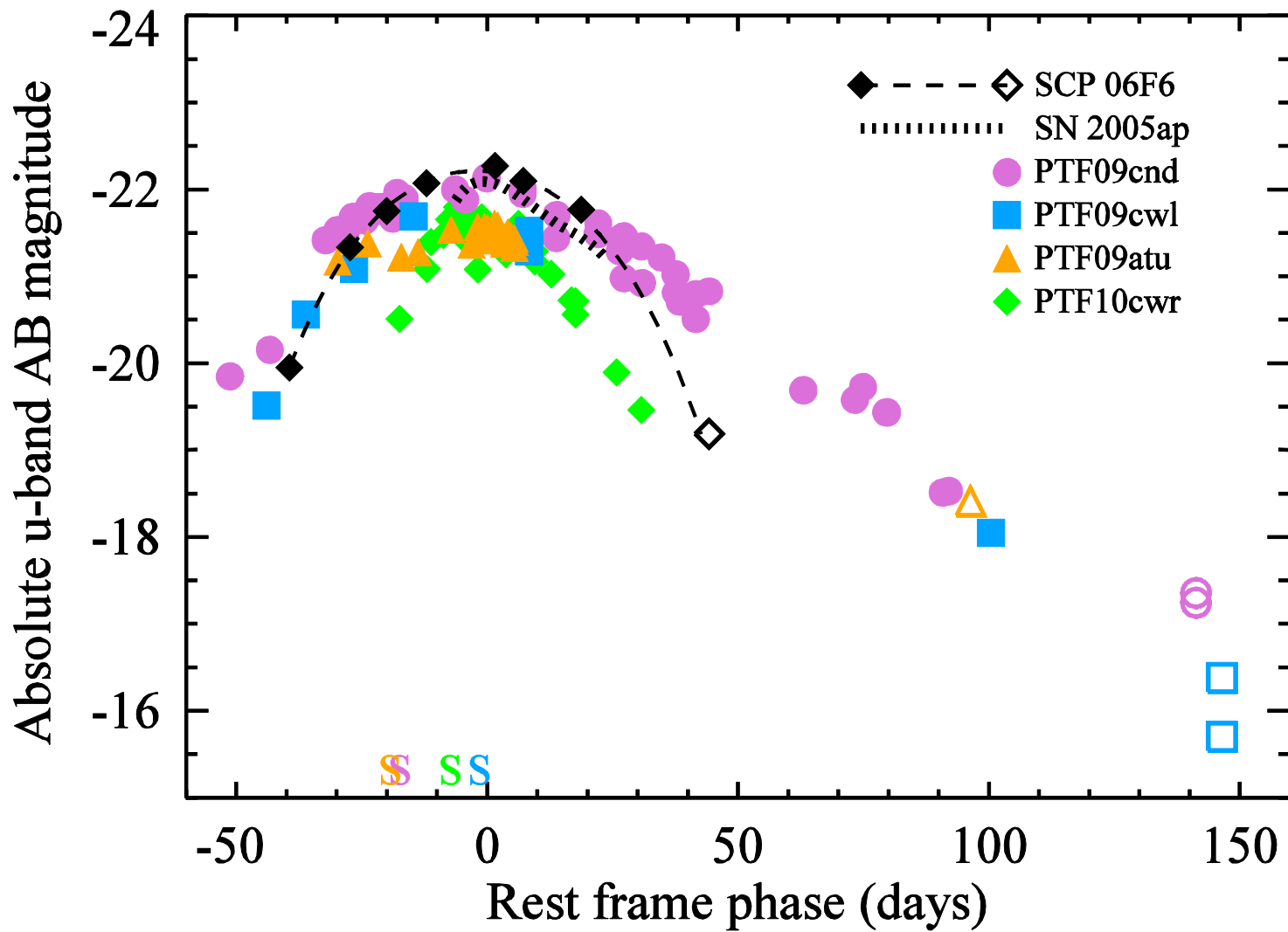
Giant Hosts (52)



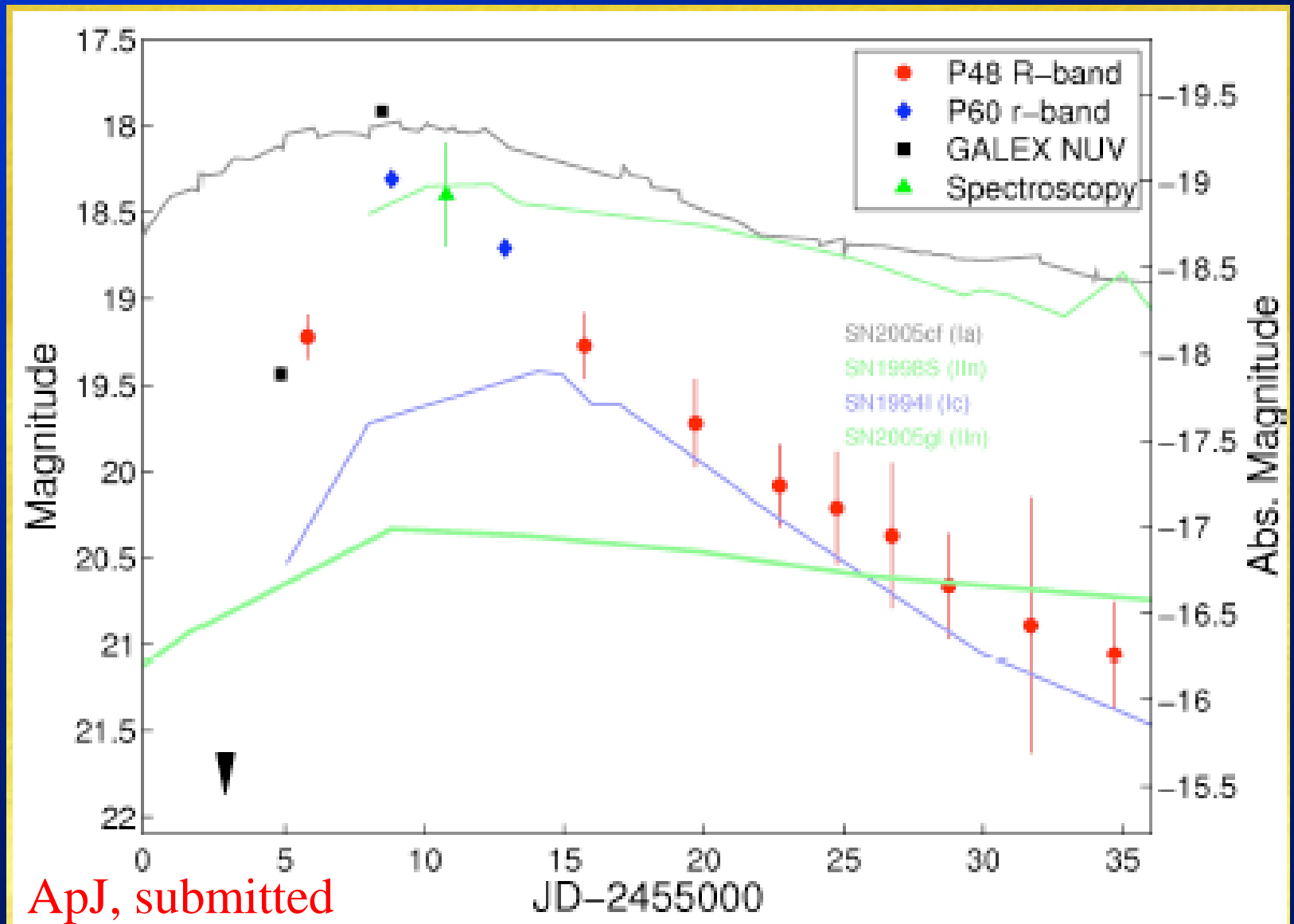
Dwarf Hosts (15)



Luminous blue SNe (Quimby)



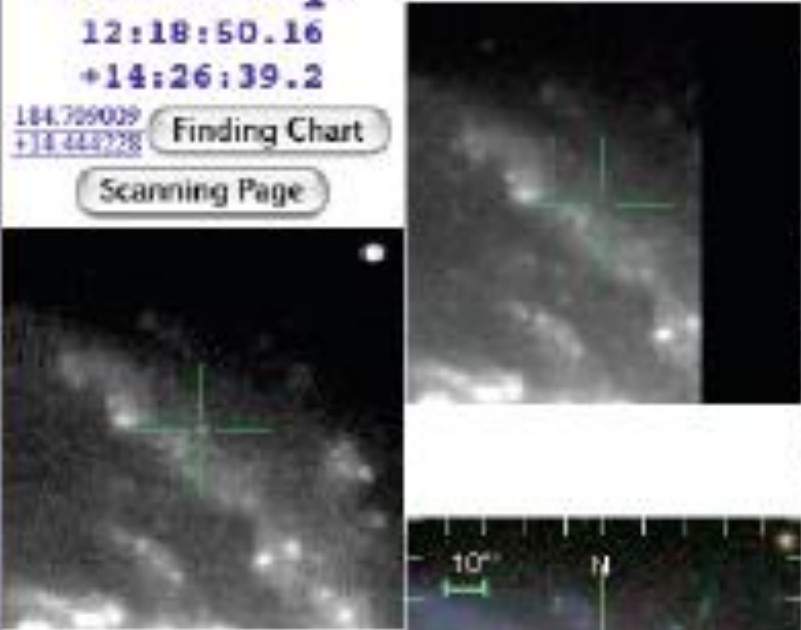
Shocking news (Ofek)



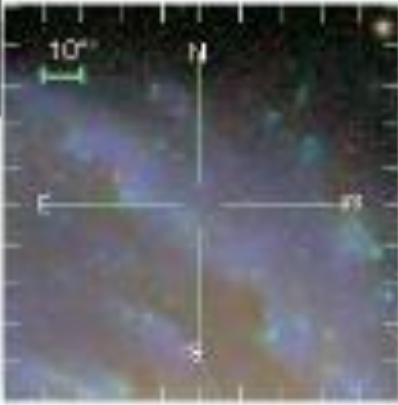
“Gap” objects (Kasliwal)

PTF 10fqs
12:18:50.16
+14:26:39.2
184.709029
+14.447738

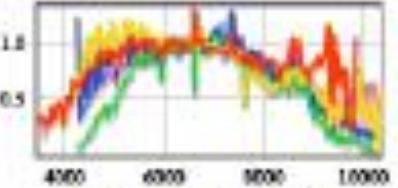
[Finding Chart](#)
[Scanning Page](#)



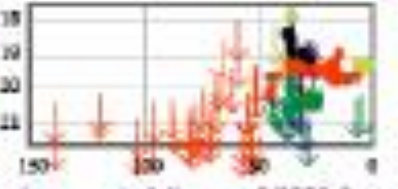
[Check NED](#)
[Check SIMBAD](#)
[Get DSS Image](#)
[Check Skyview](#)



r = 19.6 (6.0 d)

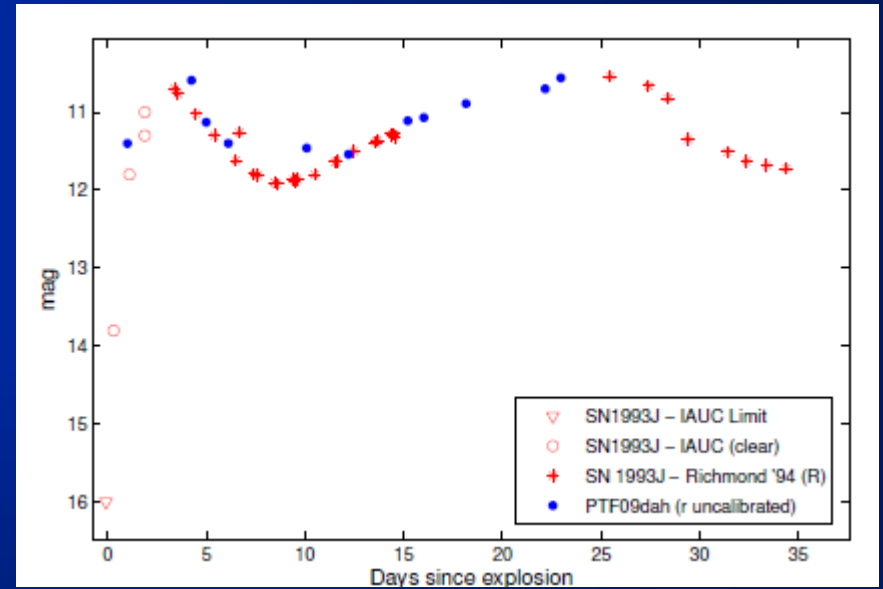
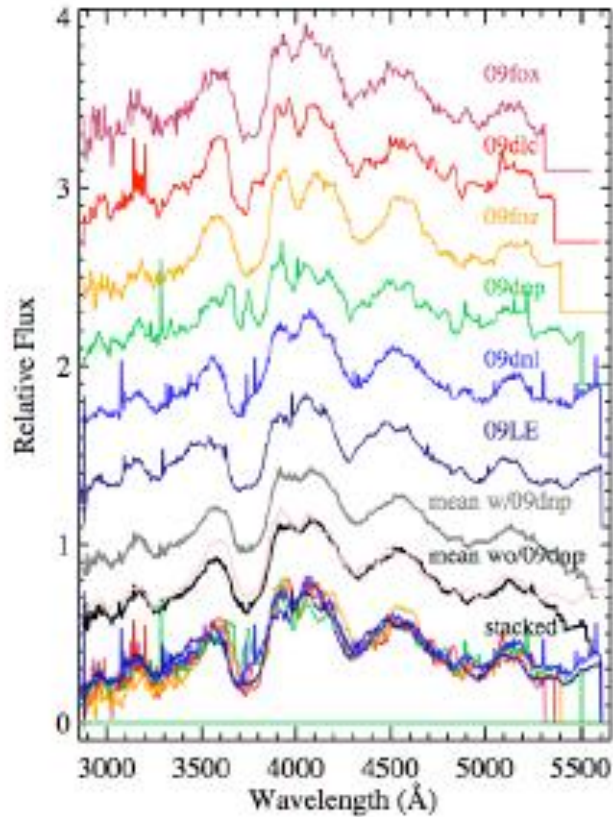


no spec flag scheduled
[Upload New Spectrum](#)



photometric follow-up 8/30/03 date
[Upload New Photometry](#)

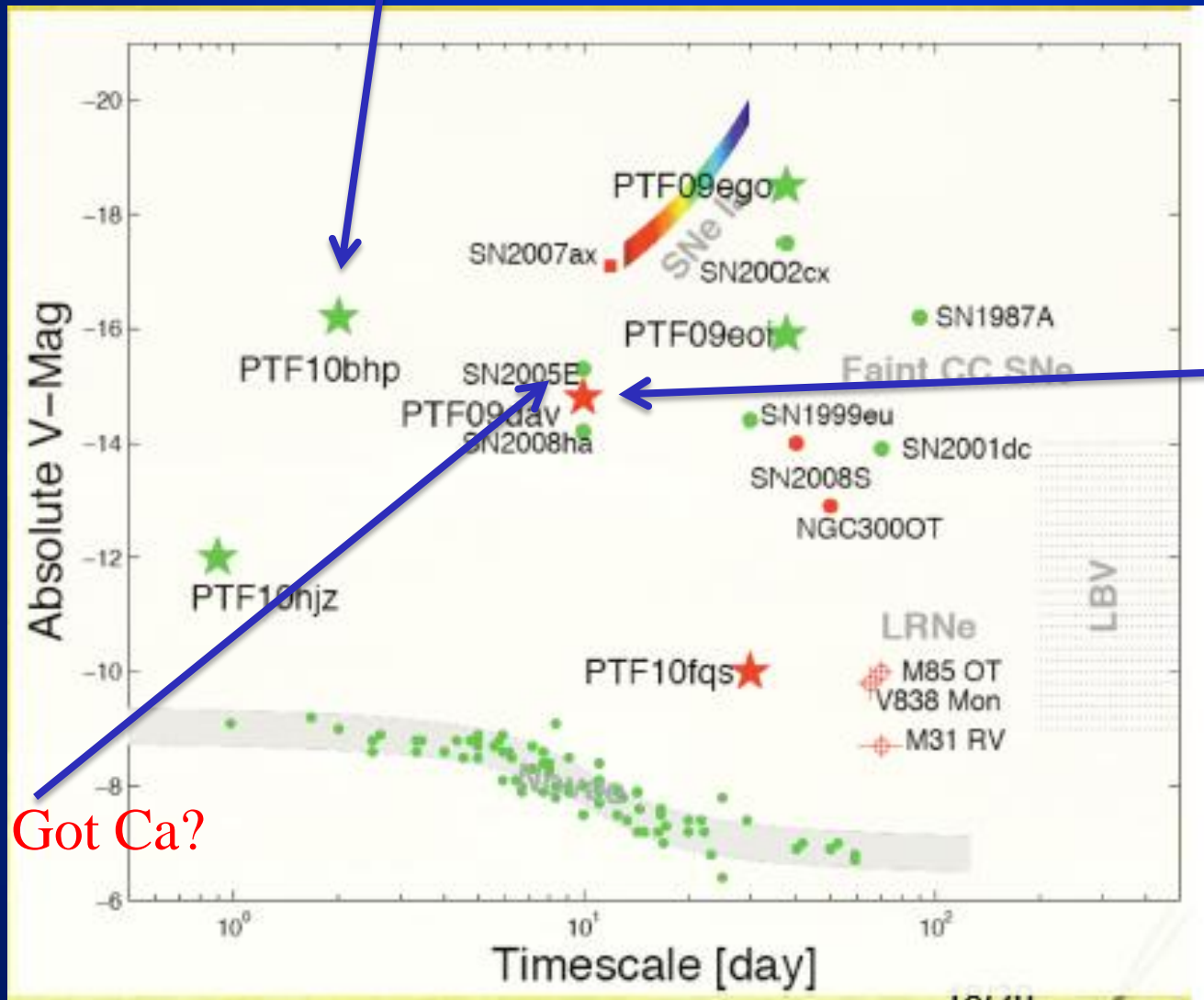
Baby Supernovae: the first days



Core-collapse SNe: Arcavi

SNe Ia: Nugent, Sullivan, Howell, Ellis

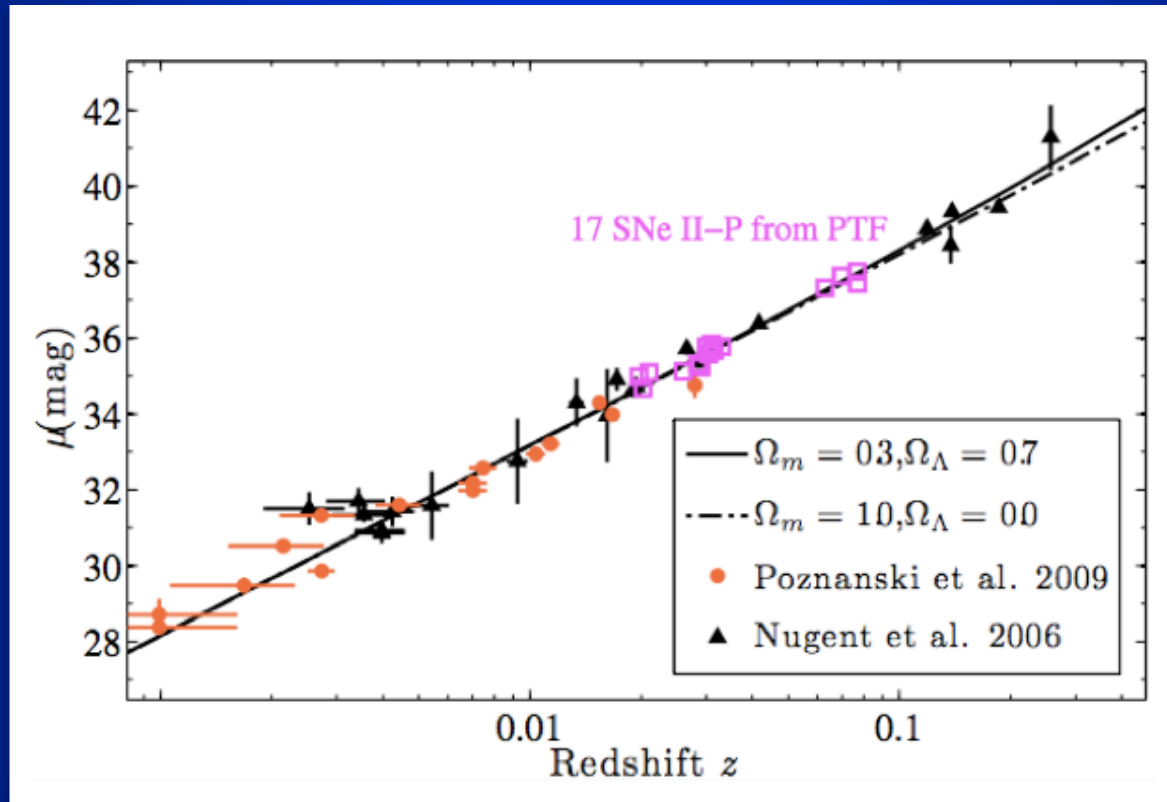
Fast transients ... ?



Got Ca?

Got
Scandium?

II-P Cosmology



- Photometry - piggy-back on core-collapse project.
- Spectroscopy - dedicated time with Keck + random.

Follow-up is key ...

PTF09dfk

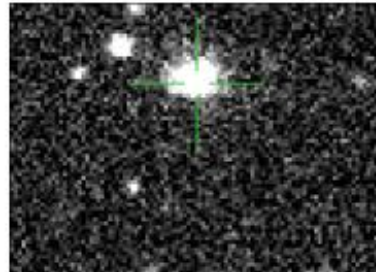
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+07:48:15.4

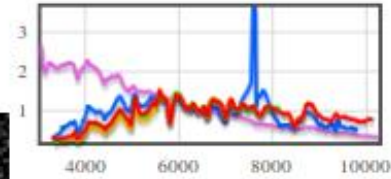
[347.305930](#)
[+7.804291](#)

[Finding Chart](#)

[Scanning Page](#)

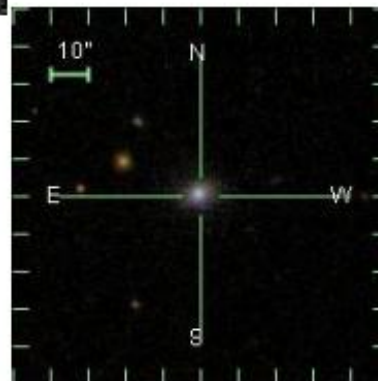
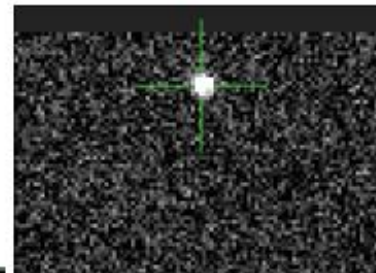


SN Ib/c



[no spec fup scheduled](#)

[Upload New Spectrum](#)



r = 16.4 (154.8 d)

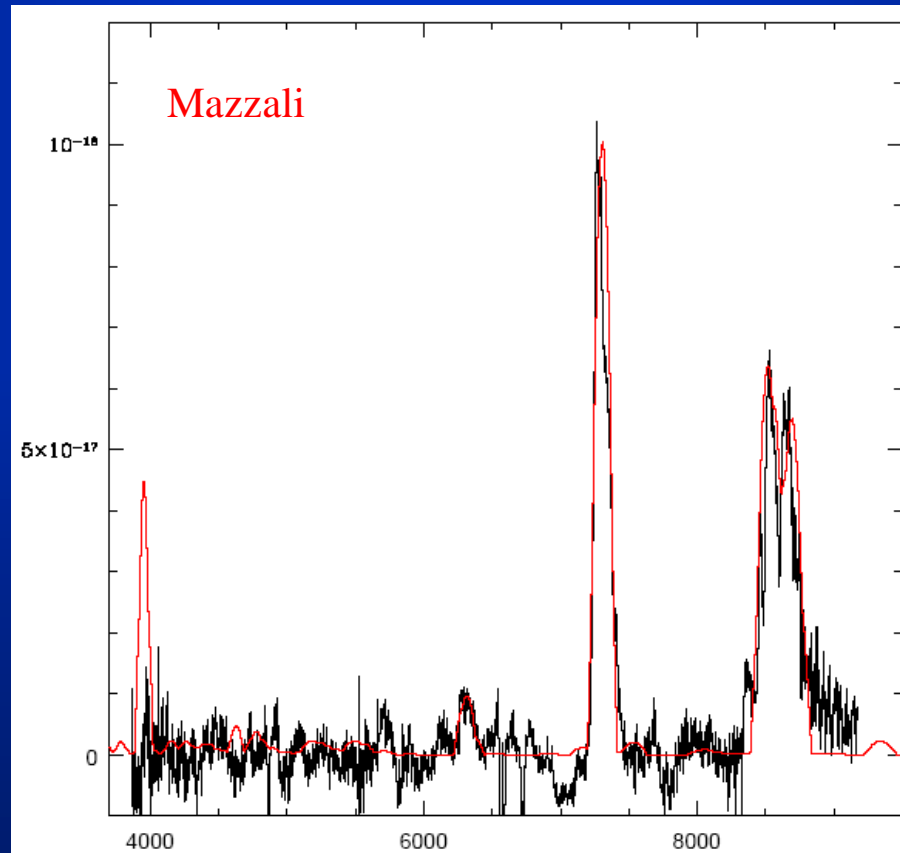


[Check NED](#)

[Check SIMBAD](#)

[Get DSS Image](#)

SN 2005E (Perets et al. Nature)



Peculiar abundances (C, O, Ca, Ni56) = (0.1 0.037 0.135 0.003) solar

Total ejected mass is < 0.3 solar !

PTF news ... SNe Ia?

