

Identification of binary and multiple systems in TGAS using the Virtual Observatory

F. Jiménez-Esteban^{1,2,3} and E. Solano^{1,2}

¹Centro de Astrobiología (INTA-CSIC), Madrid, Spain
email: fran.jimenez-esteban@cab.inta-csic.es

²Spanish Virtual Observatory

³Suffolk University

Abstract. Binary and multiple stars have long provided an effective method of testing stellar formation and evolution theories. In particular, wide binary systems with separations $> 20,000$ au are particularly challenging as their physical separations are beyond the typical size of a collapsing cloud core (5,000 - 10,000 au). We present here a preliminary work in which we make use of the TGAS catalogue and Virtual Observatory tools and services (Aladin, TOPCAT, STILTS, VOSA, VizieR) to identify binary and multiple star candidate systems. The catalogue will be available from the Spanish VO portal (<http://svo.cab.inta-csic.es>) in the coming months.

Keywords. Astronomical data bases, catalogues, virtual observatory tools, parallaxes, proper motions, binaries: visual.

1. Search of co-moving candidates

We selected TGAS (Gaia Collaboration *et al.* 2016) sources with positive parallaxes and errors $< 10\%$ in both proper motion components and parallaxes (250,466 sources). Co-moving systems were defined as any group of sources with the same parallaxes and proper motions within 3 times the sum of the individual errors ($\sim 150,000$ candidate pairs). We set a conservative limit of 500,000 au (~ 2.5 pc) in the projected sky separation to discard systems whose components are too far to be physically bound. 15,645 sources grouped in almost 7,000 systems remained.

2. Radial velocity confirmation

We searched radial velocity (RV) data at RAVE-DR5 (Kunder *et al.* 2017) and LAMOST-DR2 (Luo *et al.* 2015) catalogues, both available at Vizier. RVs were found for 2,243 sources. The components of 339 systems ($\sim 5\%$) showed the same RV within 3 times the sum of the individual errors. 459 sources were rejected because of their discrepant RV values. This left 15,186 sources in 6,703 systems (339 confirmed and 6364 candidate).

3. Binding Energies

We used the Gaia-2MASS (G-K_s) color and the absolute magnitude M_G obtained using the TGAS distance to place our candidate systems in a H-R diagram (Fig. 1). According to their position 804 objects ($\sim 5\%$) were classified as subgiants or giants and 13,400 as dwarfs.

Spectroscopic determinations of the effective temperatures (T_{eff}) of 1,972 stars were obtained from RAVE-DR5, LAMOST-DR2, and PASTEL (Soubiran *et al.* 2016). For the rest of objects, T_{eff} were estimated using VOSA (Bayo *et al.* 2008). (Fig. 2).

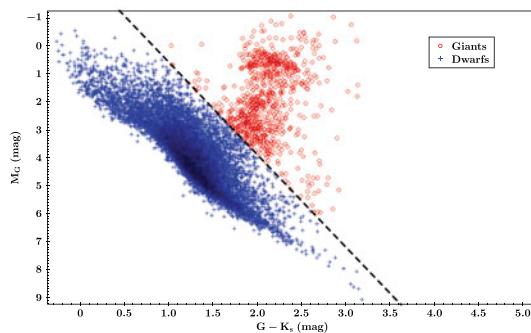


Figure 1. H-R diagram showing the location of our candidate systems. Dashed line separates dwarfs (below) from giants (above).

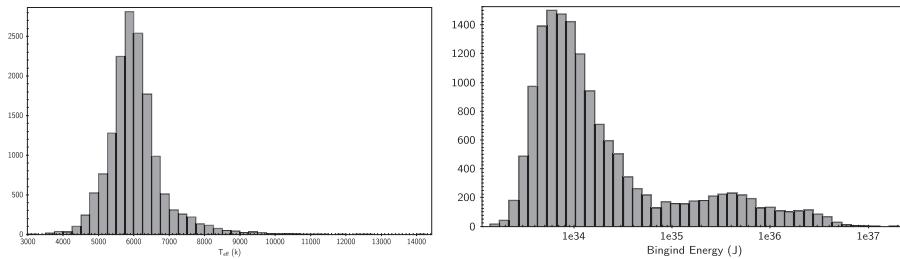


Figure 2. Left: T_{eff} distribution. The majority of our objects show effective temperatures typical of F-G spectral types; Right: Binding energy distribution. The bi-modal shape reported in Dhital *et al.* (2010) is also found here.

Stellar masses were derived by interpolating T_{eff} in the tables B1 and B2 (Gray 2008) using the dwarf/giant information. Masses and projected physical separation were used to estimate the binding energy $U = -GM_1M_2/r$ (Fig. 2). Following Dhital *et al.* (2010), we set a lower limit for the binding energy of 10^{33} J.

An analysis of the distribution of binding energies and the identification of interesting systems (weakly bound, FGK-M pairs,...) is currently on-going.

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