Massive Stars Near and Far
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Binarity in Massive Young Stellar Objects

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Abstract. Most massive stars (up to 100%) are thought to be in binary systems. The multiplicity of massive stars seems to be intrinsically linked to their formation and evolution, and so Massive Young Stellar Objects are key in observing this early stage of star formation. We have surveyed hundreds of MYSOs across the Galaxy from the RMS catalogue, using UKIDSS and VVV point source data. Preliminary results show binary fractions of $44 \pm 3\%$ for the UKIDSS sample and $32 \pm 3\%$ for the VVV sample. In addition we use the K-band magnitudes as a proxy for the companion mass, and find a significant fraction of the detected companions have estimated mass ratios greater than 0.5, which suggests a deviation from the capture formation scenario.

Keywords. binaries: general, stars: formation, stars: massive, stars: pre-main-sequence.

1. Introduction

Massive Young Stellar Objects (MYSOs) represent a crucial stage of star formation, where mass accretion and stellar multiplicity can be investigated through observations. Up to 100% of massive stars ($> 8M_\odot$) are thought to form in binary or higher order systems (Duchêne & Kraus 2013, Chini et al. 2012). To understand the origin of binarity, massive stars must be studied during their formation stage. However there have been very few studies which have looked into MYSO binarity (Pomohaci et al. 2019, Koumpia et al. 2019; 2021). We are investigating a sample of MYSOs and their companions, to determine their binary statistics and mass ratios, using data from the UKIDSS & VVV infrared surveys. This work considers hundreds of objects from the RMS catalogue of MYSOs (Lumsden et al. 2013) and as such concerns the largest study into MYSO multiplicity to date.

2. Methods

The UKIDSS (Lucas et al. 2008) and VVV (Saito et al. 2012) point source catalogues were used to search for potential companions around MYSOs. We employed statistical methods to determine whether a nearby object was physically associated with the MYSO, based on its separation from the primary and the density of background stars. The further an object is from the primary, or the denser the background source distribution, the less likely the object is to be classified as a physical companion (e.g. Pomohaci et al. 2019). Objects above a certain threshold are judged to be chance projections and are disregarded. Also, multi-colour information from UKIDSS/VVV was used to determine the mass ratios of the companions.

3. Results

In the separation range of 0-4 arcsec (corresponding to typical separations between 1000-20000 au), we find binary fractions of $44 \pm 3\%$ for the UKIDSS sample and $32 \pm 3\%$

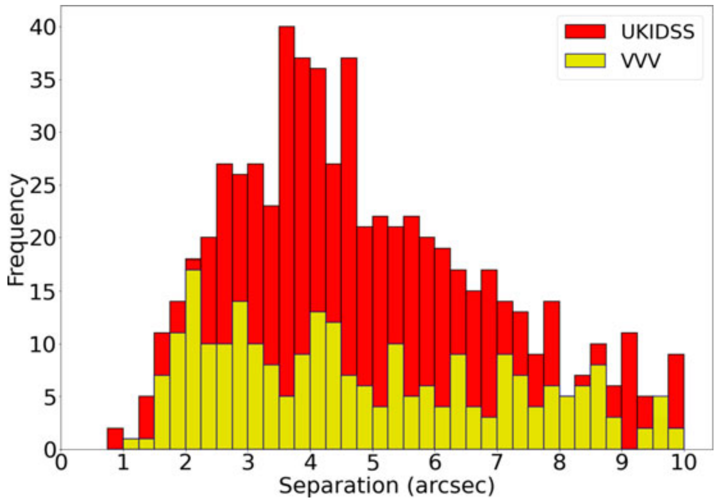

Figure 1. Histogram of object separation from its corresponding primary MYSO up to 10 arcsec. Only objects below the $P_{chance} < 20\%$ threshold (i.e. probable companions) are shown.

for the VVV sample. The larger UKIDSS fraction is due to variations in the galactic background density - lower densities increase companion likelihood, and so when excluding the low density region of the 'outer' galaxy (probed by UKIDSS but not VVV) the UKIDSS fraction is consistent with that of VVV. The separation distribution of the detected objects (up to 10 arcsec) can be seen in Figure 1. A large fraction of the mass ratios for the UKIDSS and VVV samples appear to be above 0.5.

4. Conclusions

The binary fractions found are larger than that of the MYSO binarity survey of Pomohaci et al. (2019), however when using the same separation distance and limiting magnitude, the statistics agree. The large fraction of mass ratios greater than 0.5 suggests a disagreement with the binary capture formation scenario, in which lower mass ratios are predicted (Salpeter 1955). As the binary fraction of massive stars is thought to be close to 100%, this study shows that 32% of them (in the VVV case) have observable companions at large separations. So far this work has focused on data from K-band imaging observations. Future work will involve using X-Shooter spectroscopy to identify close-in companions that cannot be resolved through imaging and help fill the gaps left by this work. Additionally, this spectra will be used to characterise the detected companions and study their environments.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1743921322001909.

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