A - Abstract

The high FIR luminosity of SB galaxies is a direct measure of their SFR and implies a high SN rate. This seems in contradiction with the fact that very few SNe have been discovered in SB galaxies. This is due to several factors, mainly extinction, too large or small depth of previous SN searches. Early attempts of NIR searches (e.g. Mannucci et al. 2003, Mattila et al. 2003), where extinction is strongly reduced, show no evidence of enhanced SN rate in SB. For this reason we started a new search to measure the SN rate using HAWK-I@VLT. We found four cases with spectroscopic confirmation. This is fully consistent with the expected number of detectable events (2.3). The magnitude limit is lower. The standard supernova scenarios and the detection limit of our IR search. The conclusion is that we do not confirm the evidence of a peculiar ratios LFIR/SFR/SN rate in SB galaxies.

B - The galaxy sample

From the IRAS Revised Bright Galaxy sample we selected a sample of 30 SB galaxies with m0.07, FIR luminosity log(L)FIR>10.8, and visible at ESO in the semester from April to October. The FIR luminosity of galaxies of our sample is about 10 times the B luminosity. The sample is isolated but some are interacting or contain double nuclei.

C - Search strategy

The SN search is performed in K band, where the extinction is strongly reduced compared to optical band, using HAWK-I@VLT. Given that the SN infrared light curves evolve relatively slowly, we do not need frequent visits; assuming an average of 300 visits per galaxy, per semester we planned for 100 visits per observing period. To reach a good S/N we estimated 25 mins per visit making a total request of 42h per period. Our search is well suited as a filler for the gaps in the other large surveys, in particular those exploiting optimal seeing, in poor seeing or non-photometric conditions. Despite this lack of restrictions, light of 10% of images have seeing >1″.

D - SN sample

During the period 85-87 we have found 6 SN candidates (5 CCSNe and 1 Ia) in our sample. The improved efficiency was partly due to a better image quality which resulted from an improved disease strategy. In two cases we obtained the discovery image (SN 2010hp, CBET244 and 2011ee, CBET773). For two other SNe the spectroscopic classification was obtained by other groups. Two candidates were lost for spectroscopic observations and confirmation was based on analysis of multicolour photometry.

E - Detection efficiency

Estimating the SN rate requires accurate estimate of the detection efficiency of the search. The magnitude limit of the SN detection. For each of the difference image we have estimated through artificial star experiments. This was found to depend on the quality of the subtracted images (mainly on seeing) together with the detailed technique used to extract the signal [SN candidates] from the background (cosmic rays, bad subtractions, etc.). There is a strong dependence on the position inside the host galaxy. The artificial star experiment proceeded as follows. For every epoch simulated supernovae were added to the search images as stellar sources with the appropriate point spread function. The subtracted images were processed with the same pipeline used for the supernova search. This allows us to measure detection efficiencies as a function of supernovae magnitude and supernova position inside the galaxy for all individual passband epochs. As seen in Fig. 4 the detection efficiency strongly depends on seeing, in particular in the nuclear region, where the magnitude limit is lower.

F - Estimate of the SN rate

through MonteCarlo simulations we estimated the expected SN rate, based on specific assumptions, in order to obtain a comparison with the observed rate.

G - Conclusions

The main result of our analysis is that the number of observed SNe is consistent with the expectations, not confirming results of previous infrared SN search that detected a number of events much smaller than expected. The comparison of predicted and observed magnitude distribution shows that even in our K band search we expected to find mainly low extinction events. The emphasis of our approach was on the accurate estimate of the detection efficiency as a function of the SN position in the host galaxy and the determination of the size and distribution of the star formation for each galaxy of our sample. To understand how different a choice of the tests parameters can influence the expected rate, we varied each of them and compute the rate repeating the MonteCarlo simulation.

References


Fig.1: Redshift distribution (left) and comparison between B and FIR luminosity (right) of the galaxy sample.

Fig.2: SNe discovered in our search.

Fig.3: Histogram of the number of detected SNe.

Fig.4: Plot of Mag. Limit vs counts. The magnitude limit for epochs with worse seeing is lower in particular in the nuclear region.

Fig.5: Comparison between expected and observed K magnitude distribution (left) and extinction distribution (right).