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FIRST RESULTS OF THE OPTICAL SPECKLE INTERFEROMETRY WITH THE 3.5 m TELESCOPE AT CALAR ALTO (SPAIN): MEASUREMENTS AND ORBITS OF VISUAL BINARIES

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ABSTRACT

First results of the optical speckle interferometry carried out with the 3.5 m telescope of the Centro Astronómico Hispano-Alemán (CAHA, Almería, Spain) in 2005 July for visual binaries are presented. Fifty stars with separations between 0″.058 and 2″.1 were observed. Two new (COU 490 and A 2257) and six improved orbits along with their systemic masses are calculated. The obtained dynamical parallaxes in conjunction with the overview of spectral and photometric data allowed us to make the first rough distance estimates for COU 490 (145 pc) and A 2257 (210 pc). Total masses of pairs with both new and improved orbits are given, being generally concordant with their known spectral types and photometric data. We conclude that high-quality optical speckle data on binaries with separations close to its diffraction limit can routinely be obtained with the 3.5 m telescope.

Key words: astrometry – binaries: visual – stars: fundamental parameters

1. INTRODUCTION

It is well known that speckle interferometry is one of the most effective techniques for high-angular-resolution observations of binary stars. The high-quality astrometric information obtained at different wavelengths and close to the diffraction limit of the telescopes is of vital importance in the determination of orbits and dynamical parameters of binary and multiple stars. In turn, determination of accurate orbits in binary systems represents a direct and reliable method for obtaining dynamical masses of stars. The knowledge of masses provides insight into the binary formation mechanisms and improves our understanding of the astrophysics in these systems.

Using our optical ICCD speckle camera, we have performed several runs with the 1.52 m telescope of the Observatorio Astronómico Nacional located at the Centro Astronómico Hispano-Alemán (CAHA, Almería, Spain). Detailed reports on these campaigns can be found in Docobo et al. (2001, 2004, 2007). Furthermore, observational time has been requested with the 3.5 m telescope of CAHA, which would provide a theoretical resolution on an order of 0″.04 in optical wavelengths.

First speckle observations with the 3.5 m telescope in standard near-IR (NIR) photometric bands were performed more than 20 years ago (Leinert & Haas 1987). As regards binaries, important results on their studies have been obtained on the basis of NIR speckle data (Woitas et al. 2001, 2003 and references therein). On the other hand, due to a 2–4 times higher resolution at optical wavelengths, much closer pairs can be resolved with this telescope. Hence, optical speckle interferometry should provide data for closest pairs that cannot be resolved in the NIR bands. Besides this, a number of wider pairs at the critical points of the orbit such as periastron passage and/or minimal apparent separation can also be observed.

In the paper, the results of our first campaign of speckle interferometric observations of 50 double stars are presented. New orbits for COU 490 and A 2257 as well as improved ones for six other binaries are reported. Systemic masses for all pairs and first distance estimates for COU 490 and A 2257 are presented.

2. OBSERVATIONS

The speckle camera, observation techniques, and reduction procedure are similar to those of previous runs at CAHA extensively described in Docobo et al. (2001, 2004, 2007) except for the scale of 5″.89 mm^{-1} at the F/10 Cassegrain focus of the 3.5 m telescope, to which the camera was attached. Correspondingly, the total field of view was about 2″.5 and the pixel scale was about 0″.0046 pix^{-1}. The scale and detector orientation angle used to convert separation and position angle to their final values were 4.084 ± 0.036 mas pix^{-1} and $-1^{\circ}.16 \pm 0^{\circ}.41$ respectively. The observations were routinely performed using the 520/24 nm filter and 20× magnification of the microscope objective.

In contrast with previous runs, data reduction was accomplished by taking advantage of the data storage and computing services of the Supercomputing Center of Galicia (CESGA). With this aim, we have extensively used the Galician Virtual Supercomputer (SVG) system which comprises 200 Intel Pentium III/4 processors with a peak performance of 528 Gflops running under Linux OS. A large amount of processing time was saved, and we hope it can be further shortened in the future.

Calibration was done by observing binaries with high-quality orbits taken from the list of calibration stars (CS) catalog supplied with the 2005 version of the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf & Mason 2008). In addition, the detector orientation was checked by using star trails in right ascension. We could not use other calibration procedures because the telescope is not equipped with a slit mask. The use of an autocorrelation function introduces a 180° ambiguity in the position angle determination. As a rule, we overcame this by stipulating new measurements to be compatible with previously known data. We assigned relative weights to each astrometric observation based on the telescope aperture and observing technique. The weighting scheme described in Docobo & Ling (2003) and Mason et al. (1999) for visual and speckle data respectively was applied.

In all, astrometric data for 50 stars were obtained under good seeing conditions between 1″.1 and 1″.5. They are presented in

Table 1
Speckle Measurements

WDS	ADS	Name	2005.0+	θ (°)	σ_θ (°)	ρ (″)	σ_ρ (″)	CS[a]
13100+1732	8804	STF 1728 AB	0.5232	13.0	0.4	0.465	0.004	c
14138+3059		COU 606	0.5179	346.7:	3.0	0.162:	0.020	
14234+0827	9247	BU 1111 BC	0.5232	274.9	0.4	0.186	0.002	c
15136+3453	9547	HO 60	0.5179	76.2	0.4	0.146	0.001	
15232+3017	9617	STF 1937 AB	0.5178	115.0	0.4	0.507	0.005	c
15360+3948	9716	STT 298 AB	0.5204	172.8	0.4	0.888	0.008	c
15390+2545		COU 612	0.5233	187.5	0.4	0.286	0.003	
15420+4203		COU 1445	0.5152	203.6	0.5	0.084	0.001	
16044−1122	9909	STF 1998 AB	0.5205	343.0	0.4	0.725	0.006	c
16059+1041		HDS 2273 Aa	0.5232	191.1	0.4	0.451	0.004	
16079+1425	9931	A 1798	0.5180	356.6	0.4	0.179	0.002	
16198+2647	10007	A 225	0.5179	301.1	0.5	0.068	0.001	
16254+3724		CHR 55	0.5152	144.7	0.5	0.096	0.001	
16283−1613		RST 3950	0.5205	84.3	0.5	0.204	0.002	
16413+3136	10157	STF 2084	0.5151	222.5	0.6	0.919	0.008	c
16450+2928		COU 490	0.5206	313.7	0.5	0.140	0.002	
16584+3943		COU 1289	0.5153	265.5	0.6	0.087	0.002	
17005+0635		CHR 59	0.5206	238.6	0.4	0.162	0.002	
17080+3556	10360	HU 1176 AB	0.5206	55.3	0.4	0.078	0.001	
17240−0921		RST 3972	0.5234	51.8:	2.6	0.064:	0.012	
17304−0104	10598	STF 2173	0.5180	175.7	0.4	0.314	0.003	c
17563+0259	10899	A 2189	0.5235	250.7	0.5	0.074	0.001	
18035+4032		COU 1785	0.5154	348.6	0.6	0.069	0.001	
18044+0337	11033	A 2257	0.5181	27.6	0.5	0.148	0.002	
18086+1838	11098	HU 314	0.5235	81.0	0.4	0.276	0.003	
18301+0404	11399	CHR 72 Aa	0.5182	42.5:	0.6	0.103:	0.002	
18443+3940	11635 Cc	CHR 77 Cc	0.5155	224.5:	1.7	0.058:	0.001	
19266+2719	12447	STF 2525	0.5208	291.0	0.4	2.100	0.019	c
19394+2215	12752	STF 2556	0.5154	358.0	0.4	0.370	0.003	c
19411+1349		KUI 93	0.5183	313.9	0.4	0.187	0.002	
19553−0644	13104	STF 2597 AB	0.5209	102.8	0.4	0.526	0.005	c
20151+3742		COU 2416	0.5183	100.0	0.4	0.214	0.003	
20216+1930		COU 327 AB	0.5156	237.7	0.4	0.103	0.001	
20231+3342		COU 1949	0.5210	76.6:	1.3	0.209:	0.002	
20311+3333		COU 1962	0.5184	60.9	0.6	0.085	0.002	
20312+1116	13946	CHR 99 Aa	0.5237	137.2	0.4	0.397	0.004	
20325−1637	13961	SEE 512	0.5238	145.1	0.5	0.120	0.001	
20375+1436	14073	BU 151 AB	0.5156	1.3	0.4	0.573	0.005	c
20494+1124	14333	J 194 AB	0.5212	337.7	0.4	0.645	0.006	
21119+2524		COU 643	0.5157	102.1	0.6	0.222	0.003	
21145+1000	14773	STT 535 AB	0.5184	33.9	0.4	0.179	0.002	c
21435+4448	15264	HO 167 AB	0.5157	202.1	0.6	1.135	0.015	
21435+4448		LIN 1 Aa	0.5157	192.9:	1.1	0.183:	0.011	
21446+2539	15281	BU 989 AB	0.5239	240.4	0.4	0.105	0.001	c
21501+1717		COU 14	0.5159	327.8	0.4	0.148	0.001	
21597+4907	15530	HU 774	0.5158	174.6	0.4	0.198	0.002	
22281+1215	15962	BU 701 AB	0.5240	186.3	0.4	0.948	0.008	
22409+1433	16173	HO 296 AB	0.5213	117.1	0.4	0.141	0.001	c
23052−0742	16497	A 417 AB	0.5213	315.9	0.5	0.086	0.001	c
23529−0309		FIN 359	0.5241	45.4	0.4	0.091	0.001	

Note. [a] Calibration stars.

Table 1, where the first four columns list identifications from the Washington Double Star catalog (WDS; Mason et al. 2006), Aitken's catalog of double stars (ADS; Aitken & Doolittle 1932), the name of the couple and the epoch of observation in fractions of the Besselian year. The next columns give position angle θ and angular separation ρ with their corresponding errors, and the last column indicates the CS. A colon stands for uncertain measurements coinciding with a relatively large magnitude difference between components ($\geqslant$3 mag).

An overview of the data presented in Table 1 shows that a wide range of separations between 0.″058 and 2.″100 has been covered. However, seeing conditions were not good enough to reach diffraction-limited resolution, which we hope to achieve during further runs.

In general, the observations confirm that high-quality optical speckle interferometry data can be obtained with the 3.5 m telescope of CAHA. In view of the successful results, we intend to use this telescope for follow-up observations of close binary and multiple systems of special astrophysical interest.

3. ORBITS AND SYSTEMIC MASSES

For a number of stars, the measurements show a systematic departure of positions from those predicted by previous orbital

Table 2
Orbital Elements

Star	Orbital elements						
WDS	P (yr)	T	e	a ($''$)	i (°)	Ω (°)	ω (°)
14138+3059	25.91 ± 0.30	2010.57 ± 0.20	0.347 ± 0.015	0.183 ± 0.001	147.5 ± 1.5	48.3 ± 3.0	175.8 ± 4.0
16198+2647	43.34 ± 1.68	2005.90 ± 0.54	0.489 ± 0.038	0.129 ± 0.003	114.4 ± 1.0	117.5 ± 1.0	183.1 ± 2.3
16450+2928	100.1 ± 5.0	2007.34 ± 3.50	0.151 ± 0.006	0.218 ± 0.008	130.1 ± 1.5	1.7 ± 2.0	68.8 ± 11.2
17563+0259	154.5 ± 4.0	1976.35 ± 0.35	0.496 ± 0.014	0.218 ± 0.002	71.7 ± 1.0	153.3 ± 1.0	327.6 ± 2.0
18035+4032	45.72 ± 0.50	1995.00 ± 0.50	0.483 ± 0.003	0.135 ± 0.002	65.7 ± 1.0	52.8 ± 1.0	147.0 ± 3.0
18044+0337	333. ± 20.	1988.73 ± 0.06	0.829 ± 0.006	0.324 ± 0.015	73.5 ± 1.0	13.6 ± 1.0	274.3 ± 2.0
20151+3742	52.26 ± 5.00	1995.83 ± 0.10	0.432 ± 0.040	0.211 ± 0.008	36.9 ± 3.0	89.4 ± 1.0	255.7 ± 1.0
20216+1930	42.46 ± 1.00	1986.60 ± 0.10	0.577 ± 0.003	0.147 ± 0.002	85.0 ± 0.5	68.0 ± 0.5	303.0 ± 1.0

Table 3
Systemic Masses

WDS	m_1	m_2	Sp. type	π ($''$)	Systemic mass ($M_\odot$)
14138+3059	10.7	11.3	M0	0.01721 ± 0.00163[a]	1.8 ± 0.5
16198+2647	10.0	9.8	G5	0.00764 ± 0.00126[a]	2.6 ± 1.3
16450+2928	8.8	8.8	F2*	0.00694 ± 0.00010[b]	3.1 ± 0.5
17563+0259	8.5	8.8	A5*	0.00475 ± 0.00015[b]	4.1 ± 0.5
18035+4032	8.7	8.9	F5	0.00732 ± 0.00010[b]	3.0 ± 0.6
18044+0337	9.8	10.0	F2*	0.00473 ± 0.00020[b]	2.9 ± 0.6
20151+3742	8.0	8.5	F0	0.01069 ± 0.00030[b]	2.8 ± 0.7
20216+1930	9.1	9.1	F8	0.008 ± 0.002[c]	3.0 ± 0.7

Notes.
Apparent magnitudes and spectral types are taken from WDS except for spectral types (marked with an asterisk) taken from Wright et al. (2003) (see comments to individual objects in the text).
[a] *Hipparcos* parallax.
[b] Dynamical parallax.
[c] Estimated parallax.

solutions. The method of Docobo (1985) was used in orbital calculations. With the aim of better adjusting the orbits to the observations, we improved them for six binaries. Besides this, the first orbits for COU 490 and A 2257 were calculated. Orbital elements for these eight stars are given in Table 2, and orbits are graphically represented in Figure 1 where our latest 3.5 m measurements are enclosed in a circle.

All orbits were previously announced in the IAU Commission 26 Information Circulars No. 160, 161, and 162. It is worth noting that new measurements, used to calculate or to improve the orbits, are generally situated close to periastron, near the position of minimal apparent separation or scarcely observed parts of orbits. This shows that observations were carried out at critical points of their apparent orbit.

Systemic masses for all pairs with newly calculated or improved orbits are presented in Table 3, which also contains data on apparent visual brightness of the components and combined spectral type of each star. For the six improved orbits, the obtained masses do not significantly differ from previously known values in spite of sometimes sensible changes both in the semi-major axis and the period of orbit for a given star. The weighted root mean squares (rms) and absolute means (AM) of (O–C) residuals in θ and ρ are given in Table 4 both for the last known orbits and those reported in this paper in order to access numerically their characteristics. Finally, Table 5 contains ephemeris until 2018.

4. COMMENTS ON INDIVIDUAL STARS

We now present brief comments on stars with either newly calculated or improved orbits. The authors of orbit and IAU Commission 26 Information Circular (CI) number, where they were announced, are given.

4.1. COU 606 (WDS 14138+3059), Docobo & Ling (2006), CI 160

According to our 2005.518 measurement, the orbit of this pair of red dwarfs has a slightly larger period than that reported by Docobo & Ling (2003). At present, speckle observations already cover 75% of orbit and show that a big part of visual observations located in the first quadrant have possibly too small separations. The dynamical parallax of $0\farcs0183$ obtained by application of Baize–Romani's method (hereinafter BRM, Baize & Romani 1946; Heintz 1978, p. 62) lies within the 1σ margin of the *Hipparcos* value.

4.2. A 225 (WDS 16198+2647), Andrade (2006), CI 160

This binary system, with apparent magnitudes of 10.04 and 9.79, was first resolved in 1901 by Aitken (1902). Although it has already completed about two revolutions since its discovery, until recently the set of available measurements from 1901 to 1991 covered an orbital arc of only 50°. During our observational run, we obtained a new measurement placed at the opposite side of orbit and very close to the periastron.

The previous orbit was calculated by Heintz (1982), who obtained a period of 44.0 yr, a semi-major axis of $0\farcs113$, and an eccentricity of 0.64. Our measurement gives residuals of $-5\fdg3$ and $0\farcs030$ in position angle and angular separation, respectively. Using our near-periastron measurement, a new, less eccentric orbit (see Table 2), was calculated.

Dynamical parallax of $0\farcs00787$ and component masses of 1.14 $M_\odot$ and 1.21 $M_\odot$ are obtained by using BRM. In good agreement with these results, the parallax $0\farcs00764 \pm 0\farcs00126$ measured by *Hipparcos* leads to a semi-major axis of 16.9 ± 2.9 AU and a total mass of 2.6 ± 1.3 $M_\odot$ (95.7% of uncertainty is caused by the large uncertainty of the *Hipparcos* parallax). According to Heintz (1982), who obtained the same mean value, the computed dynamical mass suggests an evolved pair.

4.3. COU 490 (WDS 16450+2928), Docobo & Tamazian (2007), CI 161

The apparent brightness of 8.8 mag and spectral type F5 for either component of this star in the catalog of Couteau (1999) is reported. While not included in the *Hipparcos* main catalog (ESA 1997), COU 490 appears in the Tycho-2 Spectral Type Catalog (Wright et al. 2003) with almost the same brightness $V = 8.66$ and $B - V = 0.40$ mag. At the same time, infrared colors $J - H = 0.16$ and $H - K = 0.03$ mag taken from the Two Micron All Sky Survey (2MASS Catalog; Cutri et al. 2003) suggest a somewhat earlier spectral type F0–F2V when

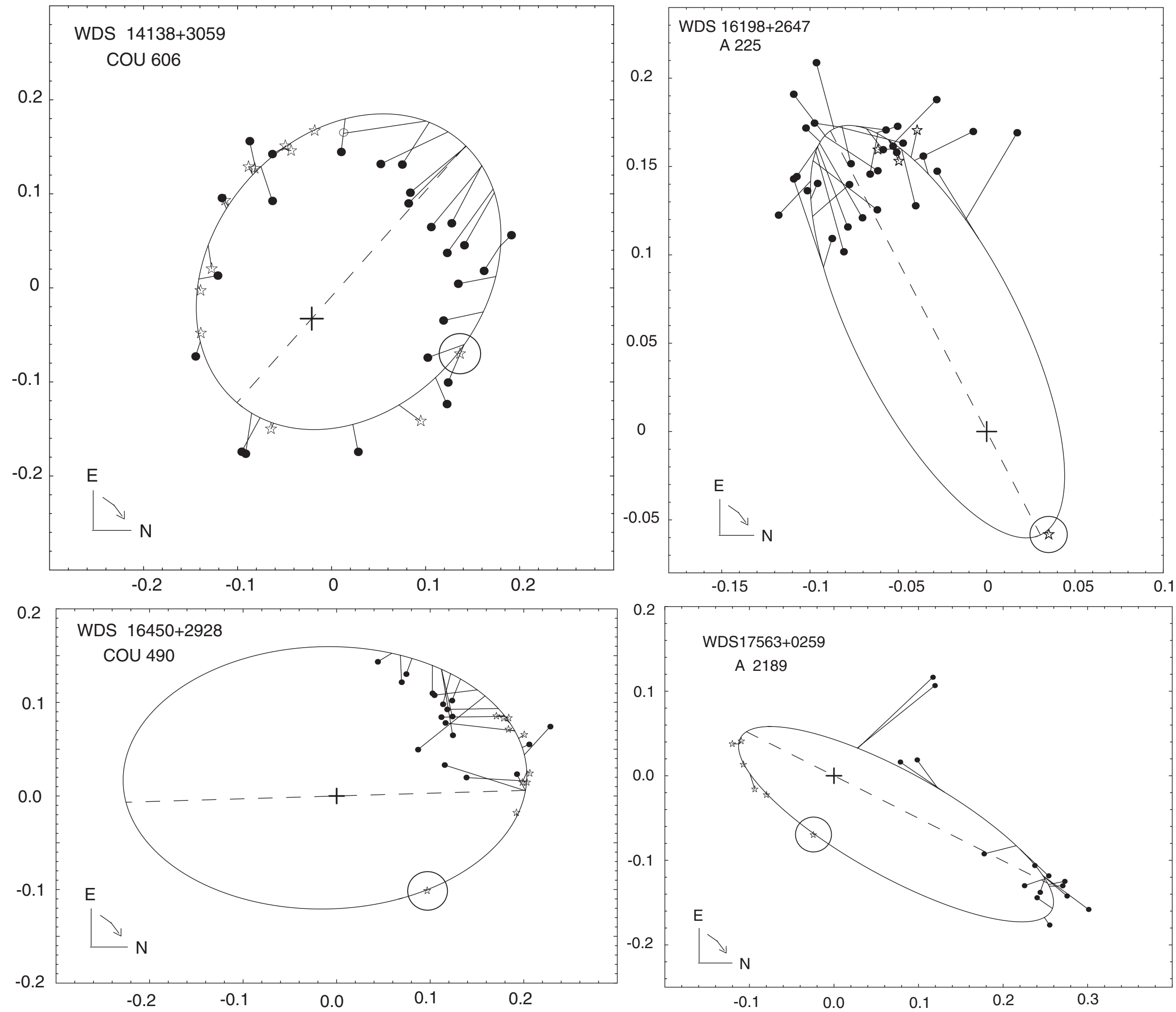

Figure 1. Apparent orbits of stars (the scale on both axes is in arcseconds). Each measurement is connected to its predicted position by an O–C line. The dashed line passing through the primary star is the line of nodes. The points and stars represent visual and speckle measurements respectively, and the arrow shows the direction of orbital motion. Latest measurements presented in this paper are enclosed in circles.

compared with standard colors of stars on the main sequence (Bessell & Brett 1988; Ducati et al. 2001).

Adopting an F2V spectral type and hence a luminosity $M = +3.0$ (Gray 2005, p. 506), we obtain a rough estimate for its spectroscopic distance equal to 145 pc (or parallax $\pi = 0\farcs00692$). By a direct application of Kepler's third law, a total mass of the system $\sim 3.12\,M_\odot$ is then being obtained, in a good accordance with the standard mass of a F2 dwarf ($1.56\,M_\odot$, Gray 2005, p. 506).

Notably, the application of BRM to this pair leads to dynamical parallax of $0\farcs00694$ (144 pc) and total mass of $3.1\,M_\odot$. Therefore, an approximate distance of 145 pc is a robust and reliable estimate for COU 490.

Due to a large dispersion of visual observations, more speckle measurements are needed in order to obtain a more reliable orbit. Our measurement contributes to this objective, being separated from previous ones by a large arc of more than 40°.

4.4. A 2189 (WDS 17563+0259), Docobo & Tamazian (2006), CI 160

The combined spectral type of this star is A5 IV/V (Wright et al. 2003), and the component brightnesses are 8.5 and 8.8 mag (Mason et al. 2006). The *Hipparcos* parallax is poorly determined ($0\farcs00367 \pm 0\farcs00112$), and its application to our orbit leads to a total mass of $8.8 \pm 8.1\,M_\odot$. Apart from having a very large relative error, such a mass is unacceptably large for a couple of A dwarfs. By applying BRM, we obtain dynamical parallax $0\farcs00475 \pm 0\farcs0005$ and reasonable masses for its components of $2.1\,M_\odot$ and $2.0\,M_\odot$, in good agreement with standard calibration (Gray 2005, p. 506).

Thus, we suggest the use of dynamical parallax as a more reliable distance estimate for this star (~220 pc). Note that six speckle measurements of this system allowed us to adjust the orbit after the periastron passage. Two visual measurements at epochs 1967.42 and 1967.47 were not taken into account in

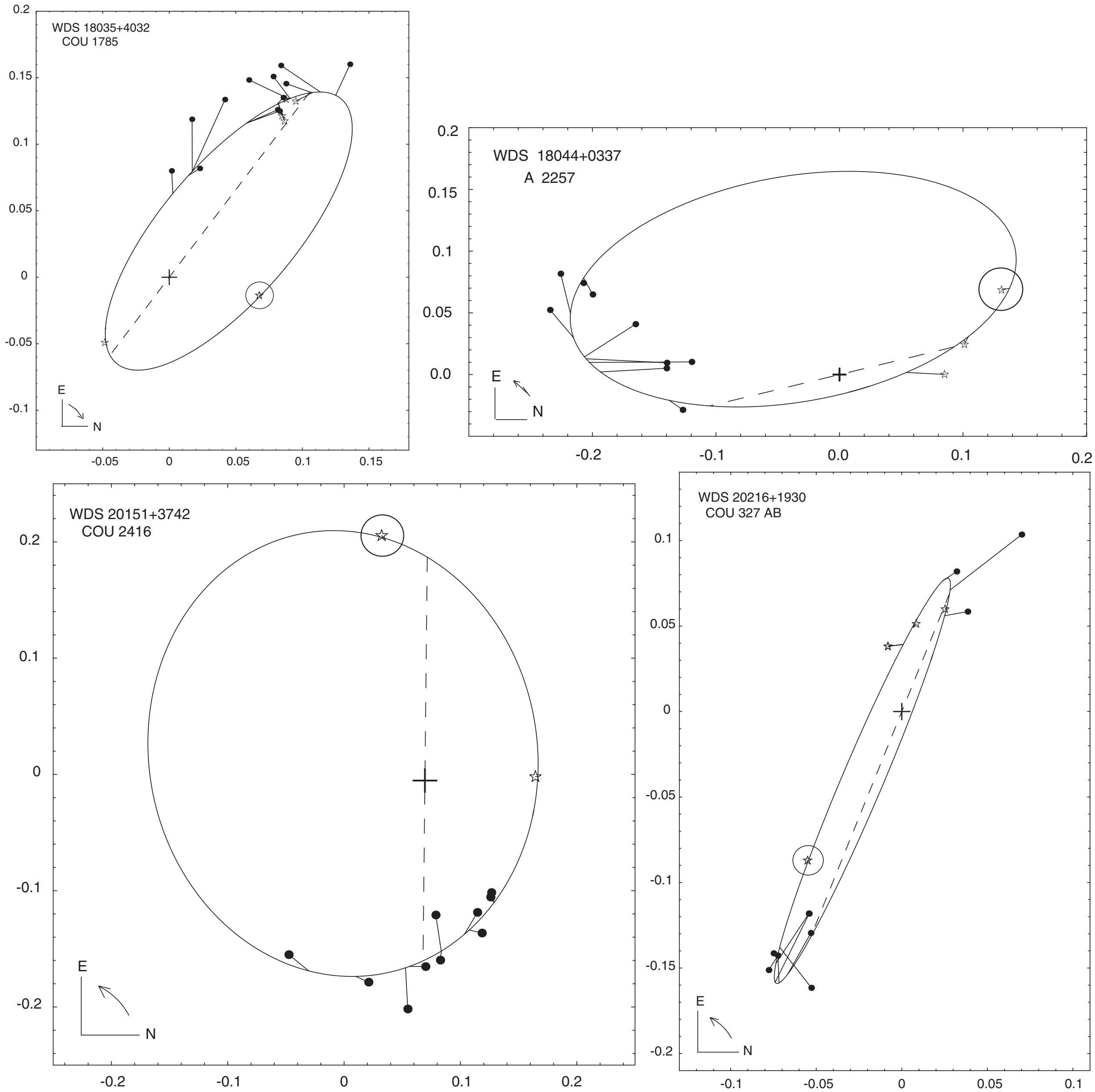

Figure 1. (Continued)

orbital or in rms and absolute means computation since they give residuals in ρ of 0″.122 and 0″.117, respectively. The previous orbit of Docobo & Costa (1991) gives almost equal values.

4.5. COU 1785 (WDS 18035+4032), Docobo & Ling (2007a), CI 161

Our 2005.515 measurement and that obtained at 1995.611 by Hartkopf et al. (1997) comprise the part of orbit where no speckle measurements have yet been performed. Therefore, a much more reliable orbit can be computed due to these measurements. The rms of $(O\text{–}C)$ residuals both in ρ and θ are significantly improved (see Table 4) in comparison with the previous solution (Docobo & Ling 2003).

There is no *Hipparcos* parallax for this star, and the systemic mass of 3.0 $M_{\odot}$ obtained on the basis of its dynamical parallax (0″.00732) is consistent with a pair of F5 type dwarfs. A parallax of 0″.01660 ± 0″.00569 is given in the catalog of Kharchenko (2001). This value leads to a total mass of 0.26 $M_{\odot}$, which is completely unrealistic for such spectral types.

4.6. A 2257 (WDS 18044+0337), Docobo & Tamazian (2007), CI 161

This star is not included in the *Hipparcos* main catalog. The WDS catalog gives brightness 9.8 mag and 10.0 mag for its main and secondary components respectively, and combined spectral type F5, whereas the Tycho-2 Spectral Type Catalog (Wright et al. 2003) assigns the F2/3 spectral type and $B - V = 0.425$ mag to this star. Infrared colors $J - H = 0.19$ and $H - K = 0.02$ mag taken from the 2MASS (Cutri et al. 2003)

Table 4
Statistical Results

WDS	Authors	rms		AM	
		$\Delta\theta$ (°)	$\Delta\rho$ (″)	$\Delta\theta$ (°)	$\Delta\rho$ (″)
14138+3059	Docobo & Ling; this paper	3.0	0.021	1.4	0.011
	Docobo & Ling (2003)	8.2	0.016	3.8	0.014
	Ling (1992)	8.1	0.018	3.9	0.016
16198+2647	Andrade; this paper	3.0	0.021	1.4	0.011
	Heintz (1982)	8.2	0.016	3.8	0.014
16450+2928	Docobo & Tamazian; this paper	3.7	0.016	1.9	0.008
17563+0259	Docobo & Tamazian; this paper	4.8	0.011	2.9	0.005
	Docobo & Costa (1991)	5.6	0.011	3.7	0.006
18035+4032	Docobo & Ling; this paper	3.6	0.012	2.7	0.008
	Docobo & Ling (2003)	18.1	0.022	8.1	0.013
	Docobo & Ling (2002)	14.7	0.015	7.4	0.012
	Couteau (1999)	13.3	0.019	9.3	0.016
18044+0337	Docobo & Tamazian; this paper	2.8	0.029	2.0	0.021
20151+3742	Docobo & Ling; this paper	2.6	0.013	1.6	0.008
	Docobo & Ling (2003)	10.7	0.016	6.7	0.011
	Mante (1999)	14.4	0.046	10.5	0.033
	Couteau (1999)	31.6	0.024	17.8	0.017
20216+1930	Docobo & Ling; this paper	6.0	0.023	4.3	0.017
	Docobo & Ling (2003)	6.2	0.021	4.6	0.015
	Docobo & Ling (2000)	5.8	0.030	4.4	0.025
	Tokovinin (1994)	6.0	0.032	4.9	0.025

Table 5
Ephemerides

Epoch/WDS	14138+3059		16198+2647		16450+2928		17563+0259		18035+4032		18044+0337		20151+3742		20216+1930	
	θ	ρ	θ	ρ	θ	ρ	θ	ρ	θ	ρ	θ	ρ	θ	ρ	θ	ρ
2008.0	298.7	0.123	266.0	0.050	298.4	0.127	264.4	0.080	8.5	0.094	27.7	0.157	110.8	0.230	240.5	0.129
2009.0	273.1	0.118	240.9	0.041	291.5	0.124	268.9	0.084	13.8	0.104	28.4	0.159	114.9	0.235	241.2	0.138
2010.0	246.7	0.119	208.4	0.039	284.2	0.121	273.0	0.088	18.2	0.114	29.1	0.161	118.8	0.240	241.9	0.146
2011.0	220.8	0.120	181.1	0.048	276.7	0.120	276.7	0.092	21.9	0.123	29.8	0.163	122.6	0.243	242.5	0.153
2012.0	195.4	0.121	164.0	0.062	269.2	0.121	280.1	0.097	25.0	0.133	30.5	0.165	126.3	0.246	243.0	0.159
2013.0	170.7	0.124	153.4	0.077	261.8	0.122	283.1	0.102	27.8	0.141	31.1	0.166	129.9	0.248	243.5	0.165
2014.0	148.3	0.133	146.6	0.092	254.6	0.125	285.9	0.107	30.2	0.149	31.8	0.168	133.5	0.250	244.0	0.169
2015.0	129.3	0.147	141.4	0.107	247.9	0.129	288.4	0.112	32.4	0.157	32.4	0.169	137.0	0.251	244.4	0.172
2016.0	113.9	0.163	137.5	0.120	241.5	0.134	290.7	0.118	34.5	0.163	33.0	0.171	140.5	0.251	244.8	0.174
2017.0	101.4	0.181	134.4	0.133	235.7	0.139	292.8	0.123	36.3	0.169	33.7	0.172	144.0	0.251	245.3	0.175
2018.0	91.1	0.197	131.8	0.144	230.3	0.145	294.7	0.128	38.1	0.174	34.3	0.173	147.5	0.251	245.7	0.174

Note. Position angles and angular separations are given in degrees and arcseconds respectively.

are fully concordant with standard values for F2 dwarfs (Bessell & Brett 1988; Ducati et al. 2001).

The application of BRM (assuming combined spectral type F2V) leads to dynamical parallax $\pi_{\rm dyn} = 0\rlap{.}''00473$ (distance 210 pc) and a dynamical mass of 2.9 $M_\odot$. Thus, by its physical characteristics the components of A 2257 are similar to those of COU 490 which is situated at somewhat lesser distance. More speckle measurements are needed in the future to better define the part of the orbit close to periastron.

4.7. COU 2416 (WDS 20151+3742), Docobo & Ling (2007b), CI 162

Our new 2005.518 observation demonstrates that, at this epoch, the secondary companion is situated at the position opposite to the first visual measurements. Along with the speckle measurement of Hartkopf et al. (2000) at 1996.699, this allowed us to improve significantly the previous solution (Docobo & Ling 2003).

4.8. COU 327 AB (WDS 20216+1930), Docobo & Ling (2007a), CI 161

Taking into account its spectral type, the most probable mass of this triple system is $3.3 \pm 0.7\, M_\odot$ (component A is itself a single-lined spectroscopic binary). Presented in this paper, the orbit based on our latest speckle measurement at epoch 2005.516 improves on the previous one (Docobo & Ling 2003). Yet it suggests that parallax of this star should be slightly larger (possibly about $0\rlap{.}''008$) than that measured by *Hipparcos* ($0\rlap{.}''00455$), unless another star exists in this system.

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