The VLT 5-year data set from the SuperNova Legacy Survey

Redshift determination and identification of type Ia supernovae

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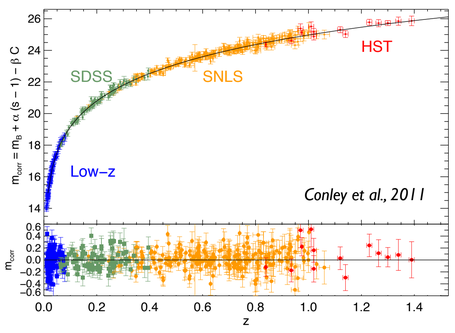
1. Cosmological context and aim

Using type Ia supernovae (SNeIa) as standardisable candles allows to constrain the cosmological parameters responsible of the accelerated expansion of the universe (Nobel Prize 2011 in Physics).



Based on a Hubble diagram built with high, intermediate and low redshift SNeIa, Sullivan et al (2011) obtain (assuming a flat univers) :

$$w = -1.061^{+0.069}_{-0.068}$$

where w is the equation of state parameter of the dark energy

To reduce the satistical and systematic uncertainties more SNeIa are needed at all redshift. Large spectro-photometric programs have been recently completed, such as the SuperNova Legacy Survey (SNLS). In this program, the spectroscopy is essential to :

↳ estimate the redshift

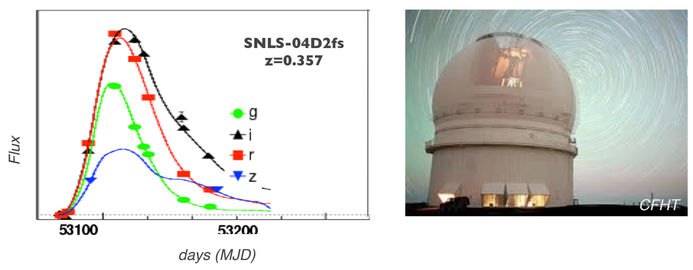
↳ confirm the SNIa nature of the candidate

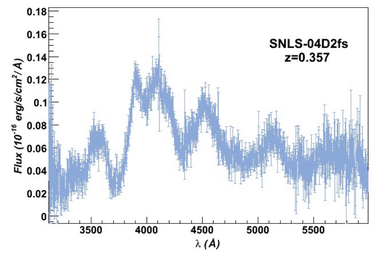
I present here the spectroscopy analysis for the SNLS 5-years data set, restricted to the spectra measured at the Very Large Telescope (VLT)

2. The SuperNova Legacy Survey experiment

- Aim ? measuring the luminosity distance of a large number of intermediate and high redshift SNeIa (0.15 < z < 1.1) in order to build the Hubble diagram and constrain the cosmological parameters
- When ? 2003 - 2008
- How many SNeIa ? 252 SNeIa published in the 3 years SNLS analysis (Guy et al, 2010)
- Method :

imaging survey	**spectroscopic program**
at the Canada-France Hawaii Telescope (CFHT) in Hawaii	at the Very Large Telescope (VLT), Gemini and Keck telescopes (Chile or Hawaii)
➔ a rolling-search to detect new SNeIa candidates ➔ to monitor their light-curves in several photometric bands	➔ to confirm the nature of the SNeIa candidates ➔ to measure their redshift

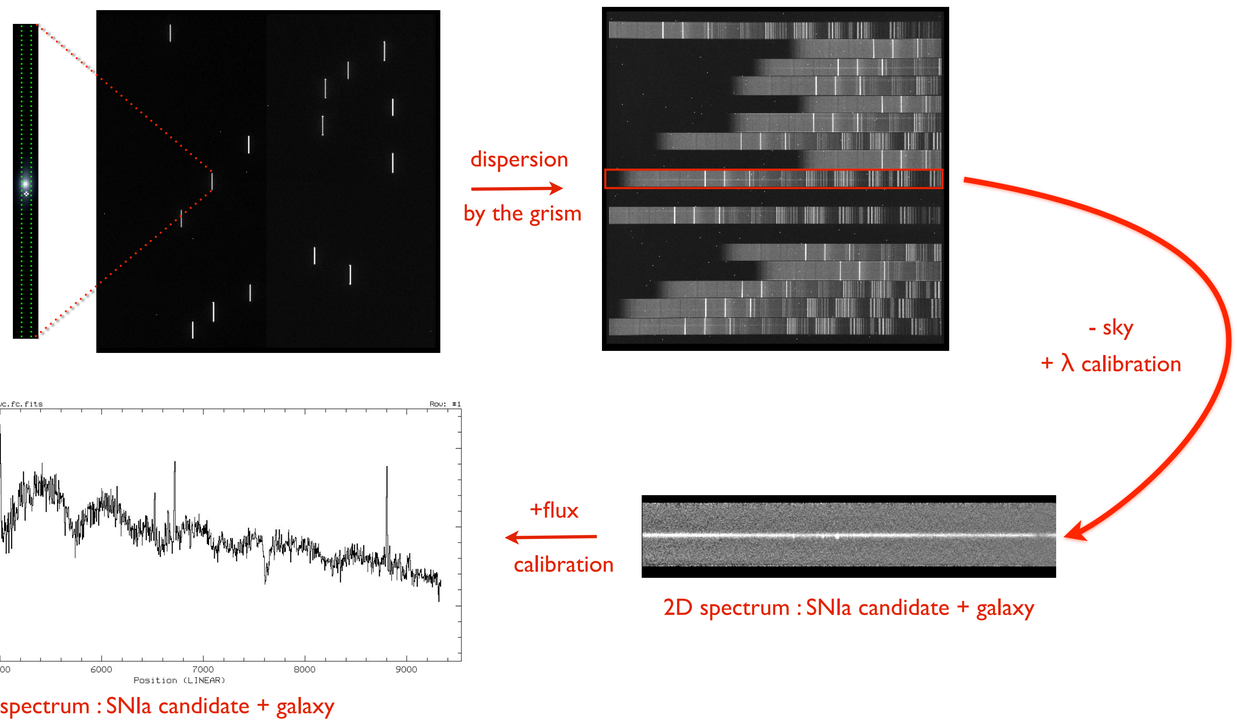




3. VLT 5 years spectral data from SNLS

- 79 SNeIa candidates measured between august 2006 and september 2007
- Spectra are measured using MOS (Multi-Objects Spectroscopy) mode with 19 slits positioned on the target and old host galaxies where identified SNeIa explosed (offline reduction by C. Lidman)

➔ example for SN07D1ah (08/27/2007) :

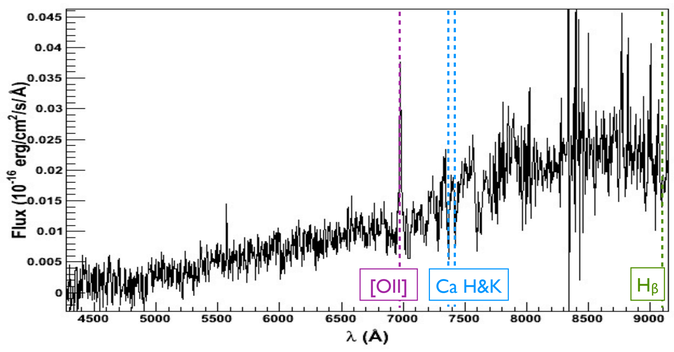


4. Redshift estimates

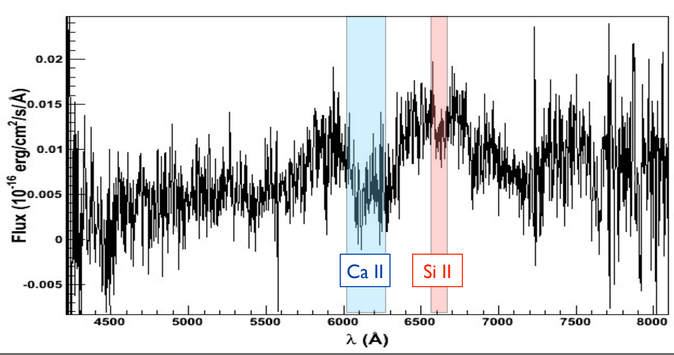
identification based on :

- host lines if present ([OII], Balmer series, CaH&K, H_β, [OIII], H_α) ➔ z ± 0.001
- SN itself if no apparent host lines (Si II, S II, Ca II) ➔ z ± 0.01

➔ example for SN07D1cd (09/21/2007) : z = 0.873 ± 0.001



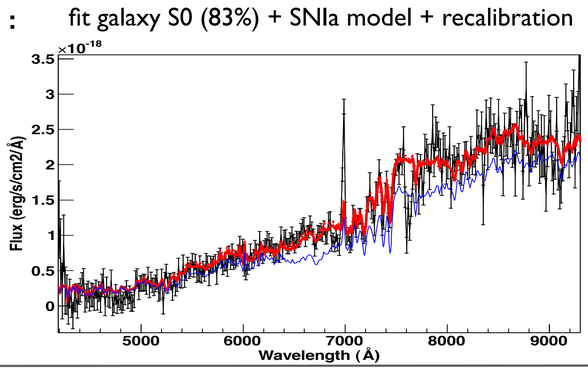
➔ example for SN06D1ix (13/18/2006) : z = 0.65 ± 0.01



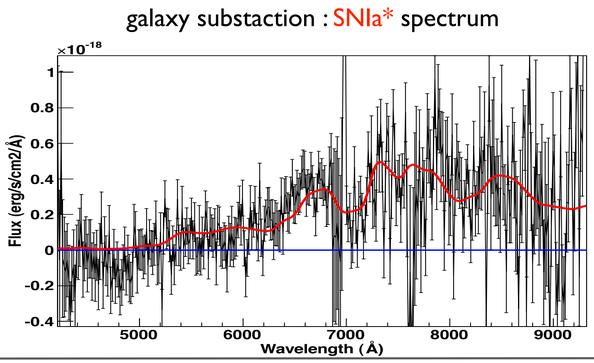
5. SNeIa identification

- We do a combined fit of observed light curves and spectrum using the spectro-photometric model SALT2 (Guy et al, 2007). A galactic component is added in the model (Pegase and Kinney templates) and recalibration of the photometric model to fit the spectrum is allowed.
- output parameters : ➔ photometric parameters : color *c* and stretch *s*
  ➔ spectroscopic parameters : host type, host fraction and recalibration parameters
  ↳ spectrum - best fit host model = SNIa candidate spectrum
- SNIa classification : ➔ SNIa : typical features (Si II, S II) + overall fit is visually good + spectral phase ≤ 5days after the maximum of light + not too strong recalibration
  Balland et al (2009)
  ➔ SNIa* = probable SNIa but other types (SNIb/Ic) can not be excluded : no typical SNIa absorption + good overall fit
  ➔ other = not a SNIa (AGN, galaxy, SNII, SNIb, SNIc) or no visible signal

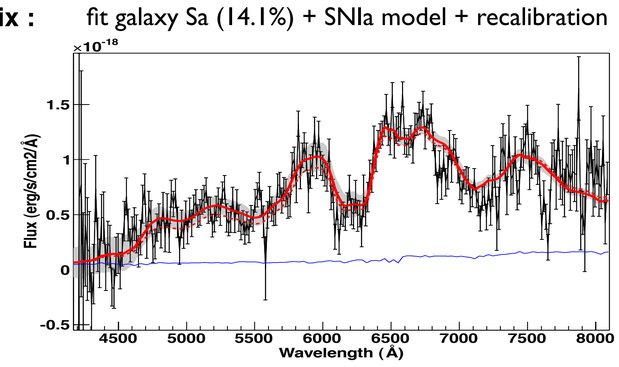
➔ SN07D1cd : fit galaxy S0 (83%) + SNIa model + recalibration



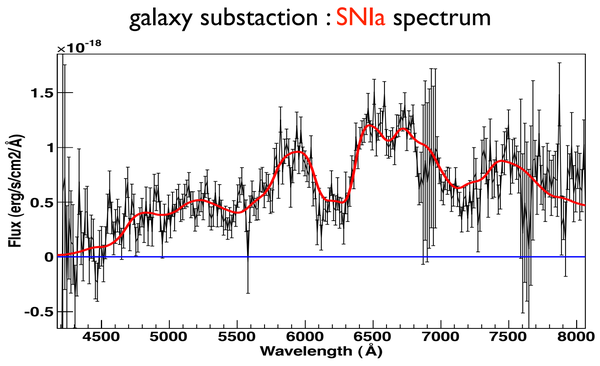
galaxy substaction : SNIa* spectrum



➔ SN06D1ix : fit galaxy Sa (14.1%) + SNIa model + recalibration

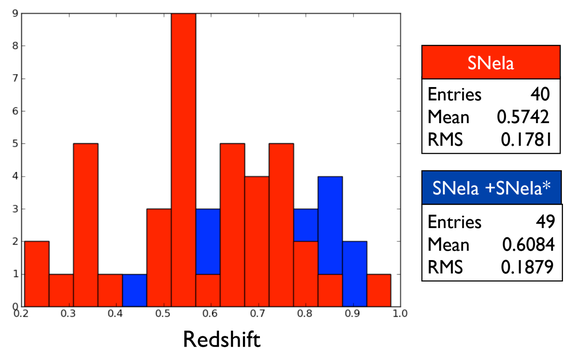


galaxy substaction : SNIa spectrum



6. Results

- 79 SNeIa candidates : 40 SNeIa, 9 SNeIa*, 30 others
- Redshift distribution for SNeIa and SNeIa+SNeIa*



- Comparison with redshift of VLT spectra from SNLS 3-years data set

	SNeIa	SNeIa+SNeIa*
SNLS 3yrs	0.60 ± 0.02	0.70 ± 0.03
SNLS 5yrs	0.57 ± 0.03	0.61 ± 0.03

7. Perspectives

- Compare these results with the analysis of Gemini and Keck spectra
- Before adding these SNeIa and SNeIa* to the SNeIa sample to build the Hubble diagram : analysis of the photometric parameters (stretch, color), light curves fit and compute the luminosity distance