# The VLT 5 year data set from the SuperNova Legacy Survey : redshifts and types of SNIa candidates

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I present the spectral analysis of 81 Type Ia supernova candidates from the SuperNova Legacy Survey 5 year data set measured at the Very Large Telescope between august 2006 and september 2007. 54 objects are identified as Type Ia supernovae and their redshifts are estimated.

## 1 Cosmological context and aim

Using Type Ia supernovae (SNeIa) as standardisable candles permits to constrain the cosmological parameters governing the accelerated expansion of the universe (e.g., Perlmutter et al [1]). Based on a Hubble diagram built with high, intermediate and low redshift SNeIa and combining with other cosmological probes (BAO+WMAP7), Sullivan et al [2] obtain (assuming a flat universe) : $w = -1.061^{+0.069}_{-0.068}$ where $w$ is the equation of state parameter of the dark energy. The SNeIa used in this analysis come from large spectro-photometric programs such as the SuperNova Legacy Survey (SNLS). In these programs, spectroscopy is essential to estimate redshifts and confirm the SNIa nature of the candidates. I present here a preliminary analysis of the SNLS 5 year spectroscopic data set, restricted to the spectra measured at the Very Large Telescope (VLT).

## 2 The SuperNova Legacy Survey experiment and the VLT 5 year spectral data

The SNLS is a 5 year experiment aiming at measuring the luminosity distance of a large number of SNeIa at intermediate to high redshift ($0.15 < z < 1.1$) in order to constrain cosmological parameters. Conducted from 2003 to 2008, this experiment is split in two surveys : 1) an imaging survey with the Canada-France-Hawaii Telescope in Hawaii to detect SNIa candidates and monitor their light curves in several photometric bands, and 2) several spectroscopic programs at the VLT, Gemini and Keck telescopes to confirm the nature of the SNIa candidates and measure their redshifts. SNLS measured 252 SNeIa during the first three years of operation [3]. Extending this set, spectra of 81 SNIa candidates have been obtained between august 2006 and september 2007 at the VLT in MOS (Multi-Object Spectroscopy) mode. These spectra have been wavelength and flux calibrated and are studied in the present work.

## 3 Spectral analysis : redshift estimates and SNeIa identification

The redshift determination is based on the presence, in the SN spectrum, of one or several host lines (e.g., [OII], CaH&K, $H_\beta$, [OIII]). An error of 0.001 is assigned to the redshift value, typi-

cal of redshift errors drawn from galactic emission/absorption lines. If no apparent host line is present, the redshift is estimated from the broad SN features (Si II, S II, Ca II) by fitting the SN spectrum with the spectro-photometric model SALT2 [4]. A typical uncertainty on the redshift in this case is 0.01.

To assess the nature of the candidates, a combined fit of the observed light curves and spectrum is done using SALT2. A galactic component is added and a wavelength tilt of the model is allowed. This procedure is illustrated for SN 06D4jh in figure 1. On the left panel, the full (SN+host) spectrum is shown in black. The best fit model is overlapped in red lines with (solid line) and without (dashed line) allowing for a wavelength tilt. The best fit host template (a Sd sunthetic template from PEGASE2) is shown in blue. On the right panel, the host model has been subtracted from the full spectrum (SN spectrum in black) and from the best fit model (SN model in red). We follow Balland et al [5] and classify the spectrum in one of the following categories : **SNIa** (typical SNIa features present and good overall fit), **SNIa⋆** (probable SNIa but other types (SNIb/Ic) can not be excluded), **SN?** (candidate of unclear type) and **other** (clearly not a SNIa).

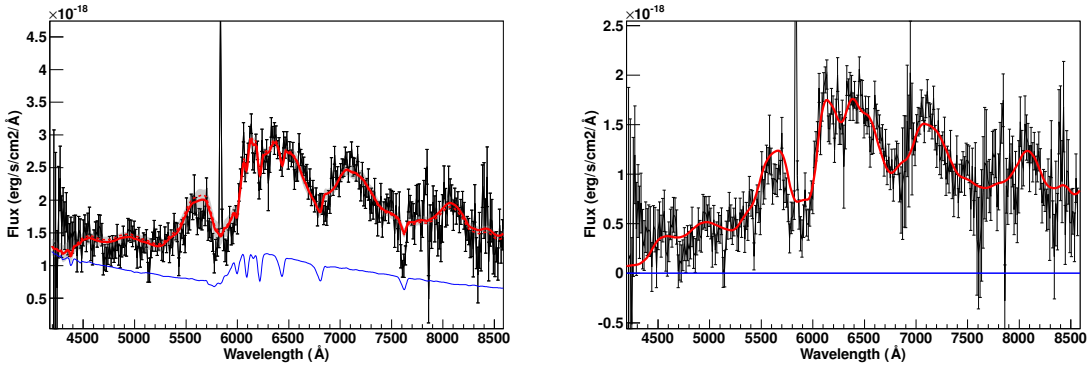


Figure 1: SN 06D4jh measured on 2006-11-14 at z=0.566 (redshift estimated from the [OII] galactic emission line visible at 5800Å) **- Left :** Full (SN+host) observer frame spectrum (black) with best fit model (red) overlapped. Dashed and solid lines are respectively without and with a wavelength tilt. The galactic component (a PEGASE2 spiral galaxy Sd) is shown in blue. **- Right :** Host subtracted SN spectrum (black) with the SN best fit model overlapped (red).

## 4 Results

Among the 81 SNeIa candidates of the SNLS VLT 5 year sample, 38 are classified as SNIa and 16 as SNIa⋆ (7 as SN? and 20 as others). The average redshift is $\langle z \rangle_{SNIa} = 0.56 \pm 0.03$ for SNeIa and $\langle z \rangle_{SNIa\star} = 0.77 \pm 0.03$ for SNeIa⋆. As expected, the SNIa⋆ sample has a higher average redshift than the SNIa sample (higher redshift means noisier spectra). Provided sufficient photometric information exist, the spectra falling into the SNIa and SNIa⋆ categories will be added to the spectroscopic sample for the SNLS 5 year cosmological analysis.

## References


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