Mem. S.A.It. Vol. 88, 838

Memorie della

The clustering properties of intermediate mass young stars

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Abstract. Building on ideas from previous investigations, we will develop an algorithm that can detect clusters around Herbig Ae/Be stars given their astrometric parameters. Here, we present the results we obtained from initial algorithm tests for the cluster NGC6475 with TGAS data, which are then cross-matched with a photometric catalog. Based on a comparison with results from the literature, we demonstrate the efficiency of our algorithm in the detection of members of cluster, recovering the same number of stars and determining the same cluster astrometric parameters. In the future, this algorithm will also enable us to detect and confirm the presence of the clusters around Herbig Ae/Be stars and determine the characteristics of these clusters, such as ages.

1. Introduction

It is a well-established result that many stars do not form in isolation; young stars are usually found to be members of clusters or associations (Testi et al. 1997, and references therein).

Previous investigations (e.g., Testi et al. 1997, 1998, 1999) analyze the occurrence of young stellar clusters around intermediate mass pre-main sequence Herbig Ae/Be stars from near-infrared images. They found that some stars in the sample were surrounded by a large number of companions, who together form a stellar cluster while the remaining stars appear single and isolated. Taking this idea further, we will investigate the presence of clusters around previously known and newly discovered Herbig Ae/Be stars through the detailed astrometric data from *Gaia* (Gaia Collaboration et al. 2016, 2017).

2. This project

Our principal objective is to analyze the presence and characteristics of clusters around Herbig Ae/Be stars using *Gaia* data. To accomplish our aim, we need to develop an method that allows us to detect a cluster given its astrometric parameters. For our initial algorithm tests, we started studying known clusters selecting stars from TGAS in a circular area with a radius of 3 degrees around the center. We then performed a selection of the stars around the cluster's parallax and proper motions taking from Gaia Collaboration et al. (2017). Finally, we cross-matched the results with a photometric catalog (e.g., Tycho) to create a Colour–Magnitude diagram for the sample.

Figure 1 shows the final result of our selection for the cluster NGC6475. We can observe that most of all the black points can be identi-

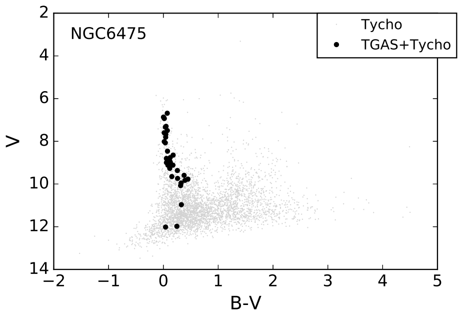

Fig. 1. Colour–magnitude diagram of the cluster NGC6475. The light grey points are the data from Tycho and the black points are the cross-match between the result of the selection from TGAS and Tycho. TGAS data was chosen in a circular area with a radius of 3 degrees around the center.

Table 1. Astrometric parameters of the cluster NGC6475

Parameter	Source	
	a	b
ϖ (mas)	3.57 ± 0.02	3.60 ± 0.05
μ_α (mas/yr)	3.10 ± 0.06	2.98 ± 0.02
μ_δ (mas/yr)	-5.32 ± 0.04	-5.48 ± 0.01

[a]Gaia Collaboration et al. (2017)
[b]This project.

fied with the main-sequence. These points represent all the possible members of the cluster. Comparing the result with Gaia Collaboration et al. (2017) we obtain the same number of stars and a similar measurement of the astrometric parameters (see table 1).

3. Conclusion and future work

The analysis performed with the initial algorithm on various known clusters with TGAS data and cross-matched with a photometric catalog generate good results; after comparison with data from the literature (Gaia Collaboration et al. 2017), we recover a similar number of stars and comparable parallax and proper motions, demonstrating that the algorithm performs well.

This work represents the first step in a long-term project, where we detect and analyze clusters and clustering properties of Herbig Ae/Be stars. In preparation for *Gaia* data release 2, we have started to developing an algorithm for cluster selection around the Herbig Ae/Be stars from Testi et al. (1997, 1998, 1999).

Acknowledgements. This project has received funding from the European Union's Horizon 2020 research and innovation programme under MSCA ITN-EID grant agreement No. 676036. This work has made use of data from the European Space Agency (ESA) mission *Gaia* (`https://www.cosmos.esa.int/gaia`), processed by the *Gaia* Data Processing and Analysis Consortium (DPAC, `https://www.cosmos.esa.int/web/gaia/dpac/consortium`). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the *Gaia* Multilateral Agreement.

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