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Hunting for the faintest hosts of the brightest supernovae

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Abstract. Superluminous supernovae (SLSNe) are an emerging class of SNe that exhibit luminosities exceeding those of SN Ia by an order of magnitude and have light curves with characteristic timescales of hundreds of days. Here we present observations of the host galaxies of 21 SLSNe observed with the Hubble Space Telescope, and show that their ultraviolet (UV) and near-infrared (nIR) luminosities and sizes and very different from those of the hosts of other core collapse events, with significant implications for their progenitors.

Keywords. (stars:) supernovae: general

The extreme luminosities of SLSNe provide evidence for exceptionally energetic explosions, and may derive from the collapse of extremely massive stars. The characterisation of their progenitors is of high importance, from both a cosmological and massive stellar evolutionary view. Like other SNe, they can be classified as hydrogen-poor (SLSN-I) and hydorgen-rich (SLSN-II) events. A minority of H-poor SLSNe have late time light curves consistent with the expectations of ^{56}Ni decay (SLSN-R). The physical mechanisms invoked to produce a SLSNe during massive star collapse vary greatly; from the interaction of the SNe shock wave with a dense shell of previously ejected circumstellar material (e.g. Chevalier & Irwin (2011)); to the injection of energy into the SNe explosion from an engine within the progenitor, such as accretion onto a central compact object, or the spin down of an internal magnetar (e.g. Kasen & Bilsten (2010)); to the explosive collapse of the most massive, Population-III analogues (Pair Instability Supernovae (PISNe), e.g. Rakavy & Shaviv (1967)). While much may be learnt about the explosions themselves from detailed observations of the SNe, a powerful complementary approach lies in studies of the local and galaxy scale environments.

We obtained HST WFC3 imaging of a sample of 21 SLSNe at nIR and rest-frame UV ($\sim$ 2500Å) wavelengths, with a sample redshift range of 0.019< z<1.2 over all SLSN classes. We combine our HST observations with further data obtained at the WHT, VLT and Gemini, as well as literature values in order to produce UV to IR spectral energy distributions (SEDs).

In Figure 1 we present the photometric properties of our SLSNe sample, alongside those of Long Gamma Ray Bursts (LGRBs) and Core Collapse SNe (CCSNe) in a like for like comparison over a similar redshift range. We find that SLSNe hosts are generally less massive, less star forming, more compact and fainter at both nIR and rest-frame UV wavelengths, than LGRB or CCSN host galaxies, although with similar specific star formation rates.

We find SLSN-I hosts to inhabit a much narrower range of host properties than SLSN-II hosts, with KS and Anderson-Darling testing showing them to be consistently less massive than the hosts of LGRBs. This implies lower metallicity environments,

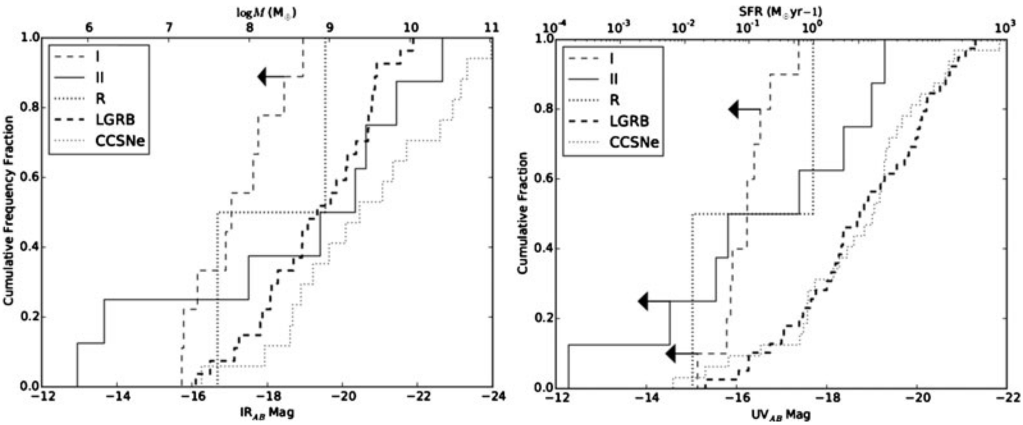

Figure 1. Adapted from Angus *et al. submitted*. *L*eft: Cumulative distribution of absolute nIR magnitudes and corresponding stellar masses of our SLSN and comparison samples *R*ight: same as left but for UV magnitudes and corresponding star formation rates. In both plots, SLSNe are broken down by spectral sub-type. Here the broad range of host properties exhibited by SLSN-II is obvious, especially compared to the more restricted range of host types for SLSN-I.

suggestive that progenitor models requiring lower metallicities are more likely (specifically the PISNe model and the internal engine model), although current spectroscopic studies of samples overlapping with this study are some what conflicting on this point (see Lunnan *et al.* (2014) and Leloudas *et al.* (2015)). The broader range of host properties exhibited by SLSNe-II, including our two lowest mass galaxies at $\sim 10^6 M_\odot$ implies that the production of theses progenitors must be replicable across a wide range of environments and metallcities, which potentially could represent some unknown stochastic process during star formation.

References

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