SEARCH FOR OPEN BINARIES IN THE SOUTHERN CELESTIAL HEMISPHERE USING *SPM*4

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Open binaries' weak gravitational binding makes them vulnerable to any perturbation, turning them into excellent probes of the gravitational field where they are located. Currently there are only a few hundreds known or suspected open binaries, therefore a search for more of these systems is highly encouraging by looking for pairs of stars with common proper motions in an extensive, deep, and high quality astrometric catalog such as the *SPM*4 (Girard et al. 2011).

Common proper motion of an open binary system happens due to the large physical separation between the components. The orbital motion μ_{orb} of each component is so small, such that, the observed proper motion $\mu_{obs} = \mu_{orb} + \mu_{CM}$, is dominated by the center-of-mass motion μ_{CM}, which is common in the system's stars.

An initial evaluation was done to understand *SPM*4's capability to detect already known open binaries of the Halo (Allen & Monroy 2014). 44 (42 doubles + 2 triples) from 241 (231 doubles + 10 triples) known candidates to open binary systems were within *SPM*4's coverage. The detection of these 44 systems in SPM4 was as follows: Case 0 (no components detected): 10 double systems = 0 stars; Case 1 (only one component detected): 24 double + 1 triple systems = 25 stars; and Case 2 (all components detected): 8 double + 1 triple systems = 19 stars. In total 44 stars were detected by *SPM*4, corresponding to a 49% of the initial sample. We conclude that *SPM*4 can efficiently detect open binaries with apparent angular separations $> 10''$ where both components are brighter than magnitude $V = 13$. The detection was less efficient for faint stars due to *SPM*4's limiting magnitude $V = 17.5$

The common proper motion criterion to find open binary candidates can generate a portion of pairs mistakenly associated, simply because by chance two or more unrelated stars are within a certain angular separation in the sky and have similar proper motion. To minimize the contamination by false binaries it is necessary to use other available observables such as magnitude, color, spectral type, etc. that allow us to roughly estimate the distance to each binary. If both stars in a pair are at about the same distance, or have the same radial velocity, the probability of their being a real physical binary increases significantly. Addition information provided by simulations with the Besancon Model of the Galaxy (Robin et al. 2003) will allow us to ascertain better the true condition of physical binary since it gives us the possibility to characterize the ranges of luminosity class (i.e. dwarfs vs giants) and distance of select populations of the Galaxy, from color-magnitude and color-color diagrams. This photometric study was applied in several one-square degree fields from *SPM*4 located at different galactic latitudes and performed in infrared magnitudes JHK (from 2MASS) which are of better quality than the optical BV measured by *SPM*4.

The J vs J-K diagrams of each field showed two sequences that become denser towards the galactic disk and bulge. These diagrams were consistent with those constructed from the Besancon model, i.e. synthetic data fit well the *SPM*4 data, except for extinction effects which were not explicitly included in the simulation[3]. The Besancon model indicates that most of the stars in the simulated fields belong to the disk and have ages of 2-10 Gyr, and more importantly, the two observed sequences are directly related to the stellar surface gravity. The bluer sequence corresponds to dwarf stars with high values of $log(g)$, while the redder one corresponds to giant stars with low $log(g)$. The distance range characterization is related to the position in the diagram, it becomes more efficient for the giants and brighter dwarfs, while it is more complex for the faint dwarfs. With our current work, we conclude that by using colour-magnitude diagrams we can make a good guess of the luminosity class and distance to our open binaries candidates selected by common proper motion, for stars brighter than $J = 13$.

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[3]As a result, when compared to *SPM*4, the simulation has more stars at fainter magnitudes and in general, simulated stars are bluer than the observed ones.

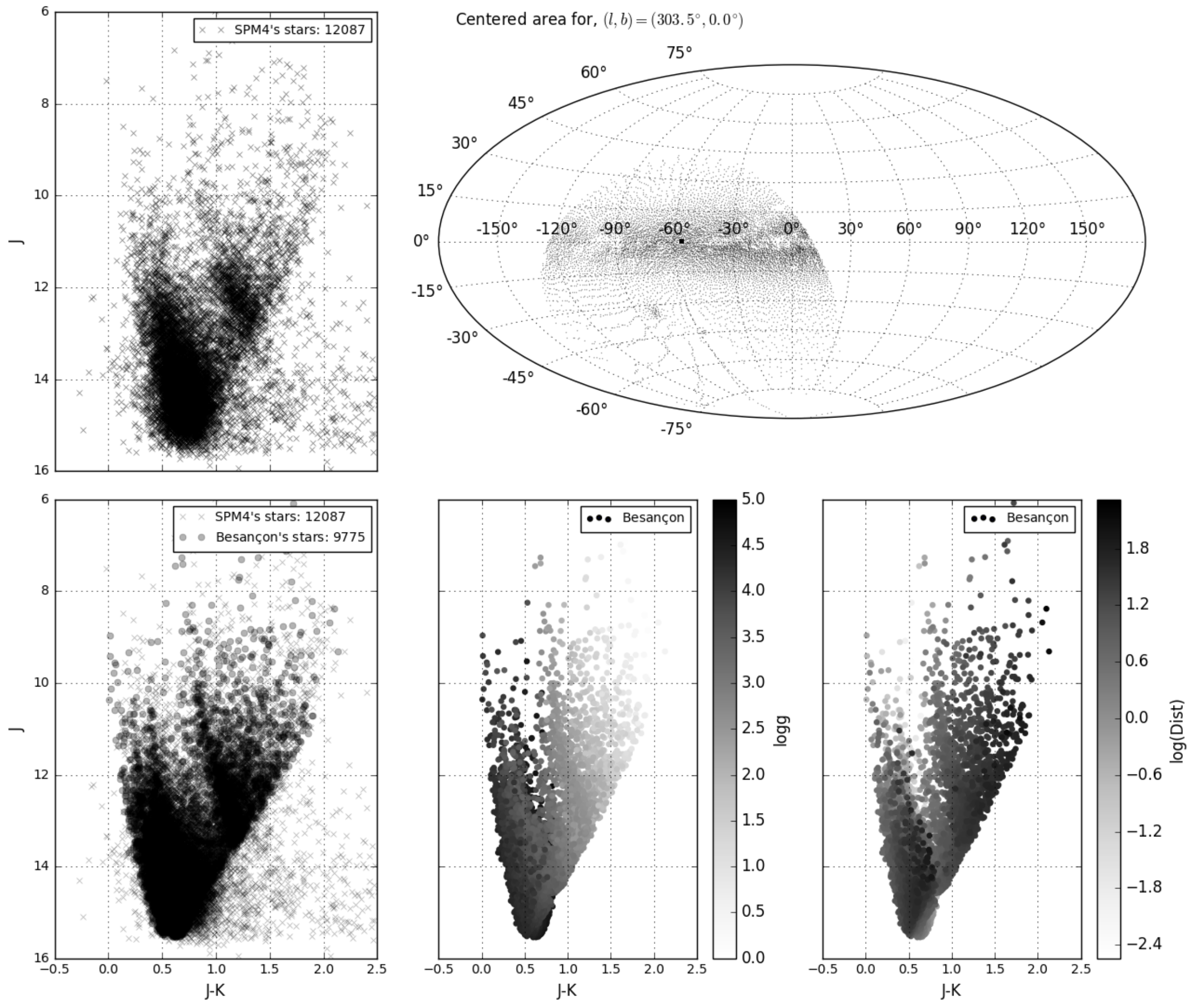

Fig. 1. J vs. J-K diagram of a field in the galactic disk

We also conclude that $SPM4$ is a reliable source for the detection of open binary candidates by common proper motion.

As expected, the detection of open binaries in this catalogue gets more difficult towards fainter magnitudes. Faint stars have lower quality proper motions, which makes the open binary search unreliable. Despite this limitation, the large extension of $SPM4$ over the sky will allow us to significantly expand the resulting list of candidates.

Part of the planned work for this investigation of open binary candidates in $SPM4$, will include the cross-match of the stars with the SIMBAD and the Virtual Observatory databases, to obtain as much additional information as possible, that can be used to ascertain the physical binarity of the candidate. Also, it is of the uttermost importance to quantify the amount of possible false candidates generated by this search. In this regard, the next step is to perform an statistical estimate of the fraction of false binaries in the final list.

REFERENCES

Allen, C. & Monroy-Rodríguez, M. 2014, ApJ, 790, 158

Girard, T. M., et al. 2011, ApJ, 142, 15

Robin, A. C., Reylé, C., Derrire, S. & Picaud, S. 2003, A&A, 409, 523