Supernova Environmental Impacts
Proceedings IAU Symposium No. 296, 2013
A. Ray & R. A. McCray, eds.

doi:10.1017/S1743921313009770

Using the environment to understand supernova properties

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Abstract. We present three studies that use supernova (SN) environments within host galaxies (HGs) to constrain SNe properties. These studies are ordered from an indirect approximation to a direct determination of the environmental parameters of the SN. We find correlations between the galactocentric distance and several parameters measured from both the SN light-curve (LC) and the host galaxy spectroscopy. We are able to recover and strength previous results pointing to a sequence on the progenitor mass of different SN types. We also confirm no significant difference in the elemental abundances of the environment where different SN types exploded, measured with a more powerful technique such as Integral Field Spectroscopy (IFS).

Keywords. (stars:) supernovae: general, (ISM:) HII regions, galaxies: abundances, techniques: spectroscopic, surveys

1. Introduction

Current SNe surveys will increase drastically the number of events discovered and available to better understand both stellar evolution and cosmology. It is well known that the use of Type Ia SNe as a cosmological distance indicators requires a better control of the systematic errors since the statistical errors will be reduced by this new huge amount of events. One approximation is to account for environmental properties in the LC standardization. On the other hand, with this new data one will be able to make constrains on the properties of the progenitor stars that produce different types of SNe. Here we present a compilation of three studies that comprise a sequence from an indirect approximation to a direct determination of the environmental parameters of the SN.

2. Summary of the studies

GCD as a proxy for galaxy parameters. We use almost 200 SNe Ia at $z < 0.25$ discovered by the SDSS-II SN Survey, to search for dependencies between SN Ia LC parameters and the projected distance to the HG center, using the distance as a proxy for local galaxy properties. We correlate the LC parameters with several definitions of the distance to the center of the HG, either normalized or not, and look for trends in the mean values of these parameters with increasing distance. We find several differences in the intrinsic color and LC stretch between SN exploding closer and further the galaxy core. More details can be found in Galbany *et al.* (2012).

Global galaxy parameters inferred from slit spectroscopy. The following step is to measure HG parameters, such as age, mass, metallicity, Hα emission, and specific star formation rate from the spectra of the HGs of those objects in SDSS-II SN sample that have the HG spectrum available in SDSS DR9. We look for correlations between these HG parameters and the redshift, SN LC parameters, and GCDs. We find that, for spiral

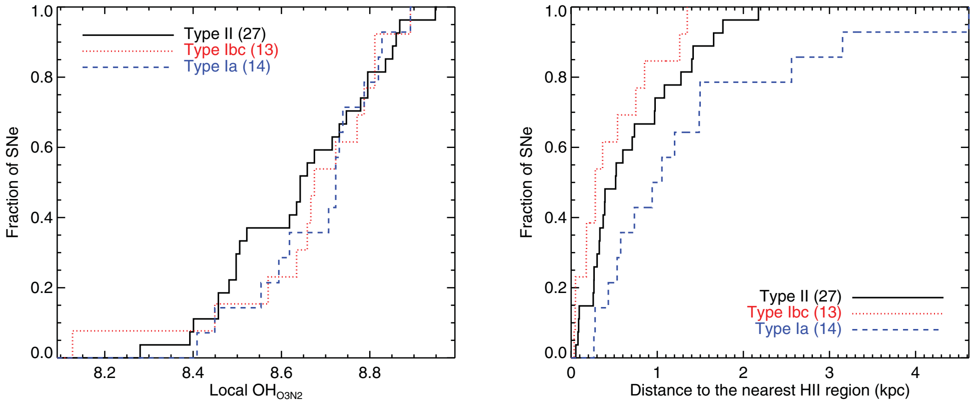

Figure 1. Fraction of SNe of different types that explode in an environment with an elemental abundance lower than each value (left), and at certain distance to the nearest HII region (right).

galaxies, SNe in more massive, old, and with high elemental abundances, tend to explode farther from the center.

Local galaxy parameters using IFS. Following Stanishev *et al.* (2012), we produce 2D maps of the gas emission lines and the stellar population parameters of nearby galaxies ($0.005 < z < 0.03$) from CALIFA and PINGS surveys that hosted an observed SN of any kind. We then look for differences among SN types that help to constrain properties of the progenitor star and environmental characteristics. With this approach we are going further than using simply an aperture spectrum centered at the galaxy core, or a spectrum from a slit positioned at the position of the SN explosion. Our sample consists of 54 SNe (27 II, 13 Ibc, 14 Ia). When correlating SN type with the local metallicity at SN position, we see that type Ibc and Ia SNe seem to explode in higher metallicity environments than type II SNe (Fig. 1, left plot). However there is a need for more statistics in order to make this difference significant. We also look for correlations between the SN type and the star formation rate traced by the Hα emission. The cumulative distributions of the distances from the SN location to the nearest HII region (right plot in Fig. 1) show a sequence from type Ibc, through type II, and type Ia SNe. The same ordering is obtained when correlating the SN type with the GCD. This result points to a difference in the lifetime and masses of their progenitor stars.

3. Conclusions

We have presented three studies that sequentially approach to a direct measurement of the local galaxy properties at the SN location. We see correlations between the LC parameters and the spectroscopic HG parameters to the GCD. We are also able to confirm and strength the differences in the progenitor mass of the main SN types, showing a decreasing sequence from type Ibc to type Ia SNe. We find no significant differences in the elemental abundance of the environments of different SN types.

References

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Stanishev, V., Rodrigues, M., Mourão, A., & Flores, H., 2012, *A&A*, 545, A58

https://doi.org/10.1017/S1743921313009770 Published online by Cambridge University Press