

Astrophysical parameters of open star clusters using *2MASS JHK_s* data

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Abstract: In the present analysis we have estimated the fundamental parameters of two poorly studied open star clusters, namely Teutsch 61 and Czernik 3, using *2MASS JHK_s* data. We have used the color-magnitude and colour-colour diagrams to determine their fundamental parameters.

1 Introduction

Open star clusters (OCs) are key objects to understand star formation, stellar evolution and the distance scale of the Galaxy. The main astrophysical parameters of an open cluster, e.g. distance, age and interstellar extinction, can be estimated by using colour-magnitude (CM) and colour-colour (CC) diagrams.

In the present work we have used the Two Micron All Sky Survey (*2MASS*) near-IR photometric data. This survey has proven to be a powerful tool in the analysis of the structure and stellar content of open clusters (Bonatto & Bica 2003). Recently more than thousands of open clusters have been discovered by analysing *2MASS* data (Kronberger et al. 2006, Froebrich et al. 2007, Koposov et al. 2008, Glushkova et al. 2010).

In the light of above discussions our aim is to derive the astrophysical parameters of the open star clusters Teutsch 61 (Teu 61) and Czernik 3 (Cz 3). Fig. 1 shows the identification maps for these clusters. To the best of our knowledge, there is no detailed study available in the literature for these clusters.

2 Data Used

Our main purpose of the present study is to derive the fundamental parameters of the clusters Teu 61 and Cz 3 by using the *2MASS* Point Source catalogue (Skrutskie et al. 2006). This *2MASS* photometric catalogue provides *J* (1.25 μm), *H* (1.65 μm) and *K_s* (2.17 μm) band photometry for

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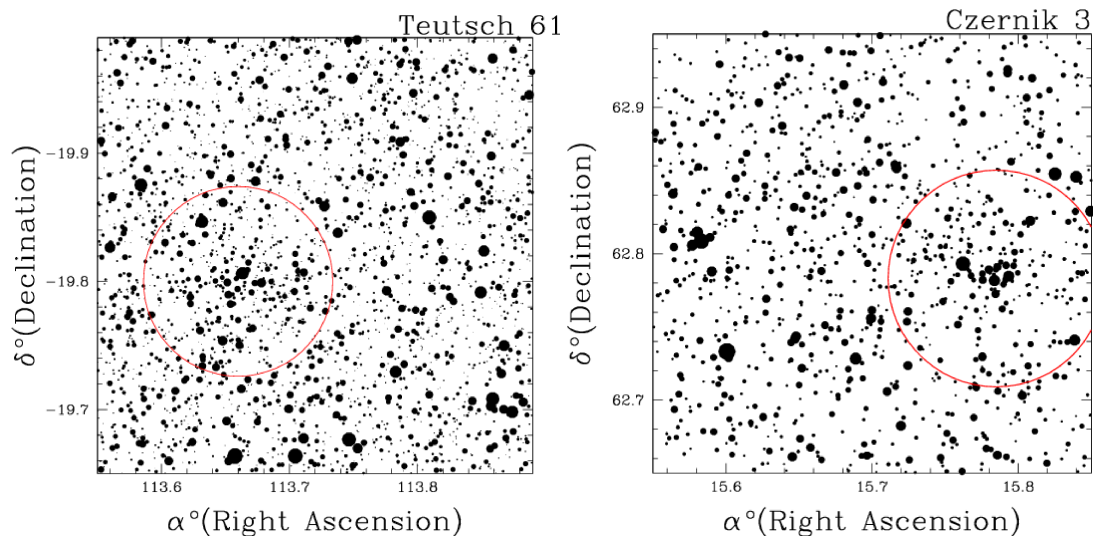


Figure 1: The finding chart of stars in Teutsch 61 and Czernik 3. The biggest size dot represent 10^{th} mag star and smallest size dots represent stars fainter than 17 mag. Circle represents the extent of the clusters.

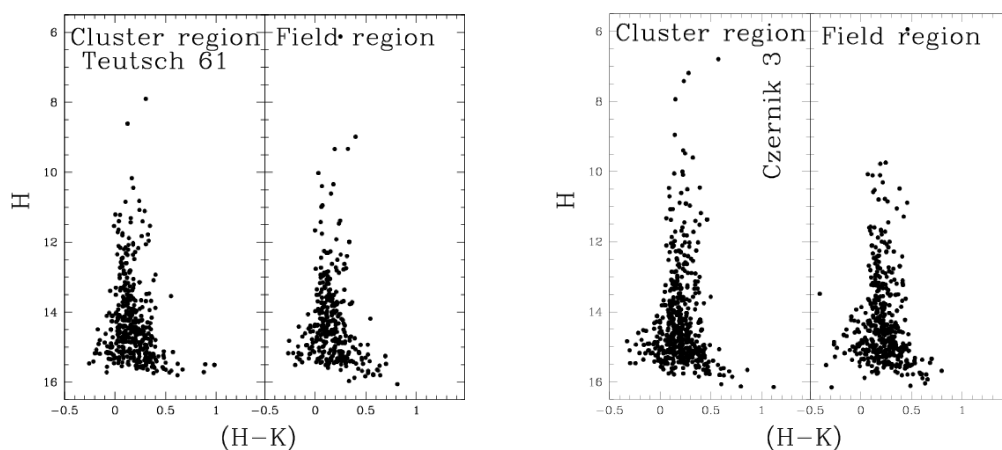


Figure 2: The $H/(H - K)$ CMDs of open star clusters Teu 61 and Cz 3.

millions of galaxies and nearly a half-billion stars (Carpenter 2001). The sensitivity of the *2MASS* catalogue is 15.8 mag for the *J*-band, 15.1 mag for the *H*-band and 14.3 mag for the *K_s*-band band at a signal-to-noise ratio of 10.

3 Colour-magnitude diagrams

Colour-magnitude diagrams play the most important role for the estimation of ages and distances of open star clusters. The $H/(H - K)$ CMDs of the cluster and field region for the clusters Teu 61 and Cz3 are shown in Fig. 2. We have considered only those stars which lie within the cluster extent as derived by Bisht et al. (2017). The CMDs shown in Fig. 2 exhibit a poor main-sequence (MS) extending from $H \sim 10.2$ mag down to $H \sim 14$ mag for Teu 61 and from $H \sim 9.0$ mag down to $H \sim 13$ mag for Cz3. Towards the fainter side, scattering is much higher because of field star contamination or larger errors in the *J*, *H* and *K_s* magnitudes.

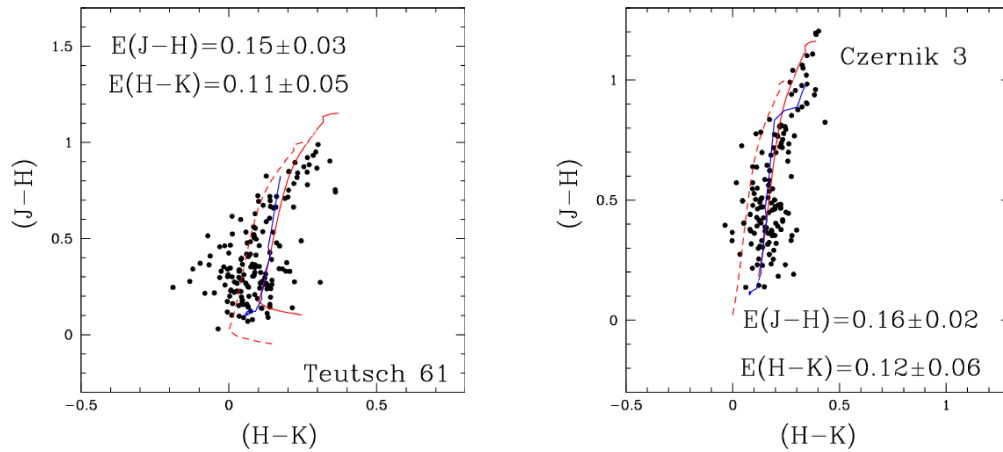


Figure 3: The $(J - H)/(H - K)$ color-color diagram of the clusters under study. The red line is the ZAMS taken from Caldwell et al. (1993). The dotted red line is the same ZAMS shifted by the values given in the text. The blue lines are the theoretical isochrones given by Girardi et al. (2000).

4 Colour-colour diagram

To estimate the interstellar reddening of the clusters, we plot the $(J - H)$ versus $(H - K)$ colour-colour diagram (CCD) in Fig. 3 for the clusters under study. The stars plotted in this figure are taken within the cluster radius. The zero age main sequence (ZAMS) shown by the solid red line is taken from (Caldwell et al. 1993). The same ZAMS shown by dotted red line is shifted by $E(J - H) = 0.15 \pm 0.03$ mag and $E(H - K) = 0.11 \pm 0.05$ mag for Teu 61, and $E(J - H) = 0.16 \pm 0.02$ mag and $E(H - K) = 0.12 \pm 0.06$ mag for Cz 3. We have also fitted the theoretical isochrone (blue line) given by (Girardi et al. 2000). The ratio $E(J - H)/E(H - K)$ for all these clusters are in good agreement with the normal interstellar extinction value suggested by (Cardelli et al. 1989). However, scattering is larger due to error in $JHKs$ data.

5 Age and distance estimation

In Fig. 4, we have shown the fitting of isochrones to our observed CMDs $H/(J - H)$ and $H/(H - K)$ CMDs. The isochrones of different age ($\log(\text{age}) = 8.05, 8.10$ and 8.15 for Teu 61 and $\log(\text{age}) = 8.00, 8.05$ and 8.10 for Cz 3) have been superimposed on the CMDs. The overall fit is good for $\log(\text{age}) = 8.10$ and 8.05 (middle isochrones in black) for Teu 61 and Cz 3, respectively. The best fitted isochrone provides an age of 130 ± 15 for Teu 61 and 115 ± 15 Myr for Cz 3. The heliocentric distance is found to be 2.55 ± 0.1 and 1.75 ± 0.1 kpc, respectively.

6 Conclusions

We have studied the two open star clusters Teu 61 and Cz 3 by using *2MASS* near-IR photometric data. The main findings of our analysis are given below:

- From the two colour $(J - H)$ versus $(H - K)$ diagram, we have estimated $E(J - H) = 0.15 \pm 0.03$ mag and $E(H - K) = 0.11 \pm 0.05$ mag for Teu 61, and $E(J - H) = 0.16 \pm 0.02$ mag and $E(H - K) = 0.12 \pm 0.06$ mag for Cz 3.

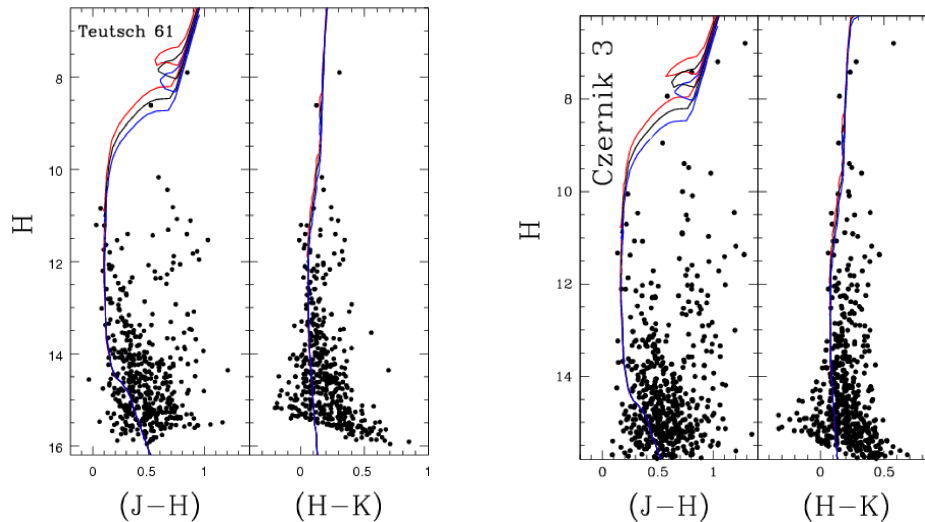


Figure 4: Color-magnitude diagrams of the clusters under study. The curves are the isochrones of $\log(\text{age}) = 8.05$ (red), 8.10 (black), and 8.15 (blue) for the cluster Teu 61 and $\log(\text{age}) = 8.00$ (red), 8.05 (black), and 8.10 (blue) for the cluster Cz 3. These isochrones are taken from Girardi et al. (2000).

- We have estimated an age of open clusters Teu 61 and Cz 3 to be 130 ± 15 and 115 ± 15 Myr, respectively. The heliocentric distance is found to be 2.55 ± 0.1 and 1.75 ± 0.1 kpc for Teu61 and Cz 3 respectively.

Acknowledgements

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