Preliminary results of the Be stars proportion in LMC open clusters and application to the NGC1850 star formation region

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Abstract

Using the ESO Wide Field Imager in its slitless spectroscopic mode, we report on the preliminary results of the Be stars proportion in various LMC open clusters compared to the SMC and the Galaxy. We also report on the populations of emission-line stars found in the LMC cluster NGC1850 and its vicinity. Those results combined to some photometric data show a possible spatial and mass segregation of the various populations of ELS, probably related to the star formation history on this region of the LMC.

Introduction

• Be stars are non supergiant B-type that show or have shown emission line mainly in Hα. The Be phenomenon is transient. Be stars are fast rotators, reaching ~80% of their angular critical velocity. The fast rotation is a major factor in the matter ejection leading to the circumstellar disk and the emission, however it cannot explain alone the matter ejection and other mechanisms such as a combination with the beating of non radial pulsations is evoked (Porter & Rivinius 2003). In addition the low metallicity (Z) increases the rotational velocities of the OBBe stars, therefore they rotate faster in the SMC than in the LMC and faster in the LMC than in the MW (Martayan et al. 2006,2007; Cranmer 2005; Keller 2004 and references therein). As a consequence it was expected to find more Be stars at lower Z. Indeed Martayan et al. (2010) found 3 to 5 times more Be stars in the SMC than in the MW.

• Following the metallicity gradient, it is expected to find a lower Be stars ratio in the LMC than in the SMC, but higher than in the MW.

• The LMC clusters analysis is performed with data from the 2.2m La Silla ESO Wide Field Imager in its slitless spectroscopic mode (Baade et al. 1999).
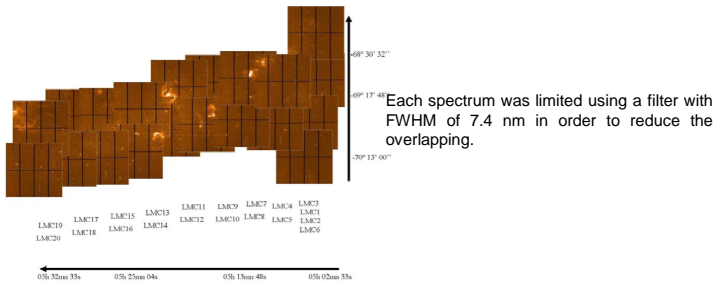

Each spectrum was limited using a filter with FWHM of 7.4 nm in order to reduce the overlapping.

Fig. 1: WFI slitless map of the LMC: 20 fields of 34 x 33 arcmin^2.

H alpha ELS in LMC

The search of emission line stars was performed using ALBUM tool (Martayan et al. 2008). Each spectrum was classified into emission-line star (ELS), non emission line star (NELS), and candidate emission line star (ELS?). To do this, the 3D spectrum was displayed using ALBUM, and the emission was recognized by a secondary peak in the spectrum profile. However, when the pattern of the emission is observed but the spectrum is too noisy or weak, the star is catalogued as candidate. These stars need further information to be fully classified. An example of how the emission is observed in the 3D spectra generated with ALBUM it is illustrated in figure 2.
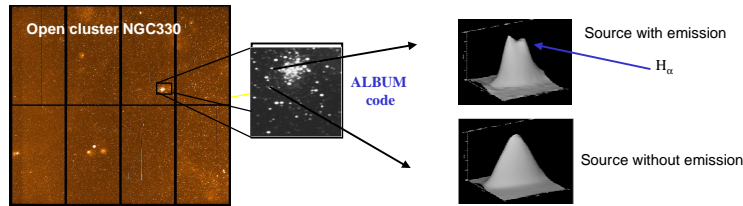

Fig. 2: WFI spectra examples in the SMC

Preliminary statistics in the LMC vs SMC and MW open clusters

To properly compare the SMC study with the LMC, it is needed to constrain the freedom degrees and therefore to use the same age distribution (see Fig. 3), leading to the metallicity being the only variable parameter. The LMC sample is formed by 90 open clusters distributed along the LMC. A total of 2948 sources were extracted. Among them 66 are emission line stars (2.24% of the sample) and 244 are candidate emission stars (8.28% of the sample) .

The table 1 shows the number of ELS and ELS? obtained in the different samples, our aim is to compare mainly between the LMC and the SMC because the techniques used to detect the ELS are the same. The *preliminary* results seem to show that the Be stars proportion is intermediate in the LMC with respect to the SMC and MW while more ELS in general are found in the LMC than in other galaxies.
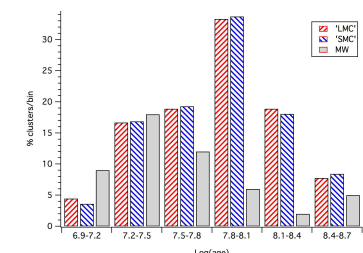

Fig. 3: Age distribution of the open clusters in the SMC, LMc and MW.

The LMC NGC1850 region

In Figure 4 the WFI-slitless image of the LMC NGC1850 field is shown. In this region, a total of 32 ELS were found and 19 ELS candidates. In one shot, this instrument allows to find the ELS corresponding to pre-main sequence (HBe/Ae, TTauri), main sequence (Be stars), and post main sequence objects (giant stars, cepheids). Images of this cluster in different wavelengths were obtained, the location of Be stars seems to follow bubbles of material/filaments. The star formation was possibly triggered by clusters dynamical interaction or by a supernova. An article is currently in preparation that deals with those aspects.
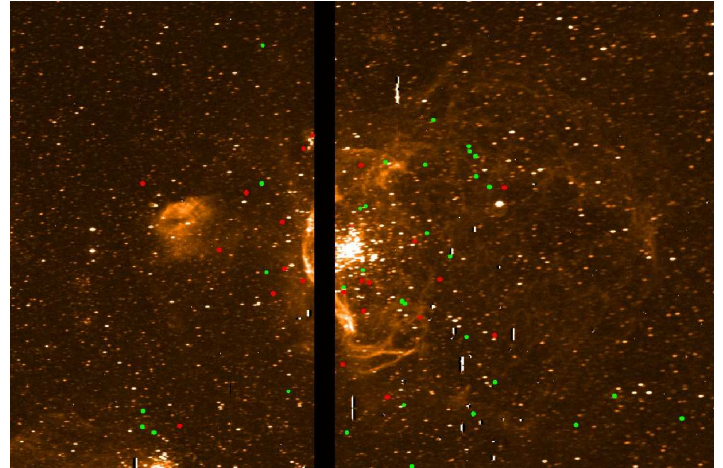

Fig. 4: the NGC1850 field, the green dots represent emission line stars and the red ones represent emission line star candidates.

ELS as tracers of the NGC1850 star formation history

One of the advantages of the slitless spectroscopy with the WFI is that this technique is not sensitive to the ambient diffuse nebulosity. Therefore only the emission arising from the circumstellar environment (disk or envelope) of the star is detected.

Cross correlating with OGLE and MACHO databases, the lightcurves and photometry were obtained allowing estimating the spectral type and the evolutionary status of the stars.

Preliminary results indicate a possible mass and spatial segregation in the NGC1850 cluster, the ELS observed in the center of the cluster are pre-main sequence objects while the ELS following the filaments and in border of the bubbles are main sequence stars, and the giant stars are found farther in the cavities.
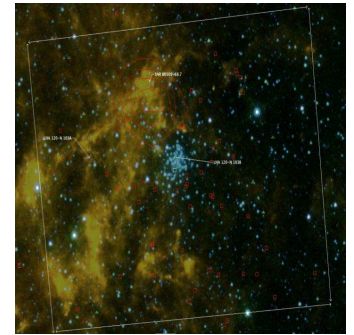

Fig. 5: The NGC1850 field: combination of SPITZER images + radio observations of a supernova remnant. Red squares: ELS and ELS? found with WFI and mainly classified as main sequence Be stars.Yellow triangles: Giant ELS stars.

Conclusions

• Multi-instruments and techniques study
• 8 million spectra obtained in the SMC (3M) and LMC (5M)
• The amount of Be stars in the LMC seems to be intermediate between the SMC and the MW in agreement with the metallicity gradient.
• The combination of WFI slitless spectroscopy with other imaging instruments/experiments such as OGLE/MACHO or SPITZER allows to give some estimates of the stellar classification. It also gives some clues on the spatial localization of the ELS depending on their evolutionary status.
• Based on those results, it appears that the star formation history of the NGC1850 field has led to a mass and spatial segregation of the stars during their evolution.

	LMC	SMC	MW*
Metallicity Z	0.008	0.003	0.020
Sample	2948	4437	20322
ELS	66	--	--
ELS?	244	--	--
ELS+ELS?	310	370	225
%ELS	2,24	--	--
%ELS+ELS?	10,52	8,34	1,11
Be	--	109	52
Be?	--	54	116
Be-min	--	109	52
%Be	--	2,46	0,26
%Be-max	2.24		

Table 1: The percentage of **Be-max in the LMC** is calculated considering that all definite ELS in the LMC sample are actually Be stars. It corresponds to an upper limit of the LMC Be stars proportion. * The MW sample comes from McSwain &Gies (2005)

References

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More details about the results presented in this poster will be published in Aguayo et al. in prep. and in Garrido et al. in prep.