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PROPER MOTION SEPARATION OF Be STARS IN THE MILKY WAY AND THE MAGELLANIC CLOUDS

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RESUMEN

Presentamos una investigación de los movimientos propios de una muestra de estrellas candidatas Be hacia la Nube Grande de Magallanes (LMC), la cual ha resultado en la identificación de dos poblaciones separadas, una en primer plano en nuestra galaxia y otra en segundo plano en la LMC. Fotometría OGLE BVI y 2MASS JHK en conjunto con movimientos propios de SPM4 fueron utilizados para discriminar las poblaciones existentes. Las dos poblaciones mencionadas fueron encontradas gracias a sus distintivos colores infrarrojos y sus cinemáticas notablemente diferentes, siendo la muestra más azul consistente con pertenecer a la LMC y la más roja al disco de la Vía Láctea. Con este trabajo se esclarece la naturaleza de la muestra más roja la cual había sido propuesta en publicaciones previas como una posible subclase aún desconocida dentro de la muestra de candidatas Be en la LMC.

ABSTRACT

We present a proper motion investigation of a sample of Be stars candidates towards the Large Magellanic Cloud (LMC), which has resulted in the identification of two separate populations, in the Galactic foreground and in the Magellanic background. OGLE BVI and 2MASS JHK photometry were used with the SPM4 proper motions to discriminate the different populations located towards the LMC. Two populations with distinctive infrared colours and noticeable different kinematics were found, the bluer sample is consistent with being in the LMC and the redder one with belonging to the Milky Way (MW) disk. This settles the nature of the redder sample which had been described in previous publications as a possible unknown subclass of stars among the Be candidates in the LMC.

Key Words: proper motions — stars: emission-line, Be

1. INTRODUCTION

Be stars are broadly defined as non-supergiant (luminosity class III to V) B-type stars that have or have had Balmer emission lines. The presence of a flattened circumstellar gaseous disk formed of material ejected from the star, a dust-free Keplerian *decretion disc*, is currently the accepted explanation for most of the observed features in Be stars: the UV stellar light is reprocessed in it and produces the line emission, and the observed IR excess and polarization result as well from the scattering of the stellar light by the disk (details in Rivinius et al. (2013)). Several mechanisms have been proposed for the mass-ejection process that forms the disk, in the so-called Classical Be it clearly comes from the rapid rotation of the star, and in binaries the material is being accreted by the companion of the Be star, generally a white dwarf. But other processes could be acting as well, including radiation-driven winds, non-radial pulsations and flare-like magnetic activity.

Mennickent et al. (2002) and Sabogal et al. (2005), have identified a large number of Be stars candidates towards the Magellanic Clouds based on their photometric variability. Mennickent et al. (2002) has proposed a classification of these variability-selected stars into four types depending on the behaviour of their light curves. Paul et al. (2012) showed that the photometric method used in the aforementioned works is very effective, their spectroscopic analysis found that most of the stars studied from a sample of such candidates in both LMC and SMC, belong to early type stars with emission supporting circumstellar material. However an enigmatic result was obtained in their work among Type-4 LMC Be candidate stars: a subgroup of the brightest and most massive stars was found in the sample with no NIR excess and large reddening although they were not located in regions with high reddening. This subgroup was not found in the SMC or in our Galaxy and were proposed as a possible subclass of stars that needed further analysis.

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2. SPM4 PROPER MOTIONS OF Be STARS CANDIDATES TOWARDS THE LMC

We crossmatched the LMC candidates from Sabogal et al. (2005) with the SPM4 proper motion catalogue (Girard et al. 2010), with a matching radius of 3 arcseconds in (RA,DEC) coordinates. A sample of 1480 stars out of 2446 were matched, and for these stars we carefully analysed color-color magnitude diagrams, by combining the VI magnitudes from OGLE-II listed by Sabogal et al. (2005) and the JHK_s infrared magnitudes from 2MASS listed in SPM4.

Three samples were defined as follows: sample A with V-J$\leq$0.5 and V$\leq$15.2 (250 stars), sample B with V-I$\geq$0.55, 1$\leq$V-J$\leq$1.7 and of Type-4 (235 stars), and sample C with V-I$\leq$0.59(V-J)-0.40 (167 stars). Our sample B is coincident in the J-H vs. H-K color-color diagram with the subgroup of stars found in Paul et al. (2012). Sample C is consistent with random mismatches between somewhat faint Be candidates and foreground red giants in SPM4, therefore this sample (about 11% of matches found) was discarded for further analysis.

3. RESULTS

Figure 1 shows the vector-point diagram of stars in samples A and B, including the proper motion error bars from SPM4. It is evident that each sample has its own characteristic kinematics, especially visible un μ_δ. Sample A stars have proper motions consistent with those of blue massive O3-O6 main sequence stars in the LMC, which can be easily selected in the same area from SPM4 (region A in Nikolaev & Weinberg (2000) defined by $J - K < 0.2$ and $11 < K < 14.75$), as seen in Figure 2. Therefore we conclude that sample A is dominated by true LMC stars. Sample B stars have proper motions towards positive values in μ_δ and a more frequent value around 10 mas/yr; their positive sign and large value are consistent with the Milky Way disk. The location of sample B stars in the K vs. J-K color-magnitude diagram is occupied in about 90%, according to Nikolaev & Weinberg (2000), by Galactic disk FGK stars at less than 1 kpc distance from us (their Region B).

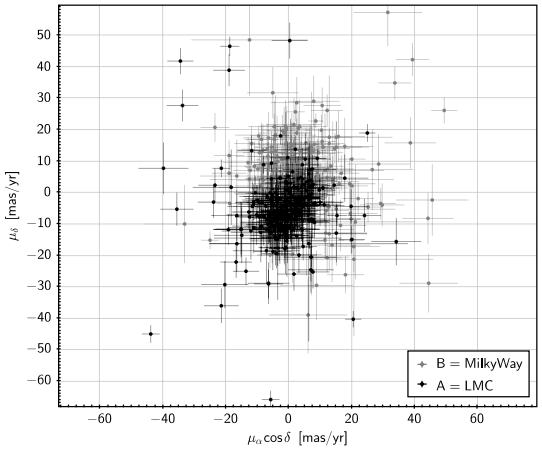

Fig. 1. Vector-point diagram of samples A and B, showing their evidently different kinematics.

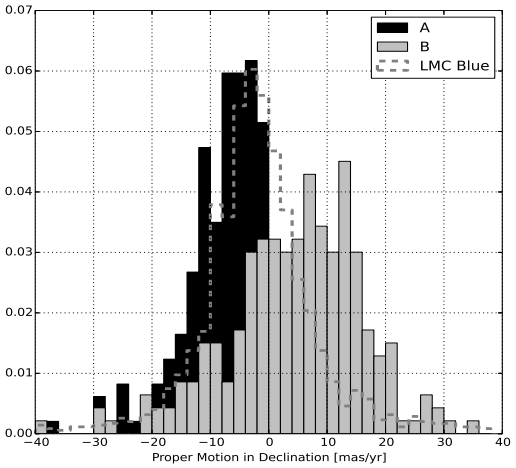

Fig. 2. Normalized histograms of μ_δ for samples A, B and LMC massive blue main sequence stars.

4. CONCLUSIONS

- Proper motions are a valuable tool for a better identification and characterisation of Be stars populations in the Milky Way and the Magellanic Clouds.
- The subgroup of Type-4 LMC Be stars candidates found by Paul et al. (2012) having intriguing properties, has proper motions that undoubtedly place these stars in the foreground, and their J-K color and K magnitude are consistent with those of FGK dwarfs at less than 1 kpc distance.

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