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 Hz. 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).

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 star formation history of the NGC1850 field has led to a mass and spatial segregation of the stars during their evolution.

Conclusions

• Multi-instruments and techniques study
• 8 million spectra obtained in the SMC (3M) and LMC (SM)
• 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.

References
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Fig. 1: WFI slitless map of the LMC: 20 fields of 34 x 34 armin2.

ELS+ELS?

Table 1: The percentage of Be-stars in ELS, ELS+ELS? found with WFI and in NGC330.

Conclusions

Fig. 2: WFI spectra examples in the SMC.

ELS

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

Table 1: The percentage of Be-stars in the LMC is calculated considering that all dubious ELS in the LMC sample are actually Be stars. The percentage of Be-stars is calculated for each age distribution, with the error bars corresponding to the number of objects contributing to the proportion.

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

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 spectra 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 to decide if the 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 is illustrated in figure 2.

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.

Conclusions

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.