Fundamental parameters and mass function of three open clusters.

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Introduction

The fundamental parameters of open clusters, and their mass function slopes, are necessary to draw inferences regarding star formation and evolution in the galactic disc and trace star formation sites. In this study, we estimate the fundamental parameters of three open clusters using archival data from Gaia DR3 and 2MASS. Their names and coordinates are given in table 1. Their 2MASS colour composite images are shown in figure 1.

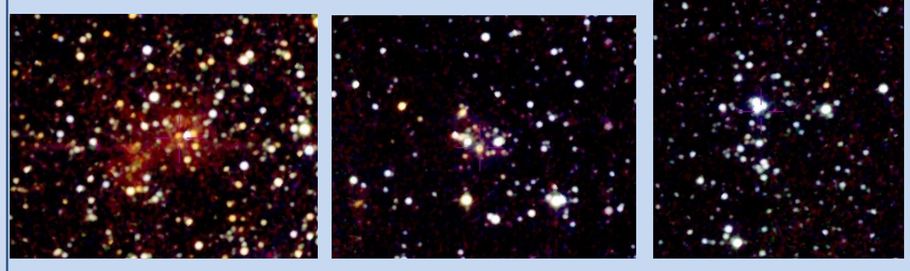

Fig1. From Left to Right, ECX6-27 IR Cluster, Majaess 30, & Teutsch 55. Images obtained from Aladin Sky Atlas.

Data from Gaia DR3 and 2MASS

The name and coordinates of the OCs are given in table 1. The vector point diagrams are shown in figure 2. The extraction radius was chosen by visually examining the density contrast between cluster and background in 2MASS images. After the identification of likely members using proper motion data, their coordinates are used to cross match the 2MASS point source catalogue in order to obtain their corresponding J, H, and K_s magnitudes. The membership selection is explained in the next section.

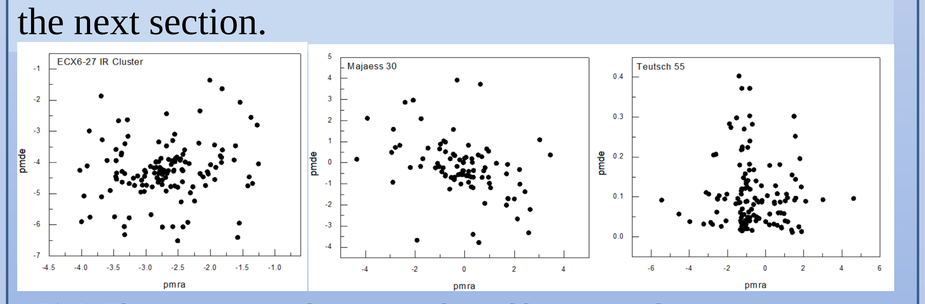

Fig2. The vector point diagrams indicated kinematic clustering in proper motion space with pmra on x-axis and pmdec on y-axis.

Cluster membership

The most likely cluster members were determined by fitting a multivariate normal distribution of the type (Dias et al., 2018)

$$f(\boldsymbol{X}) = \frac{\exp\left(-\frac{1}{2}(\boldsymbol{X}-\boldsymbol{\mu})^T\Sigma^{-1}(\boldsymbol{X}-\boldsymbol{\mu})\right)}{\sqrt{(2\pi)^k|\Sigma|}}$$

Where X is the column vector consisting of the proper motion components, $\boldsymbol{\mu}$ is the mean column vector and $\boldsymbol{\Sigma}$ is the full covariance matrix. The stars within the 1-σ width in figures 3 were adopted as the most likely cluster members. They were used to estimate the fundamental parameters.

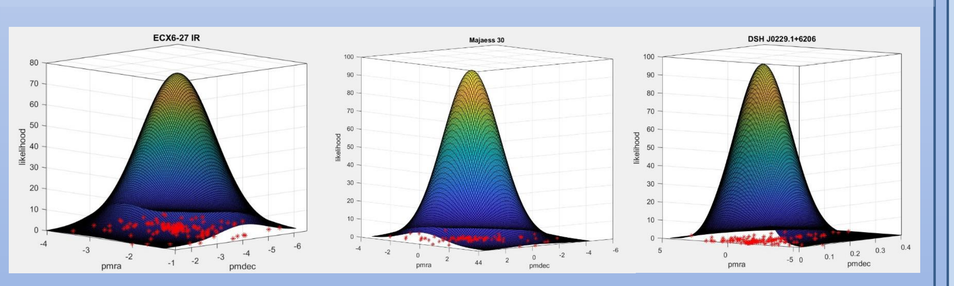

Fig3. The proper motion vs. likelihood graphs to determine the most likely cluster members.

Radial Density Profiles

The radial stellar density profiles were built from counting stars in concentric annuli around the center of each OC. The resulting distribution was fit with the King's profile (King, 1962), expressed in the form below, to obtain cluster radius 'r'.

$$f(r) = \frac{f_0}{\left(1+\left(\frac{r}{r_c}\right)^2\right)}$$

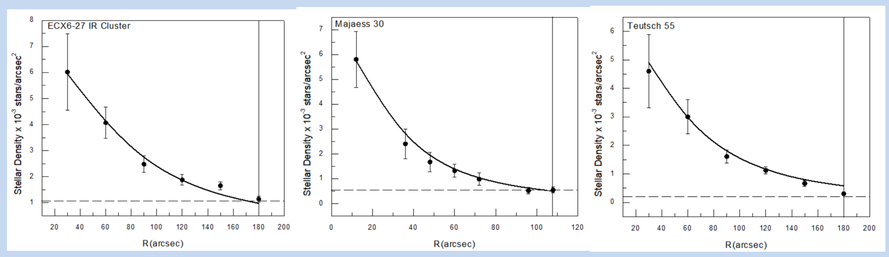

Fig4. The solid curve indicates the King's profile fit, the dashed line indicates the background density and the solid vertical line indicates the value of the radius at which the field star density is reached.

Interstellar reddening and extinction

To estimate interstellar reddening, we plot the J-H vs J-K CCDs and compare it with PARSEC unreddened MS curve of log(age) 6. The interstellar reddening E(J-H) and interstellar extinction A_J were determined using the following relations (Maurya et al., 2020; Bonatto & Bica, 2009).

$$\frac{E(J-H)}{E(B-V)} = 0.273; A_V = R_V \times E(B-V); \frac{A_J}{A_V} = 0.276$$

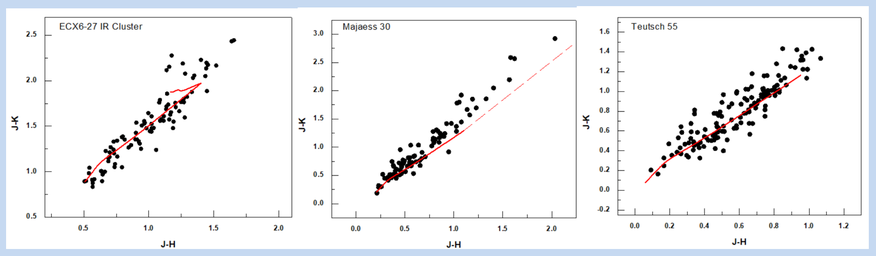

Fig5. The colour-colour diagram used to determines the average interstellar reddening E(J-H) along the lines of sights of the clusters.

Distance and log(age)

The reddening and extinction corrected colours and magnitudes were used to plot the $(J-H)_0$ vs. J_0 CMDs. The distance moduli and the log (age)s of the clusters have been found by visually fitting the PARSEC isochrones (Bressan et al., 2012) to the main sequence in the CMDs. The pre-main-sequence region in the CMDs were fit PMS isochrones taken from Seiss et al., (2000). The estimates of reddening, distance, and age determined from figures 5 are given in table 1. The PMS isochrone age curves are given in the legends in figure 6.

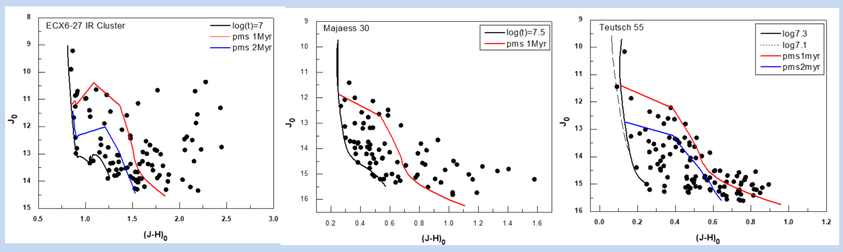

Fig6. Colour-magnitude diagrams used to determine distance and age of the clusters. Black curves are main-sequence branches of the best-visual-fit PARSEC isochrones and the colored curves are the best-visual-fit PMS curves.

Present-day Mass function

We determine the mass-function slope α using the relation given in Bonatto & Bica (2005)

$$\phi(m) = \frac{dN}{dm} \propto m^{-(1+\alpha)}$$

Where m is the mass, N is the number of members and $\phi(m)$ is the luminosity function. The mass function graph of logM vs $\log\left(\frac{dN}{dm}\right)$ was fit with a linear equation and the resulting slope was adopted as the present-day mass function (PDMF) slope. The slopes of each OC are in fair agreement with the classical Salpeter value of -2.35 within the limits of fit error.

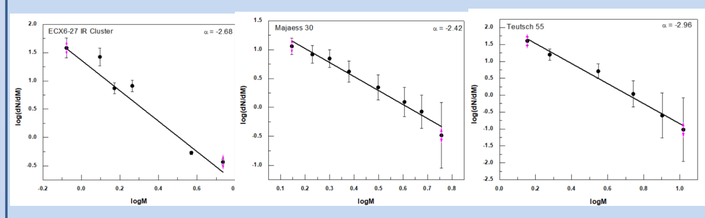

Fig7. The present-day mass function slopes of the OCs

Table 1

Parameter	ECX6-27 IR Cluster	Majaess 30	Teutsch 55
α_{2000}	20:33:56	02:44:36	02:29:08
δ_{2000}	41:22:55	60:59:43	62:06:19
<μ> (mas/yr)	5.039±0.6	0.129±0.18	0.65±0.12
No. of members	95	70	142
cluster radius	3′	1.8′	3′
E(J-H) (mag)	0.65±0.05	0.35±0.03	0.2±0.05
A_J (mag)	2.107	1.096	0.649
Average Distance (kpc)	1.995±0.2	3.162±0.25	3.467±0.4
log(age)	7±0.2	7.5±0.3	7.3±0.2
PDMF slope α	-2.68±0.3	-2.42±0.15	-2.96±0.19

Conclusions

The analysis of the cluster data reveals that the clusters are of young age and they may be used as candidates for the mapping and better understanding of the galactic spiral arms in terms of star formation and structure.

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Note: *The figures in this presentation could not be merged in their respective sections due to relatively larges offsets either in their x-axes or in their y-axes or both axes*

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