Boletim da Sociedade Astronômica Brasileira, **35**, no. 1, 304-305

Search for new star clusters with *Gaia* DR2 data

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Abstract. We report the discovery of 62 new clusters with ages between 6.9 < log(t) < 9.55, distances between 910 < d(pc) < 6300 and color excess between 0.15 < E(B - V) < 2.32. The new objects are located in the Galactic disk (-200 < z < 200pc), projected mainly towards the Galactic Bulge (-10 < l < 10 deg, -5 < b < 5 deg) and are less concentrated than the average Galactic clusters.

Resumo. Reportamos a descoberta de 62 novos aglomerados com idades entre 6.9 < log(t) < 9.55, distâncias entre 910 < d(pc) < 6300 e excesso de cor entre 0.15 < E(B -V) < 2.32. Os novos objetos se encontram no disco Galáctico (-200 < z < 200pc), projetados principalmente na direção do Bojo Galáctico (-10 < l < 10 deg, -5 < b < 5 deg) e são menos concentrados do que a média dos aglomerados da Galáxia.

Keywords. (Galaxy:) open clusters and associations: general – Galaxy: bulge – Galaxy: stellar content

1. Introduction

The *Gaia* DR2 catalogue (Evans et al. 2018; Lindegren et al. 2018), which provides precise astrometric and photometric data for a billion stars in the whole sky, has allowed a better characterization of open clusters (OCs) and revolutionized the search for new objects in the astrometric space, leading to the discovery of hundreds of new open clusters in our Galaxy, even projected towards dense fields.

In this work, we have found 96 OCs (UFMG 1 to 96) by adopting a methodology involving iterative inspection of proper motion and sky charts after applying a series of filters to enhance cluster/field contrast (Ferreira et al. 2019, 2020, 2021). However, during the elaboration of our works, other authors have reported discoveries of new star clusters, which include part of our sample, reducing it to 62 new OCs.

2. Method: Searching for star clusters

2.1. Searching regions

We have used data from *Gaia* DR2 catalogue, which provides positions, proper motions in right ascension and declination, parallaxes (l, b, μ^*_α, μ_δ, ϖ) and magnitudes in three bands (G, G_{BP} and G_{RP}). The data were acquired to search for new star clusters by two strategies:

1. selection of individual regions of 1.5 degrees radius through the Galactic disk (Fig. 1);
2. selection of an entire region covering 200 square tiles of $1 \times 1\,\mathrm{deg}^2$ area within Galactic coordinates $-5° \leq b \leq 5°$ and $-10° \leq \ell \leq 10°$.

Each circular region was divided by 4 sectors of same area and analysed individually. Then given the data inside the extraction area, we adopted the following steps:

1. application of colour and magnitude filters in each region;
2. search for overdensities in filtered VPD and sky chart of each region;

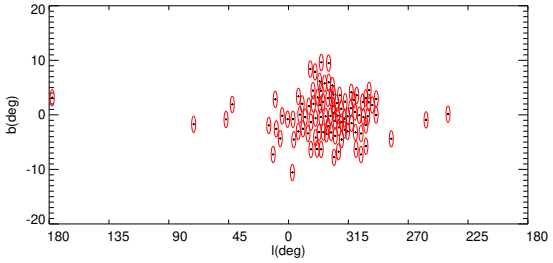

Figure 1. Spatial coverage of the Galactic fields surveyed individually (red circles).

3. analysis of the spatial bonds, proper motions and parallaxes of the stars in overdensities.

2.2. Identifying OCs candidates

To identify the discoveries, we built an OC reference database (literature catalogues present in Ferreira et al. 2021). We compared the centre coordinates with those on the literature and cross-matched our clusters member lists with the literature ones.

3. Analysis and main results

3.1. Radial density profiles

We established Radial Density Profiles (RDPs) to estimate the size of our OCs and the clusters structural parameters (central density, core - r_c - and tidal - r_t - radii) were obtained by weighted fittings of the King (1962) analytical model over their RDPs (Fig. 3).

3.2. Assessing membership and isochrone fittings

Stars membership likelihoods were obtained with an algorithm that evaluates statistically the overdensity of cluster stars in comparison to those in a nearby field in μ^*_α, μ_δ and ϖ (Angelo et al. 2019). See Fig. 4. PARSEC isochrones (Bressan et al. 2012)

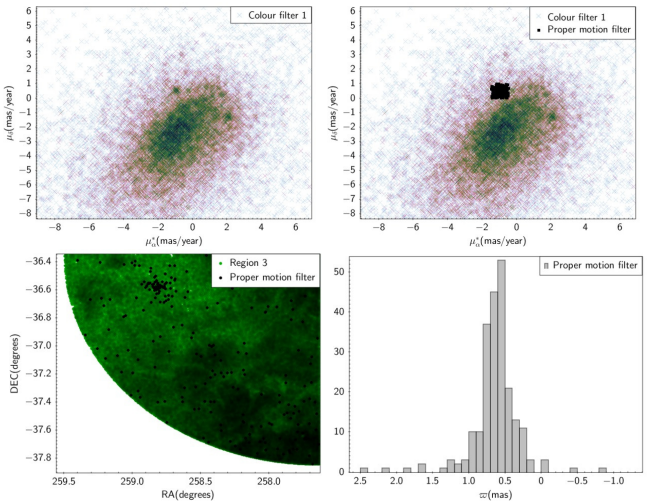

Figure 2. Top left: VPD built from a sample filtred by colour and magnitude. Top right: A 1x1 mas yr^{-1} extraction mask is applied over the visual centre of the detected overdensity. Bottom left: A Sky chart of all stars in the region (green) overploted by the subsample filtered in VPD (black). Bottom right: Parallax values of the subsample filtered by proper motion.

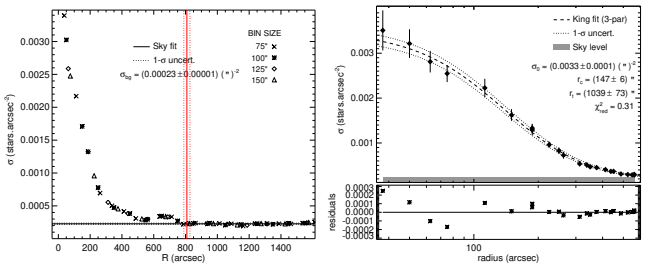

Figure 3. RDP of the cluster UFMG04 (left) with its limiting radius indicated (red line). Right: best-fitting King models (dashed line) with envelope of 1-σ uncertainties (dotted lines).

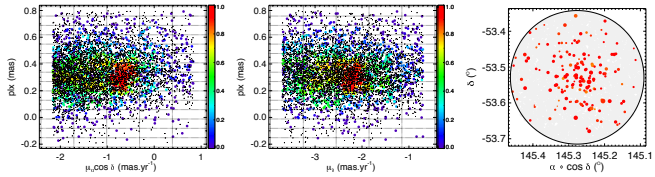

Figure 4. Results of the decontamination procedure to UFMG 6. Left and middle: Proper motions versus parallax. Right: spatial distribution of the most probable OC members.

fittings on the CMDs of the decontaminated cluster were performed to obtain logt[yr], d(pc) and E(B-V). See Fig. 5.

The clusters parameters are presented in Fig. 6 and the impact of the newly discovered OCs over the local density of the OC population (bulge direction) are presented in Table 1.

4. Concluding remarks

- We discovered and derived astrophysical parameters for 62 OCs projected in the dense stellar fields.
- The investigated OCs present d<2 kpc, 10 Myr <age< 1 Gyr and 0.1 <E(B-V)< 2.3.
- The newly discovered objects exhibit less concentrated structures, when compared to known Galactic OCs.

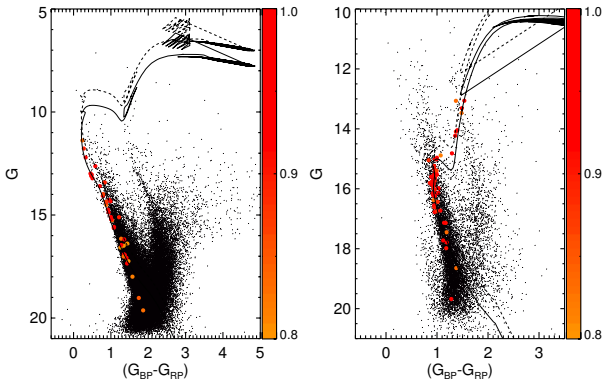

Figure 5. Decontamined CMDs: UFMG36 (left) and UFMG62 (right). The black lines are PARSEC-COLIBRI isochrones and the the colour bar represent the stars membership probability.

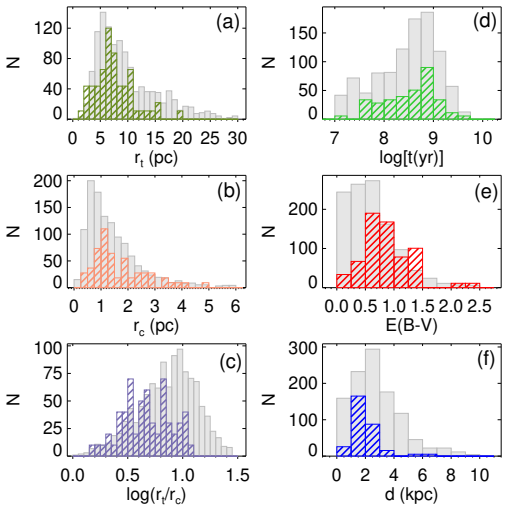

Figure 6. Discovered OCs parameters compared to those of *Gaia* DR2 confirmed OCs: (a) tidal radius, (b) core radius, (c) concentration parameter, (d) logarithm of age, (e) reddening and (f) distance.

Table 1. The impact of the newly discovered OCs over the local OC population (bulge direction).

Sample	fraction	increase
Total	34/206	17%
with *Gaia* data	34/118	29%
with astrophysical parameters	34/129	26%
with $d < 2$ *kpc*	32/82	39%
with $d < 1.5$ *kpc*	22/57	38%
with $d < 1.1$ *kpc*	6/32	19%

Acknowledgements. The authors wish to thank the Brazilian financial agencies FAPEMIG, CNPq and CAPES (finance code 001). W. Corradi wishes to thank the LNA staff.

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