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Photometric Study of Open Star Clusters SAI 102 and SAI103

Rasha Alghamdi*

King Abudalaziz University, JEDDAH, Saudi Arabia
Email: RashaAghamdi20@gmail.com

Abstract

The photometrical parameters of two open star clusters SAI 102 and SAI 103 were studied using the near-infrared region JHKs data. The cluster center has been estimated for SAI 102 (α= 09^h05^m 39.7824^s and δ =-37° 52′ 29.388″) and for SAI 103(α= 09^h 07^m 32.75^s and δ=-47° 48′13.42″). The astrophysical parameters (reddening, distance, age, etc) hade been obtained from the Color Magnitude Diagram (CMD) for each cluster. The distance from the Sun for these clusters are between 1300 and 1750pc, while the logs (age) for SAI 102 and SAI 103 are 9.7 and 9.4, respectively. Finally, the luminosity and mass functions of these clusters are estimated. The total masses of SAI 102 and SAI 103 are 317.0749 $M_\odot$ and 490.73 $M_\odot$, respectively, while the mass function slop values were -2.366 and -3.434 for SAI 102 and SAI 103, respectively.

Keywords: Open Clusters; Stars; 2MASS; PPMXL; Photometric; Mass Function; SAI102 and SAI103.

1. Introduction

Exploring the characteristics of the open clusters is essential target to understanding the structure and evolution not only of the Milky Way galaxy but also of the member stars of these clusters [1]. In fact, the open star clusters offer key insight into the toll to present insight into star formation of the Galactic disk [2,3]. Researchers at Sternberg Astronomical Institute (SAI) in Moscow compiled the physical parameters for 170 newly discovered among which 26 embedded clusters [4].

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* Corresponding author.

Glushkova and his colleagues [4] provided the first result of a large multiband surveys which determined the main parameters for 130 new and 14 unstudied known clusters by using the J, H and Ks data from 2MASS Point Source Catalog. From this clusters we have selected two clusters, SAI 102 ($\alpha = 09^h\,05^m\,43.2^s$, $\delta = -37^\circ\,52'\,05''$) and SAI103($\alpha = 09^h\,07^m\,38.5^s$, $\delta = -47^\circ\,50'\,01''$). Previously, Kharchenko and his colleagues [5] obtained photometric properties in J, H, Ks passbands for SAI 102 and SAI 103, and estimated the distance as 2889 pc and 1285pc, respectively. Reference [6] obtained SAI 103 distance as 3700 pc and its log(age) of 9 yer. Joshi Y.C and his colleagues [7] determined its distance of 1285 pc and log(age) of 8.835 yer. Results for SAI 103 obtained earlier are listed in Tabel 1.The paper is organized as follows. In section 2, data analysis of the clusters under investigation is presented. The luminosity and the mass functions of the clusters are obtained in Section 3. The conclusion and the recommendations are given in the last sections.

Tabel 1: Basic parameters of SAI 103 open clusters.

Parameter	SAI 103	References
RA (hh:mm:ss)	09 07 37.84	Karchenko and his colleagues [5]
	09 07 37.100	Bukner **a**nd his colleagues [6]
	09 07 39.00	Joshi and his colleagues [7]
DE (dd:mm:ss)	-47 49 17.5	Kharchenko and his colleagues [5]
	-47 49 09.00	Buckner **a**nd his colleagues [6]
	-47 49 30.0	Joshi and his colleagues [7]
Distance (pc)	1285	Kharchenco and his colleagues [5]
	3700	Bukner and his colleagues [6]
	1285	Joshi and his colleagues [7]
log (age)	8.835	Kharchenco and his colleagues [5]

2. Data Analysis

The physical parameters of these clusters have been determined by merging the data from 2MASS catalogue and PPMXL catalogue [8], with both datasets extracted from the Vizier website. PPMXL gives coordinates α, δ, and proper motion data and 2MASS catalogue for extract the J, H, and Ks photometry data. The limit of extracted data radius was 20 arcminutes around the published center of each cluster, which ensured the

enlargement of the area around the cluster center to include both the field and the cluster stars.

2.1. Cluster Center

The data analysis has been initiated by determining the cluster center. This involved building histograms of the star counts along both Right Ascension (α) and Declination (δ) for the square area with a side of 20 arcminutes and then fitted by Gaussian function, whereas the peaks of the Gaussian function for both α and δ are the coordinates of the cluster's center [9] as illustrated in Figure 1.

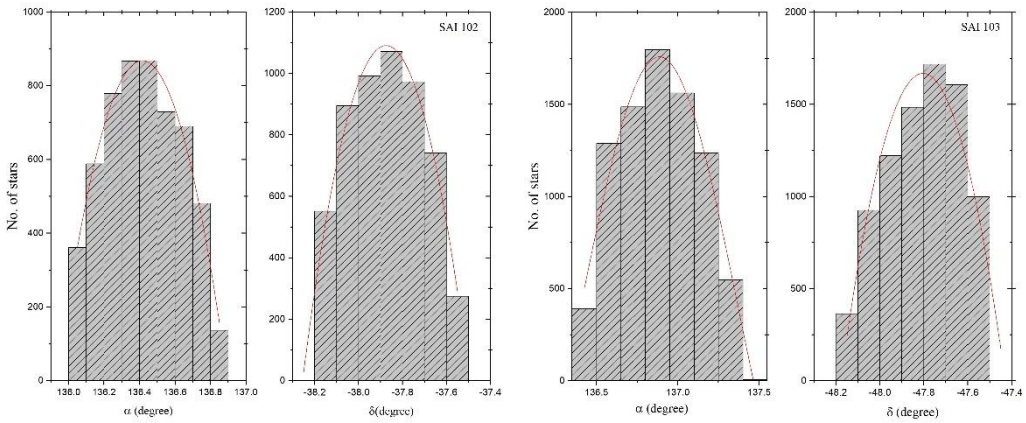

Figure 1: Cluster center estimation of the candidate clusters. The Gaussian fit (red lines) provided the coordinates of the highest density areas in and for each cluster.

Table 2: The center coordinates of the open clusters.

Cluster	RA (hh:mm:ss)	DE (dd:mm:ss)	l (degree)	b (degree)
SAI 102	$09^{h}\ 05^{m}\ 39.7824^{s}$	$-37^{\circ}\ 52^{''}\ 29.388'$	261.5022	6.2215
SAI 103	$09^{h}\ 07^{m}\ 32.7552^{s}$	$-47^{\circ}\ 48^{''}\ 13.428'$	269.10626	-0.18944

2.2 The membership of the cluster

To find out the physical parameters of the cluster, such as the age, the reddening and the distance modulus, we first had to clean the cluster from the contribution of the field stars, that means the stars that are members of the cluster had to be determined. To determine the cluster membership, we adopted a technique based on the proper motion data for each cluster, using the following steps: First, two histograms are constructed; one for the component of the proper motion in Right ascension (pm RA) and one for the component of the proper motion in Declination (pm DEC). Then, after selecting a data range from both histograms around the peak value, the stars within this range could be considered as members of the cluster [10], as shown in Figure 2.

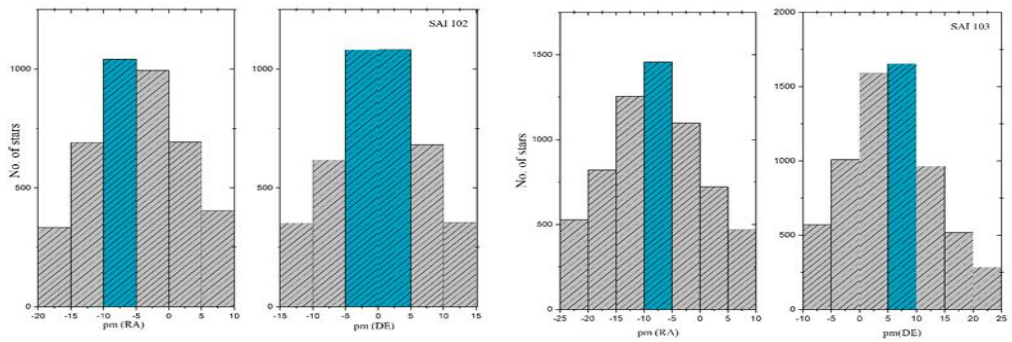

Figure 2: Proper motion histograms of SAI 102 (left panel) and SAI 103 (right panel). The blue region represents the selected data range for the member stars

2.3. Color-magnitude diagrams

The cleaned CMDs are used to derive the physical parameters (age, reddening and distance). The observed CMDs; J vs. J-H and Ks vs. J-Ks for each cluster fitted with the solar metallicity Padova isochrones [11]. Figures 3 and 4 present the best isochrone fitted the CMDs for SAI 102 and SAI 103. The astrophysical parameters (e.g., age, reddening, and distance modulus) are listed in Table 3.

Table 3: The derived parameters.

Parameters	SAI 102	SAI 103
Center: RA (hh:mm:ss)	$09^{h}\ 05^{m}\ 39.7824^{s}$	$09^{h}\ 07^{m}\ 32.7552^{s}$
DE (dd:mm:ss)	$-37^{\circ}\ 52^{''}\ 29.388'$	$-47^{\circ}\ 48^{''}\ 13.428'$
Log (age)	9.7	9.4
E(J-H) (mag)	0.062	0.268
m- M (mag)	11.15	10.65
Distance (pc)	1701.041	1350.51
MF slope	-2.36	-3.43
Total mass ($M_{\odot}$)	317.074	490.374

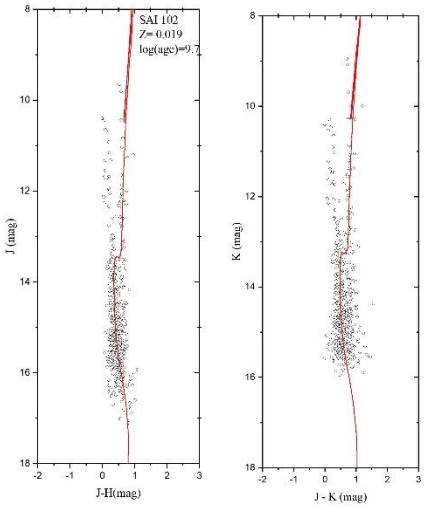

Figure 3: The color-magnitude diagrams of SIA 102. The red curves are theoretical Padova isochrones with Z=0.019 and log(age)= 9.7.

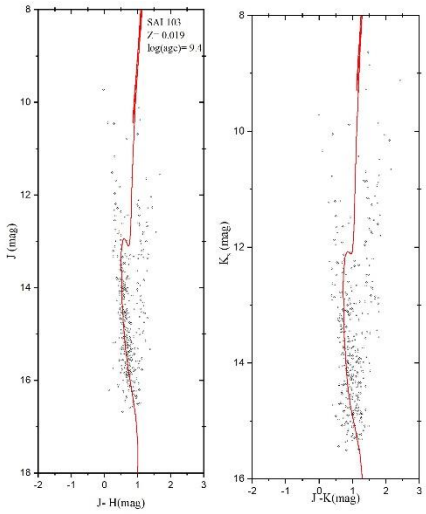

Figure 4: The color-magnitude diagrams of SIA 103. The red curves are theoretical Padova isochrones with Z=0.019 and log(age)= 9.4.

3. Clusters Luminosity and Mass Function

After correction the clusters from the contamination of the field stars, the apparent luminosity function (LF) for each star cluster is derived by counting the stars in luminosity bins of 1 mag each. The LF for SAI 102 and SAI 103 are shown in Figure 5 in J and Ks bands. The maximum value of luminosity for SAI 102 are M_J= 4.5mag and M_{Ks}=3.5 mag, while for SAI 103 is around 3.5 mag in both filters.

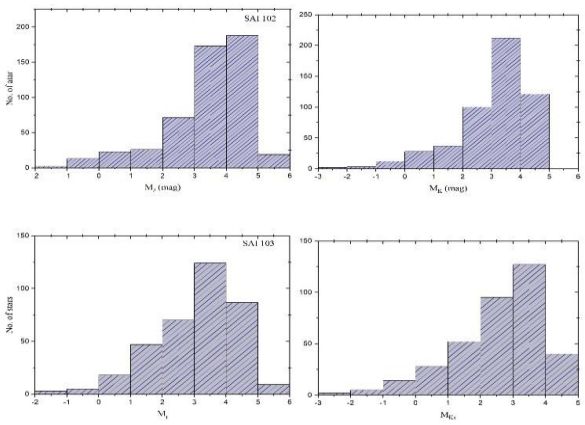

Figure 5: The LF for the candidate clusters.

The mass function (IMF) is the number of stars formed over the mass interval at the same time in a given region of space from the luminosity function of the present-day field stars assuming a constant rate of star formation [12]. Scalo [13] defined the IMF in terms of a power law as;

$$\frac{dN}{dM} \alpha\, M^{-\alpha} \qquad (1)$$

where α = 2.35, according to the original Salpeter value [14]. The MF slop for the clusters SAI 102 and SAI 103 are found to be -2.366 and -3.43 respectively, which is found to be around the Salpeter's value, as shown in Figure 6. The total mass of SAI 102 was determined to be (M_{total}= 317.074$M_{\odot}$), while of SAI 103 was (M_{total}= 490.734$M_{\odot}$).

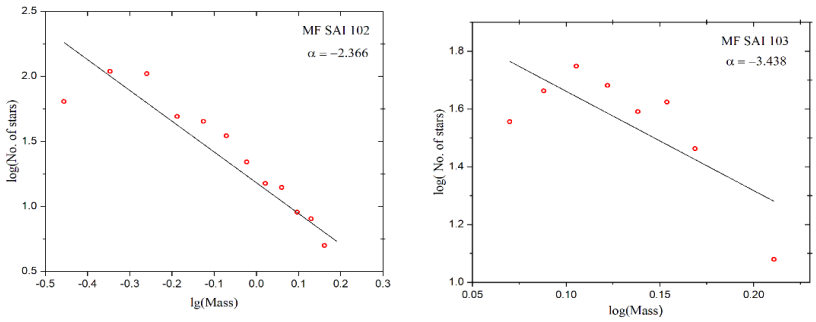

Figure 6: The mass functions of the clusters SAI 102 and SAI 103.

4. Conclusion

The scope of the present work lay in determine the photometric the poorly studied open clusters; SAI 102 and SAI 103, which are selected based on their rare studied. The near-infrared JHKs data are obtained from 2MASS Point Source Catalogue and PPMXL Catalogue [4], which used to determine the photometric parameters. All photometric parameters are listed in Table 2. The results of recalculated the center of SAI 102 and SAI 103 is in

a good agreement with that given by Glushkova and his colleagues [5], but it is greater than that given by Kharchenko and his colleagues [5]. The observed cleaned CMDs for each cluster is used easily to determined the age, distance modulus, and reddening through a visual fitting of Padova isochrones. The log(age) for Sai 102 and SAI 103 are 9.7 yer and 9.8yer, respectively. The distance modulus for SAI 102 11.15 mag and 10.65mag for SAI 103. The reddening that estimated are 0.062mag and 0.26mag for SAI 102 and SAI 103, respectively. Finally, the total mass was obtained for these two open clusters to be 317.074$M_{\odot}$ and 490.73 $M_{\odot}$ for SAI 102 and SAI 103 respectively.

4. Recommendations

This work recommends more photometric and kinematical studies for the clusters SAI 102 and SAI 103.

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