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SN 2013dx associated with GRB 130702A: a detailed photometric and spectroscopic monitoring and a study of the environment

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Abstract. We aim at characterizing SN 2013dx, associated with GRB 130702A, and their environment, through ground-based observational campaigns in the optical-IR band. We infer a synthesized ^{56}Ni mass of ∼0.2 $M_\odot$, a photospheric velocity of the ejected material declining from $\sim 2.7 \times 10^4$ km s^{-1} at 8 rest frame days from the explosion, to $\sim 3.5 \times 10^3$ km s^{-1} at 40 days, a kinetic energy of $\sim 35 \times 10^{51}$ erg, an ejected mass of ~ 7 $M_\odot$ and a progenitor mass of $\sim 25 - 30$ $M_\odot$. We also find that the host belongs to a group of galaxies, an unprecedented finding for a GRB-associated SN and, to our knowledge, for long GRBs in general.

The connection between GRBs and SNe has been firmly established on the basis of a handful of nearby events ($z < 0.3$) for which a decent spectroscopic monitoring was possible. In fact, only the simultaneous use of light curve and spectra can break the degeneracy between the SN parameters and allow for a full characterization of the progenitor. SN 2013dx, associated with GRB 130702A at $z = 0.145$, is a remarkable new entry into the small group of the most consistently investigated SN-GRB events.

We present our extensive photometric and spectroscopic campaign with the VLT, TNG, and REM telescopes, covering ∼ 40 days after the GRB detection. We obtained 5 spectra and 9 photometric epochs (U, g, r, i, z bands) with the TNG, 11 spectra and 11 photometric epochs (u, g, r, i bands) with the VLT and 7 photometric epochs (g, r bands) with REM. The VLT spectra have been acquired placing the slit with different position angles to determine the redshift of 14 nearby galaxies to study the SN environment.

The properties of SN 2013dx are similar to those of previous GRB- and XRF-SNe, with the peak luminosity intermediate between those classes, and the photospheric velocities (determined through the Si II 6355 feature and its redward shift along our spectra) are more similar to those of GRB-SNe, with velocity of the ejected material declining from $\sim 2.7 \times 10^4$ km s^{-1} at 8 rest frame days from the explosion, to $\sim 3.5 \times 10^3$ km s^{-1} at 40 days. Accordingly, the physical parameters of SN 2013dx, derived with the empirical method based on the rescaling of the quantities known for other SNe, are similar to those determined for the previous GRB-SNe, but somewhat lower than those of SN 1998bw: we estimate a synthesized ^{56}Ni mass of ~ 0.2 $M_\odot$, an ejecta mass of $M_{ej} \sim 7$ $M_\odot$, and a kinetic energy of $E_K \sim 35 \times 10^{51}$ erg. Comparing these values with that of SN 1998bw, we infer for the progenitor of SN 2013dx a mass of $\sim 25 - 30$ $M_\odot$.

Through spectroscopy of the field galaxies close to the host of the SN, we find that 65% of them have the same z as SN 2013dx, indicating that this is a group of galaxies. This represents the first report of a GRB-SN association in a galaxy group or cluster.

More details on this work can be found in D'Elia *et al.* (2015, *A&A*, 577, 116).