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Identifying the ejected population from disintegrating multiple systems

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Abstract. Kinematic studies of the Hipparcos catalogue have revealed associations that are best explained as disintegrating multiple systems, presumably resulting from a dynamical encounter between single/multiple systems in the field. In this project we explore the possibility that known ultra cool dwarfs may be components of disintegrating multiple systems, and consider the implications for the properties of these objects. We show the results obtained by cross-matching Dwarf Archive, Hipparcos Main Catalogue and Gliese-Jahrei Catalogue. We will use these catalogues and place distance and proper motion constraints on objects with colour magnitude information, to identify candidate multiple systems. We will then try to search for additional fainter objects in these associations using the Two Micron All Sky Survey, the Sloan Digital Sky Survey, the United Kingdom Infrared Deep Sky Survey and the Wide-field Infrared Survey Explorer.

Key words. Ultra cool dwarfs – Disintegrating multiple systems

1. Introduction

The glare of the parent star can make studies of the orbital populations such as giant planets, brown dwarfs and very low-mass stars a challenge. To avoid this problem, we aim to identify systems where the orbital populations have been ejected dynamically.

A very high fraction of stars is in binary or multiple systems. The components of these binary systems interact gravitationally with each other and with other stars. This could lead the bonds between the binary components becoming gradually weaker, eventually causing the system to become unbound. Normally such interactions are relatively weak; binaries can interact weakly with other stars, particularly if they have a large cross-section for interaction i.e. if they are wide binaries. Nevertheless, there are some more severe interactions between binary-star or binary-binary systems and they can lead to a more violent break-up. In theory, this could be the cause of some of the disintegrating multiple systems seen in the Hipparcos Main Catalog (hereafter HMC, Li et al. 2009). Such interactions, as well as breaking up the binary components, might also release low-mass objects previously bound to one of the components. Such low-mass objects might include low-mass stars, brown dwarfs, or exoplanets.

We will use measured proper motions to test if our candidate multiple systems are disintegrating and to look for their ejected com-

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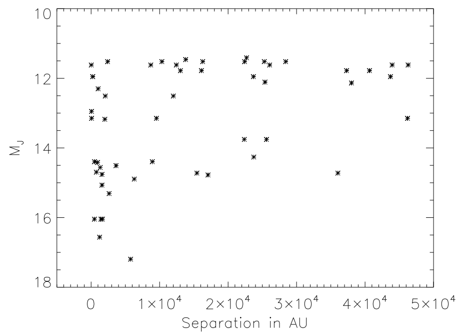

Fig. 1. The distribution of the absolute magnitudes of the brown dwarfs in our candidate systems (HMC-DA) plotted against the separation of the systems in AU. The uncertainty in the absolute magnitudes is 0.39 for the MKO system and 0.40 for the 2MASS system and arises from the Dupuy & Liu (2012) polynomial equation.

ponents. We will test our final results using Marchal's test (Li et al. 2009).

2. Goals and first results

We aim to find evidence of disintegrating multiple systems with cool nearby components. The next step will be to look for additional fainter objects using new surveys such as the United Kingdom Infrared Deep Sky Survey (UKIDSS; Lawrence et al. 2007), the Sloan Digital Sky Survey (SDSS; York et al. 2000), the Visible & Infrared Survey Telescope for Astronomy (VISTA; Emerson et al. 2004) and the Wide-field Infrared Survey Explorer (WISE; Wright et al. 2010). This method would also allow us to find new benchmark systems (e.g. Pinfield et al. 2012; Day-Jones et al. 2011). The three primary catalogues we are using are HMC, Gliese-Jahreiß Catalogue (hereafter GJC) and Dwarf Archive (hereafter DA). HMC and GJC were chosen because they contain bright nearby stars that would constitute ideal benchmarks systems. They also provide a good range of both spectral types and distance. The use of the DA is necessary as it is a catalogue of ultra cool dwarfs (UCDs) and it will allow us to check if some of the UCDs are being ejected.

First we will isolate groups containing multiple objects close to each other. Since the furthest separations of the wide binary systems are approximately 200 kAU (e.g. Caballero 2010; Caballero et al. 2006), then the stars would be so loosely bound together that gravitational interaction with other nearby objects could disrupt the system. We apply a more conservative distance constraint to objects within a group of 50 kAU to reduce the chance of contamination in the list of candidates.

The previous results will then be used to look for ultra cool members of new disintegrating multiples. To do this, we will need to cross match the main-sequence stars catalogues to look for possible multiple systems; then we will cross match them with the DA to find UCD associated with these systems.

We have cross matched HMC-GJC, HMC-HMC, GJC-GJC, DA-HMC and DA-GJC. For the cross matching between HMC-GJC however, some of the stars appeared on both catalogues. We have to scan the resulting pairs to pick out the duplicates by checking if their spectral types are the same and if their coordinates are too close to each other. In these contentious cases we used Super COSMOS Sky Survey and SIMBAD to pick these duplicates out by eye.

Then we cross match the DA with HMC and GJC. Many of the objects in the DA do not have a measured parallax. So to resolve this problem, we calculate the photometric distance using the polynomial equation from Dupuy & Liu (2012).

The cross matching between DA-HMC produced 53 possible candidate systems and DA-GJC a further 30 possible candidate systems. The results of our cross matching are summarized in Table 1. In Figure 1 we plot the separation distribution of our candidate systems against absolute magnitude; as expected fainter objects are found at shorter separation compared to brighter objects.

3. Future work and conclusions

We will be searching for additional fainter objects in these associations using surveys including UKIDSS, SDSS, VISTA and WISE.

Table 1. Numbers of candidate systems with multiples components.

Cross matched catalogues	Number of components	Number of candidate systems
HMC-GJC	2	1110
	3	14
	4	10
	5	0
	6	2
	7	1
HMC-HMC	2	10038
	3	1316
	4	174
	5	35
	6	9
	7	2
	8	4
GJC-GJC	2	489
	3	37
	4	4
	5	1

We will also be looking for new benchmark systems as well since we can use the main-sequence star to measure the parameters of the brown dwarf such as the age and metallicity, and then test the atmospheric models. It could also be used to test the formation theories for brown dwarfs and exoplanets (Stamatellos et al. 2012).

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