

Open cluster candidates in the VVVX area: VVVX CL 076 and CL 077

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Resumen / Se reportan algunos parámetros básicos de dos cúmulos estelares, VVVX CL076 y CL077, recientemente descubiertos en el área del disco galáctico, cubierta por el relevamiento público del ESO “VISTA Variables in the Via Lactea eXtended (VVVX)”. El análisis preliminar muestra que ambos cúmulos son jóvenes y relativamente cercanos al Sol.

Abstract / We are reporting some basic parameters of two newly discovered clusters, VVVX CL 076 and CL 077, recently discovered in the galactic disk area covered by the VISTA Variables in the Via Lactea eXtended (VVVX) ESO Public Survey. The preliminary analysis shows that both clusters are young and relatively close to the Sun.

Keywords / Galaxy: open clusters and associations — Galaxy: disk — infrared: stars

1. Introduction

Young star clusters are sites of recent star formation and early evolution in the Milky Way and are often only visible at the infrared wavelengths, being highly obscured by gas and dust. The VISTA Variables in the Via Lactea eXtended (VVVX) ESO Public Survey is a near-infrared photometric sky survey that covers nearly 1700 square degrees towards the Galactic disk and bulge. It offers an excellent opportunity to search for new, undiscovered star clusters in our Galaxy. Recently, Borissova et al. (2018) reported a list of 120 new star cluster candidates found by visual inspection of 40 % of the disk area covered by VVVX. In this paper, we present the near infrared photometry and Gaia DR2 proper motions and distance estimates for VVVX CL 076 and VVVX CL 077.

Fig.1 shows the composite JHK_S color images of the target clusters. The equatorial coordinates of CL 076 are $\alpha(2000) = 273.3545^\circ$, $\delta(2000) = -18.0921^\circ$ and CL 077 is centered around $\alpha(2000) = 273.3960^\circ$, $\delta(2000) = -18.0966^\circ$. Both clusters are projected very close to the Galactic plane at galactic latitudes -0.10 and -0.14 deg respectively.

2. Analysis

To construct the color-magnitude diagrams, we performed PSF photometry of a 2.5×2.5 arcmin area surrounding the selected candidate in the J , H , and K_S bands. We used the DOPHOT photometric routine fol-

lowing Alonso-García et al. (2017). The instrumental magnitudes were transformed to the standard system. This procedure is described in detail by Alonso-García et al. (2017), Borissova et al. (2011) and Borissova et al. (2014).

The most probable cluster members are selected by statistical decontamination procedure and Gaia DR2 proper motion diagrams. To separate the field stars from probable cluster members we used the iterative field-star decontamination algorithm, which divides the magnitude and color ranges into a grid of cells. In each cell, it estimates the expected number density of cluster stars by subtracting the respective field-star number density and, summing over all cells, it obtains a total number of member stars. The most probable cluster members obtained in this manner are cross-matched with Gaia DR2 catalog (Gaia Collaboration et al., 2018), the proper motion vector diagrams μ_δ vs. $\mu_\alpha \cos \delta$ are created and the stars with obviously different proper motion are rejected (Fig. 2, upper panel). The lower panel of Fig. 2 shows the color-magnitude diagrams for VVVX CL 076 and VVVX CL 077. Following Zasowski et al. (2013), we then fit the Padova theoretical isochrones with solar metallicity (Bressan et al., 2012). The best fit for VVVX CL 076 gives an age of 32 Myr, while VVVX CL 077 is most probably 10 Myr old. The confidence intervals are ± 3 and ± 2 Myr, respectively. We used the Gaia DR2 parallaxes as initial values for the distances, while the mean reddening is determined by the interactive process of the fitting. The reddening val-

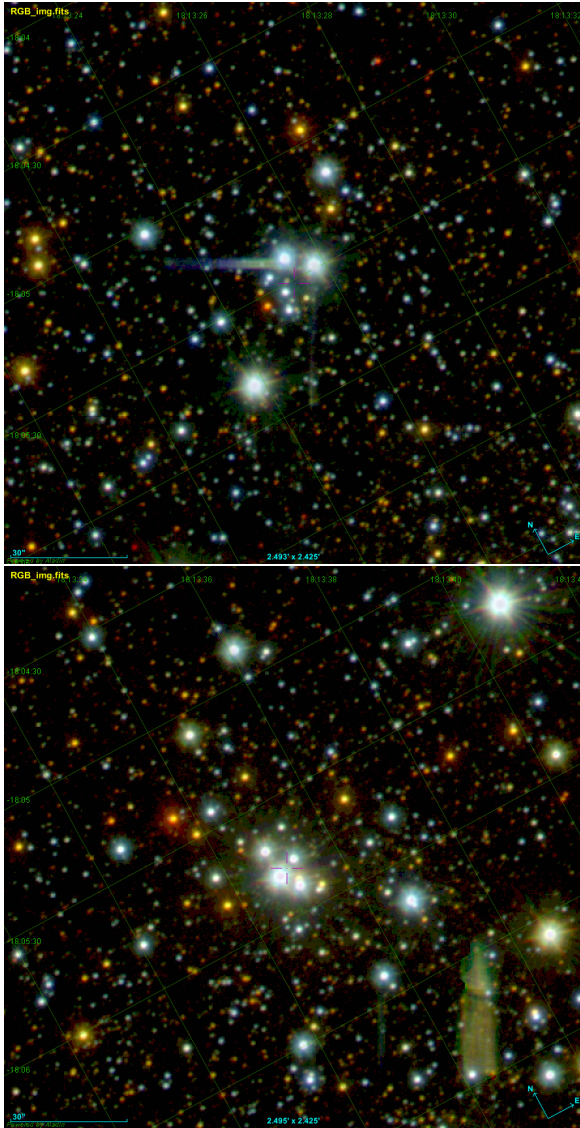


Figure 1: VVVX JHK_S composite color images of CL 076 (upper panel) and CL 077 (lower panel). The field of view is 5×5 arcmin. The North and East vectors are drawn on each image.

ues are $E(J-K_S) = 1.6 \pm 0.2$ and $E(J-K_S) = 1.7 \pm 0.2$, for CL 076 and CL 077, respectively. The errors represent uncertainty of the fitting procedure with quadratically added errors from photometry and transformation to the standard system. The Gaia DR2 mean reddening, as reported in Borissova et al. (2018) is determined as $E(BP-RP) = 1.4 \pm 0.3$ and $E(BP-RP) = 1.6 \pm 0.1$, thus the differential reddening is possible, but dipper photometry and/or spectra of individual cluster members are necessary to estimate it.

We used the Gaia DR2 (Bailer-Jones et al., 2018) distance estimates. The histogram of distance distribution of all stars within 1 arcmin radius of each cluster is shown in Fig. 3. As can be seen, most of the stars are centered around 3 kpc. If we select only most probable cluster members, CL 076 is placed around 1.6 kpc, while CL 077 stands at 1.8 kpc. The associated errors

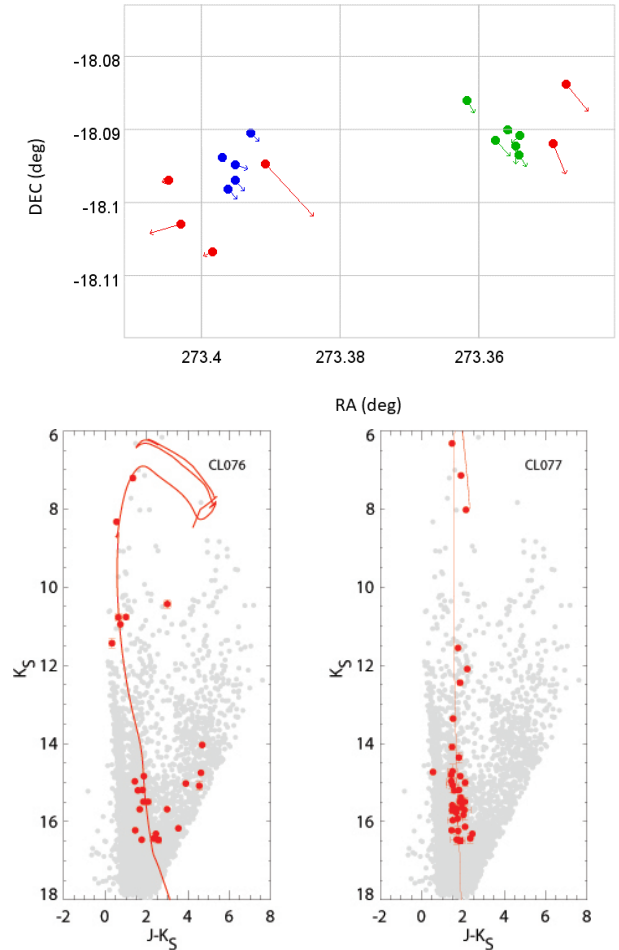


Figure 2: Upper panel: The VVVX CL 076 and CL 077 proper motion diagrams with sky vectors overplotted. Blue and green circles are most probable CL 076 and CL 077 members, respectively, while the red circles stand for field stars. The proper motion vectors are scaled by factor of 2 for better visibility. Lower panel: The VVVX CL 076 and CL 077 K_S vs $(J-K_S)$ diagram with most probable cluster members (red large circles) overplotted. The solid red lines are best fit solar isochrones of 32 and 10 Myr, respectively, taken from the Padova database.

are around 1 kpc, thus such obtained distances should be taken with caution.

The cluster radii were measured by eye on the VVVX K_S combined tiles and are estimated in Borissova et al. (2018) as $17'$ and $53'$. This method was preferred over automated algorithms, because of the small number of the most probable cluster members. The area around cluster candidates is smoothed and the density contours are over-plotted with the lower limit of the contour equal to the density of comparison field.

Since these clusters are projected very close to each other, have similar distances and proper motions, one can speculate that this is a binary system, formed by triggering on the same molecular cloud. More data are necessary to confirm (or reject) this hypothesis.

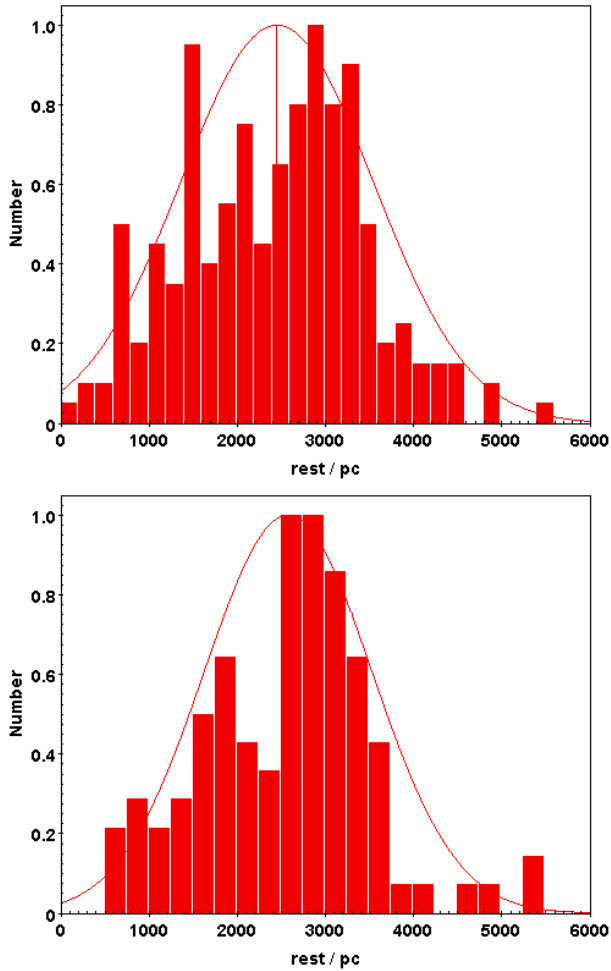


Figure 3: The histograms of distance distribution of CL076 and CL077. The solid lines are Gaussian distributions of the whole sample.

3. Summary

The newly discovered clusters projected in the VVVX disk area are analyzed using VVVX near infrared pho-

tometry and Gaia DR2 proper motion and distance estimates. The preliminary results show that both clusters are moderately reddened with $E(J - K_S) = 1.6 \pm 0.2$ and $E(J - K_S) = 1.7 \pm 0.2$. They are relatively nearby: with distances 1.6 and 1.8 kpc from the Sun, and young: with ages of 32 Myr and 10 Myr, for CL076 and CL077, respectively.

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