First results from the SDSS Supernova Survey

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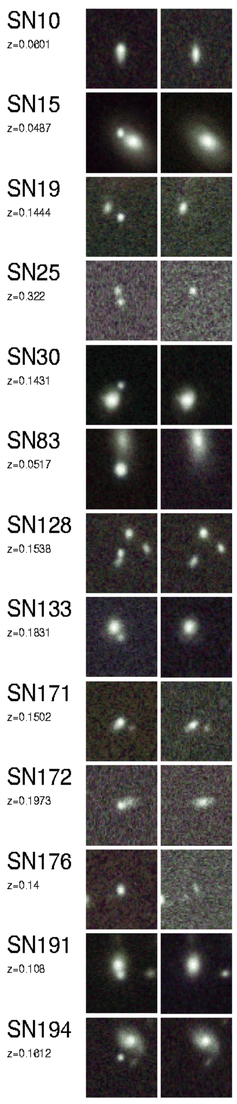
Abstract

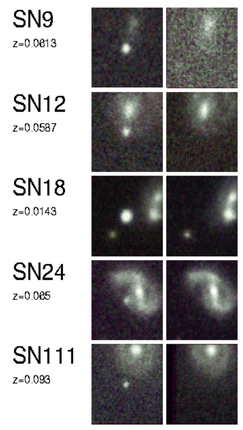
The SDSS Supernova Survey, part of the proposed SDSS II, aims to discover and measure high-quality, well-sampled, multi-band optical lightcurves for ~200 Type Ia supernovae in the redshift range z=0.05 to 0.35. The survey will involve multiple scans of a thin, 200 sq. degree stripe along the celestial equator in the Fall months of 2005-7, using the wide-field imager on the SDSS 2.5m telescope. The survey will exploit the fact that the SDSS photometric system is well characterized and calibrated to high precision. Follow-up spectroscopy is planned on the ARC 3.5m, HET, MDM, Subaru, and other telescopes, with the aim of providing redshifts, supernova types, and, for a portion of the sample, multi-epoch spectrophotometry.
A pilot survey carried out in Fall 2004 covered half the survey area and resulted in 11 useful nights of 2.5m imaging data (under varying sky conditions), supplemented by additional imaging on the ARC 3.5m and NMSU 1m. The SDSS imaging data were reduced and supernova candidates were visually inspected typically within about 50 hours (for SDSS II, this processing time will be halved), with spectroscopic follow-up on the ARC 3.5m and HET.
To date, this run has yielded 16 spectroscopically confirmed SNe Ia, 5 SNe of type II, and 1 type Ib.

Spectroscopically confirmed SN in 2004:

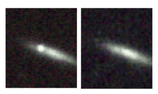
Type Ia



Type II

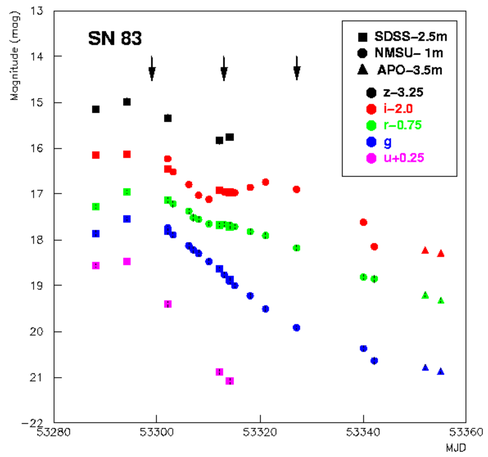


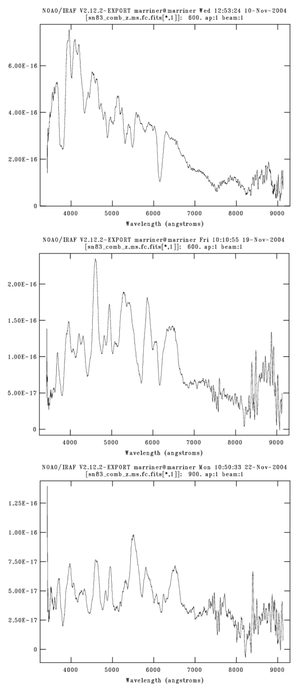
Type Ib



Compilation of spectroscopically confirmed SN identified during the 2004 fall campaign.

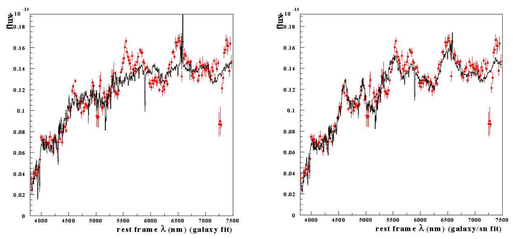
Lightcurves & multi epoch spectroscopy:





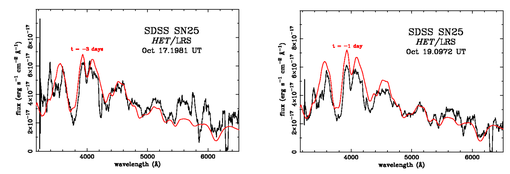
SDSS SN83 is a near by SN Ia at a redshift of z=0.0517.
Shown above are the lightcurves obtained in the SDSS filters u,g,r,i and z by the SDSS-2.5m, the NMSU-1m telescope and the ARC 3.5m telescope.
The left panel shows spectra obtained by the DIS spectrograph on the ARC-3.5m telescope at different epochs. The arrows in the lightcurve indicate when the spectra were taken. Such time series will allow for improved K corrections.

SDSS SN15: Spectral fit



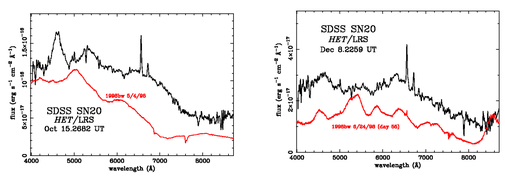
A fit of the follow-up spectra to a combination of galaxy plus SN templates allows us to classify supernovae and estimate their ages relative to maximum light.
Shown above is the spectra of SDSS SN15 obtained with the ARC 3.5m telescope. Red dots indicate the measured spectrum and the black points give the best fit (left) with galaxy only and (right) including a SN Ia component 29 days after maximum.

SDSS SN25: a SN Ia at z=0.322



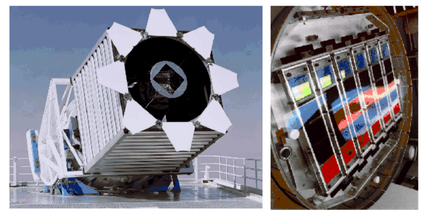
SDSS SN25 was confirmed with the HET to be a SN Ia at a redshift of z=0.322, the highest-z SN discovered during the fall 2004 campaign. Shown are two spectra obtained with the HET two days apart. Cross correlation analysis allows the distinction between the two spectra, and yields best fit-fit templates separated by two days. We also note that this event was exceptionally luminous with R ~ -20.0 mag at peak.

SDSS SN20: a peculiar SN



The large area covered by the SDSS supernova survey allows us to find rare and unusual SNe, which are otherwise poorly sampled in other surveys. Shown above is a possible hypernova discovered in the survey and followed up by HET during two epochs. The spectra reveal broad lines similar to spectra of SN1998bw. The red lines indicate the templates taken from Gal-Yam et al. (2002).

Data flow and reduction:

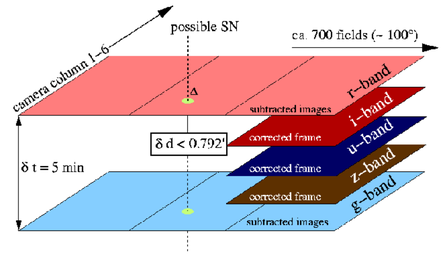


SDSS 2.5m

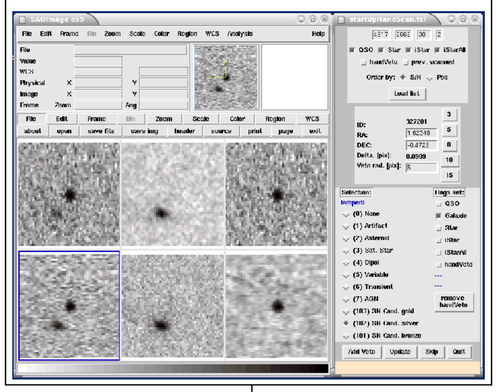
SDSS standard reduction

frame subtraction

object identification

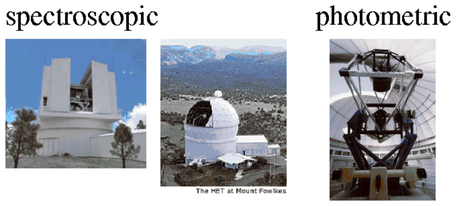


human classification



Follow up observations in 2004:

spectroscopic photometric



ARC 3.5m HET NMSU–1m

Conclusion

The SDSS Supernova Survey will be one of the three primary components of the proposed SDSS II project. The 2004 test run has shown the ability of the SDSS-2.5m telescope to detect and and identify SN of various types in the intermediate redshift range where so far only a few SN Ia are observed. Current work focuses on optimizing the selection algorithms for the SDSS II SN campaigns and deriving well-calibrated and extinction-, shape-, and K-corrected lightcurves for the Fall 2004 data.

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Participating Institutions
The SDSS is a joint project of The University of Chicago, Fermilab, the Institute for Advanced Study, the Japan Participation Group, The Johns Hopkins University, the Korean Scientist Group, Los Alamos National Laboratory, the Max-Planck-Institute for Astronomy (MPIA), the Max-Planck-Institute for Astrophysics (MPA), New Mexico State University, University of Pittsburgh, University of Portsmouth, Princeton, University, the United States Naval Observatory, and the University of Washington.