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Interferometric Imaging of Nearby Low–Mass Spectroscopic Binaries. II. ESO Observations

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ABSTRACT: We present a preliminary report on infrared interferometric observations, with emphasis on the resolved nearby sources Gl 563.4, Gl 570B and Gl 773.3. We briefly discuss their individual masses inferred from the combination of spectroscopic and visual data.

1. INTRODUCTION

A radial–velocity (RV) survey of red dwarfs (Mayor *et al.*, this Colloquium) has produced a list of new long–period binaries. When their estimated magnitude and separation are adequate, the very low–mass companion stars become candidates for direct detection by infrared interferometry that, combined with RV data, may yield the full set of orbital elements and therefore the masses.

We report here on the results for the southern sample of the candidate stars performed at ESO in Chile. We refer to those from KPNO (previous paper) for a more complete scientific rationale of this work aiming mainly at a better knowledge of the red end of the mass–luminosity relationship.

2. OBSERVATIONS

The observations were performed with the 1D scanning IR specklograph of the ESO 3.6-m telescope at La Silla, a common–user instrument (Perrier 1986) equipped with a single InSb detector and used for the last ten years for various scientific programs. The good calibration accuracy in infrared gives access to companions 4 to 5 mag fainter than their primary. With a typical magnitude limit of 7 at 2.2 μm and thanks to the M dwarfs high $[V-K]$, companions up to magnitude $V = 15$ can be detected close to the diffraction limit ($0''.14$ at 2.2 μm).

Sixteen nights spread over 4 observing runs were dedicated to interferometric imaging from June 1989 to March 1991 not including additional measures obtained with the first adaptive optics system ever used (Rigaut *et al.* 1991). Out of a preliminary list of more than 30 selected sources, more than half of the actually observed ones have been well resolved (see Table 1).

The data treatment is based on classical speckle methods producing the source visibility after telescope plus atmosphere mean MTF calibration with a reference (e.g., Perrier 1989). Theoretically, with at least two interferometric measures of the relative location of the secondary combined with the RV measures, one can completely solve for the orbital solution. To this aim, we used a maximum–likelihood–based algorithm yielding simultaneously all the orbital elements (Morbey 1975). For SB2 stars, the masses derive directly from these elements while the parallax is needed for solving the equations for SB1 stars.

TABLE 1. An overview of the characteristics of the present survey

Number of sources	26
Spectral types of primaries	dF5 – dM4
Background: CORAVEL orbits	
— well defined / ill defined	9 / 17
— range of orbital periods	1 – 16 yrs
— expected angular separations	0''.04 – 0''.52
— minimum secondary masses	0.03 – 0.50 $\mathcal{M}_{\odot}$
ESO preliminary results:	
— observed sources	17
— resolved / marginally resolved sources	8 / 4
— sources not resolved / not analyzed	2 / 3

3. PRELIMINARY RESULTS

Preliminary results of this study are given in Table 1, and some elements for three of the resolved binaries are listed in Table 2. We show the orbital motion for these stars in Figure 1 and Figure 2: the dots correspond to the calculated apparent position by phase steps of 0.01, open triangles to the ESO interferometric observations, the open square and P to the position of the primary and of the periastron respectively and the circle indicates the limit of instrumental resolution for binary stars.

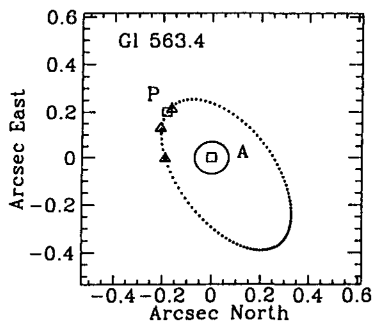

FIGURE 1. Orbital motion for Gl 563.4 (HD 130819).

Spectroscopic elements of Gl 563.4 and Gl 773.3 have been presented by Duquennoy & Mayor (1991). Gl 563.4 probably has a primary and a companion

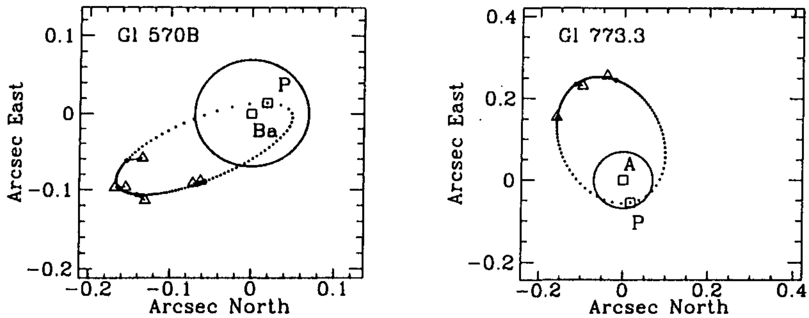

FIGURE 2. Orbital motion for: a. Gl 570B (HD 131976); b. Gl 773.3 (HD 189340).

respectively more and less massive than indicated as suggested by the absolute magnitudes. For Gl 570B, two new observations have been added to those of Mariotti *et al.* (1990), including one with adaptive optics (Mariotti & Perrier 1991); the accuracy of the inclination is now such that the errors on the masses are smaller than 0.03 $\mathcal{M}_\odot$; the new parallax is 0$''$.171. The derived masses for Gl 773.3 are affected by large errors coming from those on the inclination and the semi-major axis; for this reason the values in Table 2 rather derive from the total mass estimated from the absolute photometry of the components.

TABLE 2. Results for the three selected resolved binaries

Source	P(yrs)	a$''$	$M_K(1)$	$M_K(2)$	$\mathcal{M}_1/\mathcal{M}_\odot$	$\mathcal{M}_2/\mathcal{M}_\odot$
Gl 563.4	15.7	0.369	3.50	6.70	0.91	0.46
Gl 570B	0.85	0.146	5.29	6.43	0.51	0.36
Gl 773.3	4.67	0.168	3.40	4.60	1.38	0.33

With only a few spatial positions in most cases, the individual masses may occasionally be poorly constrained. A detailed discussion of the actual accuracy will appear in a forthcoming paper presenting all the results. Clearly further observations are required to reach the desirable accuracy in the mass estimation.

4. REFERENCES

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