The clustering properties of intermediate mass young stars

Alice Pérez Blanco[(1,2)*], René Oudmaijer[(1)] and Deborah Baines[(2)]

[(1)] University of Leeds (Leeds - UK); [(2)] ISDEFE (ESAC, Madrid - Spain)

*pyagyp@leeds.ac.uk

Abstract

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. Building on the ideas from previous investigations, which analyze the occurrence of young stellar clusters around intermediate mass pre-main sequence Herbig Ae/Be stars from near-infrared images, we will investigate the presence of clusters around previously known and newly discovered Herbig Ae/Be stars through the detailed astrometric data from ***Gaia***. This will enable us to determine the position of the Herbig Ae/Be stars in the HR diagram and allow us to detect and confirm the presence of the clusters around them.

BACKGROUND

Do Herbig Ae/Be Stars form in clusters?

Testi et al. (1997) selected a sample of Herbig Ae/Be stars and investigated their K band 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 (See figure 1). It is important to point out that they suggested the clustering may be a function of mass.

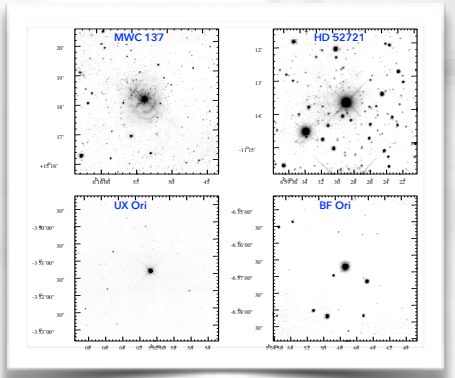

Figure 1 K band images of four Herbig stars. The upper section of the figure shows the Herbig stars surrounded by a large number of companions and the lower section of the figure the Herbig stars appear single and isolated. Figure taken from Testi et al. (1997).

FUTURE WORK

This work represents the first analysis of a long-term project, where we will be developing an algorithm for the detection and analysis of the clusters and clustering properties of the Herbig Ae/Be stars.

In preparation for the ***Gaia*** data release 2, we start to develop an algorithm for cluster selection around the Herbig Ae/Be stars from Testi et al. (1997,1998,1999).

OUR PROJECT

Our principal objective is to analyze the presence and characteristics of clusters around Herbig Ae/Be stars through ***Gaia*** data. To assess whether a Herbig star is associated with a cluster, we first need to develop an algorithm that can detect a cluster given its astrometric parameters. Here we present our initial tests, where we start studying known clusters following these steps:

1. First, we selected stars from TGAS in a circular area with a radius of 3 degrees around the center.
2. Performed a selection of the stars around the known value of the astrometric parameters. Figure 2 represents the selection process:
   A. Parallax distribution at 3 deg.
   B. Selection of parallax around the known value.
   C. Proper motion distribution in RA of the data from the selection in parallax.
   D. Selection of proper motion in RA around the known value.
   E. Proper motion distribution in DEC of the data from the selection in proper motion in RA.
   F. Selection of proper motion in DEC around the known value.

4. We cross-matched the results we obtained in step *F* with a photometric catalog to illustrate the sample in a Colour - Magnitude diagram (See Figure 3 A).

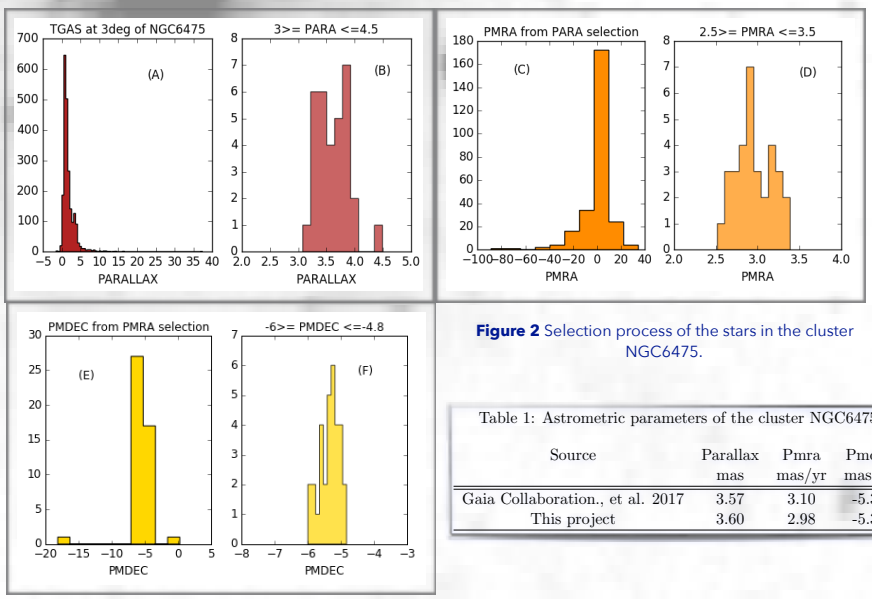

Figure 2 Selection process of the stars in the cluster NGC6475.

Table 1: Astrometric parameters of the cluster NGC6475

Source	Parallax mas	Pmra mas/yr	Pmdec mas/yr
Gaia Collaboration., et al. 2017	3.57	3.10	-5.32
This project	3.60	2.98	-5.35

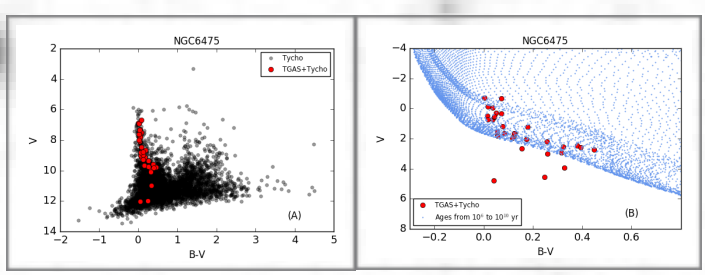

Figure 3 Colour - Magnitude diagram of the cluster NGC6475. In figure A the black points represent the data from Tycho in a circular area with a radius of 3 degrees around the center and the red points are the cross-match between the result of the selection in parallax and proper motions from TGAS and Tycho. In Figure B, the red points are the same as in figure A and the light blue points represent the isochrones of ages between 10^6 to 10^{10} yr.

References

- Bressan, A., Marigo, P., Girardi, L., et al. 2012, MNRAS, 427, 127
- Gaia Collaboration, van Leeuwen, F., Vallenari, A., et al. 2017, arXiv:1703.01131
- Herbig, G. H. 1960, ApJS, 4, 337
- Testi, L., Palla, F., Prusti, T., Natta, A., & Maltagliati, S. 1997, A&A, 320, 159
- Testi, L., Palla, F., & Natta, A. 1998, A&AS , 133, 81
- Testi, L., Palla, F., & Natta, A. 1999, A&A, 342, 515

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.