SDSS-II SN Survey: SNe Ia & Other Stuff

Peter Garnavich
Notre Dame/JINA

and the SDSS-II SN collaboration

SDSS Meeting       August 18, 2008
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.
SN 15204: 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

---

**SDSS J2147–0048 (SN2494)**

---

**Expected Lens Magnitude**

SDSS J2147–0048 (SN2494)

from Rusin et al. 2003

$\Delta \theta = 1.2$ arcsec  $z_s = 2.37$

---

\[ F_{160W} \sim H \]

\[ F_{110W} \sim J \]

SDSS z limit

---

CASTLES $z_d$ distribution

---

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 Ibn + 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

1999E  
z=0.03

2002ic  
z=0.07

2005gj  
z=0.06

7017  
z=0.27
Failed Detonations? SN 8151 => SN 2005hk

- 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

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

Jha et al. 2006

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 Search: Catch SN Ia Early

SDSS well constrains the 05hk light curve
05hk has a normal rise time but fast decay
It does not “stretch” like normal SN Ia

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

Hayden et al. in prep
SDSS Search: Catch SN Ia Early

SDSS well constrains the 05hk light curve
05hk has a normal rise time but fast decay
It does not “stretch” like normal SN Ia

88 best observed light curves over-plotted.
Do rise and fall stretch 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 stretch 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.
SDSS-II SN Collaboration

Fermilab
U. Chicago
APO

SAAO
U. Washington
U. Munich
Seoul Natl. U.
Wayne State U.
Ohio State U.
U. Tokyo
U. Notre Dame
NM State U.
KIPAC/Stanford
U. Göttingen
STScI
U. Portsmouth
Rochester IT
U. Pennsylvania
Penn State U.
U. Texas

F. DeJongh, J. Marriner, D. McGinnis, G. Miknaitis
B. Dilday, R. Kessler
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
B. Bassett, K. van der Heyden

A. Becker, C. Hogan
R. Bender, U. Hopp
C. Choi, M. Im
D. Cinabro

D. L. DePoy, J. L. Prieto
M. Doi, K. Konishi, T. Morokuma, N. Takanashi, K. Tokita, N. Yasuda
P. Garnavich, J. Gallagher, B. Tucker
J. Holtzman
S. Jha, R. Romani, C. Zheng
W. Kollatschny
H. Lampeitl, A. Riess
R. Nichol, M. Smith
M. Richmond
M. Sako
D. Schneider
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