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RR LYRAE SEARCH AND STELLAR POPULATIONS STUDY IN CANIS MAJOR: PRELIMINARY RESULTS

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RESUMEN

Se presentan los resultados preliminares de un estudio de poblaciones estelares para la búsqueda de estrellas RR Lyrae, centrado en la sobredensidad de Can Mayor, sobre un área de 8.35 gd^2 en el cielo. Las observaciones fueron hechas empleando los filtros R y V, con la cámara QUEST instalada en el telescopio Jürgen Stock de 1-m, ubicado en el Observatorio Astronómico Nacional de Venezuela. El diagrama de Hess resultante muestra una posible, pero tenue, rama de las gigantes rojas y no se observa en forma evidente una rama horizontal, concentración roja o final de la secuencia principal. Luego de una búsqueda fotométrica multi-época, 6 RR Lyrae fueron confirmadas con observaciones adicionales obtenidas a través de los telescopios de 1.0-m y 1.3-m del consorcio SMARTS en CTIO. De dichas RR Lyrae confirmadas, 5 tienen distancias heliocéntricas entre 5 y 7 kpc. La confirmación de su asociación con el sistema de Can Mayor espera por un estudio de sus velocidades radiales.

ABSTRACT

We present preliminary results of a RR Lyrae star search and stellar populations study performed in the Canis Major overdensity, spanning an area of 8.35 sq deg. The observations were made in R and V bands, with the QUEST camera installed in the 1-m Jürgen Stock Telescope at the Venezuela National Observatory. The resulting Hess diagram shows a possible, but weak, red giant branch and no obvious horizontal branch, red clump or main sequence turnoff. After a multi–epoch photometric search, 6 RR Lyrae stars were confirmed with further observations obtained at the 1.0-m and 1.3-m telescopes of the SMARTS consortium at CTIO. From these confirmed RR Lyrae stars, five of them have heliocentric distances between 5 and 7 kpc. Confirmation of their physical association with the Canis Major system awaits for a study of their radial velocities.

Key Words: **GALAXIES: INTERACTIONS — GALAXY: FORMATION — GALAXY: STRUCTURE — STARS: VARIABLES: OTHER**

1. INTRODUCTION

In a recent study of the spatial distribution of 2MASS M giants at low galactic latitudes, Martin et al. (2004) found a large stellar overdensity, covering up to 100 sq deg in the sky. The overdensity was shown as a north-south asymmetry in the density of such stars, with respect to the galactic plane. Those authors interpreted the Canis Major overdensity, as it is now called, to be a dwarf spheroidal galaxy in an advanced stage of disruption due to the Milky Way's tidal forces. In a later study, Momany et al. (2004) argued that the Canis Major overdensity could be explained by taking into account the stellar warp of the galactic disk, which happens to be maximum at a galactic longitude ($l \sim 270^o$) and lies near the estimated center of Canis Major ($240^o, -8^o$). The nature of the Canis Major overdensity is still controversial, although further observational evidence has been provided by Bellazzini et al. (2004), Martínez-Delgado et al. (2004) and Martin et al. (2004b), among others, who support the dwarf galaxy hypothesis.

In order to provide further arguments that would contribute to clarify the nature of Canis Major, we started a large–scale multi–epoch survey in a region near the center of the overdensity to search for RR Lyrae variable stars. An excess of such stars in the region would favor the hypothesis that Canis Major could be a dwarf galaxy with stellar populations similar to other known Milky Way satellites.

2. OBSERVATIONAL DATA AND PHOTOMETRY

The QUEST camera (Baltay et al. 2002) installed on the 1-m Jürgen Stock telescope at the Venezuela National Observatory was used to make the observations. Due to the low declinations surveyed, the camera was off the limits, hindering the

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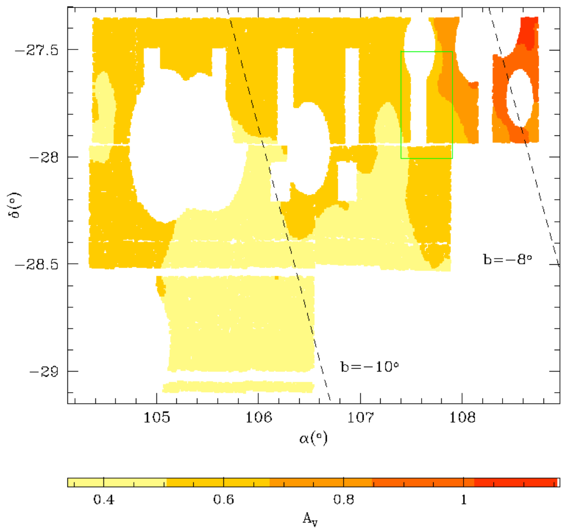

Fig. 1. Color-coded map of the extinction A_V in the observed region, from Schlegel et al. (1998). Two lines of constant galactic latitude are shown as reference. Some regions have been eliminated because of very bright stars or bad regions of the CCDs. The rectangle has been observed by Martínez-Delgado et al. (2004).

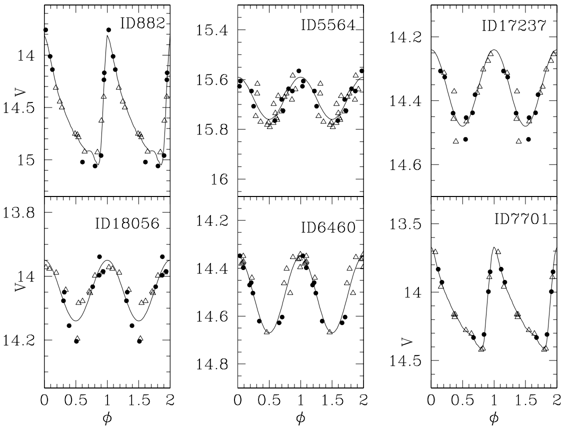

Fig. 2. Light curves of confirmed RR Lyrae stars. (•): QUEST data. (△): SMARTS data.

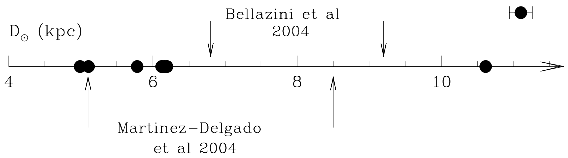

Fig. 3. Heliocentric distance distribution of confirmed RR Lyrae stars. Distance estimates obtained by Bellazzini et al. (2004) and Martínez-Delgado et al. (2004), are shown between arrows.

use of drift-scanning mode, which is the normal mode of operation at this telescope. Hence, it was used in point–and–stare mode with 2 minute exposures in R and V. The total survey area covers $\sim$ 36 sq deg. The preliminary results presented here correspond to a smaller area of 8.35 sq deg. with observations taken in 5–10 epochs between January and March 2004.

Aperture photometry was performed using standard IRAF routines and the stars limiting magnitude are between 13.9 and 19.5 in V band. At these low galactic latitudes, the extinction is highly variable (Figure 1). Magnitudes were corrected by extinction using the $E(B-V)$ provided by the Schlegel, Finkbeiner & Davis (1998) dust maps.

3. RR LYRAE STAR SEARCH

The search for RR Lyrae stars was made among variable stars selected through a χ^2 test (Vivas et al. 2004). Then, the search was restricted to stars with V magnitudes brighter than 16.2 only, which corresponds to a maximum distance of 13.5kpc. Those are the stars likely to be related to the Canis Major overdensity, according to the distance estimated by Martínez-Delgado et al. (2004) and Bellazzini et al. (2004). First, amplitude and color restrictions were applied. After that, following the method devised by Layden (1998), *ab* and *c* type light curve templates were fitted to the observational data of the remaining stars, and for each star the four best fitted light curves of each type were visually inspected. Finally, for the best candidates additional observations were obtained through the 1.0-m and 1.3-m telescopes of the SMARTS consortium at the Cerro Tololo Inter-american Observatory (CTIO). In this way, 6 RR Lyrae stars were confirmed, after a mean number of 19 observations each (Figure 2). From this group of stars. five of them lie between 5 and 7 kpc and the distance distribution is shown in Figure 3.

4. COLOR–MAGNITUDE DIAGRAM

Figure 4 shows the Hess diagram of the surveyed region, which has $\sim 55,000$ stars. Although a weak red giant branch can be identified going from $(V-R)_o \sim 0.4, V_o \sim 16.1$ to $(V-R)_o \sim 0.5, V_o \sim 13.6$, we do not detect either a horizontal branch, red clump or main sequence turnoff. According to the distance estimated from Martínez-Delgado et al. (2004), the main sequence turnoff should be close to our limiting V magnitude. The subtraction of a control field is intended to be done in the future in order to be able to perform further analysis of the Hess diagram.

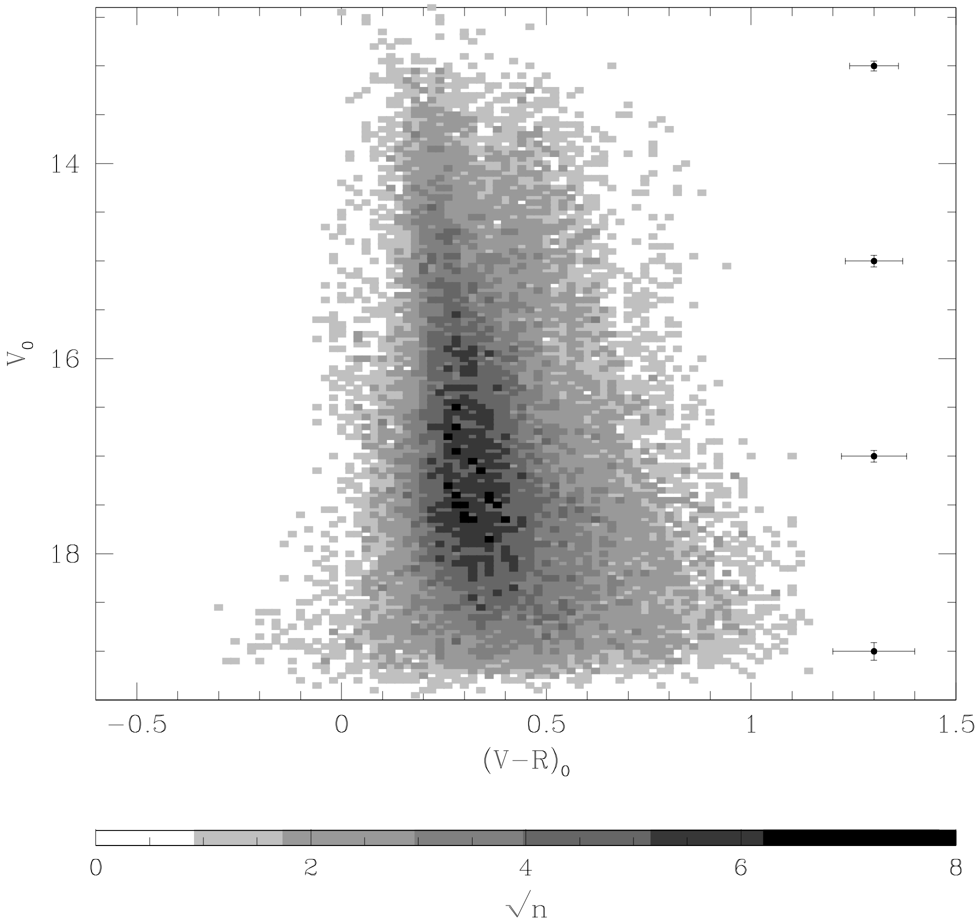

Fig. 4. Hess diagram containing about 55.000 stars. The binning is 0.02 in $(V-R)_o$, and 0.05 in V_o.

5. CONCLUSIONS

The resulting Hess diagram does not show any prominent features that may indicate the clear presence of a stellar population different from the galactic disk. However, at such low galactic latitudes, the contamination from disk stars may hide the presence of any special feature, particularly if its surface density is very low, as it would be expected in the case that the Canis Major overdensity is actually a dwarf galaxy in an advanced stage of disruption.

The results yielded by the RR Lyrae search do not show a very high number of such stars. However, between 5 and 7 kpc, 5 confirmed RR Lyrae stars were found with a mean distance of 5.6 kpc. Though not very high, this number of RR Lyrae stars is still higher than expected in that volume of the galactic halo ($\sim$ 1 RR Lyrae expected). A radial velocity study is being made to confirm whether these stars are physically associated to one another and to the Canis Major overdensity.

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