

PERSPECTIVE ON BRIGHT TYPE II EVENTS

Robert Quimby (Caltech)

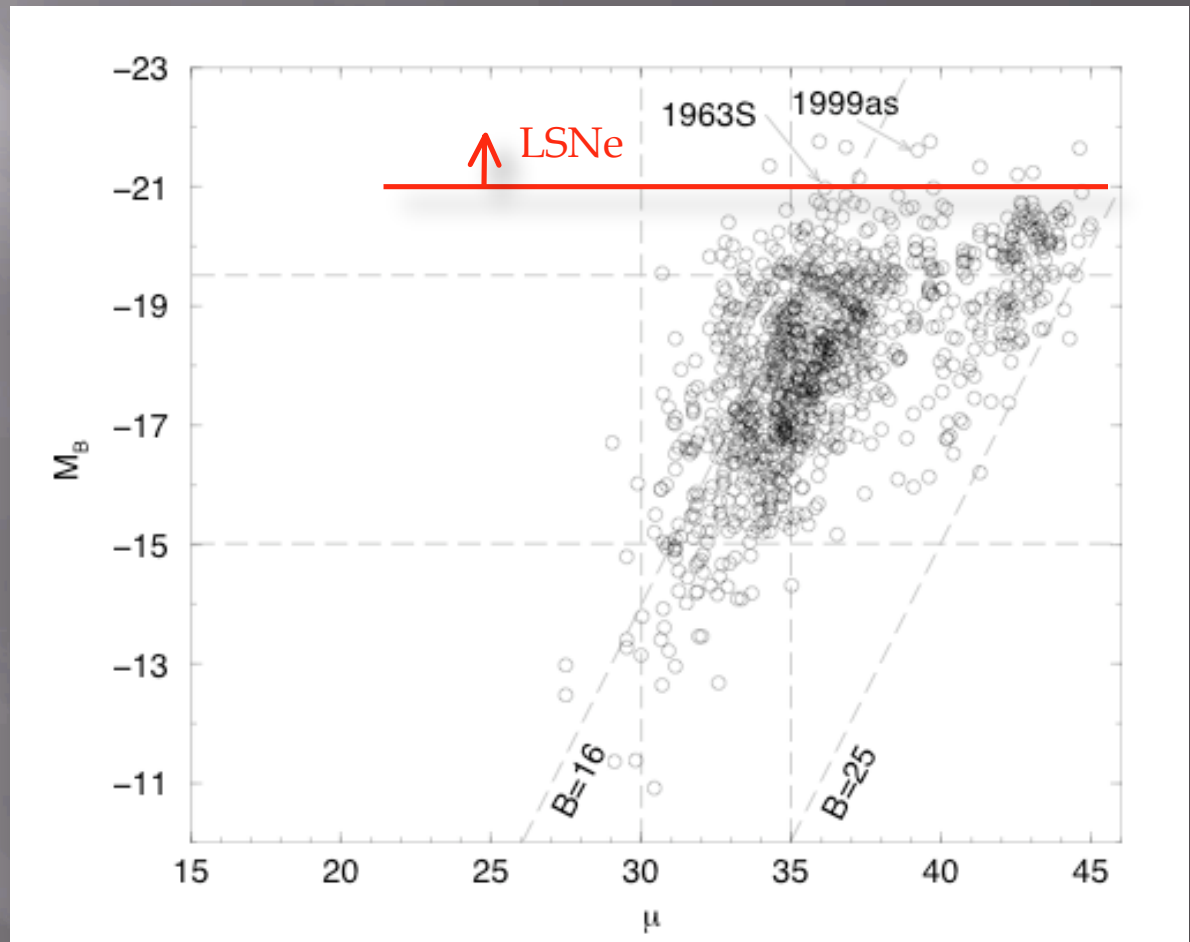
August 20, 2009

Topics

- ▣ **Review of LSNe discoveries/observations**
- ▣ **LSNe rates from TSS/RSVP (ROTSE-III)**

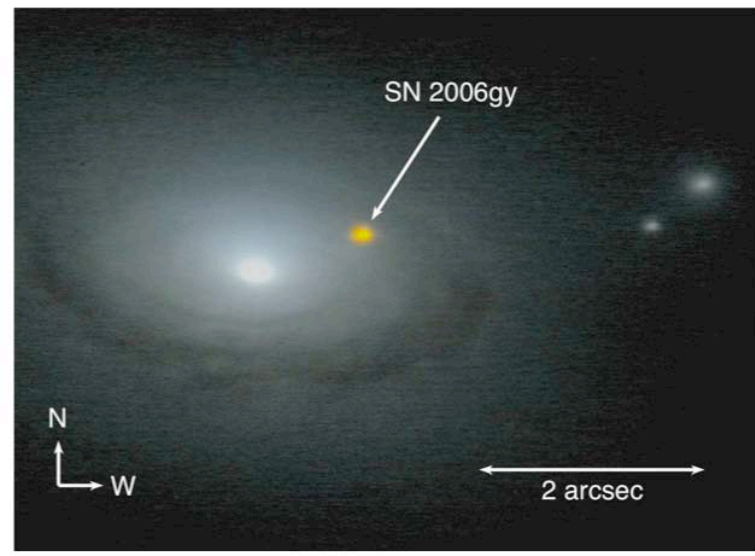
What We're Talking About

SNe with peak absolute (optical) magnitudes brighter than -21 are Luminous Supernovae (LSNe)

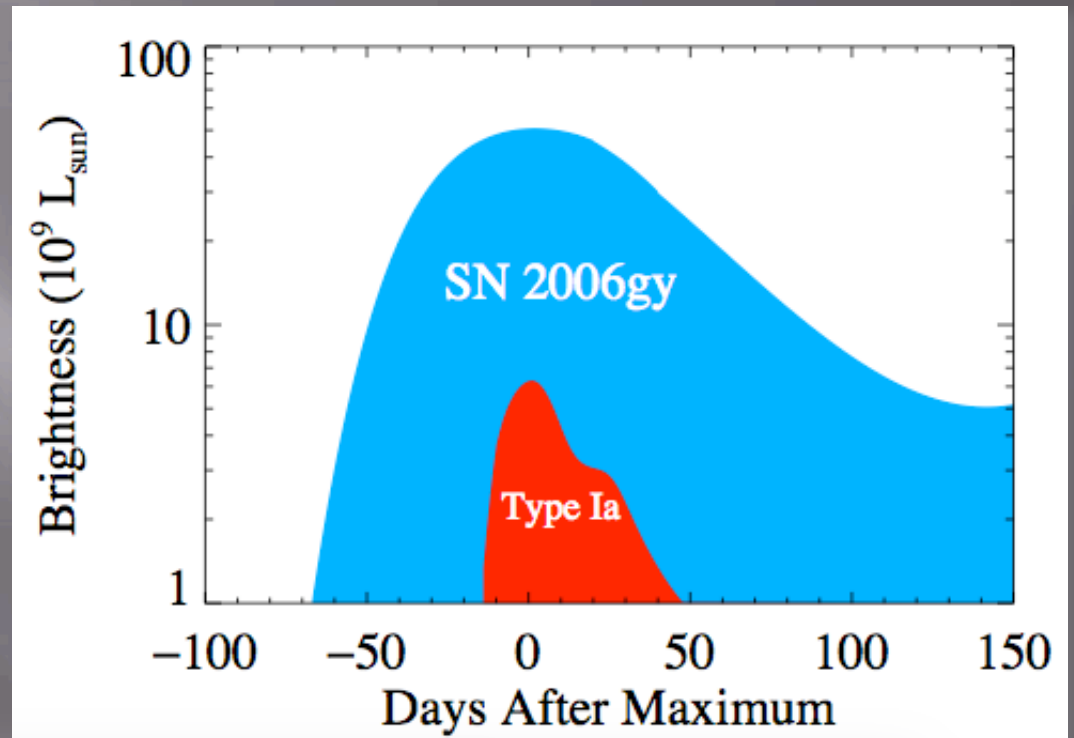


Richardson et al. 2002

SN 2006gy



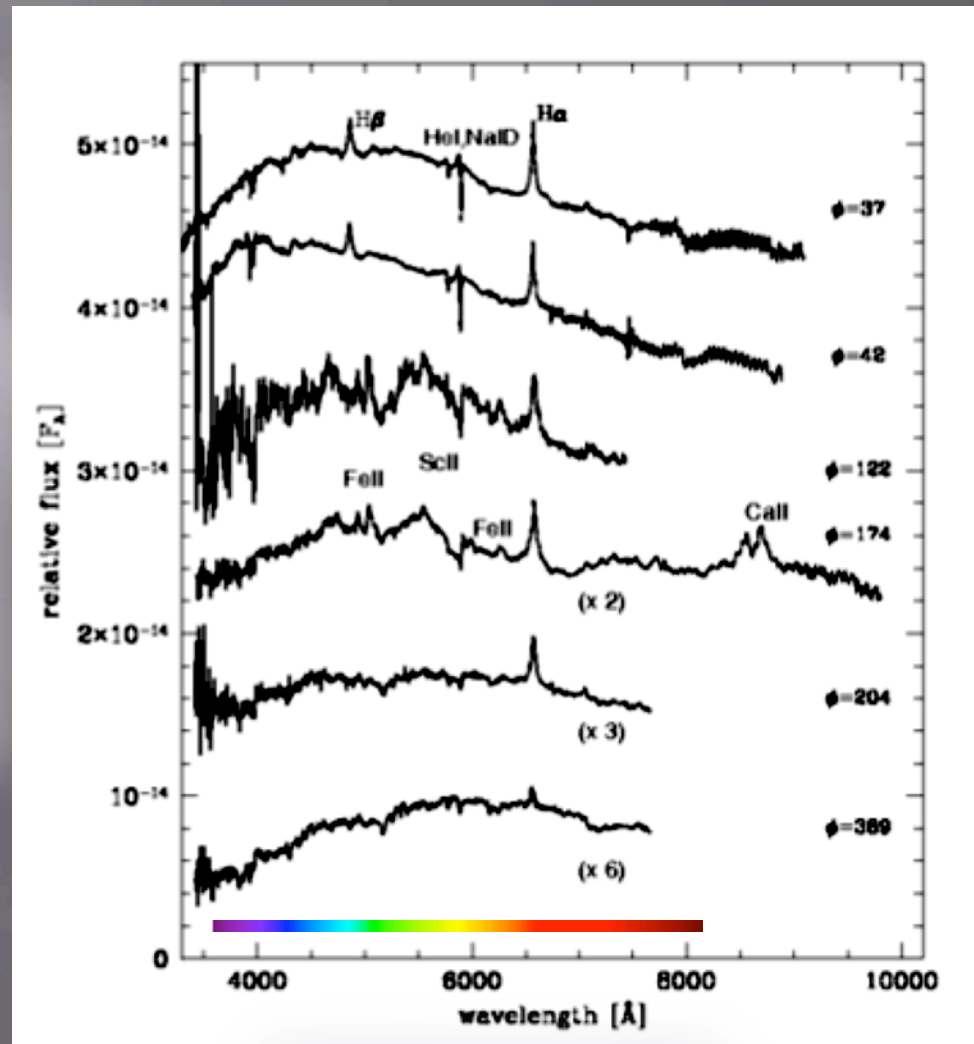
Smith et al. 2008



- Peak absolute magnitude nearly -22
- Brighter than -21 mag for ~100 days
- Integrated light $>10^{51}$ erg
- See: Ofek+ 2007, Smith+ 2007, Smith & McCray 2007, Agnoletto+ 2009, Kawabata+ 2009...

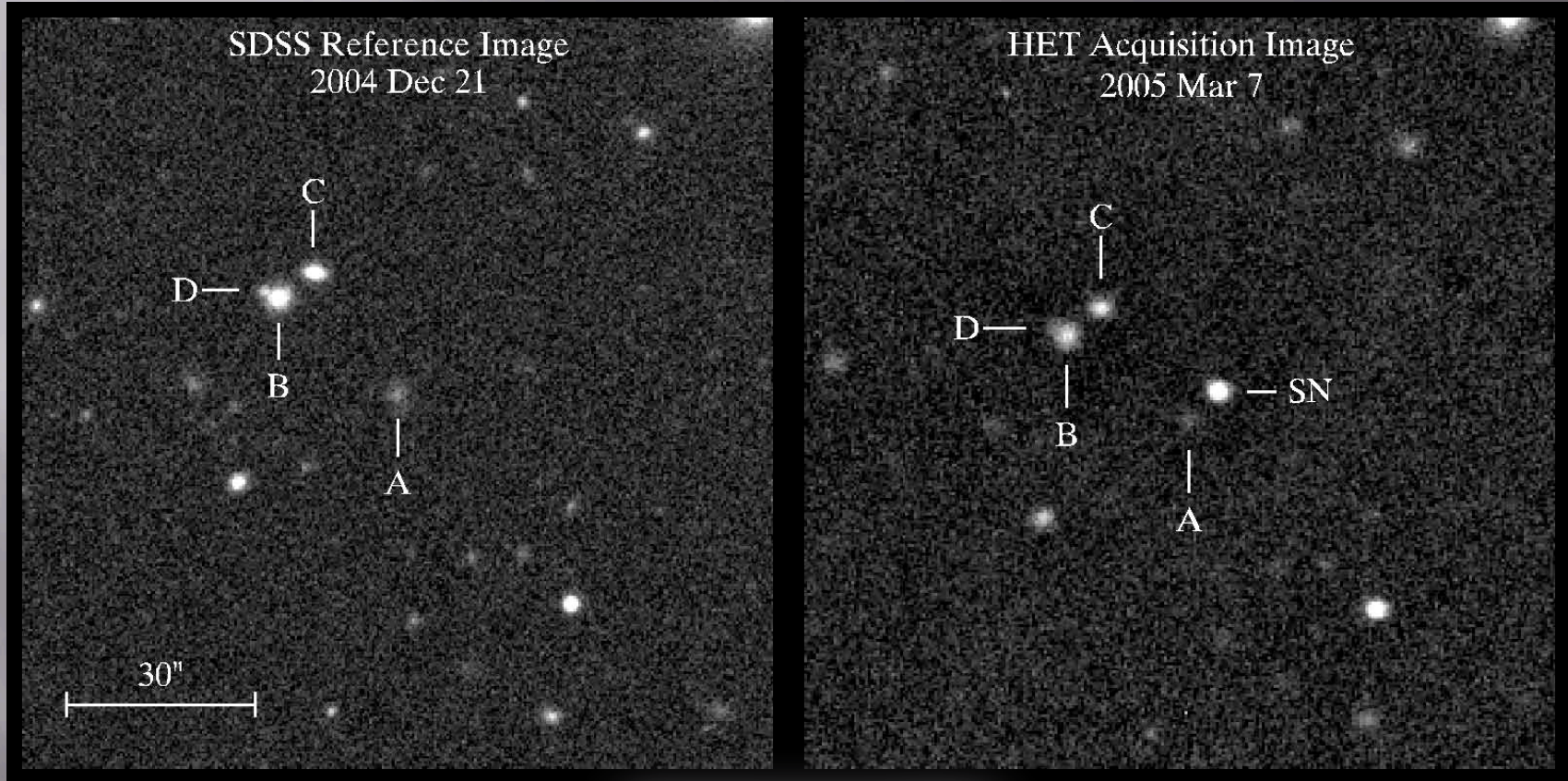
2006gy Spectral Evolution

- Prominent $H\alpha$ and $H\beta$ (broad+narrow) in early spectra
- Deep, narrow NaI D absorption (1.5 mag of extinction)
- Wealth of lines post-maximum



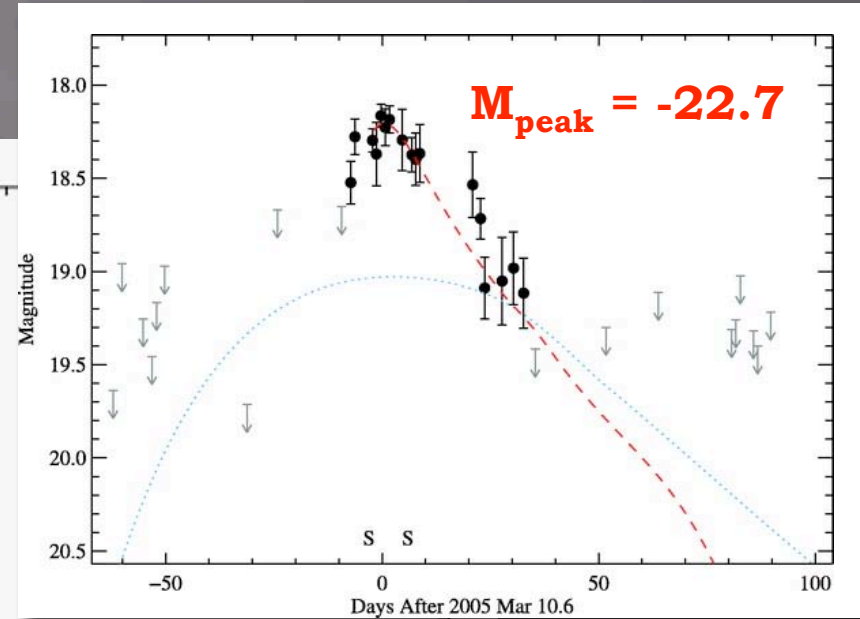
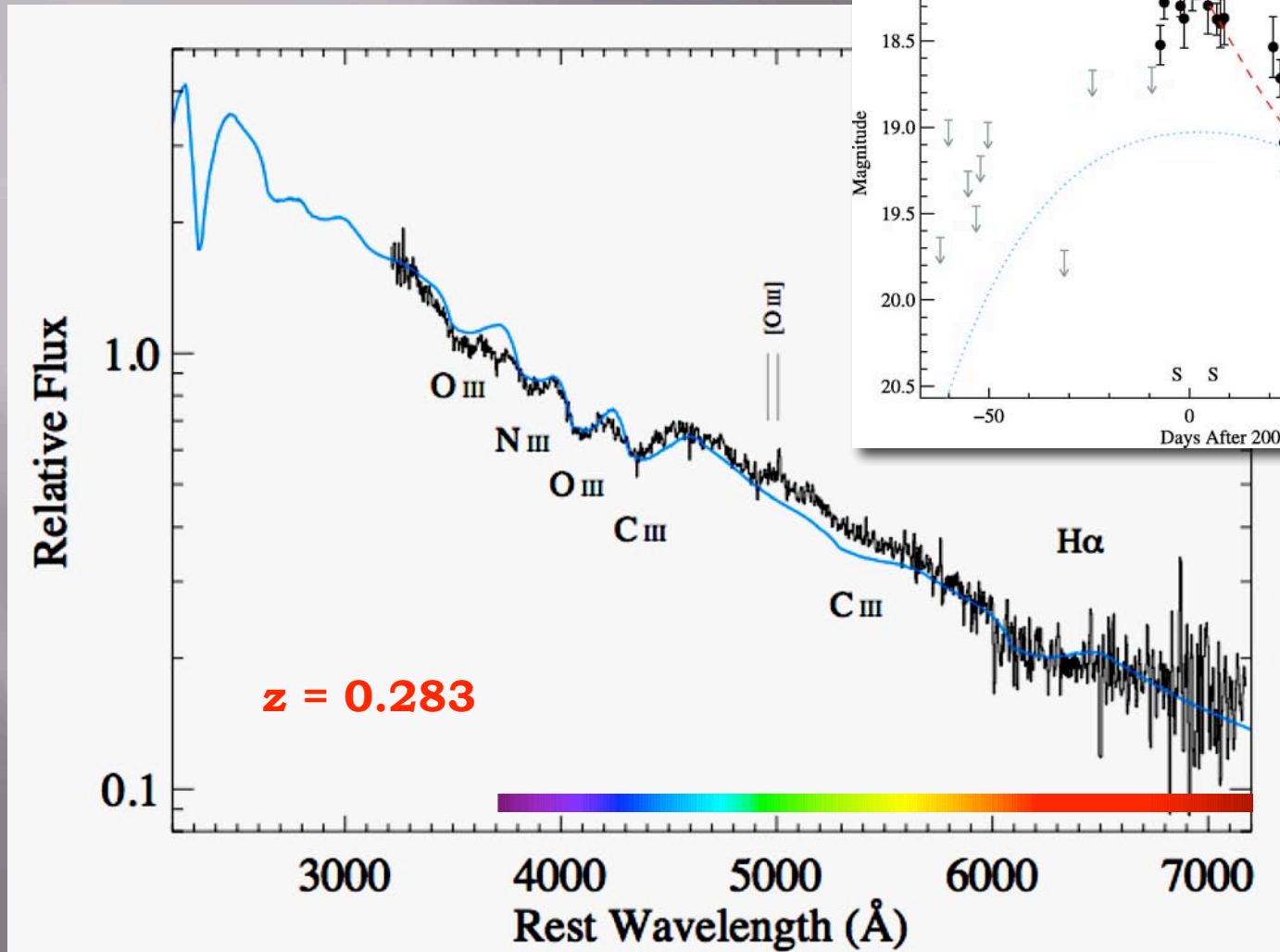
Agnoletto et al. 2009

SN 2005ap



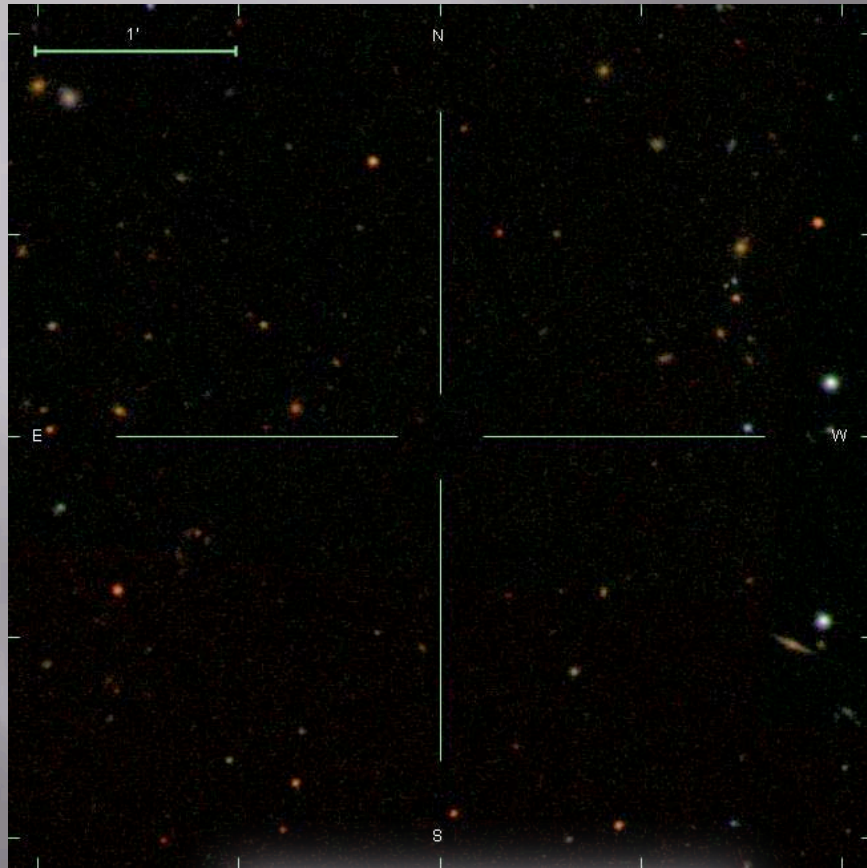
Quimby et al. 2007

SN 2005ap Observations

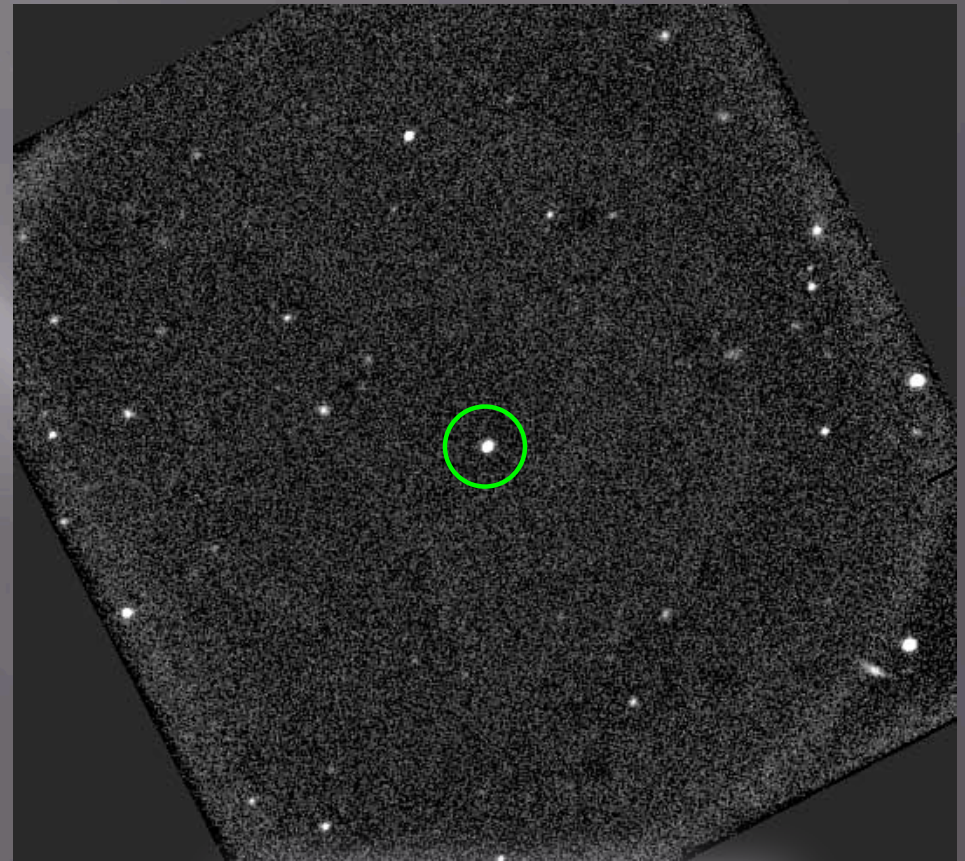


Quimby et al. 2007

SN 2008es

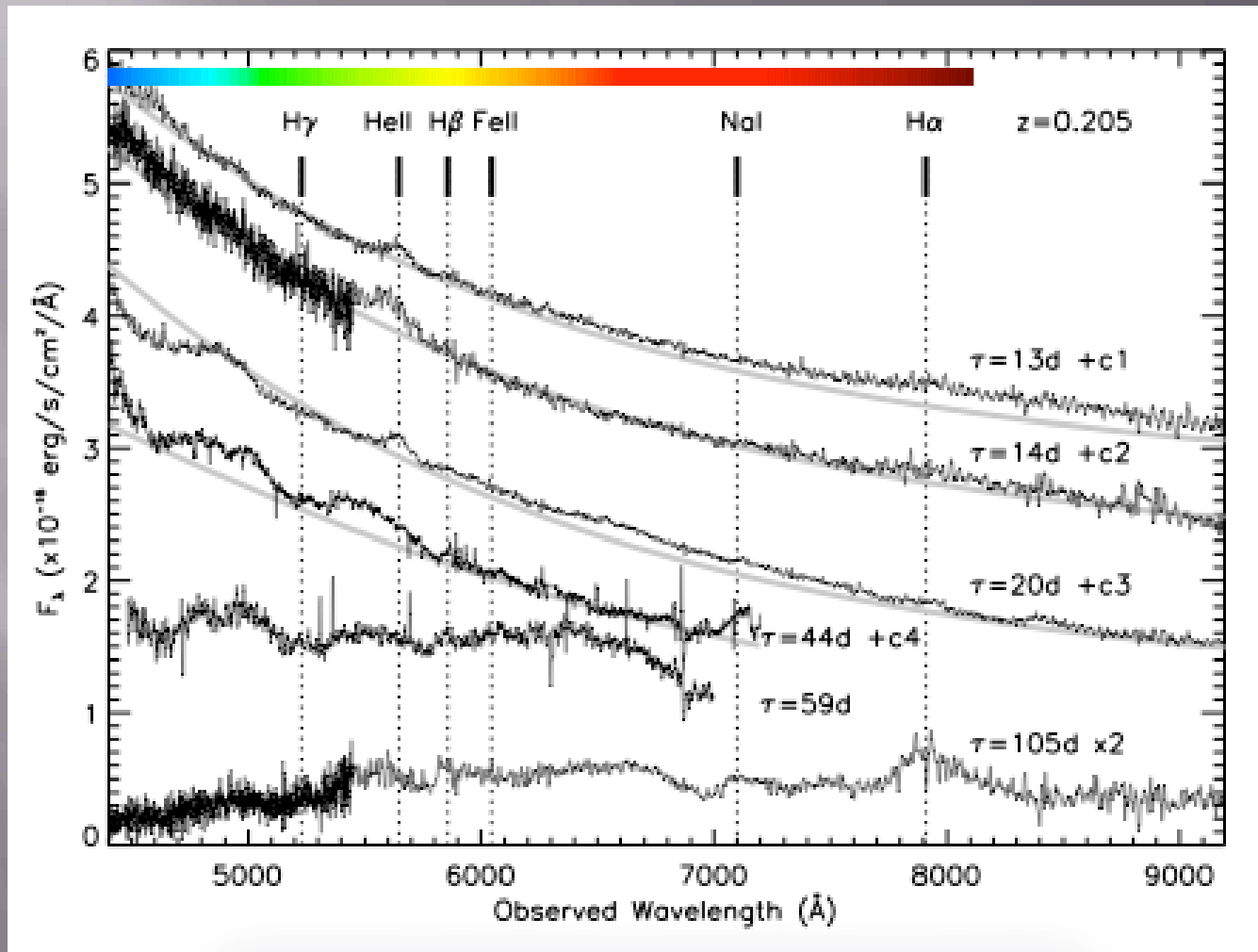


SDSS reference image



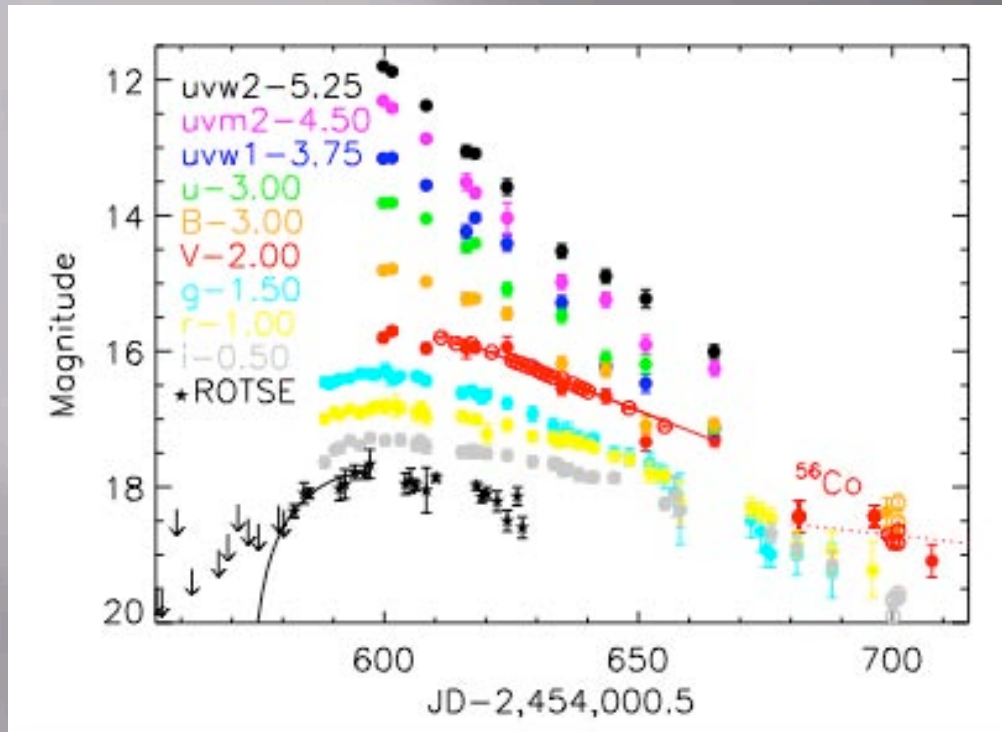
HET acquisition image

SN 2008es Spectra

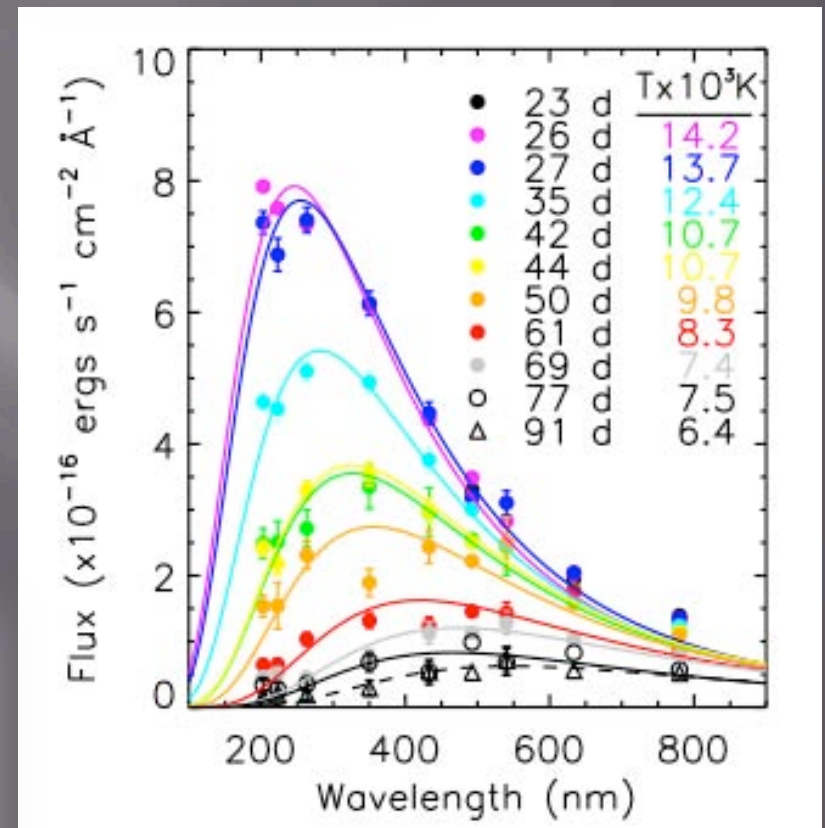


Gezari et al. 2009; see also Miller et al. 2009

SN 2008es Photometry

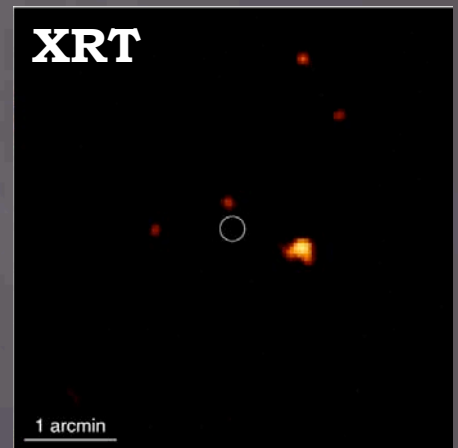
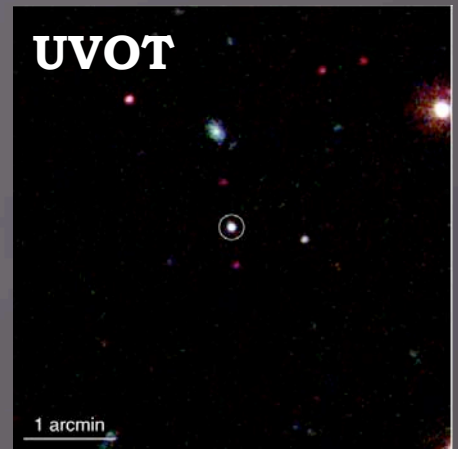
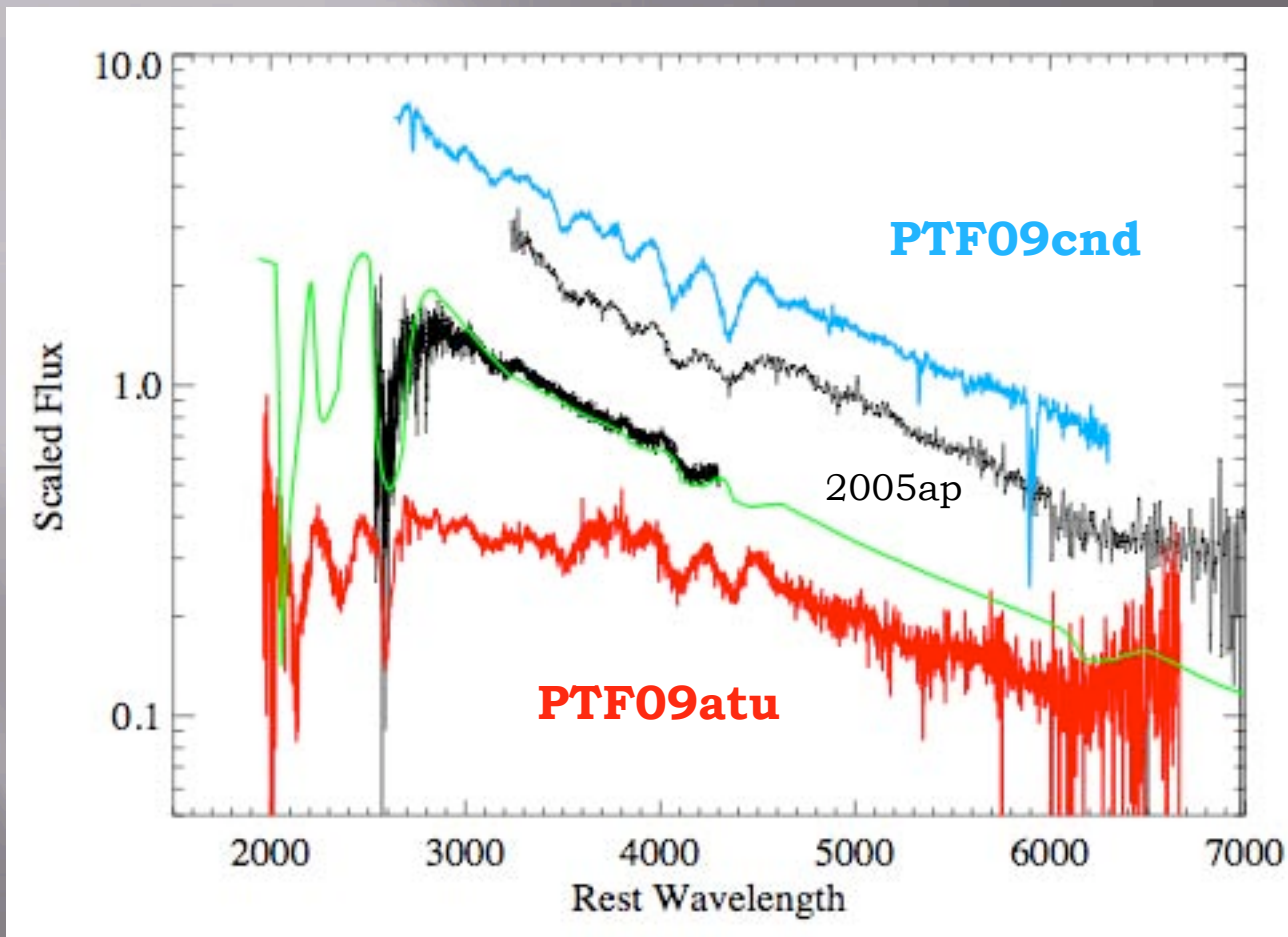


Gezari et al. 2009



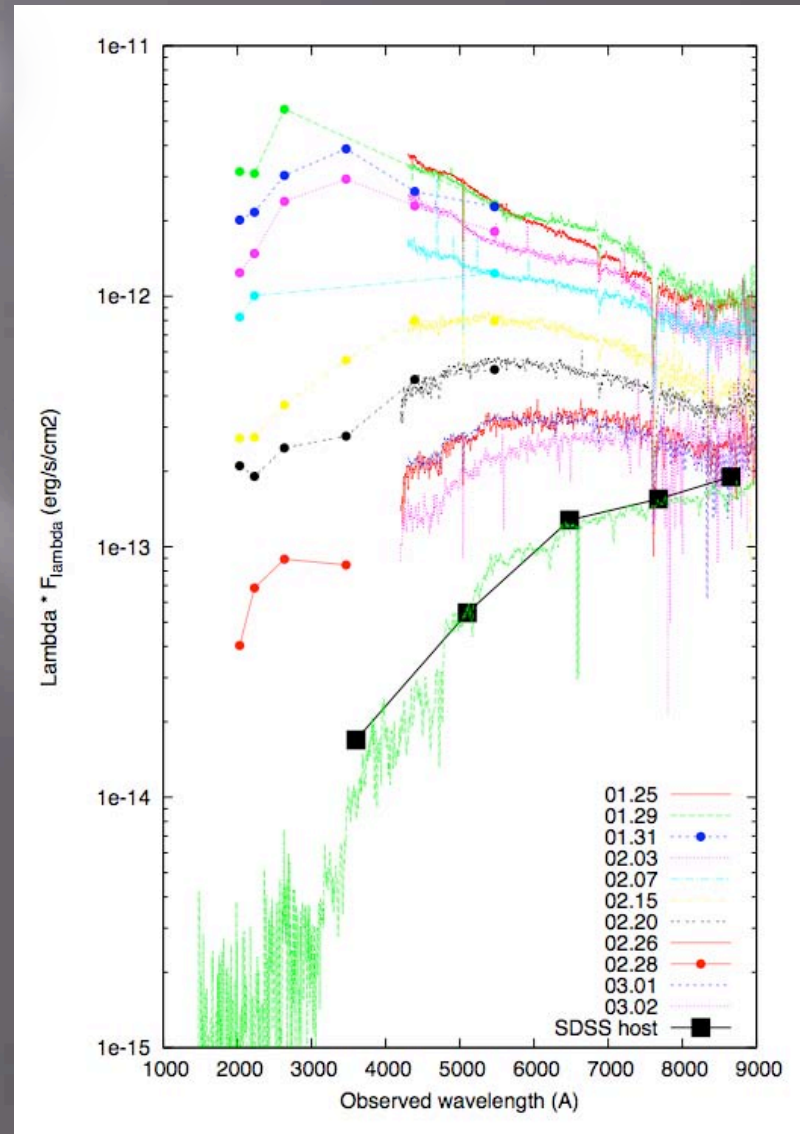
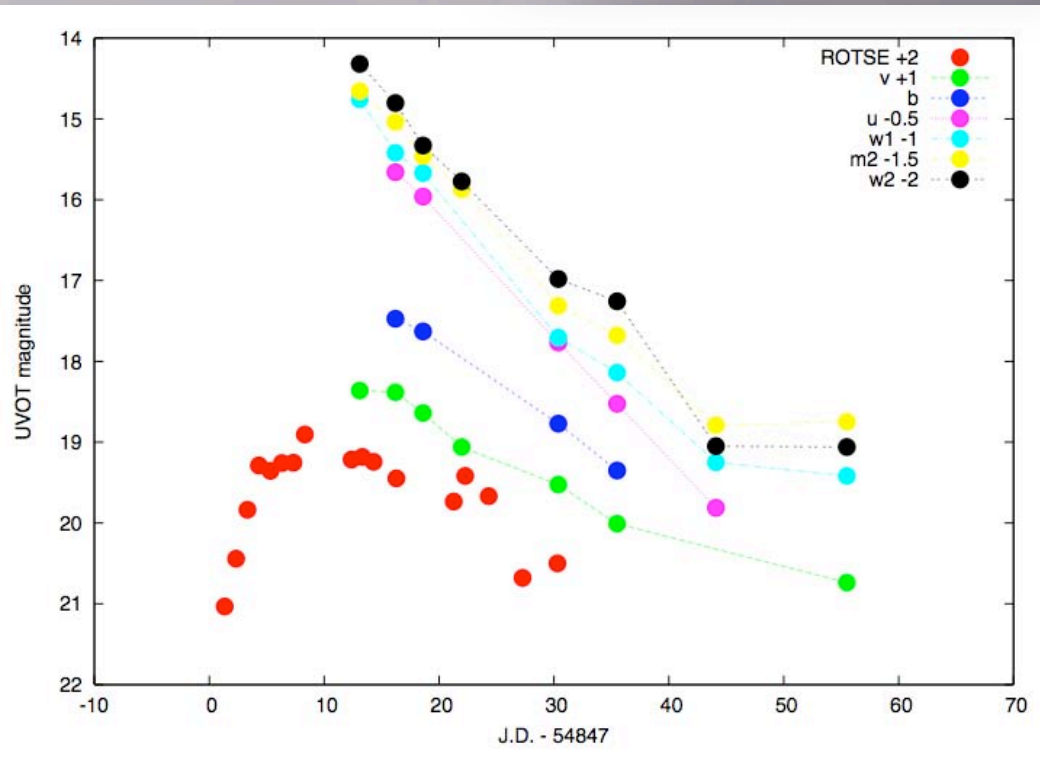
- Peak at -22.2 mag
- SED fit by 14000 K blackbody cooling to 6000 K

LSNe From PTF



New From ROTSE-III

Vinko et al. (in prep)



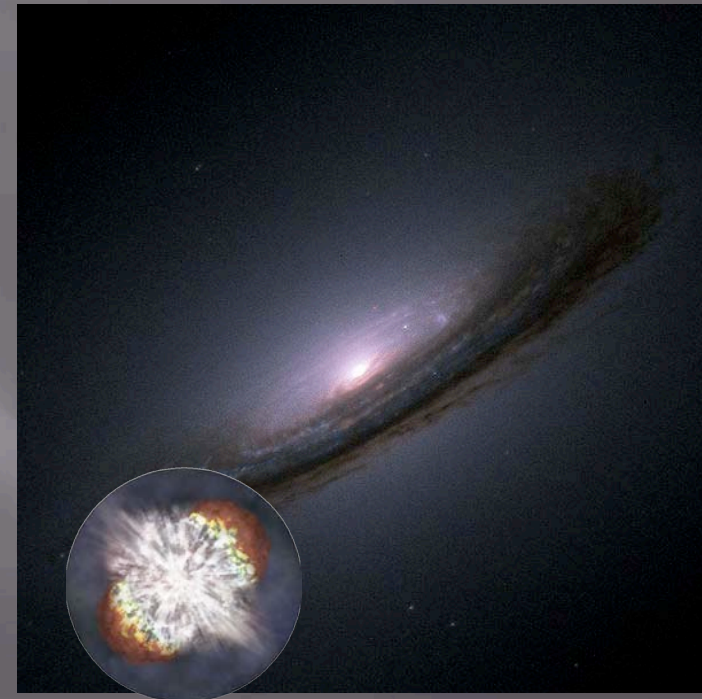
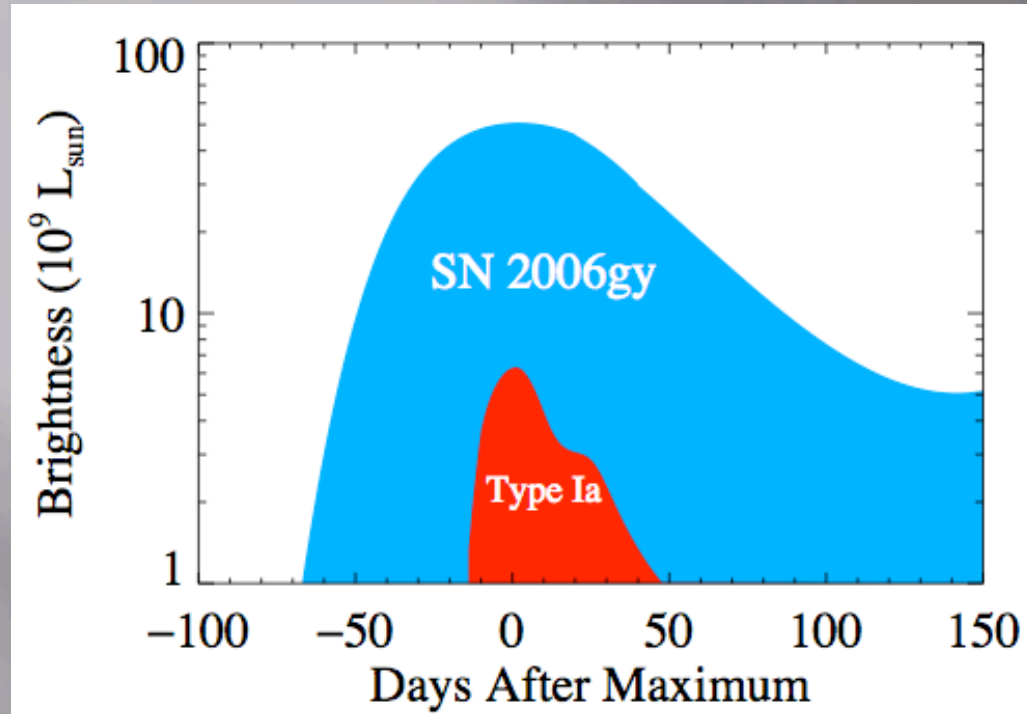
Dougie



Robert Quimby

Power Sources I

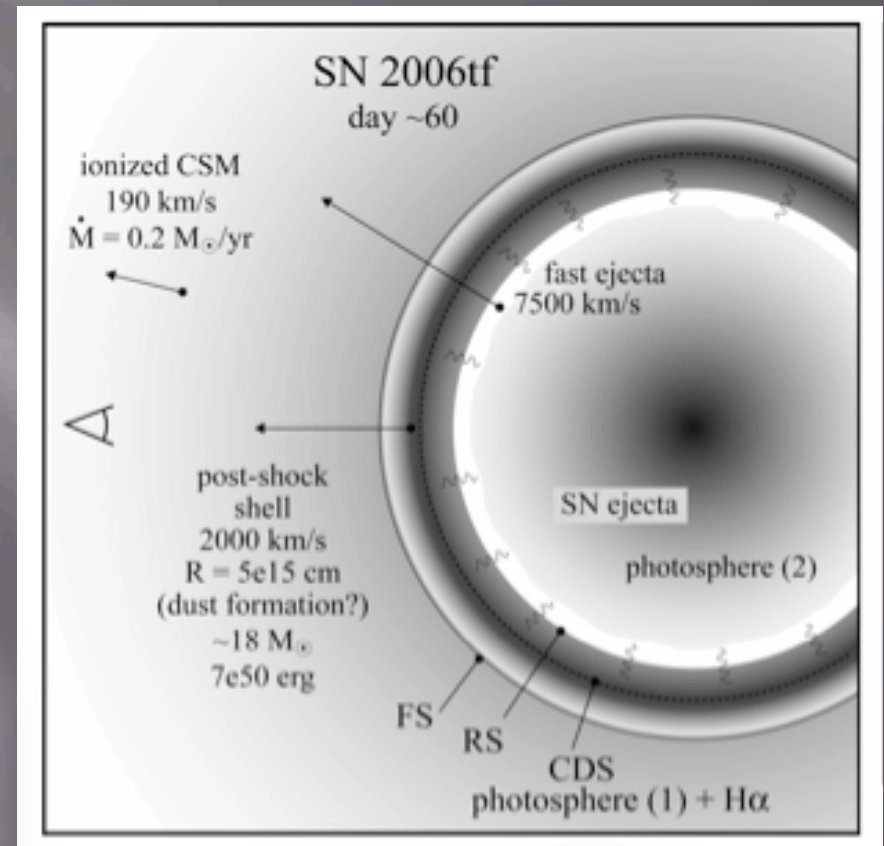
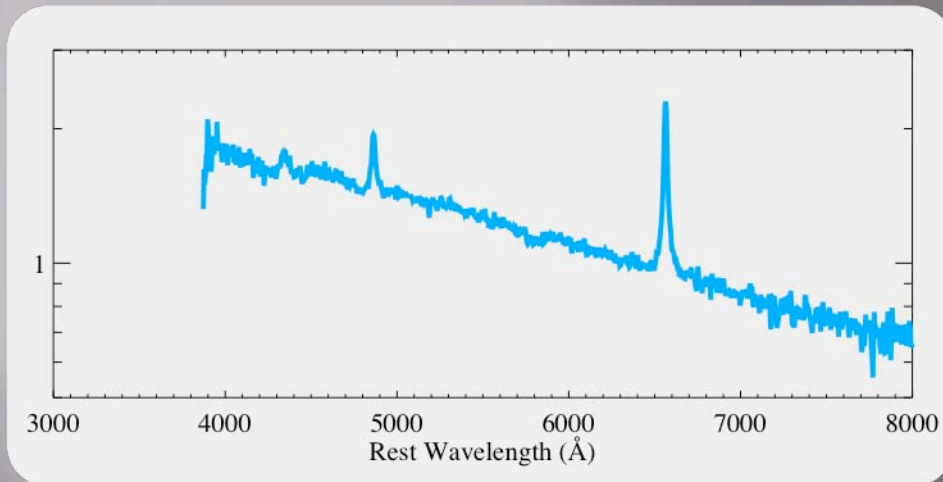
Radioactive Decay



- **Energy released by the radioactive decay of elements synthesized in the explosion (e.g. ^{56}Ni) is thermalized and re-radiated**

Power Sources II

Interactions

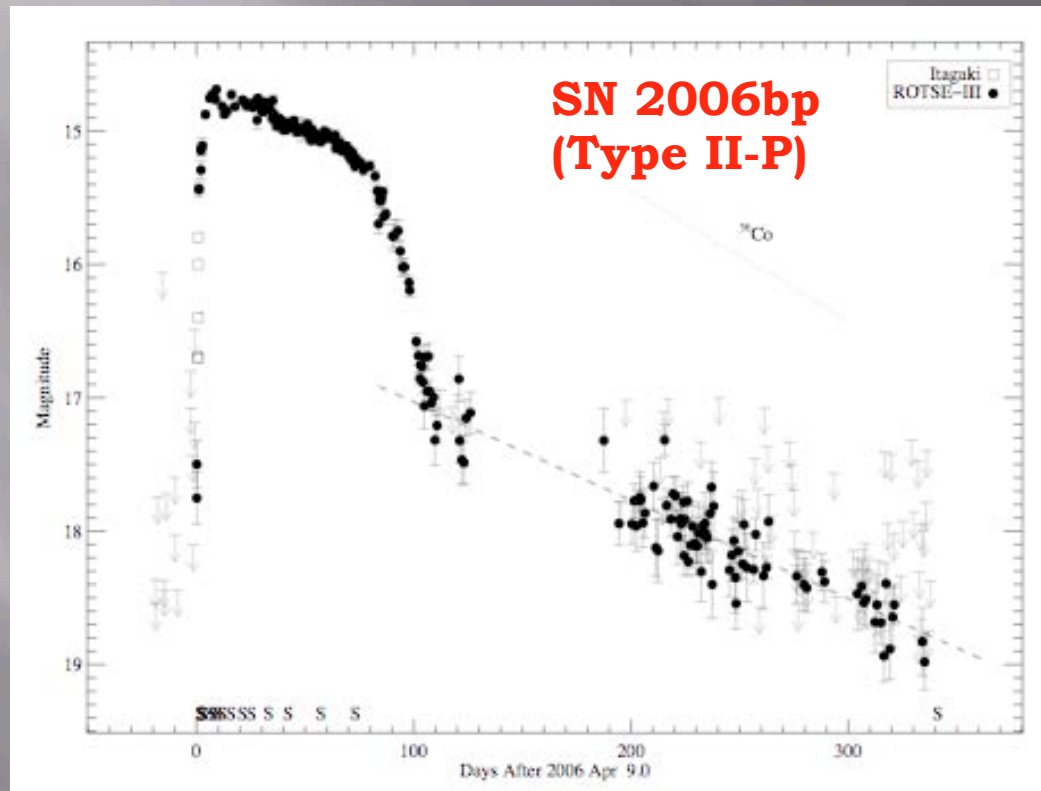


- **Ejecta run into surrounding material (progenitor wind, shells, etc.)**

Smith et al. 2008

Power Sources III

Recombination

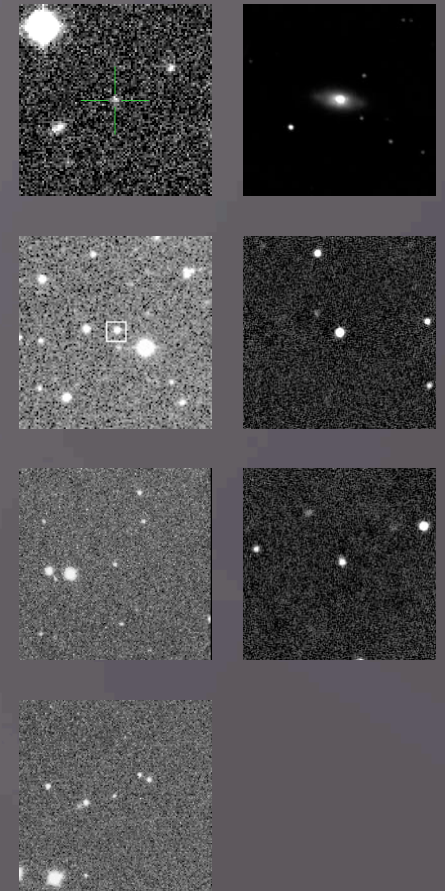
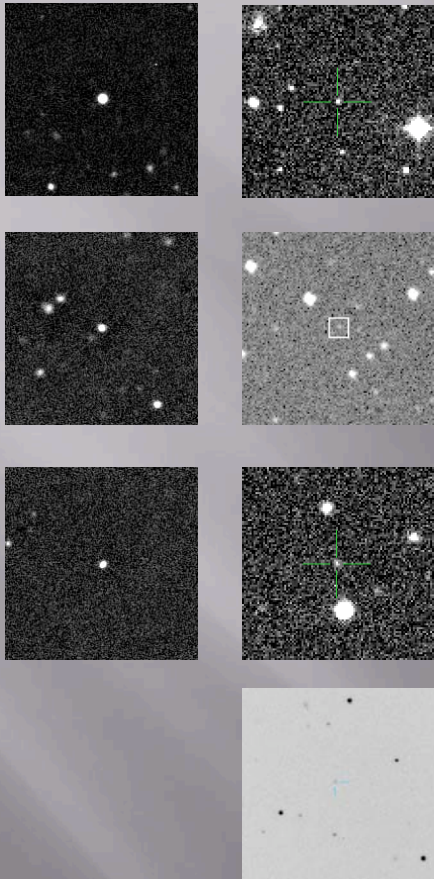


Quimby et al. 2007

- Material ionized by the blast wave recombines, releasing stored energy

The LSNe Sample*

Name	Absolute Mag	Group
SN 2005ap	-22.7	ROTSE-III
Dougie	-22.7	ROTSE-III
PTF09cnd	-22.5	PTF
SN 2008am	-22.3	ROTSE-III
CSS081009	-22.3	CRTS
SN 2008es	-22.2	ROTSE-III
PTF09atu	-22.0	PTF
SN 2006gy	-21.7	ROTSE-III
SN 1999as	-21.6	Spring '99 (SNF)
SN 1999bd	-21.6	Spring '99 (SNF)
SN 2007bi	-21.3	SNFactory
SN 2008fz	-21.1	CRTS
SM-2003	-21.1	SuperMACHO
SN 2006tf	-21.0	ROTSE-III
PTF09uy	-21.0	PTF
SN2007bw	-21	SNFactory



* these are the LSNe known to the speaker, not necessarily a complete listing.
Archival LSNe?

- SN 1988O (J. Mueller) – possibly peaked at -21.4 mag but...

LSNe From ROTSE-III



▣ TSS/RSVP

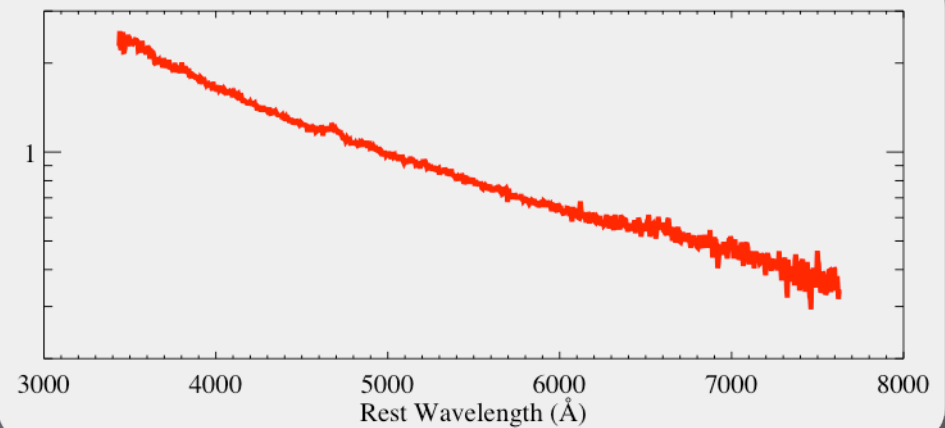
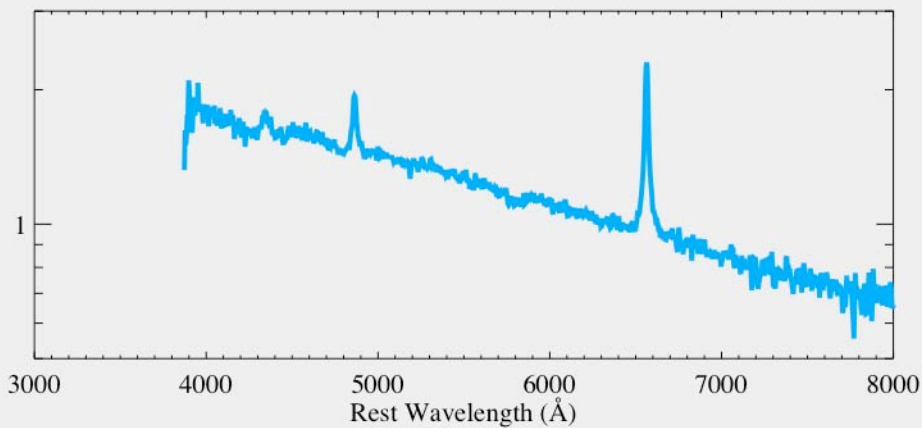
- 0.45-m ROTSE-IIIb telescope
- 1.85 X 1.85 degree FoV
- Began in Fall '04
- Target selection without (intentional) host bias
- High quality spectra of all transients
- ~80 SNe to date including 6 LSNe

$N > 2$, So...

Divide the sample into two groups

LSN-IIIn: luminous supernovae
with obvious interaction
signatures (i.e. narrow H-Balmer)

LSN: everything else

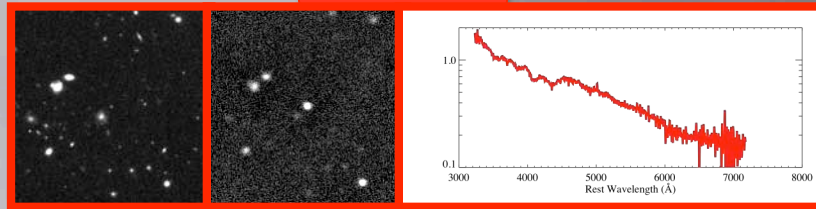


Rest Wavelength (Å)

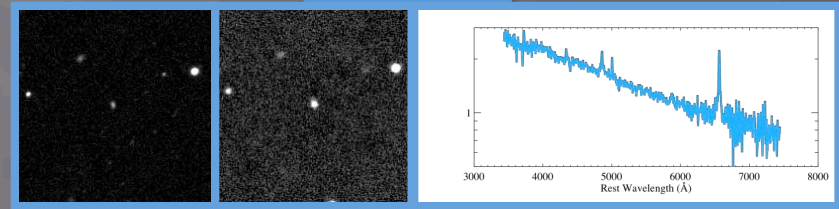
Rest Wavelength (Å)

The ROTSE-III LSNe Sample

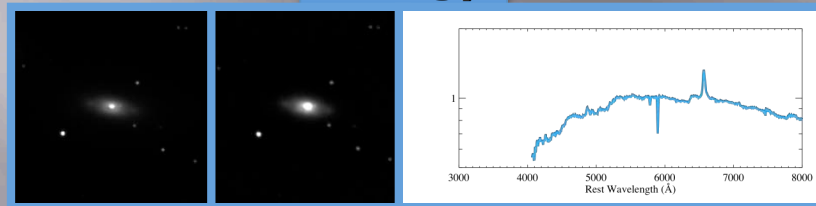
2005ap



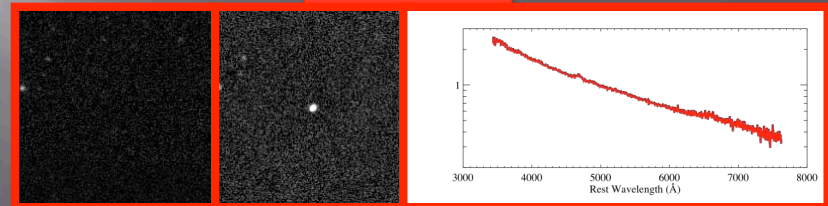
2008am



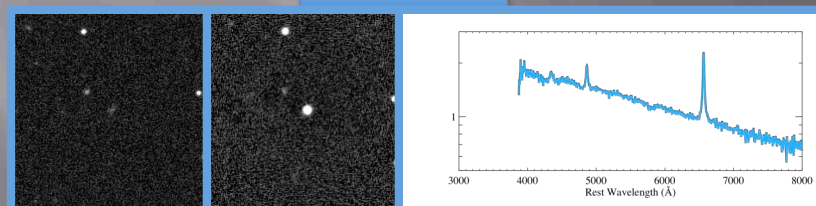
2006gy



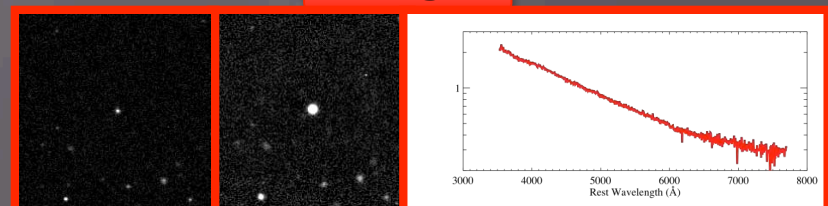
2008es



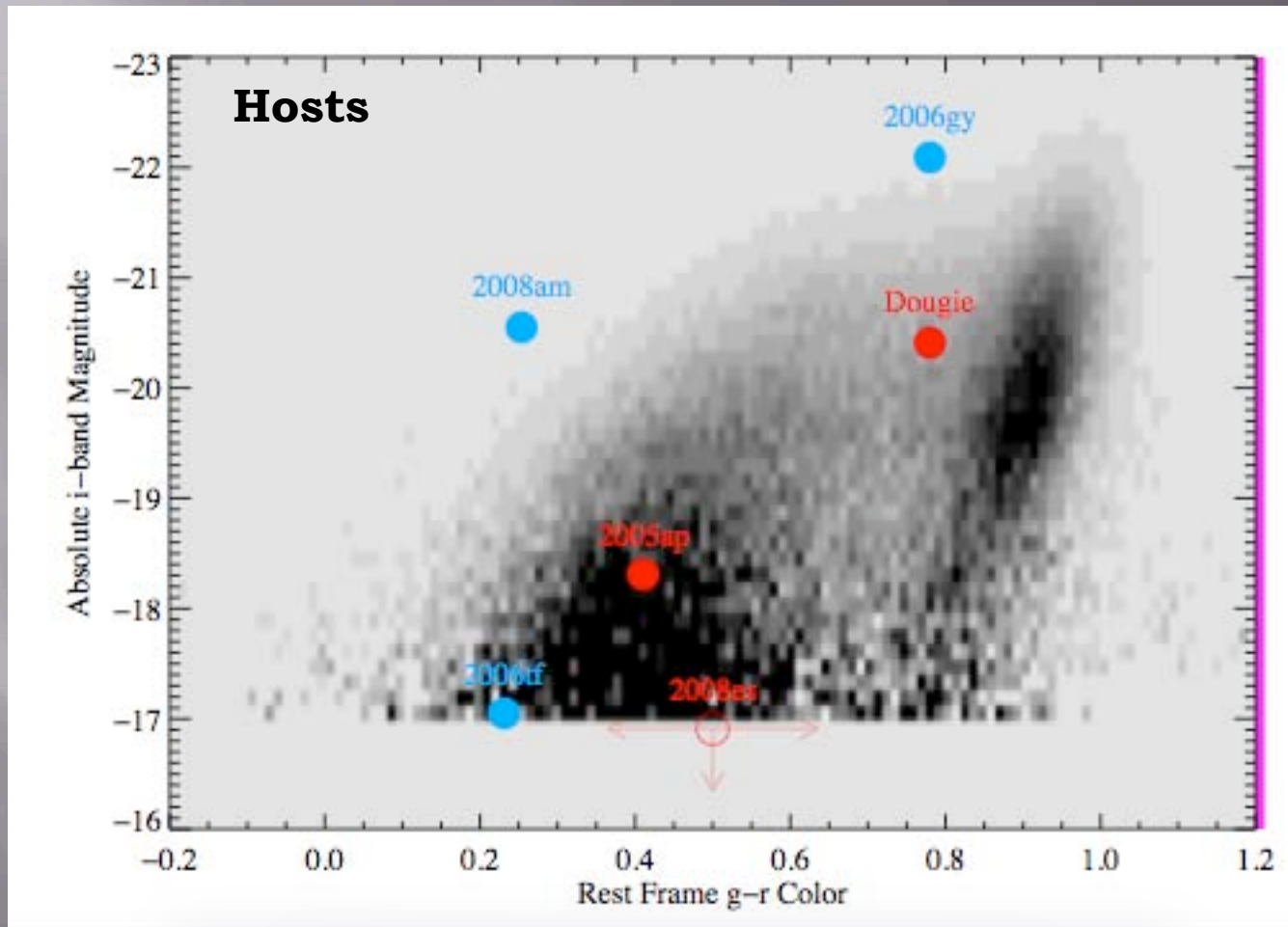
2006tf



Dougie

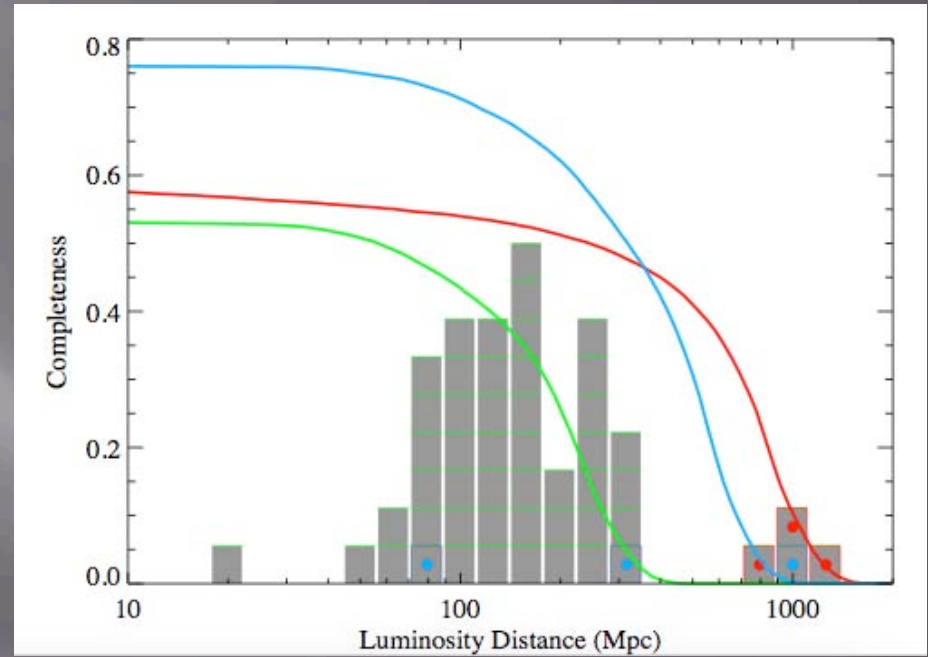
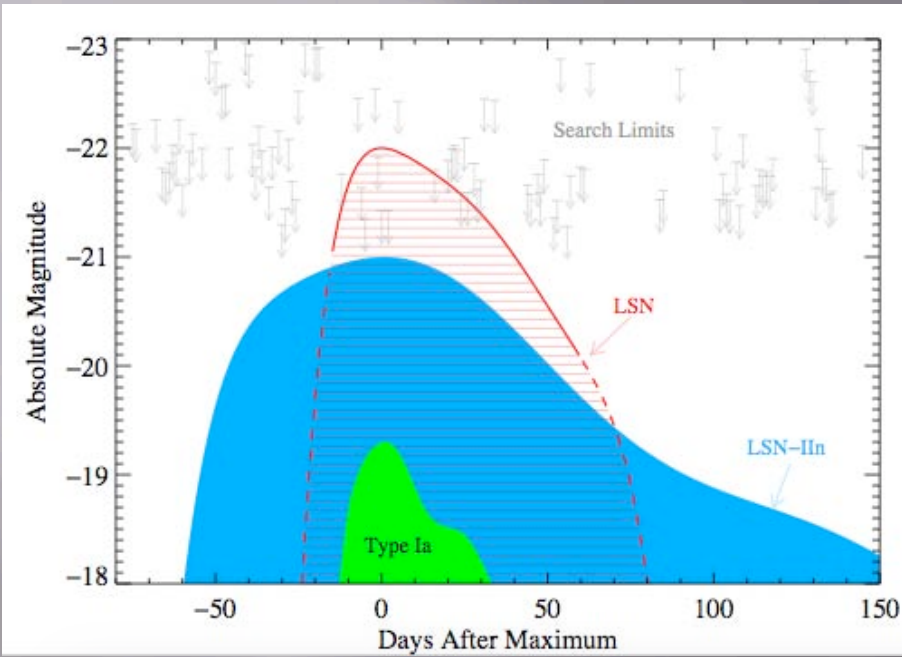


LSNe Host Galaxies



SDSS galaxy frequency distribution
(Blanton, Hogg, and the SDSS Collaboration)

LSN Completeness



- Limiting magnitudes from observing logs
- LSN template based on 2008es, LSN-IIn template based on 2006gy
- Use Type Ia sample as control group

***Preliminary* LSN Rates**

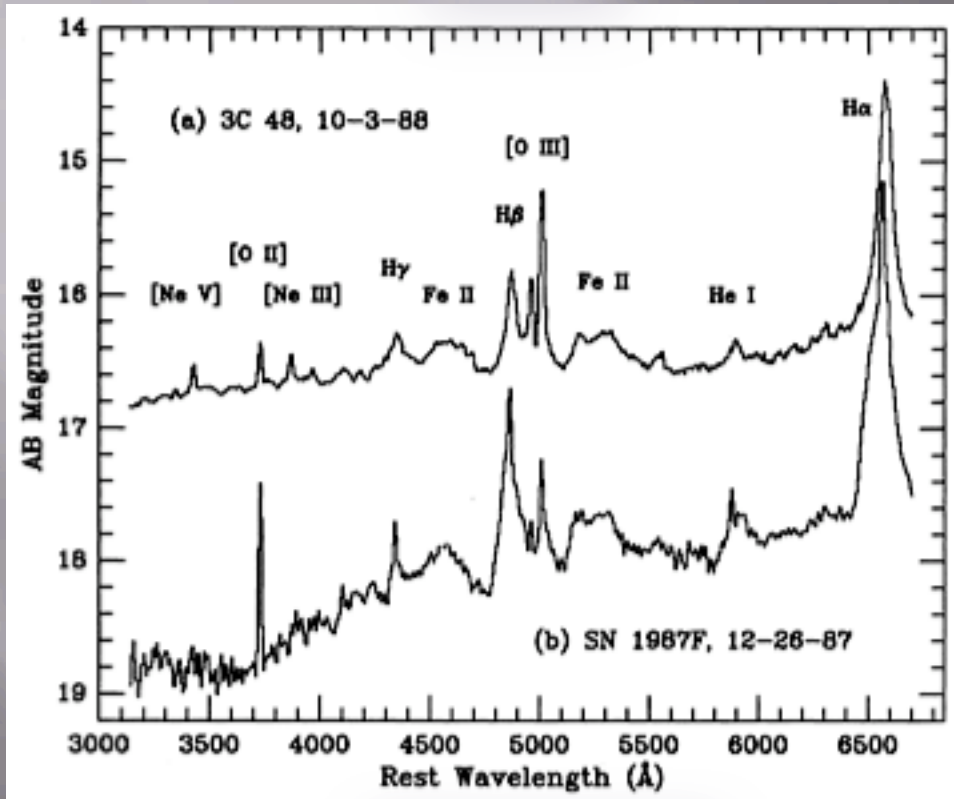
Class	Rate (# Mpc⁻³ yr⁻¹)
Type Ia	3 x 10⁻⁵
LSN-IIIn	2 x 10⁻⁷
LSN	6 x 10⁻⁸

▣ **Caveats:**

- **No correction made for “missing” LSNe-IIIn**
- **Did not account for possible range of light curves**

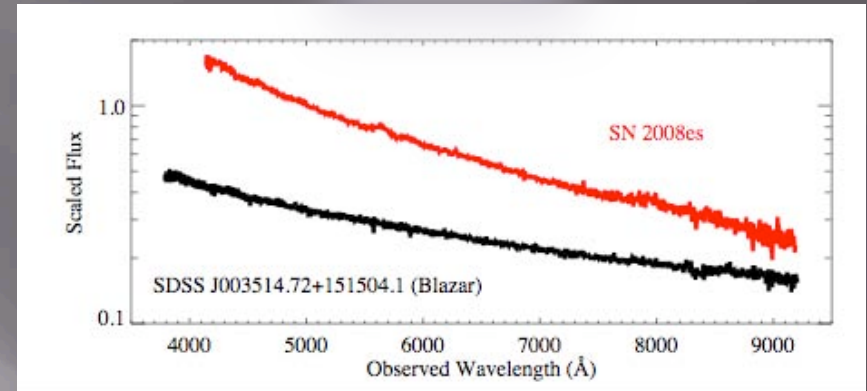
Confusion and Contaminants

AGN

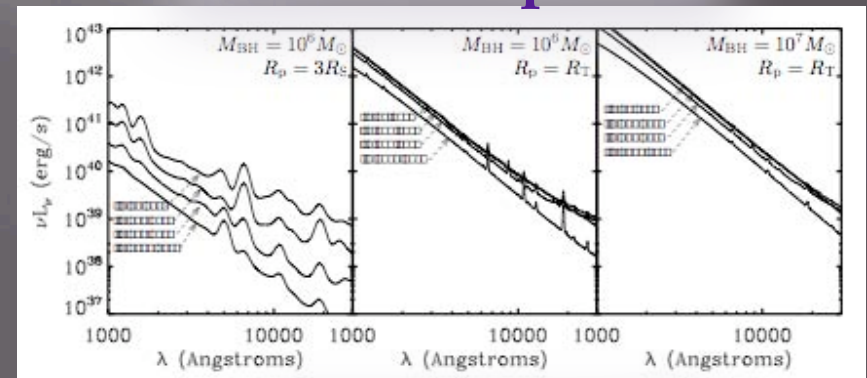


Filippenko 1989

Blazars



Tidal Disruptions



Strubbe & Quataert 2009

How To Find Your Own LSNe

- Look in all galaxies, big and small
- Don't exclude galaxy cores
- Pay special attention to events with smooth blue continua
- If the spectra are not conclusive, keep trying

