Wide pre-main sequence binaries in the Orion OB1 association

Summary: We present a binarity study of 1137 stars from the CVSO catalog having K, M spectral types with 0.3 - 0.9 M\(_{\odot}\). Among the 1021 members of the Orion OB1 association we find 135 physical binary companions to these stars with mass ratios above ~0.13. The average companion fraction is 0.09%±0.01% over 1.2 decades in separation, slightly less than, but still consistent with, the field. We found a difference between the Ori OB1a and OB1b groups, the latter being richer in binaries by a factor of 1.6±0.3. No overall dependence of the wide-binary frequency on the observed underlying stellar density is found, although in the Ori OB1a off-cloud population, these binaries seem to avoid dense clusters.

Observations and data analysis: We use near-infrared images from the Orion VISTA mini-survey (ZYJHK photometry) and fit a symmetric Moffat profile to the stellar profiles of the 1021 targets and to additional stars within 7" of the target. The fitting procedure minimizes the residuals, then the residuals are visually inspected. A persistent asymmetry in the residual of multiple images of the same target indicates a real close companion (lower left in Figure 1), and the images are re-fitted with a close binary. A large number of close companions are detected this way (Figure 2).

Adding GaiaDR2: we cross-match all targets with GaiaDR2 and define astrometrically confirmed Orion OB1a/b members according to their parallax (1.5-4mas) and proper motions (< 5mas/yr). If the parallax and PM of companions also satisfy the membership criteria, the pair is considered real (physical). As expected, the brightness ratios of pairs at different bands correlate with being a physical pair or not (Figure 3), as does the separation (Figure 3).

Separation distribution: was derived for 98 physical companions (53/45 in 1a/1b) for separations 0.6"−19.2"

(Figure 4). Interestingly, in Ori OB1a the multiplicity is 11.2%±1.3%, while in contrast, in Ori OB1b we find 16.8%±2.2%, with a most pronounced difference at separation ~600AU. The difference is significant at only 1.8\(\sigma\) level, however. One might speculate that a different stellar birth density causes the observed difference. Orion OB1b would then originate from a more widespread population with only some sparsely clustered substructures.

For the combined sample the separation distribution is consistent with the field.

Mass ratios: are derived from the J-band flux ratios and plotted for astrometrically confirmed + possible companions (Figure 5). Mass ratios for Orion OB1a/b binaries are indistinguishable from those for wide field binaries (El-Badry et al.2019).

Reference: Tokovinin, Petr-Gotzens, & Briceño, AJ 160, 268 (2020)