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Observing SNe Ia at $z > 1$ with the *HST* and at $z \simeq 0.2$ with the SDSS-II

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Abstract. SNe Ia are currently providing the most direct measurements of the accelerated expansion of the Universe and also put constraints on the nature and evolution of the so-called 'dark energy'. Despite major efforts to increase the number of known high-redshift SNe Ia with reliable distance estimates, two regions in the Hubble diagram remain only sparsely observed. At redshifts $z > 1$ the limitations of ground-based instruments require the *Hubble Space Telescope* and its superior angular resolution to get meaningful distance estimates, while at intermediate redshifts ($z \simeq 0.2$) the large solid angle necessary presents an obstacle to most surveys that can be overcome with the Sloan Digital Sky Survey, SDSS-II.

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The *HST* has been used in conjunction with the GOODS survey (Giavalisco *et al.* 2004) to search for supernovae at a redshifts above $z > 1$ (Riess *et al.* 2004). In total ~ 900 orbits have been used in 2002 – 2005 to discover and follow up very high redshift SNe. Photometric observations are carried out using the *HST*-ACS instrument (Advanced Camera for Surveys) and spectra are obtained by the ACS/grism filter. A preselection of possible SN Ia candidates for spectroscopic follow-up is done based on the UV deficit caused by the metal-rich atmospheres of SNe Ia. In total the program revealed 135 SN events of which 50 turned out to be of Type Ia, including 19 SNe Ia at a redshift larger than 1. These SNe increase the known sample by more than a factor of two compared to Riess *et al.* (2004). This dataset further supports the previously reported deceleration at high redshifts and puts more stringent constraints on the equation of state of the dark energy'', attributed as $w(z)$, at $z > 1$. Nevertheless a cosmological constant is still compatible with the data.

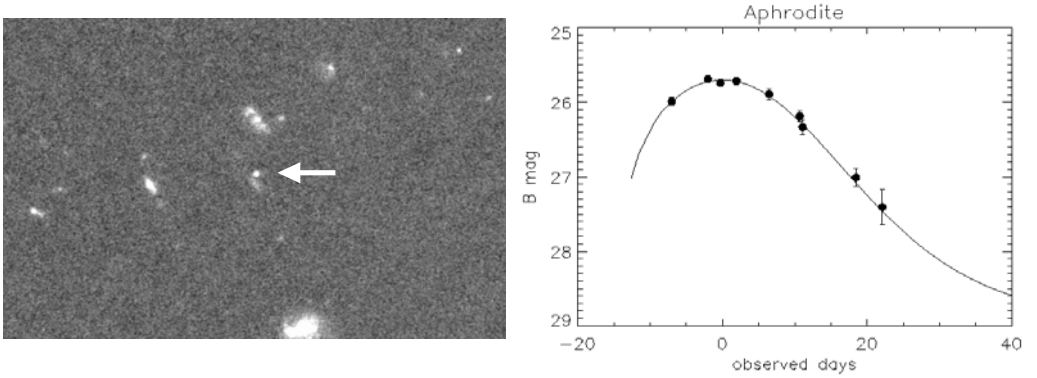

Figure 1. The discovery image of one of the very high-redshift SN, at a redshift of $z = 1.3$. The right panel shows the obtained lightcurve in the B-band.

In the intermediate redshift range between $z = 0.1$ and $z = 0.4$ the SDSS supernova survey (SDSS-SN webpage; Sako *et al.* 2005; Lampeitl *et al.* 2006) is currently finding a significant number of SN Ia by observing in repeated scans a 120 degree wide portion of the galactic equator. In total an area of 280 sq. degrees is surveyed. The SDSS camera measures simultaneously light curves in the SDSS filters (u,g,r,i and z). Photometrically identified SNe candidates are then spectroscopically observed on a variety of instruments including the ARC (3.5 m), HET (9.2 m), Subaru (8.2 m), WHT (4.2 m), NTT (3.6 m) and MDM (2.4 m). All new discovered SN are reported to the IAU (SDSS telegrams) and also made public available through the SDSS-SN webpage. The program will last over a three year period – each year using the time between September and November when there is the least conflict with other on-going projects. The 2005 campaign is already completed and two additional years of observations are coming up in 2006 and 2007. During the first year of data collection 129 SNe of Type Ia have been discovered and spectroscopically confirmed by the SDSS SN survey (SDSS telegrams). These data also provide a unique opportunity to search for peculiar SNe events as demonstrated, for example. by the discovery of SN2005gj (Prieto *et al.* 2005).

With respect to cosmology, approximately two-thirds of the identified SNe Ia will provide light curves suitable for cosmology. This dataset is of particular value because it will connect the low-redshift SNe Ia sample to the high-redshift sample and test for a smooth transition between these two regions. Ultimately this dataset will constrain the equation of state of 'dark energy' in the nearby universe and will, in combination with other datasets like SNLS (Astier *et al.* 2006), ESSENCE (Matheson *et al.* 2005) and the *HST data* improve the overall knowledge of the equation of state w for 'dark energy'.

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