The Type II supernovae 2006V and 2006au: two SN 1987A-like events

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Abstract. We studied optical and near-infrared (NIR) light curves, and optical spectra of Supernovae (SNe) 2006V and 2006au, two objects monitored by the Carnegie Supernova Project (CSP) and displaying remarkable similarity to SN 1987A, although they were brighter, bluer and with higher expansion velocities. SN 2006au also shows an initial dip in the light curve, which we have interpreted as the cooling tail of the shock break-out. By fitting semi-analytic models to the UVOIR light curve of each object, we derive the physical properties of the progenitors and we conclude that SNe 2006V and 2006au were most likely Blue Supergiant (BSG) stars that exploded with larger energies as compared to that of SN 1987A. We are currently investigating the host galaxies of a few BSG SNe, in order to understand the role played by the metallicity in the production of these rare exploding BSG stars.

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the spectral lines of our SNe reveal high expansion velocity, in particular for SN 2006au. Overall the spectra exhibit typical Type II features. The complete photometric datasets enabled us to build bolometric light curves (BLCs) for both SNe, by converting the magnitudes into fluxes at the proper effective wavelength and then integrating the resulting spectral energy distributions. We also estimated the explosion day of our objects by applying the expanding photospheric method, e.g. Dessart & Hillier (2005). This allowed us to properly model the BLCs, using the semi-analytic model of Imshennik & Popov (1992). We also modelled the early BLC of SN 2006au with the analytic model of Chevalier (1992). The best model fit gave us estimates for the ejecta mass ($M_{ej}$), the explosion energy ($E$), the progenitor radius ($R$) and the $^{56}$Ni mass of both events. We obtained $M_{ej} \approx 20 M_\odot$, $E \approx 2 - 3 \times 10^{51}$ erg and $R \approx 75 - 100 R_\odot$. The $^{56}$Ni mass was estimated to be $0.127 M_\odot$ for SN 2006V and $\leq 0.073 M_\odot$ for SN 2006au. The physical parameters we derived for the progenitors, in particular the small radii, are consistent with a scenario where both SNe 2006V and 2006au were BSGs which exploded with larger energies as compared to that of SN 1987A. In order to understand why these rare 87A-like SNe have BSG progenitors, we are measuring the metallicity at the explosion site of each event in the sample by Pastorello et al. (2012). We will be able to test if the sub-solar metallicity is a necessary ingredient to produce exploding BSG stars, as it has been thought for SN 1987A (see Podsiadlowski 1992). Preliminary results suggest some of these SNe were produced at solar metallicity, opening interesting questions on their origin.

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Figure 1. Light curves of SNe 2006V and 2006au compared to those of SN 1987A.