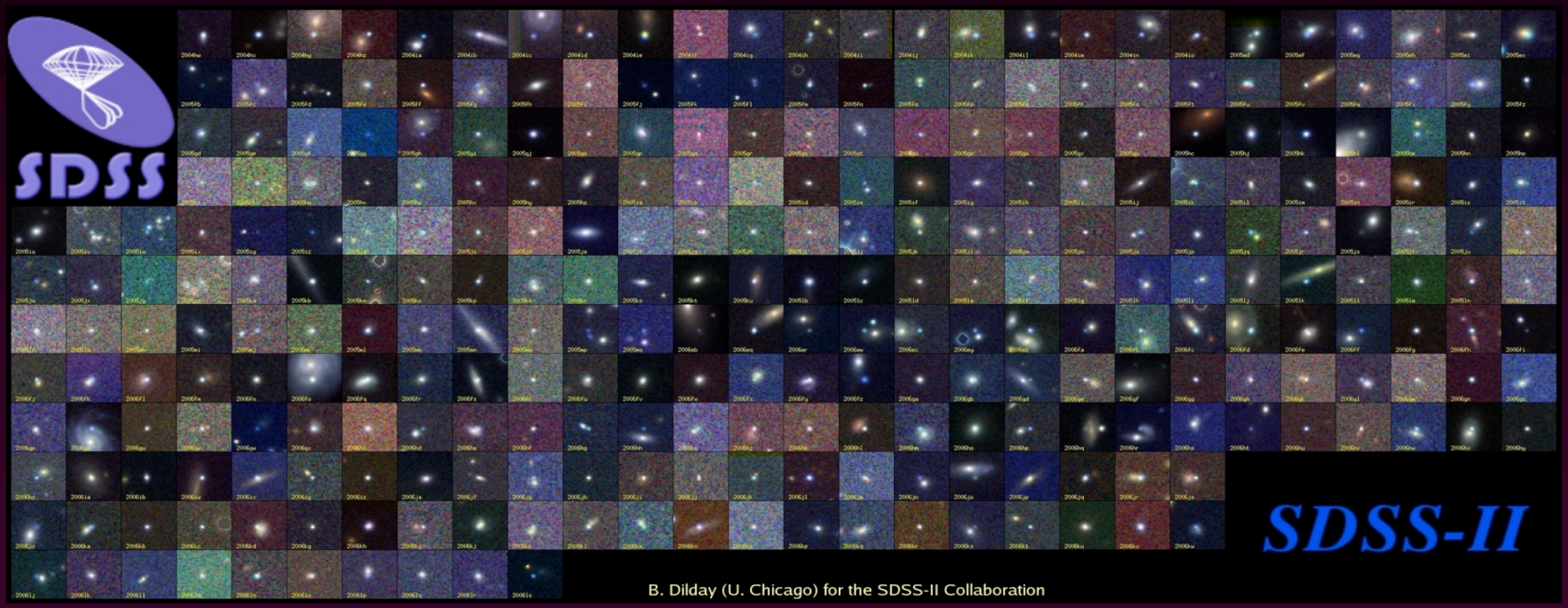
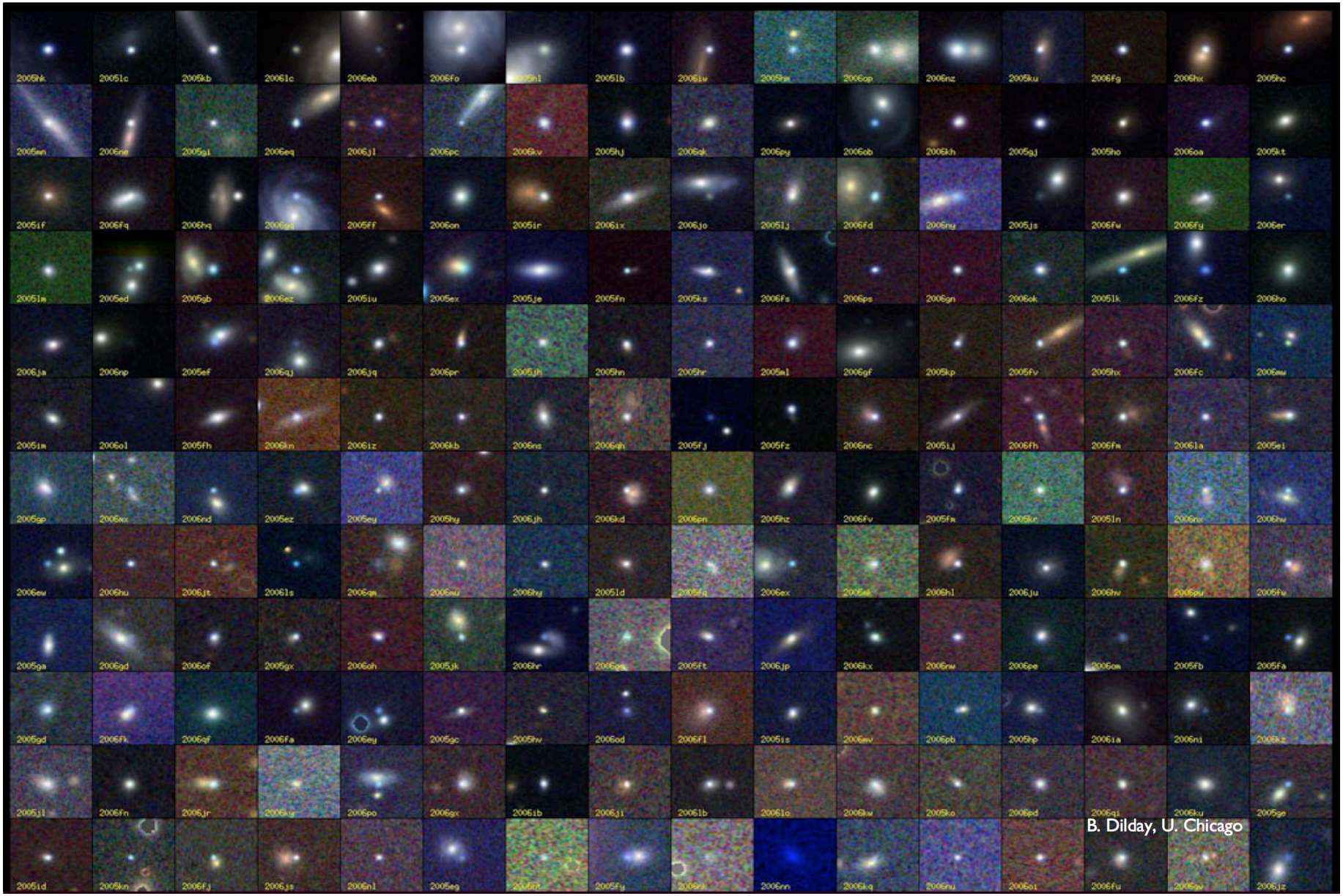
SDSS-II SN Survey: Sne Ia & Other Stuff

Peter Garnavich
Notre Dame/JINA

and the SDSS-II SN collaboration



SDSS Meeting August 18, 2008


B. Dilday, U. Chicago

SDSS and the Time Domain

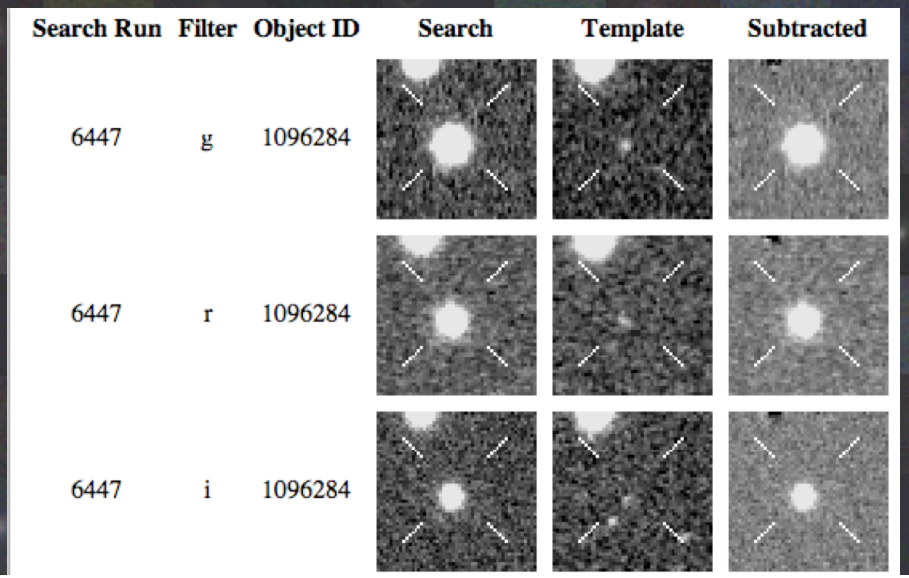
2005-2007: ~500 spec. confirmed supernovae - great for cosmology

- New ultra-short period CV - SN15204 rare helium dwarf nova
- First gravitational lens discovered through variability - SN2494
- Best observed circumstellar interaction in a type Ia - SN4524 (+SN7017)
- Best observed deflagration-only (?) type Ia - SN8151 (+SN20208)
- "Democratic" search with fast cadence => rise phase of SN Ia
- Demographics of host galaxies

>22000 Supernova Candidates

Color + early rise enough to select SNIa 95% (Masao Sako)

Need fast selection for spectroscopic follow-up.

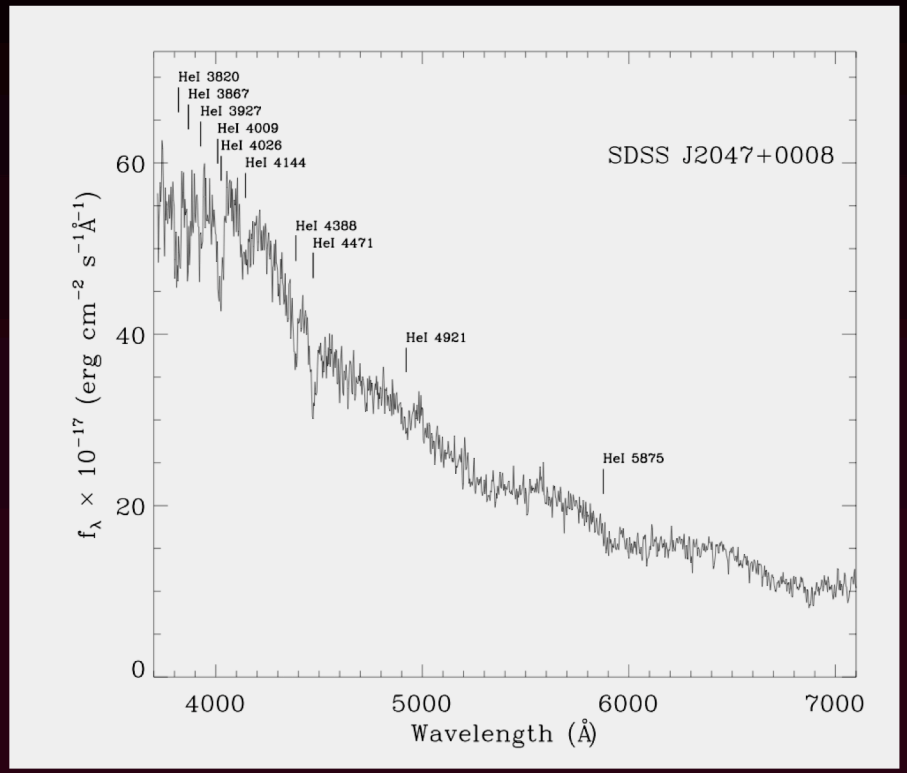


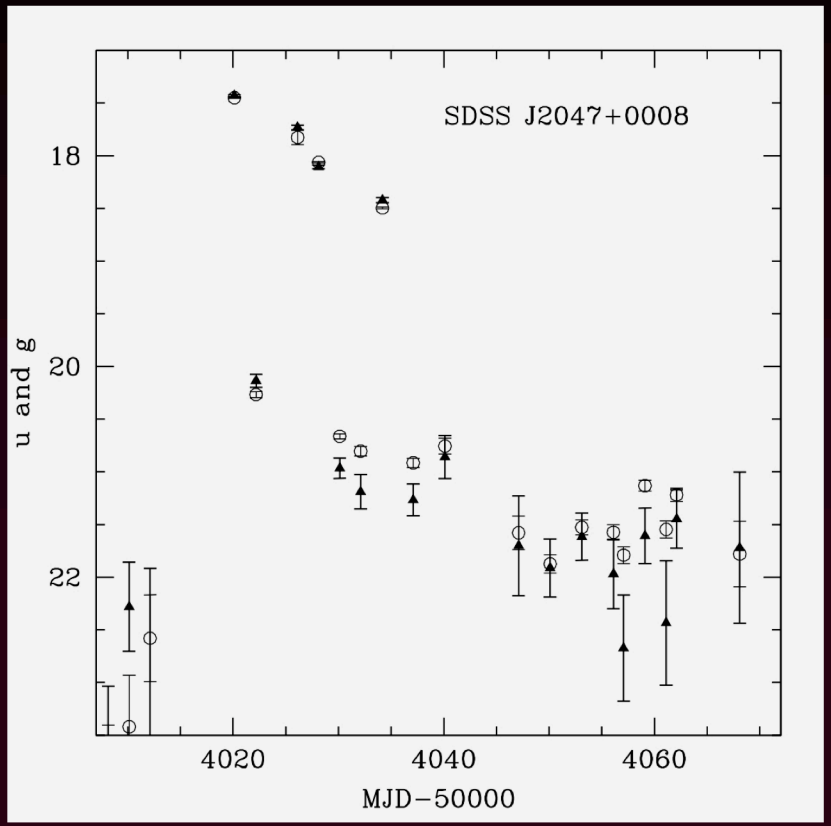
Search Run	Filter	Object ID	Search	Template	Subtracted
6447	g	1096284			
6447	r	1096284			
6447	i	1096284			

SN15204: Rare Helium Dwarf Nova - New AM CVn Star

Binary white dwarf with ultra short period
Primary accreting helium through an unstable disk
Maybe a source of Type Ia supernovae

Only a dozen systems known
Driven by gravitational radiation
Quiescent state ~23 mag
Too faint to be found by color selection

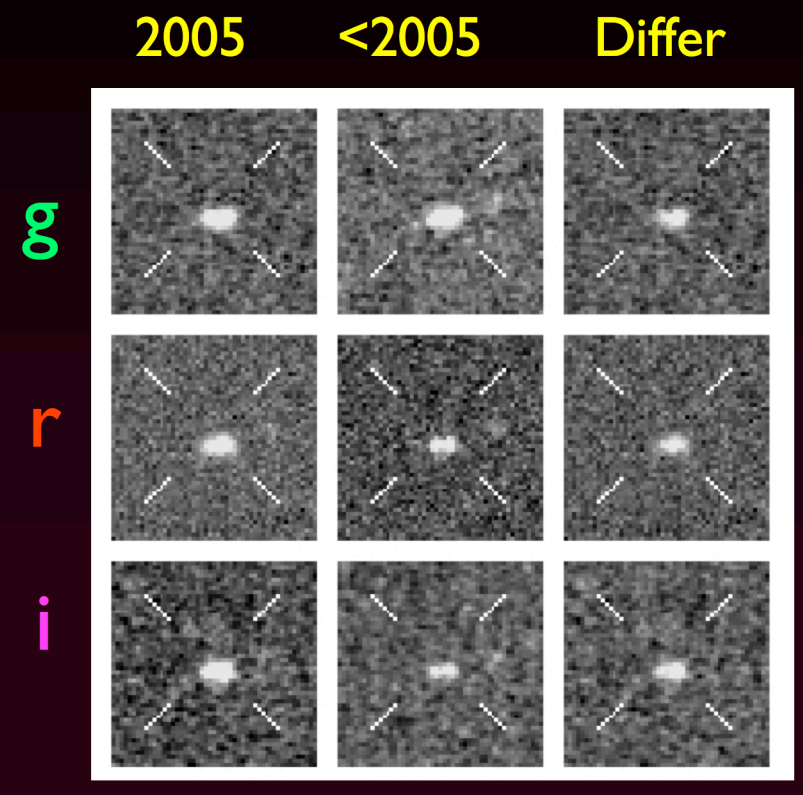




Anderson et al. 2007

Gravitational Lens Found Through Variability - SN2494

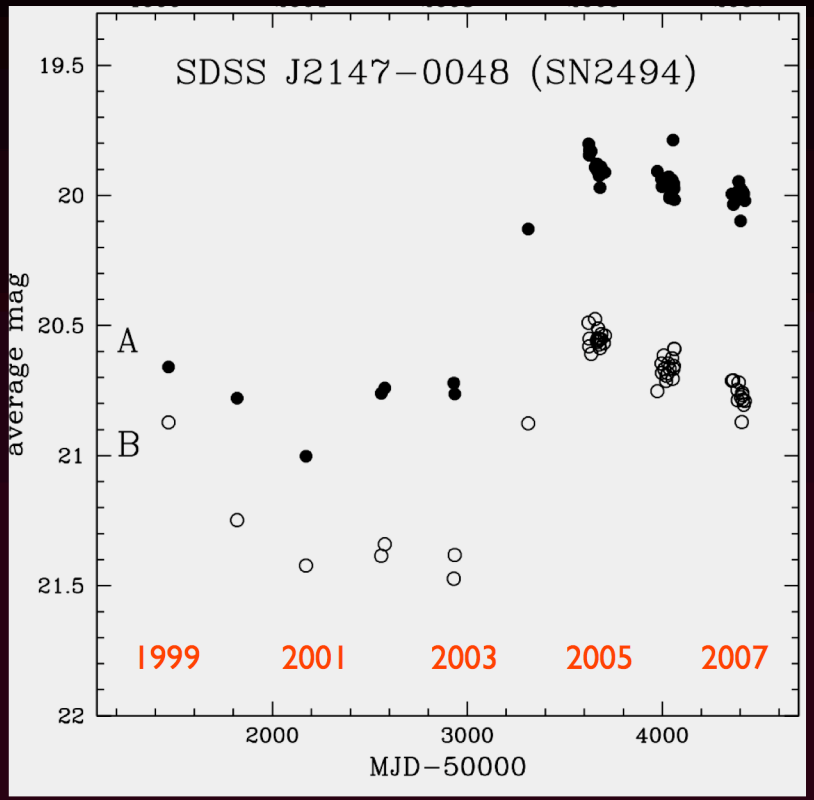
=> Clear residuals in subtracted images … but hand scan showed it was resolved!!!
=> Component separation 1.2 arcsec
=> KPNO Spectrum indicates a QSO at z=2.37

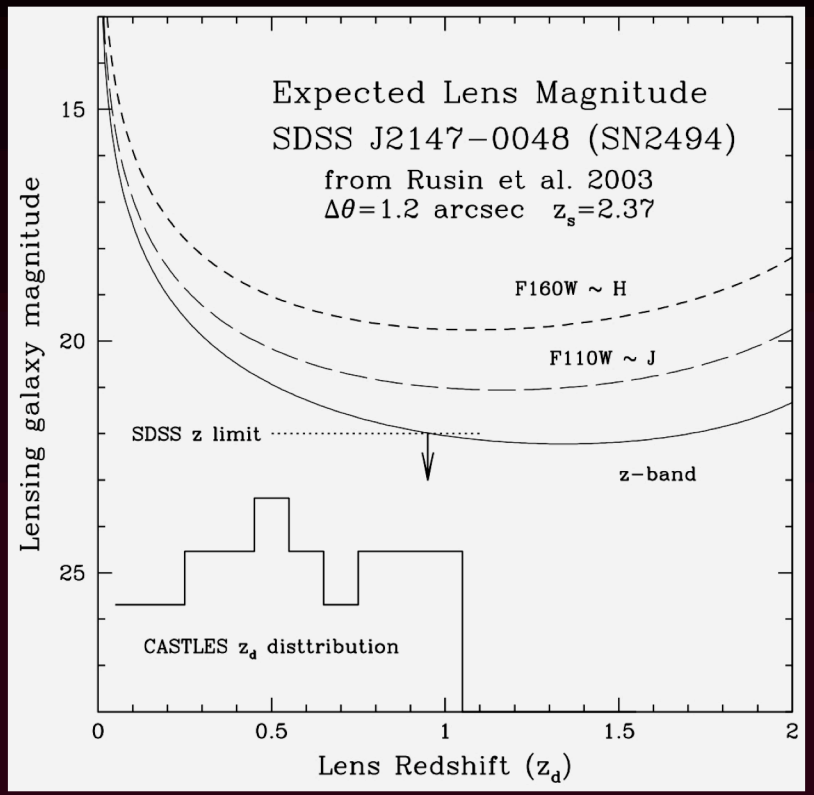


Garnavich et al. in prep

Gravitational Lens Found Through Variability - SN2494

=> Excellent light curve (scene modelling method by J. Holtzman)
=> Variability means good candidate for time-delay measurement
=> Lacki et al. 2008 => variability maybe a good way to find lenses





Garnavich et al. in prep

"The Exception Proves the Rule"

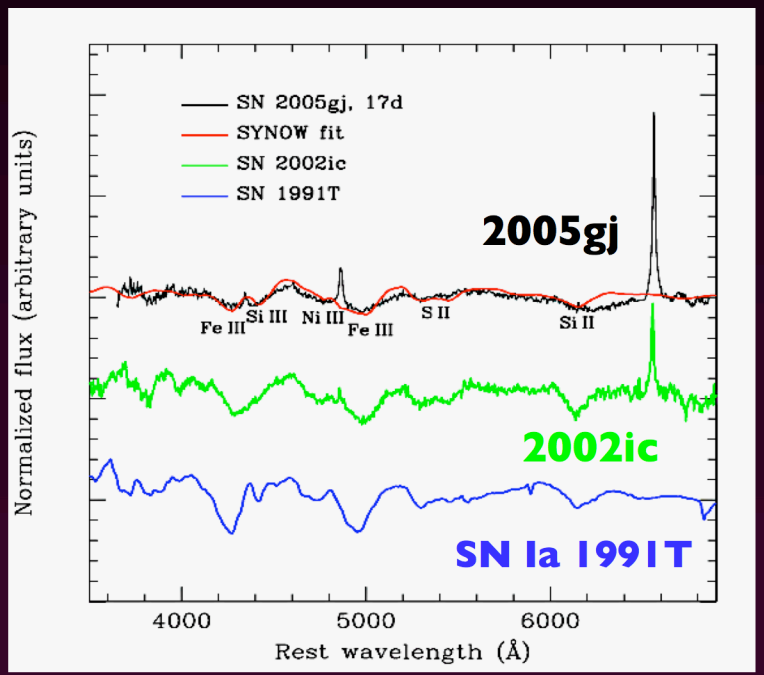
SN Ia are very boring - one is much like another - but a few are peculiar

Odd Type Ia Supernovae can tell us about how they explode

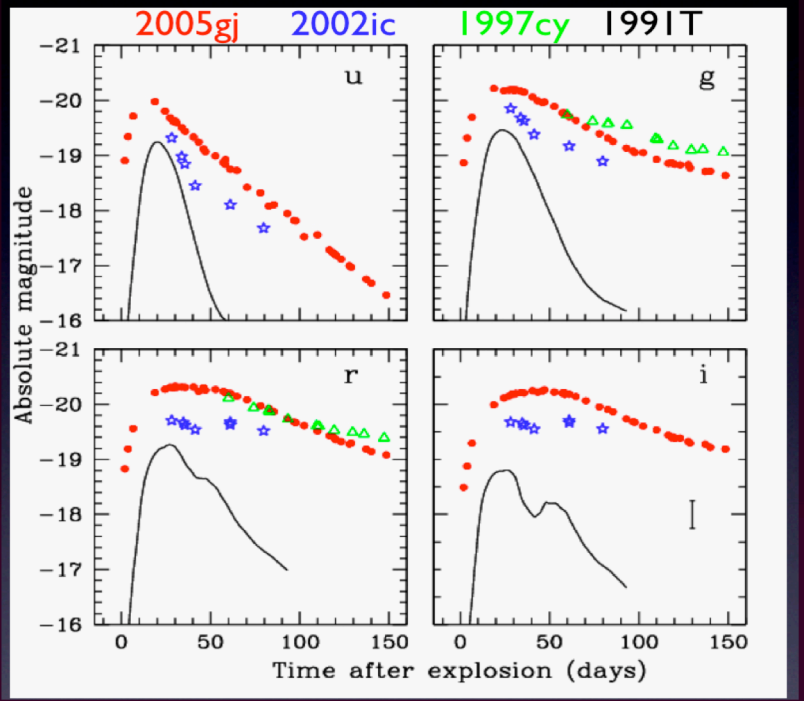
SN 4524 = 2005gj => a type Ia with hydrogen emission - looks like a type IIn + Ia.

Single Degenerate progenitors should have some H emission, but it is never seen.

05gj is an explosions inside a circumstellar shell - kinetic energy turned to visible light



Prieto et al 2007

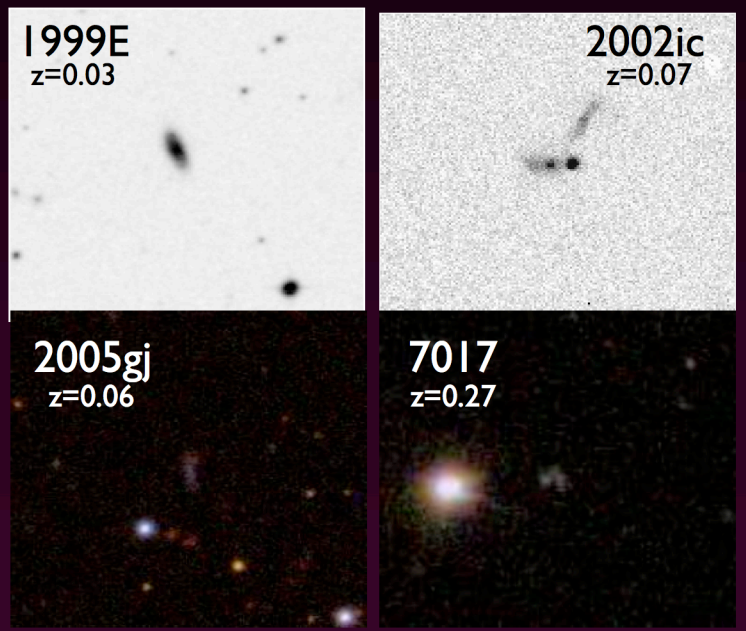


Best Observed Example => SN 2005gj

Summary of 2005gj-*like* supernovae:

- ★ Balmer lines in emission: strong ejecta-CSM interaction and clumpy medium
- ★ Well explained by "luminous" SN Ia with continuum added
- ★ Wind from the precursor ~70 km/s
- ★ Undetected in X-rays or Radio
- ★ SDSS discovered SN 7017 too
- ★ <12% of all SN Ia in SDSS-II
- ★ found in dwarf, star forming galaxies (low metallicity ?)

- ★ Are there many type IIn that hide type Ia explosions?

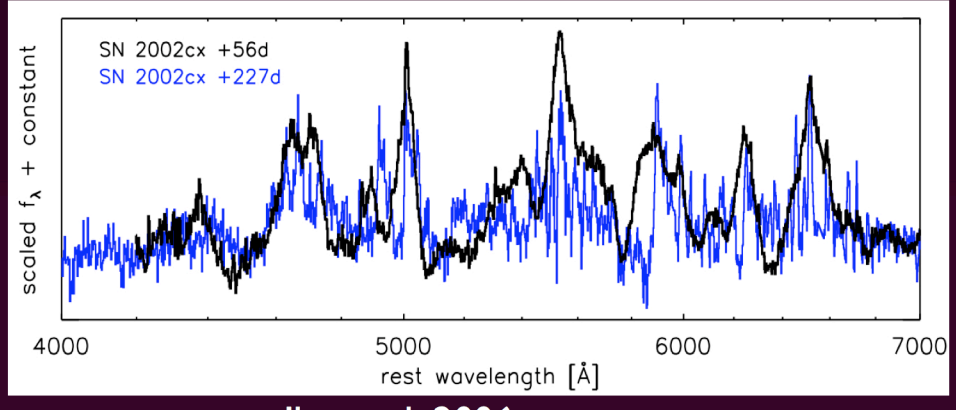


Host galaxies

Failed Detonations? SN 8151 => SN 2005hk

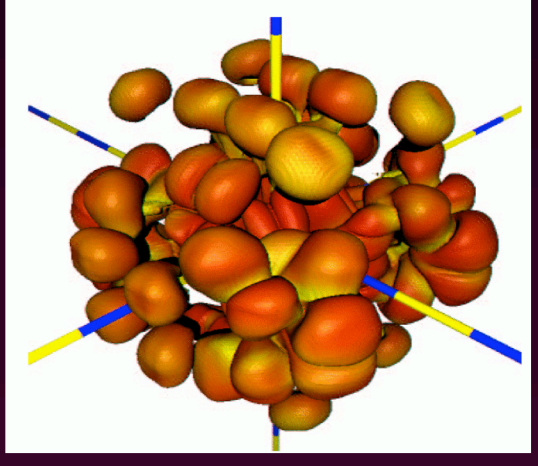
Phillips et al. (2007)

- ★ Extensive follow up photometry and spectroscopy with CSP, SDSS-II, KAIT
- ★ Very similar photometric and spectroscopic properties to SN 2002cx
- ★ Low velocities and "small" chunks of radioactive Ni



Jha et al. 2006

- ★ Normal SN Ia are combinations of detonations and deflagrations
- ★ 3D models easiliy make deflagrations - Ni fragmentation due to instabilities

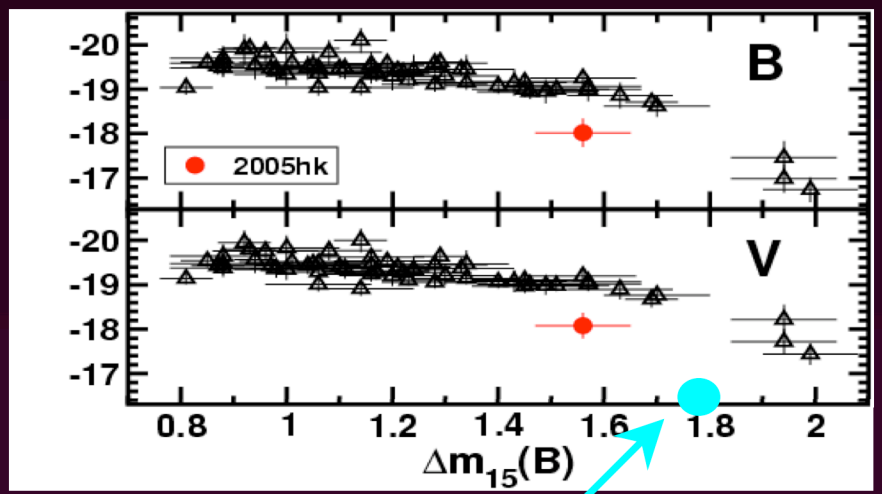


3D deflagration model of Blinnikov et al. (2006)

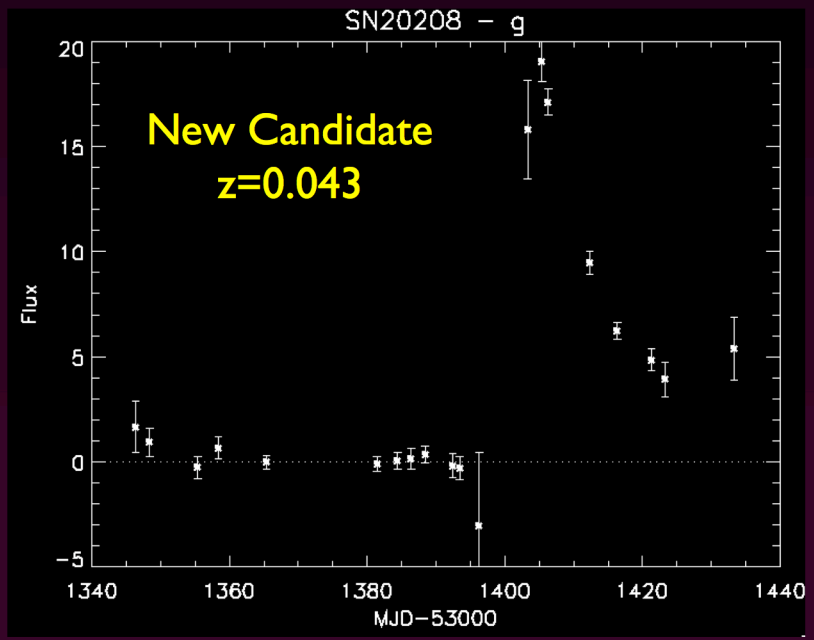
SN 2005hk / SN 20208

- **Deflagrations are faint for their light curve shape**

SDSS has identified another SN like 05hk, but even fainter.
May account for ~5% of all thermonuclear explosions.



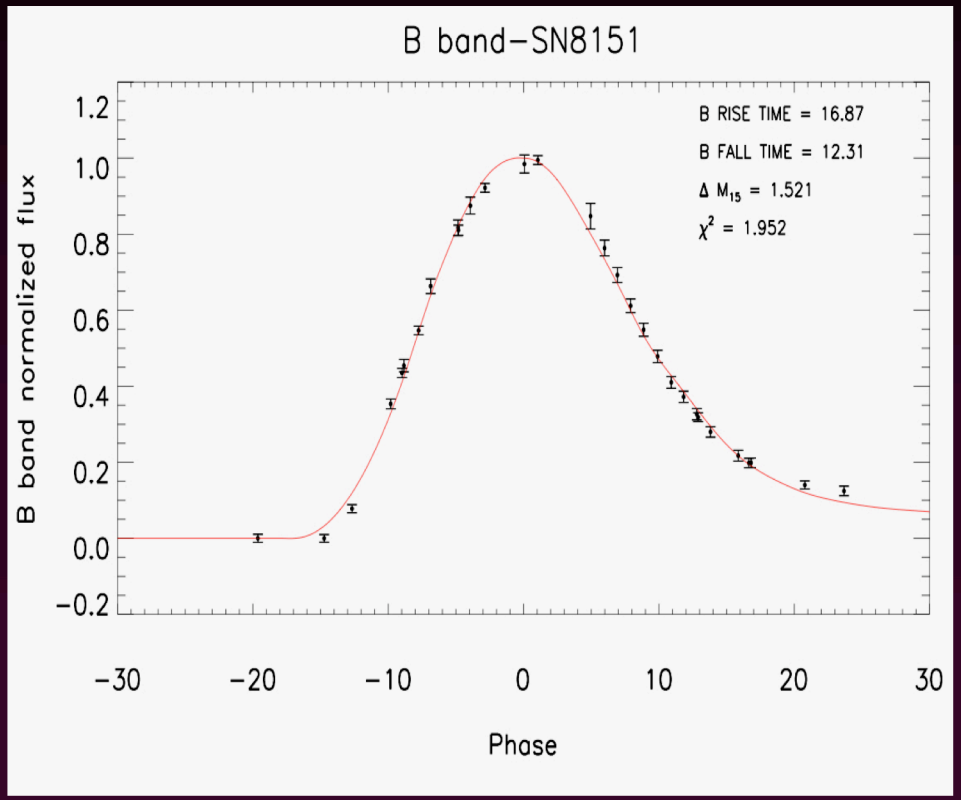
SDSS SN 20208

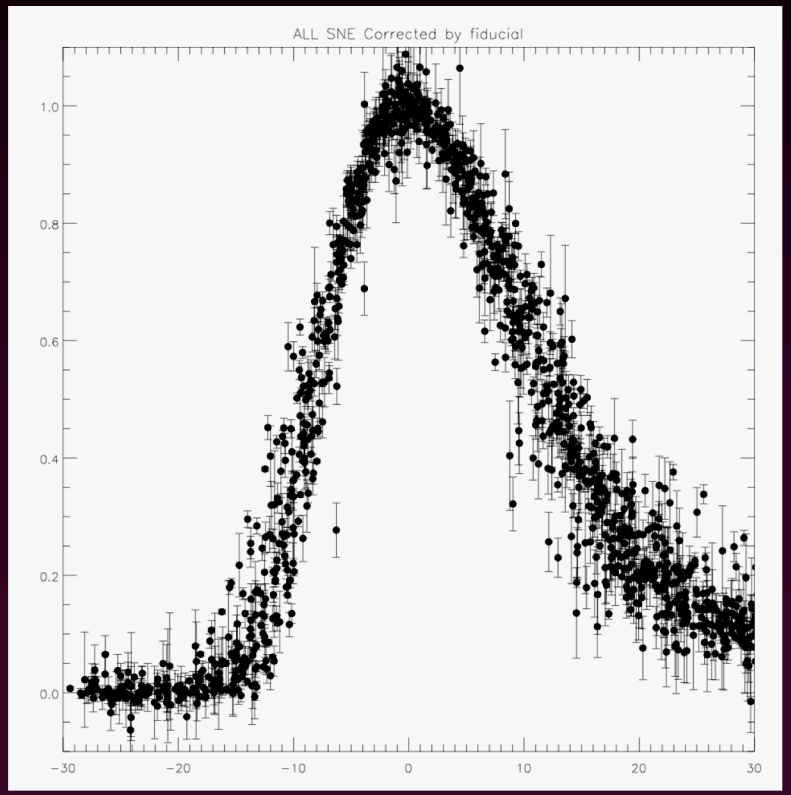


SDSS Search: Catch SNIa Early

SDSS well constrains the 05hk light curve
05hk has a normal rise time but fast decay
It does not "stretch" like normal SNIa

88 best observed light curves over-plotted.
Do rise and fall strecth differently?
Second parameter? Ni distribution?



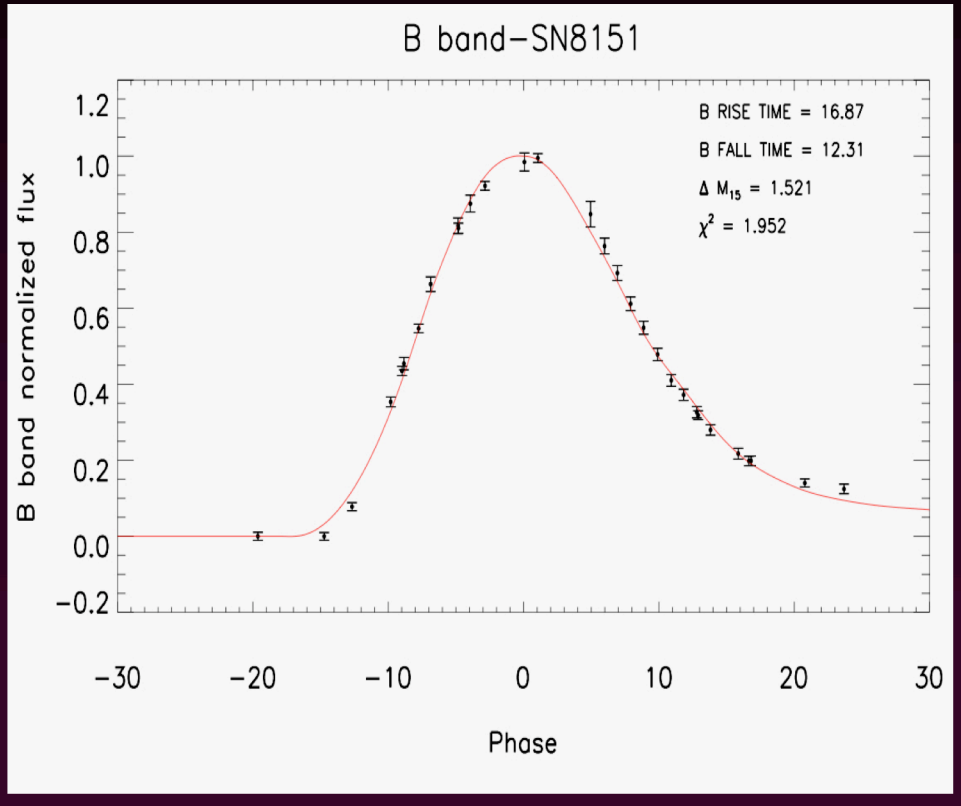


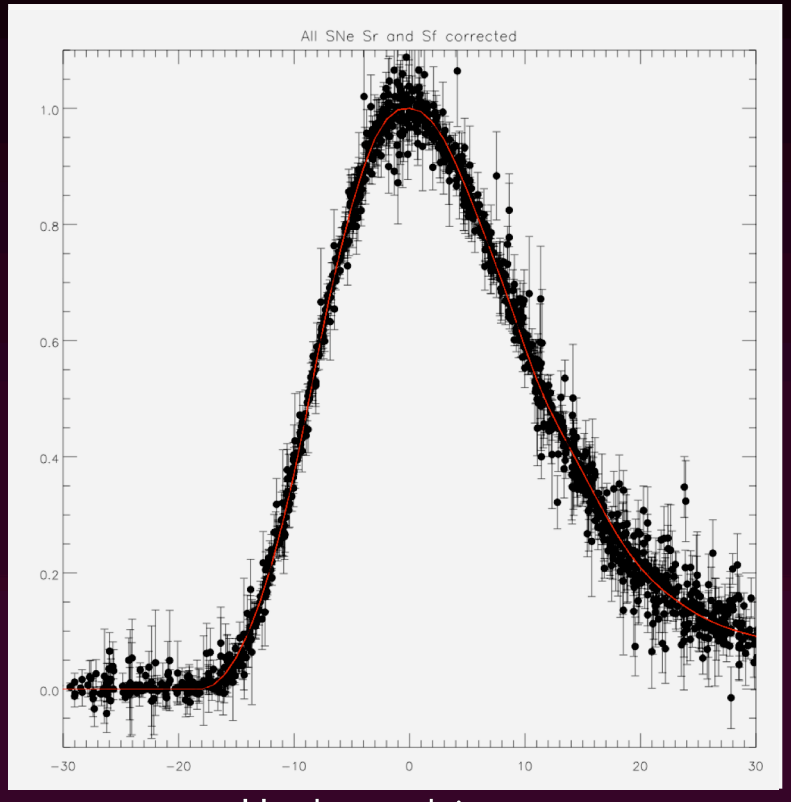
Hayden et al. in prep

SDSS Search: Catch SNIa Early

SDSS well constrains the 05hk light curve
05hk has a normal rise time but fast decay
It does not "stretch" like normal SNIa

88 best observed light curves over-plotted.
Do rise and fall strecth differently?
Second parameter? Ni distribution?



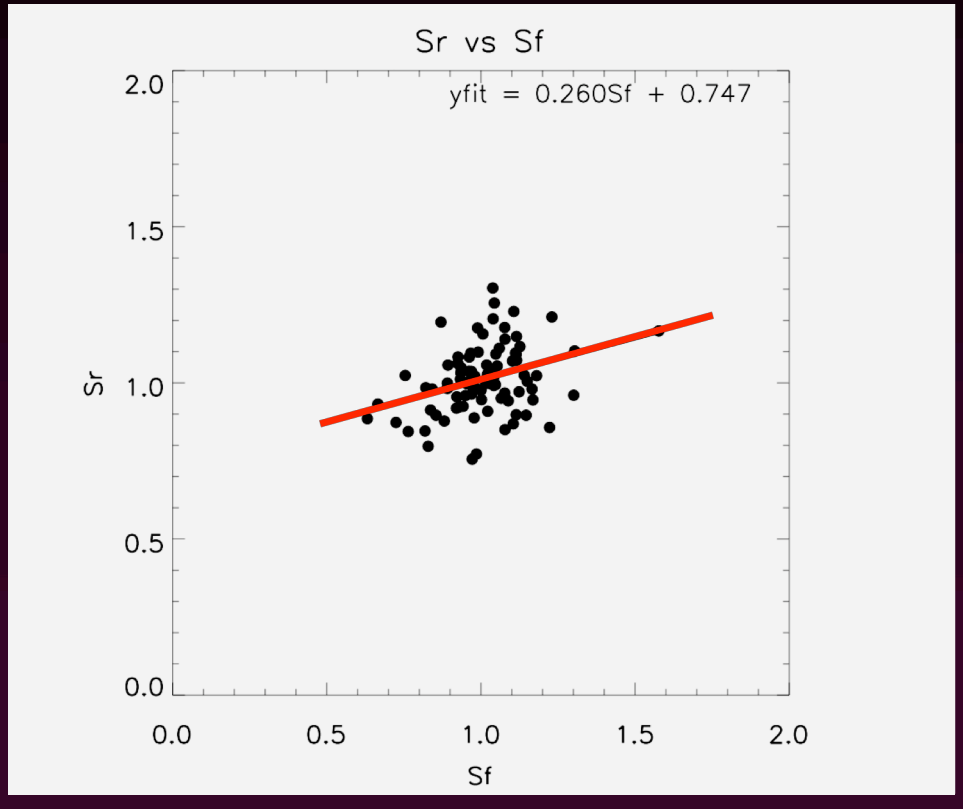


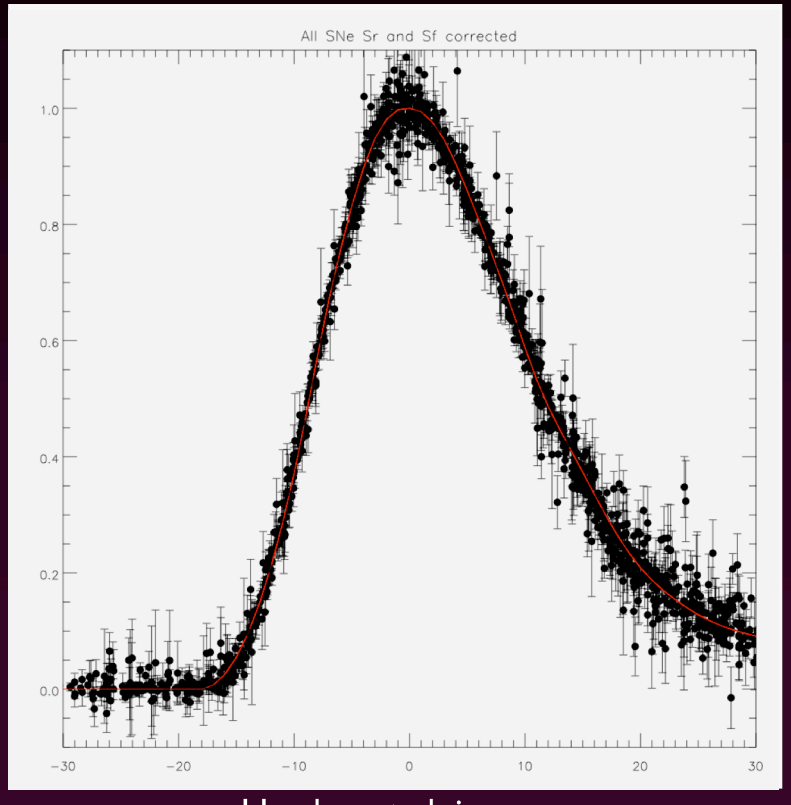
Hayden et al. in prep

SDSS Search: Catch SNIa Early

SDSS well constrains the 05hk light curve
05hk has a normal rise time but fast decay
It does not "stretch" like normal SNIa

88 best observed light curves over-plotted.
Do rise and fall strecth differently?
Second parameter? Ni distribution?





Hayden et al. in prep

Supernova Host Galaxies

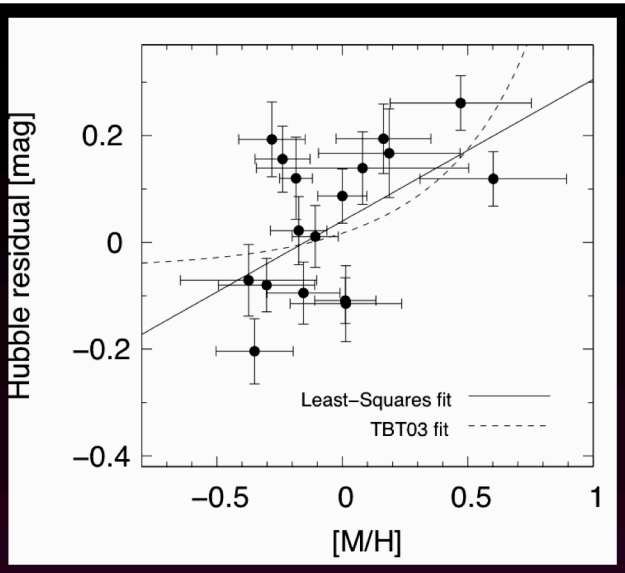
Correlating SN properties with host characteristics may solve the progenitor problem.

Currently lots of telescope time is being used to characterize the SDSS hosts!

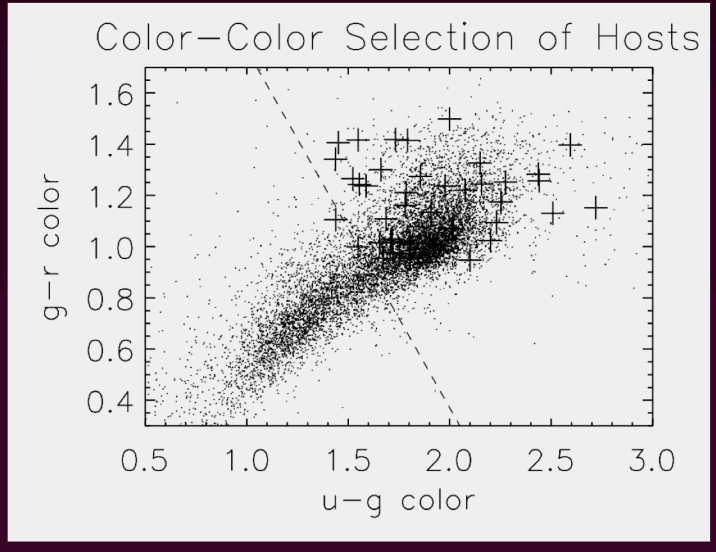
Direct measurement of metallicity in a local sample of Early (E/S0) SNIa hosts suggests Hubble residuals correlate with host metallicity.

This may impact the measurement of cosmological parameters.

Gemini program to get high S/N spectra of early type hosts in SDSS.



Gallagher et al. 2008



SDSS-II SN Collaboration

J. Frieman

Fermilab	F. DeJongh, J. Marriner, D. McGinnis, G. Miknaitis
U. Chicago	B. Dilday, R. Kessler
APO	H. Brewington, J. Dembicky, M. Harvanek, J. Krzesinski, B. Ketzeback, D. Long, O. Malanushenko, V. Malanushenko, R. McMillan, K. Pan, G. Saurage, S. Snedden, S. Watters
SAAO	B. Bassett, K. van der Heyden
U. Washington	A. Becker, C. Hogan
U. Munich	R. Bender, U. Hopp
Seoul Natl. U.	C. Choi, M. Im
Wayne State U.	D. Cinabro
Ohio State U.	D. L. DePoy, J. L. Prieto
U. Tokyo	M. Doi, K. Konishi, T. Morokuma, N. Takanashi, K. Tokita, N. Yasuda
U. Notre Dame	P. Garnavich, J. Gallagher, B.Tucker
NM State U.	J. Holtzman
KIPAC/Stanford	S. Jha, R. Romani, C. Zheng
U. Göttingen	W. Kollatschny
STScI	H. Lampeitl, A. Riess
U. Portsmouth	R. Nichol, M. Smith
Rochester IT	M. Richmond
U. Pennsylvania	M. Sako
Penn State U.	D. Schneider
U. Texas	C. Wheeler

with help from: J. Eastman, L. Watson, R. Assef, K. Schlesinger, A. Crotts, M. Stritzinger, J. Sollerman, A. Goobar, G. Leloudas, R. J. Foley, A. V. Filippenko, A. Aragon-Salamanca, M. Bremer, M. Turatto, P. Ruiz-Lapuente, F. Castander, A. Romer, C. Collins, J. Lucey, A. Edge, Y. Ihara