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VVV GALACTIC STAR CLUSTERS: VVV CL059

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RESUMEN

El sondeo VVV (Vista Variables in the Vía Láctea) mapea el disco interno y bulbo de nuestra galaxia, y uno de sus principales objetivos es buscar nuevos cúmulos estelares en cinco bandas infrarrojas diferentes con el objetivo de construir una muestra estadisticamente significativa. Los nuevos cúmulos abiertos nos permiten calcular su distancia y edad, así como también obtener información importante sobre formación, evolución y las teorías dinámicas de estos sistemas en el entorno galáctico. Presentamos algunos resultados recientes del estudio fotométrico y espectroscópico del cúmulo joven VVV CL059, donde derivamos parámetros fundamentales como enrojecimiento, distancia y la edad, ajustando isócronas al diagrama color-magnitud. Además obtuvimos una vista preliminar del movimiento propio de las estrellas del cúmulo.

ABSTRACT

The VISTA variables in the Vía Láctea (VVV) maps the inner disk and bulge area of our galaxy, and one of the principal objectives is to search for new star clusters in 5 different infrared bands with the aim of building a statistically significant sample. The new open clusters allows us not only to estimate their distance and age, but also provide important information about formation, evolution and dynamical theories of these systems in the Galactic environment. We present some recent results of photometric and spectroscopic investigations of VVV young cluster CL059, we derived fundamental parameters such as reddening, distance and age by fitting isochrones to the color magnitude diagram. In addition we obtained preliminary proper motions for the cluster stars.

Key Words: circumstellar matter — infrared: stars — open clusters and associations: general — stars: low mass

1. INTRODUCTION

The Vista Variables in the Vía Láctea (VVV) is one of the six ESO Public Surveys using the 4 m VISTA telescope (Arnaboldi et al. 2007). VVV is scanning the Milky Way (MW) bulge and an adjacent section of the midplane, where star formation activity is high (Minniti et al 2010). One of the main goals of the VVV Survey is to study star clusters of different ages in order to build a homogeneous, statistically significant sample. To study VVV CL059 cluster (Fig. 1), we use VVV images in the J, H, and Ks bands and spectra taken with ISAAC, VLT, ESO.

2. OBSERVATION AND DATA REDUCTION

Images The images (Fig. 2) in J, H, and Ks bands of 10x10 arcmin fields, were retrieved from the VISTA Science Archive (VSA) database (Cross et al., 2012).

Photometry The PSF photometry was performed on the VSA preliminary reduced images. We used DAOPHOT software (Stetson, 1987) within the Image Reduction and Analysis Facility (IRAF). We also used the Dophot software (Schechter et al. 1993) for comparison. The J, H and Ks photometry was calibrated using the 2MASS Point Source Catalog (Skrutskie et al. 2006). Generally, we are using several hundred stars in common to apply a least−squares linear regression. For saturated stars (usually Ks $\leq$ 12 mag) the 2MASS magnitudes were used.

Fig. 1. A VVV true color image from J, H, Ks bands. The field of view is approx. 2.2 × 2.2 arcmin and North is to the left, East is up.

3. RESULTS

Spectroscopy Two of the stars show Brackett series in emission and can be classified as YSOs. The

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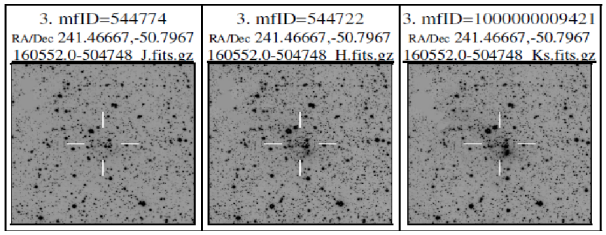

Fig. 2. Images obtained by VISTA in J, H and Ks bands (right to left) centered on RA= 16h 05m 52s DEC= 50 47′48″. North is up and East is to the right.

other spectroscopically observed objects are evolved red giants (Fig. 4). The analysis yields a reddening and distance modulus for the VVVCL059 cluster of E(J−Ks)=2.9 and (M−m)=9.5 Kpc.

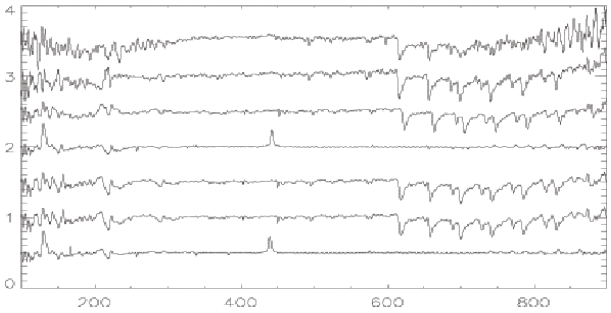

Fig. 3. ISAAC spectra of program stars.

Photometry The (J−Ks) vs. Ks color magnitude diagram is shown in Fig. 4. The best Padova isochrone fit (Z=0.019, Marigo et al. (2008)) implies an age of 25.11 Myr which agrees with the result of 20−30 Myr derived from Borissova et al. (2011).

Proper Motion Based on 4 years of VVV data, we calculated the proper motions of the stars. As a first approach we retrieved the CASU catalogs in a 5×5 arcmin area around cluster: 13.04.2010 (first epoch) and 07.04.2014 (second epoch). The plot of pmRA vs. pmDEC is shown in Fig. 5. At the distance of the cluster and with a 4 year baseline it was not possible to calculate the motion of the cluster, nevertheless, the obtained results can be used to calculate the membership probabilities and a clean color-magnitude diagram.

4. CONCLUSIONS AND FUTURE WORK

From spectroscopy, we select two candidate stars as members of the cluster. The distance to the stars is 9.5±1.0 Kpc, therefore, this is the estimated distance to the cluster. Also, the reddening is E(J−Ks)=2.9 and the extinction is A_k=1.829. From

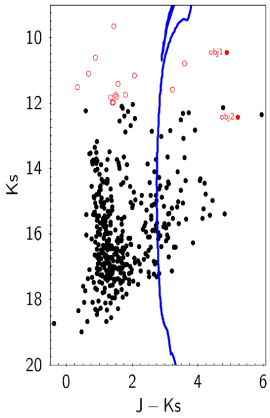

Fig. 4. (J−Ks) vs. Ks color magnitude diagram for CL 059. Black circles are all stars within the estimated cluster radius, while red open circles are 2MASS bright stars. Stars with spectra are denoted by red circles and are labeled. The best isochrone fit is shown in blue with an age of 25.11 Myr.

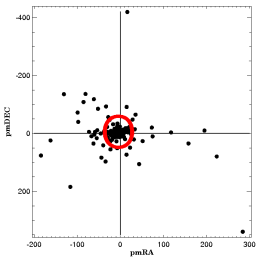

Fig. 5. Proper motion diagram from 20102014 epoch.

the color magnitude diagram we determine that the age is 25.11 Myr. In order to verify this and to derive spectral types and distances from spectra with more accuracy, we are planning to perform an automatic PSF−fitting photometric pipeline for the VVV survey (Mauro et al. 2013) and calculate the relative proper motions of stars including 2MASS images to extend the baseline between the two epochs.

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