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Spectral analysis of type II supernovae

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Abstract. We present spectroscopic analysis of 63 type II supernovae. We present preliminary results on correlations between spectroscopic and photometric properties, focusing on light-curve decline rates, absolute magnitudes and H_α lines profiles. We found the ratio of absorption to emission of H_α P-Cygni profile as the dominant measured parameter as it has the highest median correlation with all other parameters.

Keywords. Supernova, Spectra, Photometry

1. Introduction

Type II Supernovae (SNe II) were initially classified in two subclasses depending to the shape of the light curve. SNe showing constant luminosity are called *plateau* (SN IIP), and SNe with linear decline are called *linear* (SN IIL; Barbon *et al.* 1979). While many individual analysis have been published (e.g. Hamuy 2003), few statistical analysis of SN II have been presented, to date . Patat *et al.* (1994) examined some properties of 51 SN II and concluded that SN IIL have large ratio of absorption to emission (a/e) of H_α P-Cygni profile values. Here, we show how the spectral and photometric properties are correlated using a large sample of high cadence and quality spectral sequences.

2. The sample and measurements

The sample of type II Supernovae (SNe II) employed in this study was obtained by CSP between 2004 and 2009 plus data from previous samples. From this database we selected a sub-sample of events with sufficient data to measure important spectral and photometric parameters. A large variety of SNe II are included in this sub-sample, which can be seen in the diversity of H_α. Figure 1 (left) shows this variety in SNe II focusing on the H_α P-Cygni profile.

For this initial study of SNe II spectral properties we choose to focus on H_α line profiles. We measure two spectral properties: the ejecta velocity via the FWHM of emission of H_α, and the ratio of EWs of absorption to emission of H_α, initially proposed by Patat *et al.* (1994). From photometry we measure properties of the V-band light-curves (see in this edition, Anderson 2013): s1: initial decline from maximum, s2: *'plateau'* decline rate (these are in V-band mags per 100 days), M_{max}: maximum absolute magnitude. All the spectral measurements are interpolated to the B_{inf}, defined as the time of transition between s1 and s2.

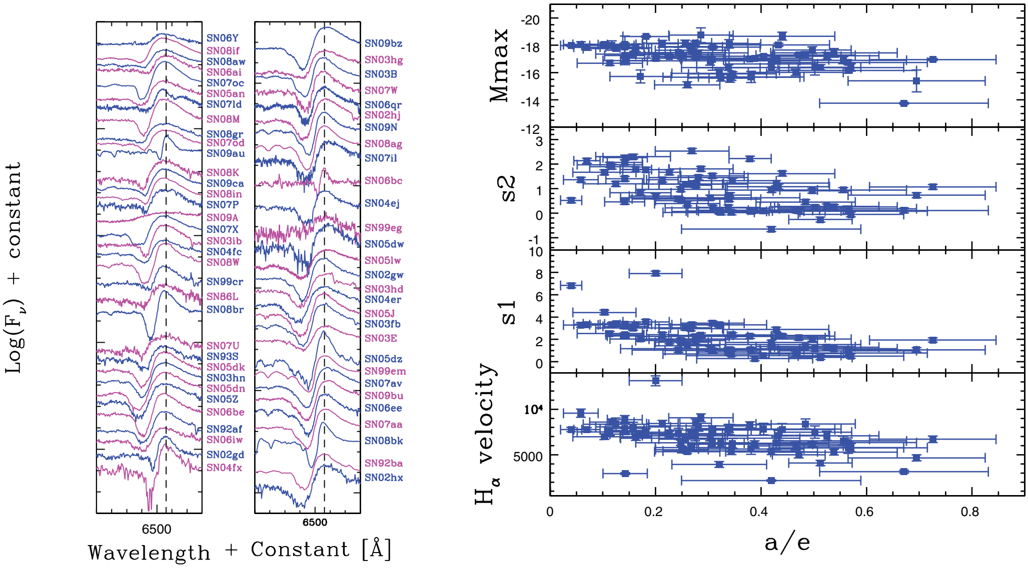

Figure 1. *Left:* Spectral sequences of 63 SNe focousing on the H_α PCygni profile near B_{inf}. The SNe are ordered in terms of a/e (ratio of absorption to emission in H_α) increasing. *Right:* : Correlations between (a/e) in H_α and ejecta velocity, s1, s2 and M_{max}.

3. Results

In Figure 1 (right) we correlate a/e with the ejecta velocity and three photometric parameters: s1, s2, M_{max} (corrected for A_v using NaD lines in spectra). a/e was defined as the dominant measured parameter as it has the highest median correlation with all other parameters. This plot shows that SNe with smaller (a/e) have higher H_α velocities, higher slope after the maximum and in the $'plateau'$ phase and are brighter. While, SNe with higher (a/e) have smaller H_α velocities, smaller slope after the maximum and in the Plateau phase, and are dimmer.

The spectral diversity found in H_α P-Cygni profiles and their correlations with light curves properties could be interpreted as circumstellar material (CSM) interaction (Pastorello *et al.* (2006), Inserra *et al.* (2011), Roy *et al.* (2011), Inserra *et al.* (2012)). However, we can not rule differences in properties such as the changes in the mass, temperature and density of the ejecta.

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