Supernovae in paired galaxies

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Abstract. We investigate the influence of close neighbor galaxies on the properties of supernovae (SNe) and their host galaxies using 56 SNe located in pairs of galaxies with different levels of star formation (SF) and nuclear activity. The mean distance of type II SNe from nuclei of hosts is greater by about a factor of 2 than that of type Ibc SNe. The distributions and mean distances of SNe are consistent with previous results compiled with the larger sample. For the first time it is shown that SNe Ibc are located in pairs with significantly smaller difference of radial velocities between components than pairs containing SNe Ia and II. We consider this as a result of higher star formation rate (SFR) of these closer systems of galaxies.

Keywords. supernovae: general – galaxies: fundamental parameters, interactions, starburst

Interaction with a neighbor galaxy can be a triggering mechanism for nuclear activity and/or circumnuclear starburst (Barton *et al.* 2000, Ellison *et al.* 2008). Observational results (e.g. Cappellaro *et al.* 1999, Mannucci *et al.* 2005, Petrosian *et al.* 2005, Habergham *et al.* 2012) suggest that core-collapse (CC) SNe are tightly connected with recent SF. The aim of this study is to investigate to what extent gravitational interaction with a close neighbor can be connected with nuclear activity and/or enhanced SF in galaxy pairs, using SNe as tracers of recent SF. The complete study is presented in Nazaryan *et al.* (2013).

The sample of the current study was obtained by cross-matching a sample of selected pairs of galaxies with the catalog of SNe by Hakobyan *et al.* (2012) containing 3876 SNe located within the SDSS DR8 coverage. We used three catalogs of galaxies with different levels of nuclear activity to construct our sample of close pairs of galaxies. These catalogs are the following: (1) the catalog of Markarian (MRK) galaxies, (2) the Second Byurakan Survey (SBS) galaxies catalog, and (3) the North Galactic Pole (NGP) galaxy catalog. Results of a close neighbors search for MRK galaxies are published (Nazaryan *et al.* 2012). We also conducted the search of neighbors for SBS and NGP galaxies using the same criteria. For the current study, we identified 56 SNe in 44 hosts (19 SNe Ia, 12 SNe Ibc, 15 SNe II, and 10 unclassified). Pairs of galaxies are presented via two parameters describing strength/stage of interacting/merging: difference of radial velocities dV_r and linear projected distance $D\mathrm{p}$ between pair members.

Hosts of type Ibc and II SNe in our sample (with median t-types Sbc and Sc respectively) are of later morphological classes than those of type Ia. This is well known observational result (Cappellaro *et al.* 1999). Morphologies of hosts from our sample are consistent with those of the unbiased sample of 1021 nearby hosts of different types SNe from Hakobyan *et al.* (2012). SN hosts of our sample tend to form pairs with neighbors

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with similar morphologies. The percentage of barred galaxies among our hosts is larger (2σ) than that in the sample from Hakobyan *et al.* (2012). Since our sample consists of paired hosts only, the excess of bars is expected (e.g. Méndez-Abreu *et al.* 2012).

We studied radial distributions of SNe of different types. The mean value of R_{SN}/R_{25} of is 0.53 ± 0.10 for type Ia. The mean normalized distance R_{SN}/R_{25} of SNe II, is roughly double that of SNe Ibc (with 3.35σ level of significance). Our mean values for CC SNe within estimated errors are in agreement with those of Hakobyan (2008) and Hakobyan *et al.* (2009). The higher type II to Ibc ratio of mean normalized distances in our sample is marginally significant (1.54σ) than that in the Hakobyan *et al.* (2009) sample.

We found that the distributions of dV_r of pairs containing SNe Ia and II is the same with practically consistent mean values (about 130 $km\ s^{-1}$). But the same distributions of pairs with Ibc and II SNe are significantly different (3.2σ) with smaller mean dV_r of for Ibc (56 $km\ s^{-1}$ in average). However, there is no difference between mean values of Dp of pairs with SNe of different types. To explain the strong dependence of CC SNe types on dV_r, we considered SFR as the main parameter affecting SN production in galaxies. SN rate and number ratio of type Ibc to type II SNe should increases with increasing of SFR (Cappellaro *et al.* 1999, Mannucci *et al.* 2005, Petrosian *et al.* 2005, Hakobyan *et al.* 2011). Also we expect a relatively larger amount of star-forming galaxies in pairs with smaller dV_r and Dp due to interaction-triggered starbursts (Barton *et al.* 2000, Ellison *et al.* 2008). Therefore, the excess of Ibc SNe compared to II SNe in the pairs with smaller dV_r and Dp can be a result of a higher SFR in their stronger interacting hosts.

As a conclusion, we consider that close environment of galaxies can have some observable effect on SN production due to the impact on SF of galaxies.

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