New approaches to SN studies using IFS

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CALIFA Survey

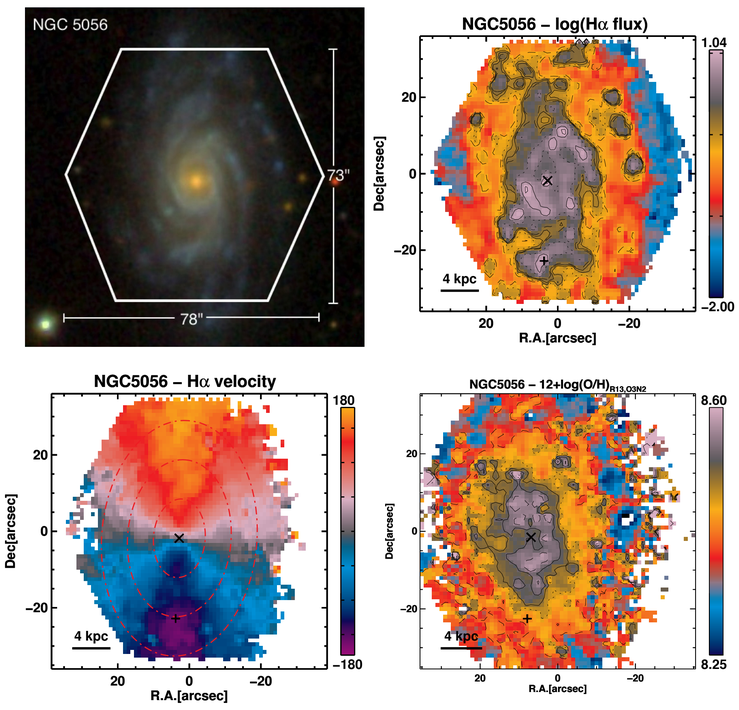
We use optical Integral Field Spectroscopy of nearby SN host galaxies (0.005<z<0.03) provided by the Calar Alto Legacy Integral Field Area (CALIFA) survey with the goal of finding correlations in the environmental parameters at the location of different SN types. With this approach we are going further than using simply aperture spectrum centered at the galaxy core, or a spectrum from slit positioned at a SN explosion, since we have 2-dimensional spectroscopic information of the whole extent of the galaxy. So far, we have studied the impact of the star-formation and the metallicity in the determination of the SN type.

The CALIFA Survey have obtained spatially resolved spectroscopic information of more than 600 galaxies in the Local Universe, using the Potsdam Multi Aperture Spectrograph (PMAS) mounted on the 3.5m telescope at the Calar Alto Observatory.

We selected from the whole sample those galaxies that ever hosted any kind of SN, which resulted on 110 galaxies that hosted 125 SNe (43 type II, 27 type Ibc, and 55 type Ia).

We fitted the ~4000 spectra per galaxy using STARLIGHT (Cid Fernandes+05, MNRAS, 358, 363) to extract the information of the stellar populations (SP), and fitted the ionized gas emission lines in the pure nebular emission line spectra. We then produced 2D maps of ionized gas and SP parameters, and performed several comparisons between the global value from the integrated spectrum and the local values at the SN position.

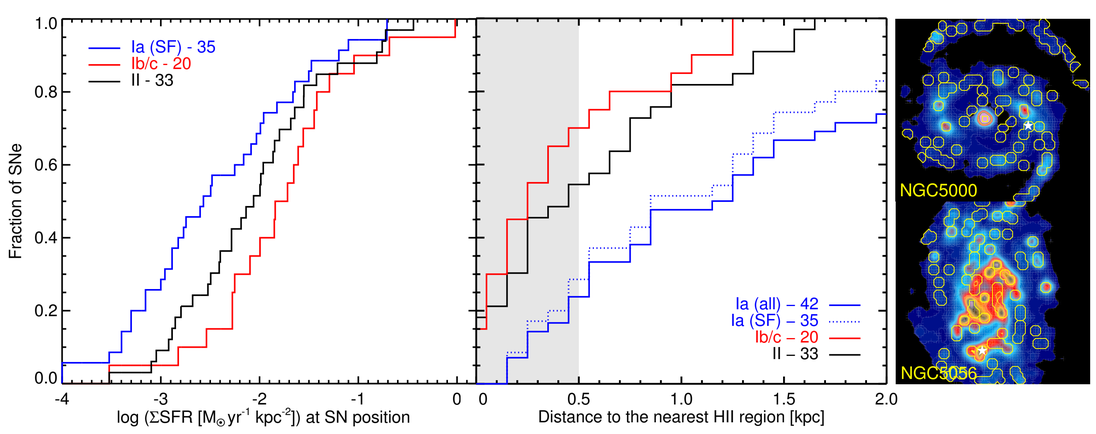
This poster summarizes the main results of the two studies presented so far.

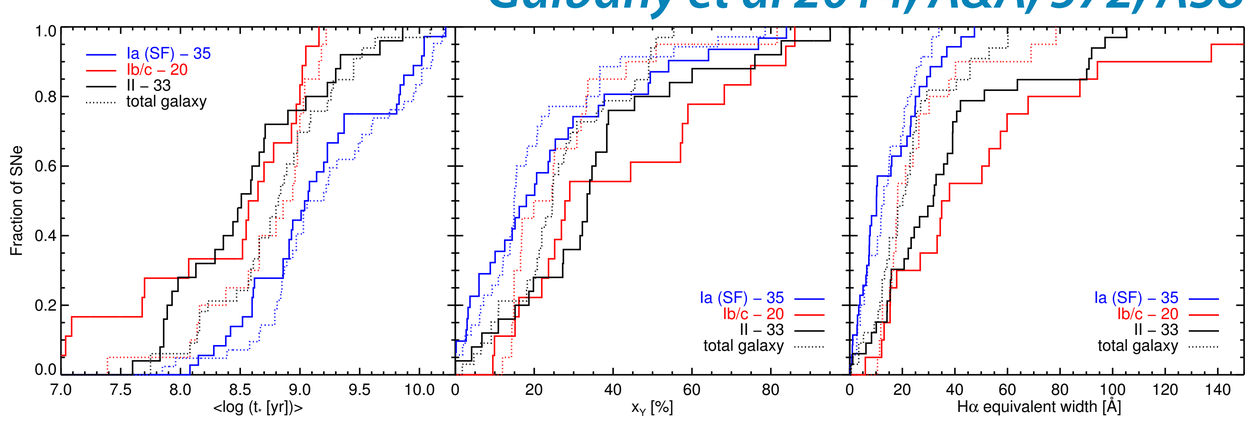


I. Correlation to star-forming (SF) regions

By studying various indicators of the ongoing and recent SF we found that:

Galbany et al 2014, A&A, 572, A38

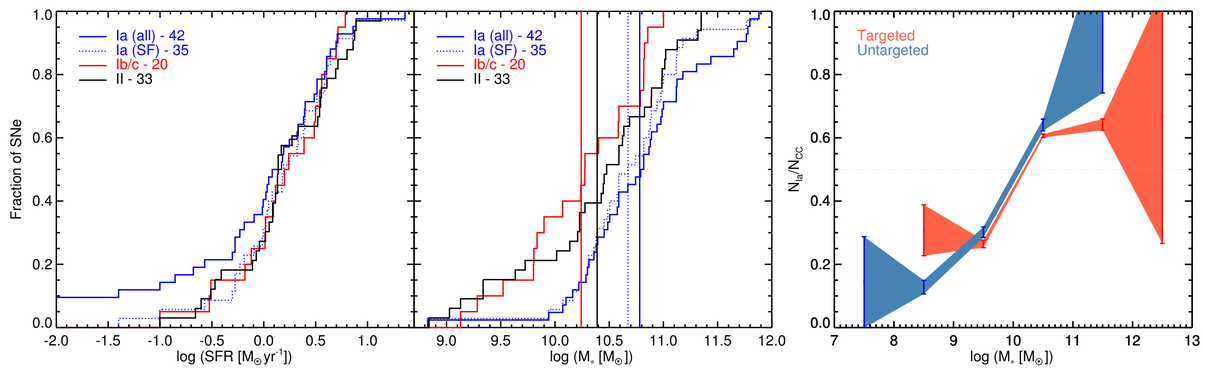




The ΣSFR @SN locations forms a sequence from being most intense for SN Ib/c and weakest for SNe Ia. After determining the deprojected distance on the galaxy disc to the closest HII region, SN Ib/c are also the SN type most spatially related to SF regions, followed by SN II and finally SNe Ia, which are most weakly related to the SF.

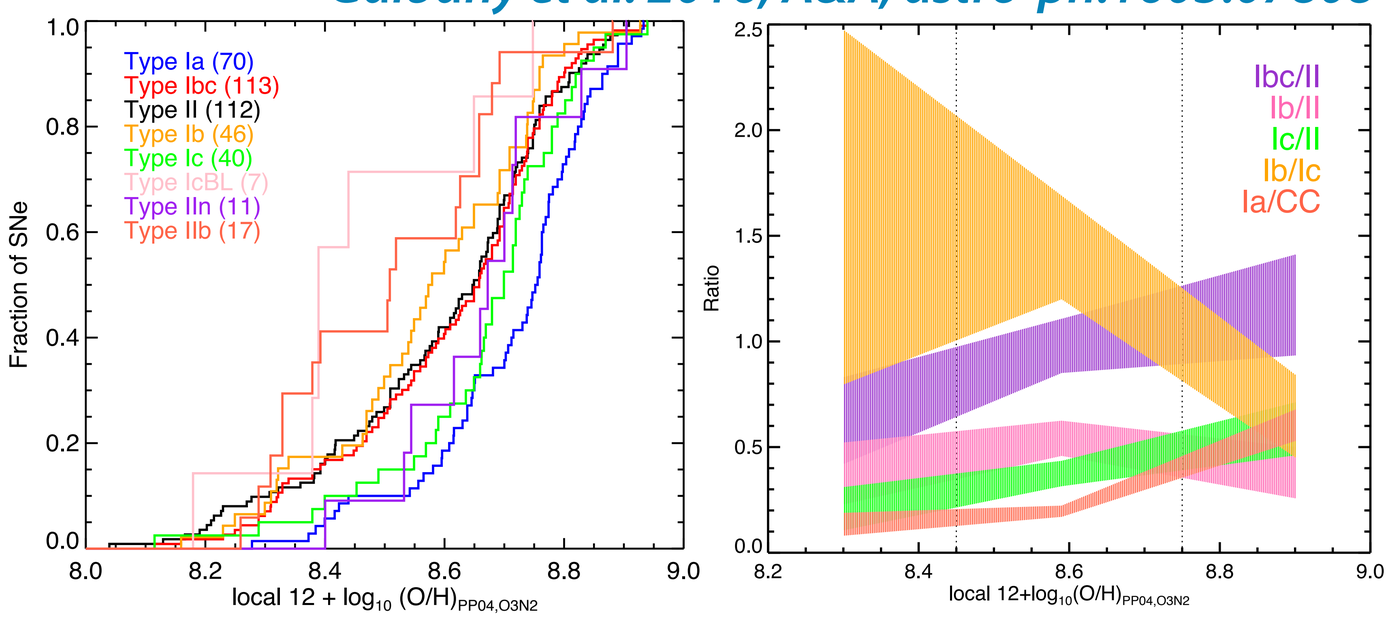
There is a clear sequence from SNe Ibc to SNe Ia, the former exploding at places with higher Ha EW, lower stellar ages and more contribution of younger SP models. Comparing global and total values, while CC SNe tend to explode at positions with younger SP than the galaxy average, the SP properties @SN Ia locations are one average the same as the global ones. This suggests that SNe Ia do not tend to explode in regions with specific properties but are rather randomly distributed in the galaxies.

While the total ongoing SF inferred from Hα emission is on average the same for the hosts of the three SN types, the masses of the SN Ia hosts are by ~0.3-0.4 dex higher than the masses of the CC SN galaxies due to the larger fraction of old SP in the SN Ia hosts. The ratio between the number of CC SNe and SNe Ia increases with decreasing the galaxy mass and it should be expected to discover SNe Ia preferably in high-mass galaxies and CC SNe in lower-mass galaxies.



II. SN environmental metallicity

Galbany et al. 2016, A&A, astro-ph:1603.07808



By extending our SN sample with published measurements of the metallicity at the vicinity of the SN, we found a sequence from higher to lower local metallicity,

$$Z_{Ia} > Z_{IIn} > Z_{Ic} > Z_{Ibc} \sim Z_{II} > Z_{Ib} > Z_{IIb} > Z_{Ic\text{-}BL}$$

and significant difference between the distributions of SNe Ia and CC SNe, and SNe Ib and SNe Ic.

We also found that the Ibc/II ratio increases with metallicity which supports that at least part of the SNe Ibc can be produced by single stars interacting with metallicity driven winds. The Ic/II ratio still increases while Ib/II ratio remains constant. This indicates that SNe Ic are driving the previous relation. This is also confirmed with the decrease of the Ib/Ic ratio with increasing metallicity. Finally, we also found that the Ia/CC ratio increases with metallicity.

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