V: M dwarfs in multiple systems

M. Cortés-Contreras[6], J. A. Caballero[10], F. J. Alonso-Floriano[6], A. Klutsch[6], J. López-Santiago[6], D. Montes[6], R. Dorda[6], J. Alonso-Santiago[6], J. C. Morales[4], V. J. S. Béjar[8], A. Quirrenbach[3], P. J. Amado[2], R. Mundt[1], I. Ribas[4], A. Reiners[5] and the CARMENES Consortium[1,2,3,4,5,6,7,8,9,10,11]

[1]Max-Planck-Institut für Astronomie • [2]Instituto de Astrofísica de Andalucía • [3]Landessternwarte Königstuhl • [4]Institut de Ciències de l'Espai • [5]Institut für Astrophysik Göttingen • [6]**Universidad Complutense de Madrid** • [7]Thüringer Landessternwarte Tautenburg • [8]Instituto de Astrofísica de Canarias • [9]Hamburger Sternwarte • [10]Centro de Astrobiología • [11]Centro Astronómico Hispano-Alemán – Calar Alto Observatory

Our URL: **http://carmenes.caha.es/**

Abstract. With the help of CARMENCITA, the CARMENES Cool dwarf Information and daTa Archive (see SEA poster by Caballero et al.), we investigate the membership in double, triple or higher-order multiplicity systems of more than 1300 of the brightest, latest M dwarfs in the solar neighbourhood observable from Calar Alto. We use data compiled from the literature and measured by us. Angular separations range from a few tenths of arcseconds to several arcminutes, which translate into a very wide interval of projected physical separations. Studying M dwarfs in multiple systems provides information on a wealth of topics, e.g. from dynamical masses, through distance and metallicity, to the formation and evolution of weakly bound systems.

We have identified 282 M-dwarf multiple systems, some of which are companions to bright F, G, K stars and white dwarfs or lie in close binaries resolved only with adaptive optics or lucky imaging.

Angular separations (ρ) were measured for systems separated by over 5 arcsec. Closer angular separations were taken from the Washington Double Star catalogue or other sources. For those stars without parallax determination, we estimated spectro-photometric distances (d) from our own M_J-spectral type relation.

Projected physical separations (s) in the range from 0.5 to 55000 AU were computed with the equation $s = \rho\ d$. Only 55 systems have $s < 10$ AU and just seven have $s > 10000$ AU (Fig. 1).

Masses (M_1, M_2) of the components were estimated with the NextGen models from Baraffe et al. (1998, A&A 337, 403) assuming a typical age interval of $\tau \sim 1$–5 Gyr (Fig. 2).

Finally, gravitational potential energies ($U^*_g = -GM_1M_2/s$) and periods (P) were estimated from the total mass M_1+M_2 (Fig. 3).

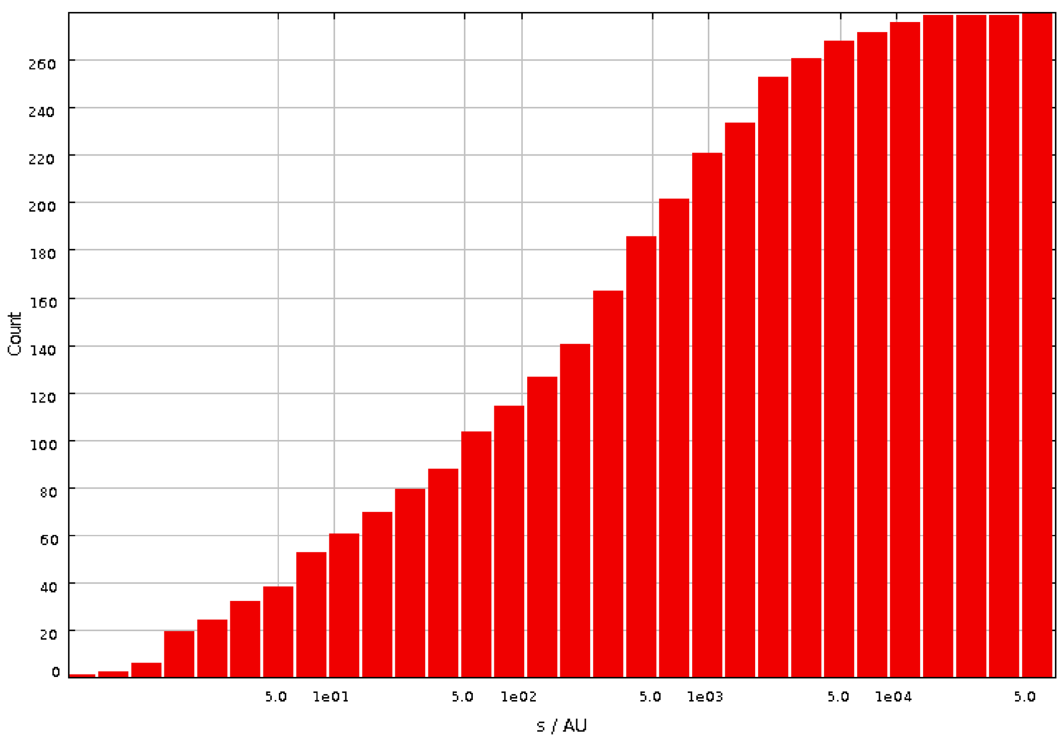

Fig. 1. Cumulative projected physical separations in logarithmic scale. The Öpik law predicts a linear trend from 1 to 10⁴ AU, which we fail to fit (see Poveda & Allen 2004, RMxAC 21, 49).

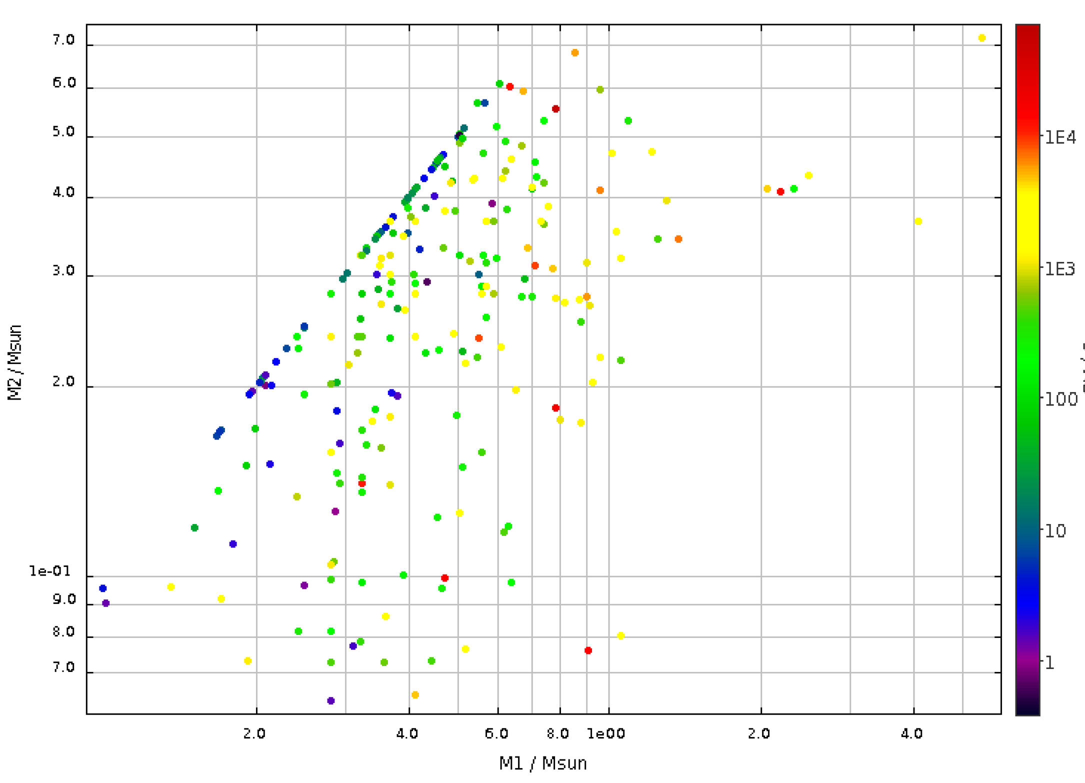

Fig. 2. Masses M_2 vs. M_1 in logarithmic scale. Colour bar indicates projected physical separations.

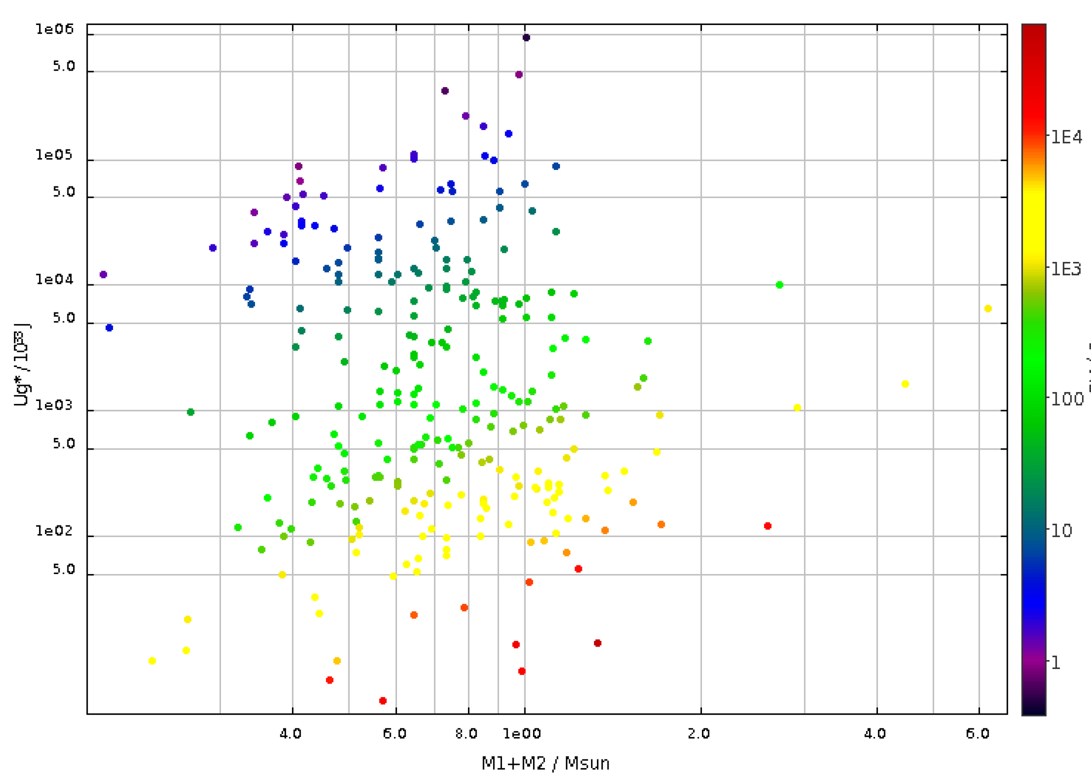

Fig. 3. Same as Fig. 2 but for binding energy ($-U^*_g$) vs. total mass (M_1+M_2). There is a U^*_g threshold at -10^{33} J.

Name	d (pc)	s (AU)	M_1 ($M_\odot$)	M_2 ($M_\odot$)	P (yr)
GJ 190	9.30	0.48	0.50	0.50	0.33
BD+27 1348	12.04	1.20	0.44	0.29	0.83
KX Lib BC (GJ 570 BC)	5.84	0.88	0.59	0.39	0.85
LP 823-4	12.50	0.84	0.21	0.20	1.20
HU Del	8.86	0.96	0.29	0.13	1.47
BD+68 946	4.53	1.28	0.40	0.40	1.62
BB Cap	8.30	1.66	0.29	0.16	1.93
Ross 28	13.90	1.10	0.25	0.10	2.02
Wolf 1062	10.20	1.51	0.38	0.19	2.47
G 67-53 AB	11.94	1.70	0.30	0.25	3.00
GJ 802 AabB	15.75	1.46	0.28	0.06	3.02
DG CVn	10.50	1.83	0.34	0.30	3.08
LP 122-59	9.22	1.50	0.21	0.21	3.19
Ross 54	16.02	1.76	0.45	0.40	3.60
GJ 623	8.01	1.70	0.31	0.04	3.74
G 78-28	18.38	2.19	0.37	0.20	4.18
GJ 1005	6.00	1.82	0.18	0.11	4.57
NLTT 33370	16.39	2.13	0.21	0.15	5.17
BF CVn+GJ 490 B LP 268-4	19.26	14700	0.91	0.08	1.8 x 10⁶
V368 Cep NLTT 56725	19.20	18500	0.78	0.18	2.6 x 10⁶
Ross 370 A G 246-30	14.40	16800	0.47	0.10	2.9 x 10⁶
V869 Mon GJ 282 C	14.21	55300	0.78	0.55	11.3 x 10⁶

Table 1. Basic parameters of the 18 systems with the shortest periods (in orange: our estimations) and the four systems with the lowest binding energies (in blue).

Results • A list of the close binary systems with the shortest orbital periods, useful for determining dynamical masses; six systems with periods $P \lesssim 5$ yr proposed here for follow-up (Table 1) • The most fragile systems containing M dwarfs, useful for study low-mass star formation and evolution of wide pairs in the Galactic field • A comprehensive catalogue of M dwarfs with solar-like primaries, useful for metallicity and kinematic analyses (see SEA poster by Alonso-Floriano et al.) • A study of triple, quadruple and even quintuple systems • Application of the Öpik law in pieces (i.e., in narrow s intervals)

Calar Alto