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UNRAVELLING THE LUMINOSITY DISTRIBUTION OF IC 4665

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Abstract. The study of star formation is extremely challenging due to the lack of complete and low-contaminated samples of young, nearby, clusters and star forming regions. We aim at providing a membership analysis with a high completeness and low contamination of the young, nearby, open cluster IC4665. We apply modern Bayesian statistical tools to the recent *Gaia* DR2 catalogue to identify high probability members. We find a list of 543 members of IC4665 with membership probabilities $> 87\%$, 251 of which are new members. We compute the magnitude distribution of these sample which peaks at $G \sim 10$, equivalent to ~ 0.25 $M_{\odot}$.

Keywords: Stars: luminosity function, Galaxy: open clusters and associations: individual: IC4665

1 Introduction

Despite the extraordinary progress achieved over the past decade, the understanding of star formation is still far from complete. Young, open clusters are excellent targets where to study this process since they contain all their initial members in a similar state in which they were formed.The major difficulty in these kind of studies arises from the high level of contaminated and incomplete samples available, specially in the sub-stellar regime.

The COSMIC-DANCE project (Bouy et al. 2013) started over the last few years with the aim of overcoming all these difficulties. Combining extremely precise on-ground, deep photometry and proper motions with modern statistical techniques we are able to provide accurate membership probabilities which are then used to study the internal properties of the cluster such as the mass function, or the spatial and kinematic distributions.

In this work, we have focused on the nearby (< 500 pc), young (~ 30 Myr) open cluster IC4665. In Sect. 2 we describe the membership analysis and the results we obtain, and in Sect. 3 we conclude.

2 Membership analysis

To select candidate members we use the same bayesian statistical approach as in Olivares et al. (2018) which is based on the work presented by Sarro et al. (2014). Broadly, this algorithm separates all the sources within two populations namely, the cluster and the field. The field model is a Gaussian Mixture Model (GMM) and the cluster model is a product of two independent models: a GMM for the astrometry and a principal curve in photometry. These models are used to infer posterior membership probabilities for each source and then, classify all the sources.

To start the model we need a catalogue of sources of the spatial region where the cluster is located and an initial list of members. For the catalogue, we use the parallaxes, proper motions, and G, G_{BP}, G_{RP} photometry from the *Gaia* DR2 catalogue (Gaia Collaboration et al. 2018b), within a circular region of 3° radius centred on IC4665. This results in a dataset of 1 419 629 sources with a limiting magnitude of $G = 21$. Recently, two studies have published members of IC4665 using the *Gaia* DR2 data. The work of Gaia Collaboration et al. (2018a) published a list of 174 members and the work of Cantat-Gaudin et al. (2018) published a list of 175 members. Both studies have a magnitude limit of $G = 18$, and most of the sources in common. We combine their results and we find a list of 203 members which we use as initial list to start the algorithm.

Our membership analysis results in 543 members of IC4665 with membership probabilities $> 88\%$. This list contains 189 of the initial members taken from the literature, i.e. we recuperate the 93% of the initial

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list. When we compare our members with the deepest study by Lodieu et al. (2011), we only find 173 of they 1 372 members. We estimate they have a contamination of $\sim 87\%$ due to a problematic photometric calibration (their i-band photometry display an offset of ~ 1 mag compared to PanSTARRS). We also find 38 members in common with the Gaia-ESO survey (Bravi et al. 2018). After excluding all the members already reported in the literature, we find 251 new members.

In Fig. 1 left, we show the absolute G, $G - RP$ color-magnitude diagram of our members. We see that the 30 Myr isochrones reproduce well the bright main sequence of the cluster, however, they show discrepancies for masses < 1 $M_{\odot}$. In Fig. 1 right, we show the absolute G magnitude distribution. We see that it peaks at $G \sim 10$ corresponding to $\sim$0.25 $M_{\odot}$.

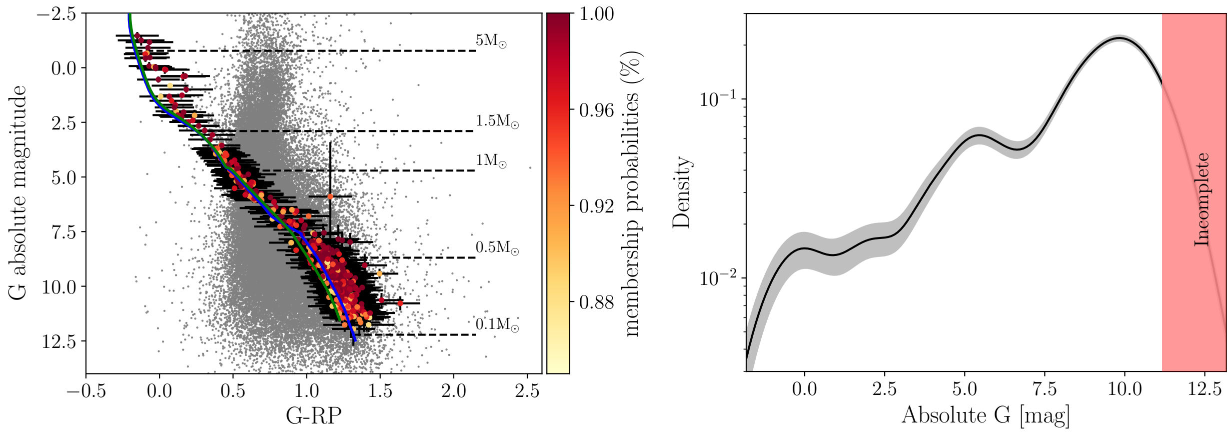

Fig. 1. Left: (Absolute G, $G - RP$) color magnitude diagram of the IC4665 open cluster. The COSMIC-DANCE members are color-coded according to their probabilities. The PARSEC+COLIBRI and the MIST isochrones of 30 Myr are overplotted in blue and green respectively. The corresponding masses are indicated (in units of solar mass). The field stars are plotted in gray. **Right:** Absolute G magnitude distribution of IC4665. The gray shaded region indicates the uncertainty estimated from bootstrap. The red shaded region indicates the incompleteness of the Gaia catalogue.

3 Conclusions

We present a Bayesian membership analysis of the nearby, young open cluster IC4665. With the *Gaia* DR2 catalogue we find 543 members of which 251 are new members. We see that the models reproduce well the bright sequence of the cluster but are still uncertain in the low-mass regime. We obtain a magnitude distribution which peaks at $G \sim 10$, equivalent to $\sim$0.25 $M_{\odot}$.

In the near future, we plan to extend the membership analysis to the faintest stars, using the COSMIC-DANCE catalogue. With this, we expect to find members 9 mag deeper than the ones reported here with *Gaia*, corresponding to objects ~ 25 times less massive.

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