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K dwarf triples and quadruples in the SUPERWIDE catalog of 90,000 nearby wide binaries

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Abstract. The SUPERWIDE catalog is an all-sky catalog of ∼90,000 wide binaries with projected orbital separations ∼100 to 100,000 AU, mostly located within 500 pc of the Sun. These consist of common proper motion (CPM) pairs of high proper motion stars (> 40 mas/yr). A Bayesian analysis using positions, proper motions and distances from *Gaia* Data Release 2 (DR2) shows these pairs to have probabilities > 99% of being gravitationally bound systems. Here, we examine K+K wide binaries, which allow for easy identification of unresolved higher-order systems because the K dwarf main sequence is narrow and unresolved subsystems are easily identified as over-luminous. We found 980 systems where at least one of the wide components is over-luminous, which means they are higher-order systems (triples and quadruples). Although metallicity efffects generally complicate the identification of over-luminous stars, we show that this can be easily accounted for in wide binaries, making the identification of unresolved subsystems relatively straightforward. Taking these effects into account, we calculate the higher-order multiplicity fraction to be 39.6%.
Key words: stars: binaries – stars: low mass

1. Examining the over-luminosity of K+K wide binary components

Through a Bayesian analysis of *Gaia* Data Release 2 (*Gaia* Collaboration et al. 2018), we compile a catalog of ∼90,000 CPM pairs with >99% probabilities of being wide binaries. From this sample, we assemble a subset of 2,227 K+K wide binaries through a color cut $1.01 < G_{BP} - G_{RP} < 1.81$ and set a primary star distance limit $d < 250$ pc, with the primary star being the bluer component. An examination of the color-magnitude diagram shows a doubling of the main sequence in this region, representing the single star main sequence and the over-luminous branch of unresolved binaries. To better determine which stars are over-luminous, we define an arbitrary dividing line near the limit of the single/double loci, and define an "over-luminosity factor" for every component calculated relative to that line.

Because stars in wide binaries have correlated metallicities, a comparison of the over-luminosity factor of the primary and secondary components is used to identify the over-luminous components (i.e. unresolved binaries) as shown in Figure 1, which we call the "lobster diagram." True wide binaries, i.e. without unresolved subsystems, are represented by the linear concentration of points starting around −0.1, the "body" of the lobster. Pairs in the purple shaded region represent possible quadruple systems where both components are over-luminous. The pairs in the yellow shaded regions represent possible triple systems where only one of the components is over-luminous. Finally, the red dotted areas (the "claws") represent the areas where equal mass unresolved binaries should exist. With this analysis, we identify 1,343 true wide binaries, 449 pairs with an over-luminous primary, 339 pairs with an over-luminous secondary and 96 pairs where both components are over-luminous. From this, we calculate the higher order multiplicity fraction of K+K wide binaries to be 39.6%. If we only select pairs with projected physical separations larger than 10,000 AU, this value drops to 38.3%. This is significant because most predictions put the higher order multiplicity of these wide systems to be much larger, ∼70% (Law et al. 2010). However, our method probably underestimates the number of unresolved companions as it requires the tertiary to contribute enough light to cause the system to be over-luminous.

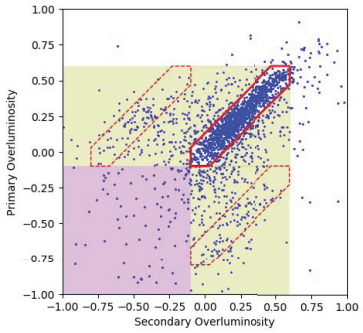

Figure 1. The "Lobster Diagram" showing the over-luminosity of the primary component plotted against the over-luminosity of the secondary component for the 2,227 K+K wide binaries.

References

Law N. M., Dhital S., Kraus A., Stassun K. G., West A. A., 2010, ApJ, 720, 1727

Gaia Collaboration, et al., 2018, A&A, 616, A1