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Be stars in the Low Metallicity Environment of Sextans A galaxy

Beatriz E. Sabogal[1*], and Alejandro García-Varela[1]
[1] *Universidad de los Andes, Departamento de Física, Cra. 1E No. 18A-10, Edificio Ip, A.A. 4976, Bogotá, Colombia*

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ABSTRACT

One of the important questions about the Be phenomenon is related to its dependence on metallicity of the host galaxy. Studies of Be stars in our Galaxy and in the Magellanic Clouds have shown that the fraction of Be stars, with respect to B stars, is greater in lower metallicity environments. However, systematic studies have been limited to these three galaxies. It is necessary to dispose of studies of the fraction of Be stars in other galaxies to confirm this behaviour. This work presents the preliminary results of a search for Be star candidates in Sextans A galaxy, that will be useful to obtain the fraction of Be stars in it, and a statistical comparison with the fraction of Be stars in the Milky Way and the Magellanic Clouds.

Key words: Stars: emission-line, Be - Stars: variables: general - Methods: statistical - Astronomical data bases: catalogues

1 INTRODUCTION

Be stars are non-supergiant, very fast rotators, whose spectra show or have shown at some time one or more Balmer lines in emission (Collins 1987). Their spectral types range from late O to early A. This rapid rotation can be an innate or acquired stellar property that, combined to a mechanism, such as non-radial pulsations, causes episodic matter ejections creating a circumstellar decretion disk (Rivinius, Carciofﬁ & Martayan 2013), where the observed emission is originated. This disk can appear and desappear in several time scales. This is the Be phenomenon and is a subject of current research.

1.1 Metallicity Effect

From a theoretic point of view, at low metallicities the maximum rotational velocity for a star can reach more than 800 Km/s (Chiappini et al. 2006). This fact allows that the Be phenomenon can include stars from O types to F types. Therefore, it is expected that the fraction of Be stars relative to B stars can be higher in those low metallicity environments. Observationally, Sabogal et al. (2005) performed a statistical and comparative study between the populations of Be star candidates (BeSC) in the Large and the Small Magellanic Cloud (LMC and SMC). Those authors concluded that outbursts of BeSC have a significant dependence on metallicity. Martayan et al. (2010) performed a slitless Ha spectroscopic survey of the SMC and the LMC using the 2.2m ESO/WFI telescope, and found that Be stars are more abundant in the SMC than in the LMC. They claimed that some stars could be born as Be stars, and others seem to become Be stars during the main sequence. They also mentioned that this fact could depend probably on the metallicity. All these studies suggest that the fraction of B stars showing the Be phenomenon depends on the metallicity of the parent galaxy, being minor in higher metallicity environments, and also it suggest that the eruptive properties of the Be stars (morphology of the light curves), depend on this parameter.

1.2 Searching for extragalactic Be stars

Mennickent et al.(2002), Keller et al. (2002) and Sabogal et al. (2005) searched for BeSC in the SMC and the LMC, using OGLE and MACHO photometric databases. Martayan et al. (2010) performed a spectroscopic survey of the SMC and the LMC in order to study different aspects of the Be stars in those galaxies. They also performed a comparison between the relative frequency of SMC Be stars and that of the Galaxy. They reported F=35in the Galaxy, with F=Ne/NB0, where Ne is the number of Be stars and NB0 is the number of B0 stars. Bresolin et al. (2007)] studied the stars in the low metallicity galaxy ([Fe/H] = -1. 3 dex) IC 1613, located at 721 Kpc. As a by-product, they identified six main sequence B stars that were confirmed to be Be stars. However, a large fraction of B and Be stars could have been left out of the sample. The aim of the present project

* E-mail: bsabogal@uniandes.edu.co

Table 1. Data of Sextans A

Distance (Kpc)	R.A.	Dec	[Fe/H] (dex)	Apparant dimensions	Other names
1320	10 11 00.8	-04 41 34	-1.45	$5'.1 \times 3'.5$	UGCA205 DDO75

is to discover in a systematic way an extragalactic Be star population beyond the Magellanic Clouds, that will be useful to perform a future spectroscopic and photometric follow up in order to confirm the result that the fraction of Be stars is larger in lower metallicity environments. **Sextans A Galaxy his is a dwarf irregular galaxy, member of the NGC 3109 association. Its dynamical mass is about 109 solar masses. It has a round-shaped stellar body, surrounded by an elongated stellar halo, that has been interpreted as a tidal tail (Bellazzini et al. 2014). Kaufer et al. (2004) reported a very low mean stellar metallicity of: [Fe/H] = -1.03 dex. Bellazzini et al. (2014) obtained a lower value of [Fe/H]SextansA = -1.45 dex. This galaxy has lower metallicity than the Magellanic Clouds and our Galaxy ([Fe/H]SMC = -1.0 dex and [Fe/H]LMC = -0.7 dex, Pietrzyski et al. 2003; [Fe/H]MW = -0.3 dex, Allen 2000), for this reason it is useful to prove if the fraction of B stars showing the Be phenomenon depends on the metallicity of the parent galaxy.**

2 THE DATA

We obtained V, R, I and Ha images of Sextans A galaxy from different public databases of the international observatories, such as these of ESO, SUBARU, HST and KPNO. The bias and flat-field reduction of the images is being performed using IRAF. In particular, for this work we used KPNO data, obtained with the Mayall 4m telescope, by Massey et al. (2007). We performed PSF photometry of the resolved sources in the galaxy, that resulted in a sample o 1506 stars. This process was done for the stars at the same way described by Pietrzyski et al. (2002).

3 RESULTS AND DISCUSSION

We obtained the color-color diagram (R-Ha) vs (B-V) for the galaxy (Figure 1). The identification of the B stars will be doing by a ZAMS fit. The Cepheid distance to the Sextans A is 1.32 Mpc (Dolphin et al, 2003; Sakai et al. 1997), and AvSEXT A = 0.145 mag (Schlegel et al. 1998). This implies that this galaxy is no strongly affected by galactic extinction and has low stellar density; therefore, blending and spatial resolution are not potential problems that prevent detection of B and Be stars. Contamination of Galactic stars should be low since the number of blue disk stars in these directions is expected to be low, due to the direction of the line of sight.
Be stars appear brighter in the Ha images than in the R images, and therefore, the position of these stars in the (R-Ha) vs (B-V) diagram should be displaced regarding normal main sequence stars (Keller et al. 1999, Wisniewski et al. 2006).
Selection o BeSC in figure 1 was made using (B-V) ¡ 0.2 mag and (R-Ha) ¡ 2.8 mag, based on the criteria explained by Wisniewski et al. (2006) and the clear separation of main sequence stars from the Ha emission-lined sources. We found a total of 72 BeSC in Sextans A, where it is expected contamination of other objects like PNe and LBV stars (Massey et al. 2007 found 9 LBV candidates in this galaxy).

Figure 1. Image of Sextans A obtained with KPNO-Mayall 4m telescope.

4 CONCLUSIONS

This work presents the selection for the first time of a sample of 74 Be star candidates in the low metallicity galaxy Sextans A. This sample of stars will be very important and useful for a future spectroscopic and photometric follow up that will confirm the hypothesis that the lower the metallicity of a galaxy, the greater the fraction of Be stars in it.
Once the B and Be stars of Sextans A can be selected, we will determine the fraction of Be stars in this galaxy: F=Ne/NB0. A statistical comparison between the fractions of Be stars reported for the Milky Way, the SMC, the LMC galaxies, and the fraction of Be stars found in this project for the Sextans A galaxy was performed.
This work could open a new stage in the performing of surveys of extragalactic Be stars, in the sense that obtaining light curves of Be stars in low metallicity environments will allow to confirm that outbursts of Be stars are more energetic that their counter-

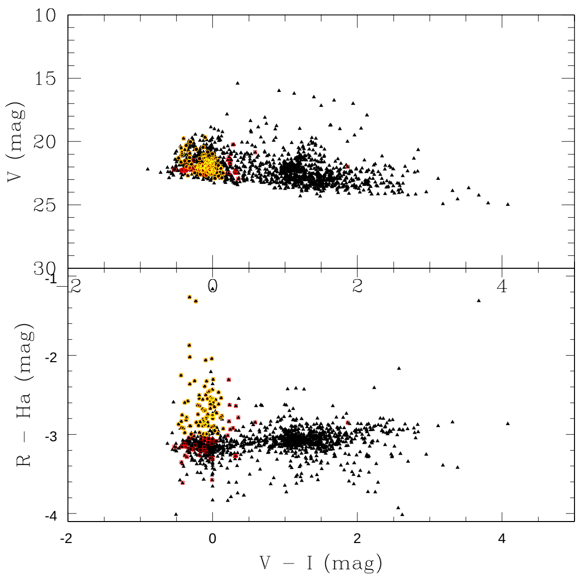

Figure 2. (R H_{α}) vs (B-V) diagram for Sextans A. Red points are BeSC.

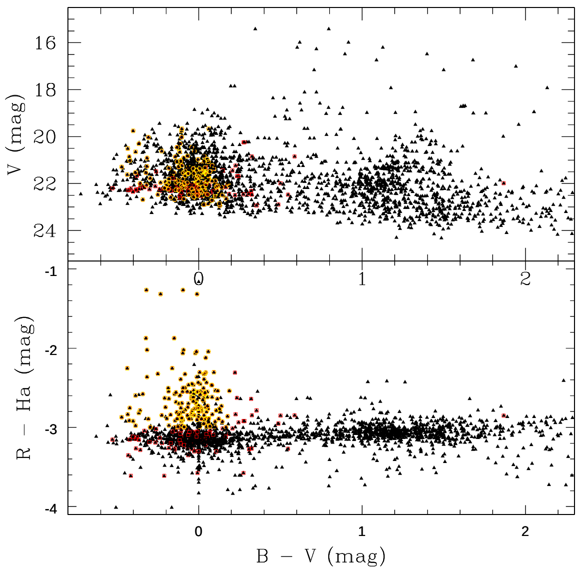

Figure 3. Figure 2. (V) vs (B-V) diagram for Sextans A. Red points are BeSC.

parts in the Milky Way or in the Magellanic Clouds.

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