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Speckle observations with PISCO in Merate – I. Astrometric measurements of visual binaries in 2004

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ABSTRACT

We present relative astrometric measurements of visual binaries made with the Pupil Interferometry Speckle camera and Coronagraph (PISCO) at the 1-m Zeiss telescope of Brera Astronomical Observatory, in Merate. We provide 135 new observations of 103 objects, with angular separations in the range 0.1–4.0 arcsec and with an accuracy better than ∼0.01 arcsec. Our sample is made of orbital couples as well as binaries whose motion is still uncertain. Our purpose is to improve the accuracy of the orbits and constrain the masses of the components.

This work already leads to the revision of the orbits of three systems (ADS 5447, 8035 and 8739).

Key words: techniques: interferometric – astrometry – binaries: close – binaries: visual.

1 INTRODUCTION

Since its beginning in the early 1970s, speckle interferometry has shown its ability in providing accurate measurements of binary stars. In 1993–1998, we undertook an extensive observational programme of close visual binaries with the Pupil Interferometry Speckle camera and Coronagraph (PISCO) with the 2-m Télescope Bernard Lyot (TBL) at the Pic du Midi Observatory, which lead to a series of papers (Aristidi et al. 1997b; Aristidi et al. 1999; Scardia et al. 2000a,b; Prieur et al. 2001, 2002a,b, 2003). Unfortunately, as a result of a change of scientific policy of the time allocation committee, the use of PISCO on the TBL stopped in 1998. The following years were dedicated to the processing of the observational data and the publication of the results. We also tried and eventually found a telescope on which PISCO could be mounted. The INAF–Osservatorio Astronomico di Brera (OAB, Brera Astronomical Observatory) kindly offered us the possibility of using its 1-m Zeiss telescope for that purpose. We report here on the results of the first observations performed at this site, during the first semester of 2004.

This paper is then the first of a series that will be devoted to the speckle measurements of visual binaries with the 1-m Zeiss telescope of the OAB. In Section 2, we present our sample of the binaries that are going to be monitored in the next few years with PISCO in Merate. We describe the instrumental set-up, the observations and the reduction procedure in Section 3. The astrometric measurements are given in Section 4 with a detailed discussion of some particular cases. Finally, in Section 5 we provide new orbital parameters of ADS 5447, 8035 and 8739, partly derived from those observations, and give some estimates of the component masses.

2 DESCRIPTION OF THE SAMPLE

The purpose of this work is to observe all the visual binaries (orbital or not) accessible with PISCO on the Zeiss telescope in Merate, equipped with an intensified CCD (ICCD) detector. Our sample thus consists of visual binaries with the following characteristics:

(i) declination larger than $-5°$;
(ii) brighter than 9th magnitude in V;
(iii) with a magnitude difference between the components smaller than 4;
(iv) with an angular separation smaller than 4.0 arcsec.

The orbital couples whose orbits were recent and of good quality were used for calibrating the scale and orientation of our data (see Section 3.2).

3 OBSERVATIONS AND DATA REDUCTION

3.1 Observations

This work is based on observations made with the old, but still valid, Cassegrain Zeiss telescope (diameter, D = 102 cm; equivalent focal length, F = 16 m) of the Merate branch of the OAB. When it was installed in Merate in 1926, it was one of the biggest telescopes in Europe (Giotti 1929). Since then, it has continuously been used for observations of astrometry, spectroscopy or photometry by astronomers of the OAB.

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Table 1. Filter characteristics.

Name	Central wavelength (nm)	Bandwidth (nm)
V	530	57
R	644	70

Our observations were carried out with the PISCO speckle camera developed at the Midi-Pyrénées Observatory (Prieur et al. 1998). PISCO is a remotely controlled versatile instrument whose observing modes (e.g. imaging or spectroscopy) can be configured in real time. For this programme, PISCO was used in its full pupil imaging mode. The atmospheric chromatic dispersion was corrected in real time with computer controlled Risley prisms. Note that some of the observations made before March 2004, were not well corrected, as a result of a bad tuning of the control program. In this case, the autocorrelation peaks were elongated, which degraded the accuracy of the measurements.

PISCO can make use of various detectors, as described in Prieur et al. (1998). The observations presented here were performed with the ICCD (with a microchannel plate) belonging to Nice University. The characteristics of the filters are given in Table 1.

3.2 Data reduction and calibration

The video data produced by the ICCD are stored as frames on Super VHS (SVHS) tapes with a rate of 50 frames s^{-1}. The exposure time of those elementary frames can take any value between 64 μs and 16 ms, but the time interval between two successive frames is fixed (20 ms). Note that this detector cannot work in genuine photon counting mode and does not provide the coordinates of individual photo-events.

A specially designed program (by JLP), can control a videotape recorder and a digitizing board, thus allowing fully automatic processing of these tapes (Prieur et al. 2001). The first step of the data reduction consists of computing the autocorrelation of the elementary frames, using the method described by Worden et al. (1977). The mean cross-correlation of two frames separated by a delay larger than the coherence time is subtracted from the mean autocorrelation of the elementary frames. This procedure allows the removal of the background of the mean autocorrelation and nicely increases the contrast of the secondary peaks of binary stars. Astrometry parameters are then derived from this autocorrelation, by carefully measuring the location of the secondary peaks, following the procedure described in Prieur et al. (2001).

The orientation and the magnification of the frames were determined from the ephemerides of the objects with valid orbits, i.e. orbits whose ephemerides are in good agreement with the observations made in the last years. We only discarded the most aberrant points and the measurements obtained with difficulty (e.g. when the fringes of the power spectrum were diffuse). The selected measurements are listed in Table 2 with the mention C (for calibrator) in the notes column. The corresponding residuals are displayed in Fig. 1.

Two eyepieces, of focal length equal to 10 and 20 mm, were used for controlling the last magnification stage of PISCO (this is indicated with 10 or 20 in the notes column of Table 2). The corresponding calibrated scale values for the angular separation ρ were 0.03183 ± 0.00012 arcsec $pixel^{-1}$ (with 32 measurements) and 0.07438 ± 0.00021s arcsec $pixel^{-1}$ (with 22 measurements) for the 10- and 20-mm eyepieces, respectively. The uncertainty for the position angle θ was found to be $\pm 0\overset{\circ}{.}13$ (with 54 measurements). Those uncertainties were included in the error budget of ρ and θ, displayed in columns 7 and 9 of Table 2.

We also checked the validity of this calibration with the binaries proposed by the US Naval Observatory as standards (Hartkopf & Mason 2004) that are included in this sample, namely ADS 1615, 6650 AB, 7203, 8119, 8539, 8575, 8804, 8987 and 9167. The corresponding scale values, as determined with those objects only, would be 0.03224 ± 0.00039 arcsec $pixel^{-1}$ (with three measurements) and 0.07422 ± 0.00033 arcsec $pixel^{-1}$ (with six measurements), for the 10- and 20-mm eyepieces, respectively. Those values are thus compatible with the values obtained with the larger sample of valid orbits, which is the calibration we shall use in this paper. For the future, we plan to determine the scale with a slit mask placed at the top of the telescope: the measurement of the separation of the fringes produced by the two slits of this mask will allow an absolute scale determination.

Let us remind the reader that the diffraction limit λ/D of a telescope with a diameter $D = 1$ m is 0.11 arcsec for $\lambda = 550$ nm. A pattern whose size is the diffraction limit, is therefore sampled on 2.9 and 1.5 pixels with the 10- and 20-mm eyepieces, respectively.

The variations of the focal length of the Cassegrain Zeiss telescope, caused by the temperature changes between summer and winter periods, are negligible, i.e. smaller than the calibration errors. This constancy was checked both experimentally (no variation was detected between summer and winter) and theoretically. For this, we have used the ZEMAX software of the GOLEM (Gruppo ottica e lenti Merate, Optical Laboratory of Merate) and introduced all the available data. When the temperature increases from 0° to 25°C, the resulting Cassegrain focal length increases by 3 mm only. This variation represents less than 0.02 per cent of the nominal focal length ($F = 16222.4$ mm) and is negligible compared with our calibration errors (0.3 and 0.6 per cent for 10 and 20 mm, respectively).

4 ASTROMETRIC MEASUREMENTS

The astrometric measurements are displayed in Table 2. The designation is given in the first three columns: the Washington Double Star catalogue name (WDS, http://ad.usno.navy.mil/wds/wds.html) in column 1, the official double star designation in column 2 (sequence is discoverer number) and the ADS number in column 3 (Aitken 1932). For each observing sequence, we give the epoch of observation (column 4) in a fraction of Besselian years (2004+), the filter (column 5) whose characteristics are listed in Table 1, the angular separation ρ (column 6) and its error (column 7) in arcseconds, and the position angle θ (column 8) and its error (column 9) in degrees. The errors were estimated by adding quadratically the calibration errors (see Section 3.2) to the standard deviation of a series (from 4 to 8) of independent measurements obtained with the same data set (see Prieur et al. 2001). This procedure generally leads to good error estimates, but can underestimate the errors on θ in the case of very diffuse fringes (see Section 4.1).

The position angle follows the standard convention: it is measured relative to the north direction and increasing in the direction of increasing right ascension (i.e. eastwards). This angle was measured on the autocorrelation function, which leaves a 180° ambiguity. When the signal-to-noise ratio was good enough, the restricted triple-correlation technique described in Aristidi et al. (1997a) allowed us to remove this ambiguity and determine the quadrant where the companion was. This is noted with a Q in the notes column of Table 2.

Table 2. Measurements. See text for explanation of the 'Notes' column.

WDS	Name	ADS	2004+	F	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes
00318+5431	STT 12	434	0.051	V	0.334	0.006	198.4	1.8	orb.,10
			0.051	R	0.339	0.005	199.6	1.5	orb.,10
01095+4715	STT 515 AB	940	0.079	V	0.511	0.008	212.0	0.4	orb.,10,C
			0.079	V	0.510	0.004	212.6	0.3	orb.,10,C
			0.082	V	0.507	0.005	213.9	0.6	orb.,10,Q,C
			0.082	V	0.513	0.009	213.2	0.6	orb.,10,Q,C
01559+0151	STF 186	1538	0.101	V	0.944	0.007	63.7	0.4	orb.,10,C
			0.112	V	0.955	0.007	62.8	0.4	orb.,10,C
02020+0246	STF 202 AB	1615	0.101	V	1.815	0.004	270.6	0.4	orb.,20,C
			0.112	V	1.825	0.013	270.4	0.3	orb.,20,C
02140+4729	STF 228	1709	0.082	V	0.938	0.004	105.8	0.3	orb.,10,Q,C
			0.093	V	0.943	0.005	105.8	0.3	orb.,10,Q,C
02537+3820	BU 524 AB	2200	0.095	V	–	–	–	–	NF,10
			0.101	V	0.219	0.029	343.2	3.6	orb.,10,C
02589+2137	BU 525	2253	0.095	V	–	–	–	–	orb.,10
03054+2515	STF 346 AB	2336	0.093	V	0.383	0.009	252.0	1.5	orb.,10
			0.098	V	0.391	0.005	251.9	1.2	orb.,10
			0.101	V	0.390	0.006	251.3	0.6	orb.,10
03175+6540	STT 52 AB	2436	0.082	V	0.487	0.004	61.1	0.3	orb.,10
			0.093	V	0.499	0.010	61.2	0.6	orb.,10
03344+2428	STF 412 AB	2616	0.027	R	0.702	0.004	356.1	0.3	orb.,10,C
			0.027	V	0.702	0.004	355.7	0.5	orb.,10,C
			0.093	V	0.709	0.003	355.9	0.6	orb.,10,C
			0.095	V	0.708	0.006	355.5	0.6	orb.,10,C
			0.101	V	0.714	0.004	356.1	0.3	orb.,10,C
			0.112	V	0.709	0.006	355.9	0.6	orb.,10,C
04239+0928	HU 304	3182	0.082	V	0.208	0.014	8.1	0.9	orb.,10,C
			0.095	V	0.207	0.011	8.2	0.4	orb.,10,C
05308+0557	STF 728	4115	0.213	V	1.187	0.007	46.0	0.3	orb.,20,C
05386+3030	BU 1240 AB	4229	0.095	V	0.203	0.016	338.5	1.9	orb.,10
05413+1632	BU 1007	4265	0.095	V	0.255	0.018	332.8	1.9	orb.,10,Q,DF
06024+0939	A 2715 AB	4617	0.213	V	–	–	–	–	orb.,NF,10
06041+2316	KUI 23 AB		0.095	V	0.197	0.013	292.0	1.5	orb.,10,Q,DF
			0.205	V	0.211	0.011	287.1	2.3	orb.,10,DF
			0.208	V	0.198	0.004	288.3	1.6	orb.,10,DF
06149+2230	BU 1008	4841	0.241	V	1.765	0.022	258.5	0.3	orb.,20
06384+2859	MCA 27		0.095	V	0.212	0.012	295.3	1.6	orb.,10,DF
			0.205	V	–	–	–	–	orb.,10,DF
			0.208	V	0.233	0.011	288.6	1.6	orb.,10,DF
06462+5927	STF 948 AB	5400	0.211	V	1.871	0.011	251.5	0.4	orb.,20
06474+1812	STT 156	5447	0.211	V	0.274	0.005	198.3	1.0	orb.,10
06531+5927	STF 963 AB	5514	0.211	V	0.238	0.006	138.0	0.9	orb.,10
06573+5825	STT 159 AB	5586	0.211	V	0.569	0.003	226.8	0.3	orb.,10,C
07128+2713	STF 1037 AB	5871	0.205	V	1.093	0.027	131.8	1.2	orb.,20,C
07351+3058	STT 175 AB	6185	0.211	V	–	–	–	–	orb.,NF,10
07521+0317	BD+3°1824		0.260	V	–	–	–	–	NF,10
07573+0108	STT 185	6483	0.260	V	–	–	–	–	orb.,NF,10
08033+2616	STT 186	6538	0.306	V	0.982	0.004	74.2	0.3	10,Q
08041+3302	STT 187	6549	0.205	V	0.402	0.007	163.9	0.8	orb.,10,C
			0.205	–	0.400	0.010	164.4	2.5	orb.,10,DF,no filter
08095+3213	STF 1187 Aa-B	6623	0.306	V	2.965	0.012	22.8	0.3	orb.,20,Q,C
08122+1739	STF 1196 AB	6650	0.213	V	0.944	0.003	242.3	0.3	orb.,10,C
08198+0357	FIN 346		0.241	V	0.252	0.010	60.6	0.3	10
08213−0136	STF 1216	6762	0.213	V	0.524	0.006	118.5	0.6	orb.,10
08285−0231	A 551 AB	6828	0.241	V	–	–	–	–	orb.,NF,10
08468+0625	SP 1 AB	6993	0.208	V	–	–	–	–	orb.,10,DF
08542+3035	STF 1291 AB	7071	0.241	V	1.491	0.007	311.1	0.3	20
08580+3014	HO 252	7107	0.241	V	–	–	–	–	NF,10
09006+4147	KUI 37 AB		0.205	V	0.689	0.008	5.3	0.3	orb.,10,C
09036+4709	A 1585	7158	0.205	V	0.140	0.006	307.0	2.0	orb.,10,C
09104+6708	STF 1306 AB	7203	0.304	V	4.006	0.011	351.8	0.4	orb.,20,C

Table 2 – *continued*

WDS	Name	ADS	2004+	F	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes
			0.304	R	4.011	0.016	352.0	0.5	orb.,20,C
09127+1632	STF 1322	7236	0.306	V	1.803	0.010	52.7	0.6	20,Q
09184+3522	STF 1333	7286	0.260	V	1.918	0.016	48.8	0.5	20
09188+3648	STF 1334 AB	7292	0.306	V	2.613	0.012	314.9	0.5	20,Q
09208+6121	STF 1331 AB	7300	0.306	V	0.933	0.003	153.0	0.4	10
09210+3811	STF 1338 AB	7307	0.208	V	1.045	0.011	292.2	0.5	orb.,10,C
09245+0621	STF 1348 AB	7352	0.320	V	1.912	0.012	351.9	0.7	20
09273+0614	STF 1355	7380	0.320	V	1.865	0.013	351.9	0.4	20
09285+0903	STF 1356	7390	0.205	V	0.627	0.013	93.3	0.3	orb.,10,C
09498+2111	KUI 44		0.211	V	–	–	–	–	NF,10
			0.213	V	–	–	–	–	NF,10
09521+5404	STT 208	7545	0.208	V	0.303	0.010	276.3	0.3	orb.,10
10057+4103	A 2142	7631	0.304	V	1.045	0.025	296.5	0.8	20
10163+1744	STT 215	7704	0.211	V	1.425	0.019	178.1	0.7	orb.,20
10205+0626	STF 1426 AB	7730	0.304	V	0.932	0.007	309.2	1.0	20
10260+5237	STF 1428	7762	0.304	V	2.843	0.015	87.7	0.3	20
10279+3642	HU 879	7780	0.205	V	0.323	0.006	218.6	0.6	orb.,10,C
10350+0839	STF 1450	7837	0.306	V	2.111	0.012	246.9	0.3	20,Q
10493−0401	STF 1476	7936	0.383	V	2.414	0.007	15.9	0.3	20,Q
11037+6145	BU 1077	8035	0.213	V	0.367	0.010	90.2	0.4	orb.,10
			0.397	V	0.371	0.003	88.6	0.9	orb.,10,Q
11136+5525	A 1353	8092	0.399	V	0.557	0.011	304.4	0.5	orb.,10,Q,C
11182+3132	STF 1523 AB	8119	0.213	V	1.745	0.007	340.2	0.3	orb.,20,C
			0.323	V	1.766	0.011	339.7	0.3	orb.,20,Q,C
11239+1032	STF 1536 AB	8148	0.213	V	1.817	0.012	106.6	0.3	orb.,20,C
11308+4117	STT 234	8189	0.399	V	0.502	0.038	165.3	1.7	orb.,20,C
11323+6105	STT 235 AB	8197	0.241	V	0.679	0.004	182.0	1.1	orb.,10,C
11329+5525	A 1593 AB	8207	0.408	V	–	–	–	–	NF,20
11363+2747	STF 1555 AB	8231	0.205	V	0.721	0.003	148.0	0.3	orb.,10,C
12060+6842	STF 3123 AB	8419	0.241	V	0.258	0.005	224.1	0.8	orb.,10,DF
12108+3953	STF 1606	8446	0.304	V	0.399	0.003	170.0	0.3	orb.,10
12244+2535	STF 1639 AB	8539	0.241	V	1.724	0.007	324.4	0.4	orb.,20,C
12272+2701	STF 1643	8553	0.399	R	2.651	0.007	7.1	0.4	orb.,20,Q
12306+0943	STF 1647	8575	0.304	V	1.346	0.018	245.2	0.3	orb.,20
12349+2238	WRH 12		0.304	V	0.281	0.017	20.0	1.8	orb.,10,Q,C
12409+0850	STF 1668	8625	0.306	V	1.140	0.016	277.7	0.3	20,Q
12417−0127	STF 1670 AB	8630	0.306	V	0.593	0.005	300.3	0.9	orb.,10
			0.397	V	0.569	0.003	296.2	0.3	orb.,10
			0.443	V	0.564	0.004	294.7	0.4	orb.,10,Q
12533+2115	STF 1687 AB	8695	0.323	V	1.097	0.010	278.2	0.6	orb.,20,Q
12587+2728	STF 1699	8721	0.380	V	1.664	0.007	278.8	0.3	20,Q
13007+5622	BU 1082	8739	0.397	V	1.227	0.029	88.8	0.5	orb.,20,Q
13039−0340	BU 929	8759	0.380	V	0.601	0.003	286.5	0.8	10,Q
13048+7302	BU 799 AB	8772	0.383	V	1.330	0.007	354.9	0.2	20,Q
13100+1732	STF 1728 AB	8804	0.380	V	0.376	0.004	12.2	0.8	orb.,10,C
13120+3205	STT 261	8814	0.380	V	2.488	0.009	159.2	0.2	20,Q
13207+0257	STF 1734	8864	0.380	V	1.095	0.007	266.7	0.6	20,Q
13284+1543	STT 266	8914	0.383	V	2.002	0.007	176.1	0.3	20,Q
13343−0019	STF 1757 AB	8949	0.397	R	1.954	0.007	219.1	0.4	orb.,20,Q,C
13375+3618	STF 1768 AB	8974	0.380	V	1.754	0.014	188.3	0.4	orb.,20,Q,C
13377+5043	STF 1770	8979	0.383	V	1.695	0.010	211.6	0.2	20,Q
13396+1045	BU 612 AB	8987	0.378	V	0.261	0.003	196.5	1.5	orb.,10,C
13461+0507	STF 1781	9019	0.397	V	0.817	0.007	275.6	0.6	orb.,20,Q
13491+2659	STF 1785	9031	0.397	R	3.199	0.009	266.2	0.4	orb.,20,Q,C
13563+0517	STT 273 AB	9060	0.383	V	1.035	0.019	111.9	0.3	20
14131+5520	STF 1820	9167	0.432	R	2.640	0.007	118.4	0.3	orb.,20,C
14148+1006	KUI 66		0.432	R	1.014	0.019	199.6	0.5	20,Q
14153+0308	STF 1819	9182	0.441	V	0.896	0.007	190.7	1.0	orb.,20,C
14203+4830	STF 1834	9229	0.408	V	1.552	0.020	102.3	0.5	orb.,20,C
14323+2641	A 570	9301	0.380	V	–	–	–	–	orb.,NF,10
14369+4813	A 347	9324	0.408	V	0.585	0.019	251.2	1.4	orb.,20

Table 2 – *continued*

WDS	Name	ADS	2004+	F	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes
14380+5135	STF 1863	9329	0.441	V	0.661	0.007	62.6	0.6	20
14407+3117	STF 1867	9340	0.443	V	0.721	0.013	357.5	1.3	20
14411+1344	STF 1865 AB	9343	0.380	V	0.676	0.007	118.3	0.4	orb.,10,Q,C
14416+5124	STF 1871	9350	0.441	V	1.848	0.009	309.8	0.3	20
14417+0932	STF 1866	9345	0.443	V	0.768	0.007	25.4	0.9	20
14450+2704	STF 1877 AB	9372	0.399	V	2.818	0.007	162.9	0.3	20,Q
14463+0939	STF 1879 AB	9380	0.443	V	1.688	0.010	85.1	0.4	orb.,20,C
14484+2422	STF 1884	9389	0.441	V	2.109	0.007	55.3	0.3	20,Q
14489+0557	STF 1883	9392	0.399	V	0.875	0.012	280.1	0.5	orb.,20,C
14497+4843	STF 1890	9406	0.443	V	2.668	0.007	45.5	0.3	20,Q
14515+4456	STT 287	9418	0.443	V	0.789	0.023	355.7	1.7	orb.,20
14534+1542	STT 288	9425	0.443	V	1.125	0.014	254.0	0.4	orb.,20,Q,C
15245+3723	STF 1938 BC	9626	0.441	V	2.246	0.008	7.6	0.3	orb.,20,Q,C

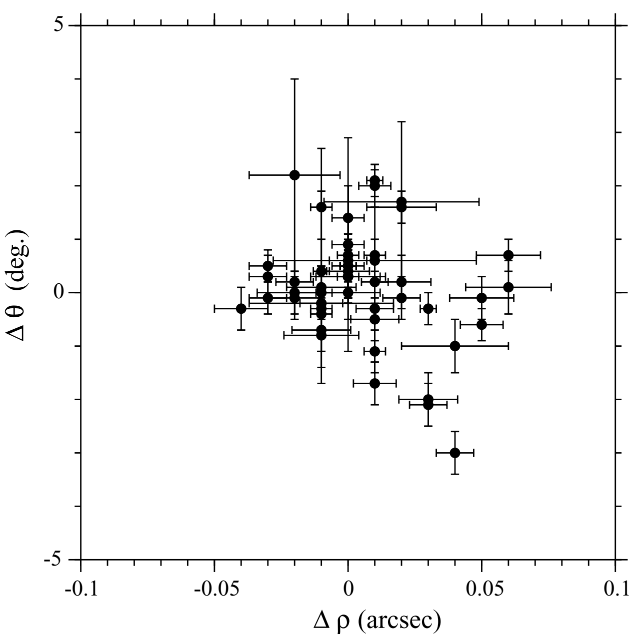

Figure 1. Residuals of the measurements used for the calibration.

In the notes, orb. was added for the objects for which an orbit is known; the residuals with the corresponding ephemerides will be discussed in Section 4.1. In this column, we also give some complementary information about the fringes visible in the power spectrum: NF, for no fringes, and DF, for diffuse fringes.[1] When the fringes were diffuse, the measurements were more difficult to perform, especially for the position angle, and the corresponding errors are larger.

The smallest (1σ) errors for the angular separation (column 7) were estimated at 0.003 arcsec for close pairs (i.e. $\rho < 1$ arcsec) and 0.03 per cent for wide pairs (i.e. $\rho > 1$ arcsec) on the basis of the uncertainties coming from the determination of the centre of the autocorrelation peak and those affecting the scale calibration (see Section 3.2). Similarly, the smallest (1σ) error for the angle position (column 9) was 0°.3.

[1] The power spectrum of a binary star exhibits a set of parallel fringes that are perpendicular to the vector linking the two components and whose mutual distance is inversely proportional to their angular separation.

4.1 Comparison with published ephemerides

Table 3 contains the $(O - C)$ residuals (observed minus computed) for the objects with a known orbit, whose origin is given in column 3. The residuals relative to the separation and position angles are given in columns 4 and 5, respectively. The orbital elements used for computing the ephemerides were found in the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf & Mason 2004), where the reader can also find the full bibliographic references of the orbits mentioned in column 3. For STF 1555 AB, we added the residuals from the recent orbit of Docobo & Ling (2004), which is not included yet in the Sixth Catalog. The residuals obtained with our new orbits of STT 156, BU 1077 and BU 1082 (see Section 5) are also displayed here for an easier comparison with the older orbits. Note that we have added (in brackets) the ephemerides of the seven objects we did not resolve, and for which an orbit is known (see discussion in Section 4.2).

The residuals of our measurements are displayed in Fig. 2. They are well centred around the origin ($\Delta\rho = 0, \Delta\theta = 0$). Some residuals are rather large, which can be explained by two origins: (i) the non-validity of old orbits and/or (ii) large errors of our measurements.

Let us examine now some cases with large residuals and try to identify the objects whose orbits need to be revised.

(i) KUI 23 AB, 06041+2316: we have done three measurements of this object. The first is in good agreement with the orbit of Heintz (1986), whereas the two others have large residuals in θ: the fringes of the corresponding power spectra were very diffuse (DF in the notes column of Table 2), which leads to a noisy estimation of the position angle.

(ii) STT 156, 06474+1812: the residuals are large both for ρ and θ with the orbit of Baize (1992). Our measurements are in good agreement with those recently published. We propose a new orbit in Section 5.

(iii) MCA 27, 06384+2859: our two measurements show a large difference, because one was made during bad weather conditions. As in the case of KUI 23 AB, the measurement obtained from the power spectrum with diffuse fringes leads to a bad estimation of the position angle. The second measurement obtained with better conditions is fully compatible with the orbit of Hartkopf & Mason (2000).

Table 3. $O - C$.

WDS	Name	Orbit	$\Delta\rho_{(O-C)}$ (arcsec)	$\Delta\theta_{(O-C)}$ (°)
00318+5431	STT 12	Heintz (1995)	−0.10	0.0
		”	−0.10	1.2
01095+4715	STT 515 AB	Scardia et al. (2001)	0.01	−1.7
		”	0.01	−1.1
		”	0.01	0.2
		”	0.01	−0.5
01559+0151	STF 186	Mourao (1977)	0.03	−2.1
		”	0.04	−3.0
02020+0246	STF 202 AB	Scardia (1983)	0.01	1.8
		”	0.02	1.6
02140+4729	STF 228	Soderhjelm (1999)	−0.01	−0.4
		”	−0.01	−0.4
02537+3820	BU 524 AB	Docobo et al. (2001)	0.02	1.7
02589+2137	BU 525	Costa (1978)	(0.51	269.6)
03054+2515	STF 346 AB	Heintz (1981)	−0.03	−3.0
		”	−0.03	−3.1
		”	−0.03	−3.7
03175+6540	STT 52 AB	Heintz (1998)	0.08	4.2
		”	0.09	4.3
03344+2428	STF 412 AB	Scardia et al. (2002)	0.00	0.7
		”	0.00	0.3
		”	0.00	0.5
		”	0.00	0.5
		”	0.01	0.7
		”	0.00	0.5
04239+0928	HU 304	Hartkopf (2000)	−0.01	−0.8
		”	−0.01	−0.7
05308+0557	STF 728	Seymour (1999)	−0.03	0.5
05386+3030	BU 1240 AB	Scardia (1985)	−0.02	−0.3
05413+1632	BU 1007	Docobo et al. (1999)	−0.02	−1.6
06024+0939	A 2715 AB	Fekel et al. (2002)	(0.04	39.7)
06041+2316	KUI 23 AB	Heintz (1986)	−0.01	0.6
		”	0.01	−5.6
		”	0.00	−4.5
06149+2230	BU 1008	Baize (1980)	0.17	3.4
06384+2859	MCA 27	Hartkopf et al. (2000)	0.00	7.1
		”	0.02	0.7
06462+5927	STF 948 AB	Popovic et al. (1996)	0.17	3.4
06474+1812	STT 156	Baize (1992)	−0.09	−8.7
		This paper	0.00	2.2
06531+5927	STF 963 AB	Docobo et al. (1984)	0.03	−2.8
06573+5825	STT 159 AB	Alzner (2000)	0.00	0.4
07128+2713	STF 1037 AB	Soderhjelm (1999)	−0.01	−0.2
07351+3058	STT 175 AB	Hartkopf et al. (1989)	(0.08	134.6)
07573+0108	STT 185	Hartkopf et al. (2001)	(0.23	7.6)
08041+3302	STT 187	Mason et al. (1999)	0.00	0.6
		”	0.00	1.1
08095+3213	STF 1187 Aa-B	Olevic et al. (2001)	0.06	0.7
08122+1739	STF 1196 AB	Soderhjelm (1999)	0.01	2.1
08213−0136	STF 1216	Docobo et al. (1994)	0.05	0.1
08285−0231	A 551 AB	Zulevic (1995)	(0.47	298.4)
08468+0625	SP 1 AB	Hartkopf et al. (1996)	(0.21	257.1)
09006+4147	KUI 37 AB	Hartkopf et al. (1996)	−0.01	−0.2
09036+4709	A 1585	Barnaby et al. (2000)	0.00	0.9
09104+6708	STF 1306 AB	Scardia (1985)	0.05	−0.1
		”	0.06	0.1
09210+3811	STF 1338 AB	Scardia et al. (2002)	0.03	−2.0
09285+0903	STF 1356	Van Dessel (1976)	−0.01	0.1
09521+5404	STT 208	Heintz (1996)	−0.02	−1.8
10163+1744	STT 215	Zaera (1984)	−0.08	−2.0
10279+3642	HU 879	Mason et al. (2001)	0.00	1.4

Table 3 – *continued*

WDS	Name	Orbit	$\Delta\rho_{(O-C)}$ (arcsec)	$\Delta\theta_{(O-C)}$ (°)
11037+6145	BU 1077	Aristidi et al. (2004)	−0.11	25.2
		”	−0.12	25.4
		Soderhjelm (1999)	−0.01	−14.6
		”	−0.01	−13.1
		This paper	0.00	−1.0
		”	−0.01	0.7
11136+5525	A 1353	Docobo et al. (1999)	0.02	0.2
11182+3132	STF 1523 AB	Mason et al. (1995)	−0.03	−0.1
		”	−0.01	0.0
11239+1032	STF 1536 AB	Soderhjelm (1999)	0.00	0.3
11308+4117	STT 234	Docobo et al. (2001)	0.01	0.6
11323+6105	STT 235 AB	Soderhjelm (1999)	−0.01	1.6
11363+2747	STF 1555 AB	Costa et al. (1983)	−0.16	1.4
		Docobo et al. (2004)	0.03	−0.3
12060+6842	STF 3123 AB	Hartkopf et al. (1996)	0.00	1.3
12108+3953	STF 1606	Mason et al. (1999)	0.01	3.9
12244+2535	STF 1639 AB	Olevic et al. (2000)	−0.02	0.2
12272+2701	STF 1643	Hopmann (1964)	0.37	−3.6
12306+0943	STF 1647	Hopmann (1970)	0.08	−3.2
12349+2238	WRH 12	Seymour et al. (2002)	−0.02	2.2
12417−0127	STF 1670 AB	Soderhjelm (1999)	0.05	4.3
		”	0.05	3.7
		”	0.05	4.1
12533+2115	STF 1687 AB	Heintz (1997)	0.06	−1.0
13007+5622	BU 1082	Scardia (1980)	−0.21	7.2
		Heintz (1981)	−0.17	2.6
		This paper.	−0.13	1.4
13100+1732	STF 1728 AB	Hartkopf et al. (1989)	−0.01	−0.3
13343−0019	STF 1757 AB	Heintz (1988)	0.02	−0.1
13375+3618	STF 1768 AB	Soderhjelm (1999)	0.00	0.3
13396+1045	BU 612 AB	Mason et al. (1999)	−0.01	0.4
13461+0507	STF 1781	Heintz (1986)	0.00	5.6
13491+2659	STF 1785	Heintz (1988)	−0.04	−0.3
14131+5520	STF 1820	Kiyaeva et al. (1998)	0.05	−0.6
14153+0308	STF 1819	Houser (1987)	0.01	−0.3
14203+4830	STF 1834	Seymour et al. (2000)	0.04	−1.0
14323+2641	A 570	Heintz (1991)	(0.20	93.5)
14369+4813	A 347	Baize (1987)	0.08	−0.9
14411+1344	STF 1865 AB	Wierzbinski (1956)	−0.03	0.3
14463+0939	STF 1879 AB	Mason et al. (1999)	−0.02	−0.1
14489+0557	STF 1883	Seymour et al. (2000)	0.00	0.0
14515+4456	STT 287	Heintz (1997)	−0.05	0.6
14534+1542	STT 288	Heintz (1998)	−0.02	0.0
15245+3723	STF 1938 BC	Soderhjelm (1999)	0.00	0.4

(iv) BU 1077, 11037+6145: the residuals in θ are large with the recent orbits of Soderhjelm (1999) and Aristidi et al. (1999), for our two measurements. Despite its short period (44 yr), the current part of its orbit had never been observed before (see Fig. 4). We propose a new orbit in Section 5.

(v) STF 1643, 12272+2701: the residuals are large both for ρ and θ. Our measurement is in agreement with those performed by other observers. It is clear that the orbit of Hopmann (1964) is not valid: the companion seems to be moving along a straight line. This system may be an optical pair only.

(vi) BU 1082, 13007+5622: the residuals are large with the orbit of Scardia (1980) both for ρ and θ. The orbit of Heintz (1981) is better but still gives significant residuals for the separation angle. We propose a new orbit in Section 5.

In Fig. 2, we have also given the name of some other objects whose measurements have lead to large residuals: STT 52 AB, BU 1008, STF 946 AB, STT 1670 AB, STF 1781 and STT 1781. We shall perform more observations of those objects in order to be able to confirm those values and revise their orbits in the future if possible.

4.2 Unresolved objects

There are 11 unresolved objects in Table 2. Among this list, there exist published orbits for seven objects (ephemerides in Table 3, indicated in brackets). Little can be said about the four remaining objects without any known orbit: BD +3°.1824, HO 252, KUI 44 and A 1593 AB, because they could have been too close to be separated by the Zeiss telescope at that time, i.e. with ρ smaller than the diffraction limit of the telescope (0.11 arcsec in V, see Section 3.2).

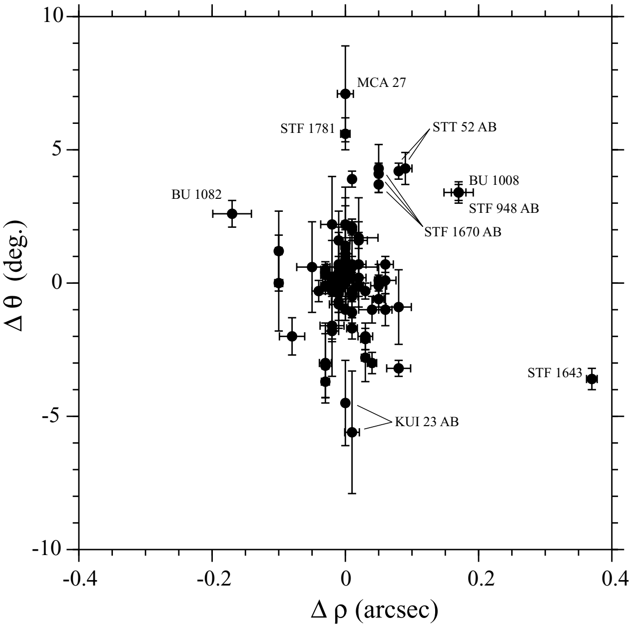

Figure 2. Residuals with published orbits.

In Table 3, we see that the separations computed with known orbits were too small for A 2715 AB (0.04 arcsec) and STT 175 AB (0.08 arcsec). The problem remains for the last four objects: BU 525 (0.51 arcsec), STT 185 (0.23 arcsec), A 551 AB (0.47 arcsec), SP 1 AB (0.21 arcsec) and A 570 (0.20 arcsec). The recent measurements of those objects in the Fourth Catalog of Interferometric Measurements of Binary Stars (Hartkopf et al. 2004), show that the ephemerides are valid. The absence of detection must be a result of unfavourable weather conditions (e.g. fast atmospheric turbulence).

5 NEW ORBITS

The observations of Table 2 allowed us to revise the orbits of STT 156–ADS 5447, BU 1077 AB–ADS 8035 and BU 1082–ADS 8739. Additional observations were taken from lists kindly supplied by the United States Naval Observatory of Washington.

For those three systems, preliminary orbital elements were calculated with the analytical method of Kowalsky (1873). When possible, those elements were improved with the least-squares method of Hellerich (1925).

The new orbital elements are presented in Table 4 and the ephemerides in Table 5, whereas the orbits are displayed in Figs 3, 4 and 5.

In Table 4, 'Node' and 'Omega' are the position angle of the node and that of the periastron, respectively (angles are measured from the north and increasing to the east), i is the inclination of the orbit relative to the plane of the sky, e the eccentricity, T the epoch of periastron passage, P the period, n the mean angular motion and a is the mean semimajor axis. The four parameters A, B, F and G are the Thiele–Innes constants (useful for an easier computation of the ephemerides).

The ephemerides are presented in Table 5, with the date in Besselian years in column 1, the angular separation ρ in arcseconds in columns 2, 4 and 6 and the position angle θ in degrees in columns 3, 5 and 7.

Table 5. New ephemerides.

Epoch	ADS 5447		ADS 8035		ADS 8739	
	ρ (arcsec)	θ (°)	ρ (arcsec)	θ (°)	ρ (arcsec)	θ (°)
2004.0	0.275	196.7	0.362	95.2	1.360	86.9
2005.0	0.268	193.6	0.400	78.0	1.341	88.6
2006.0	0.262	190.2	0.441	64.0	1.319	90.3
2007.0	0.255	186.7	0.482	52.3	1.295	92.1
2008.0	0.249	183.0	0.522	42.5	1.268	94.0
2009.0	0.244	179.2	0.559	34.0	1.238	95.9
2010.0	0.239	175.2	0.593	26.5	1.205	98.0
2011.0	0.234	171.0	0.624	19.8	1.169	100.1
2012.0	0.229	166.6	0.652	13.8	1.130	102.5
2013.0	0.225	162.0	0.678	8.2	1.088	105.0

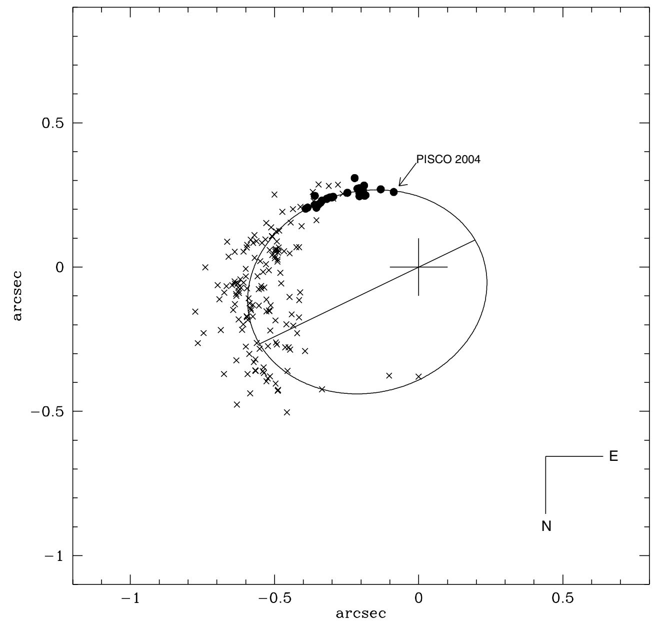

Figure 3. STT 156–ADS 5447.

Table 4. New orbital elements.

Name	Node (°)	Omega (°)	i (°)	e	T (yr)	P (yr)	n (° yr^{-1})	a (arcsec)	A (arcsec)	B (arcsec)	F (arcsec)	G (arcsec)
ADS 5447	82.9	324.7	155.8	0.477	2022.302	224.631	1.60263	0.427	−0.18026	0.37364	0.34593	0.20556
ADS 8035	48.7	268.5	160.3	0.427	2001.939	44.553	8.08027	0.600	−0.43442	0.36138	0.38519	0.46012
	±21.8	±20.5	±4.2	±0.010	±0.15	±0.13	±0.023	±0.039				
ADS 8739	95.4	113.9	50.4	0.412	1921.828	106.400	3.38347	1.250	−0.67669	−0.57324	0.42924	−1.10662
	±1.5	±1.1	±1.4	±0.013	±0.44	±0.85	±0.027	±0.042				

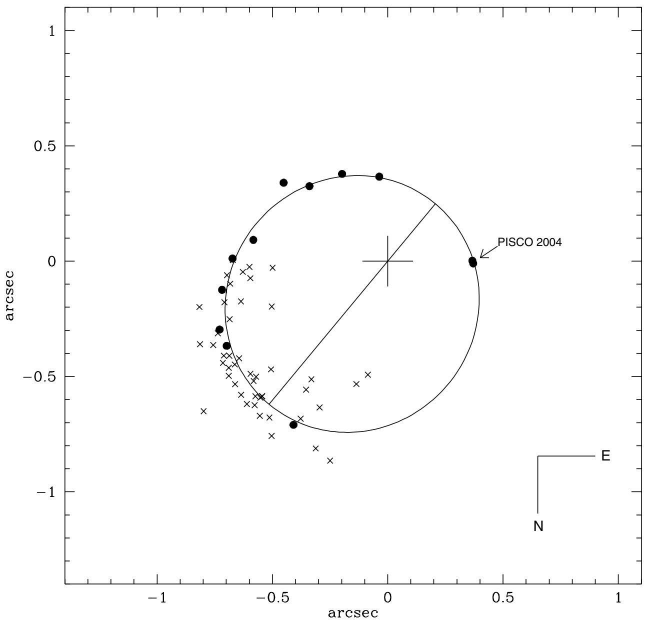

Figure 4. BU 1077 AB–ADS 8035.

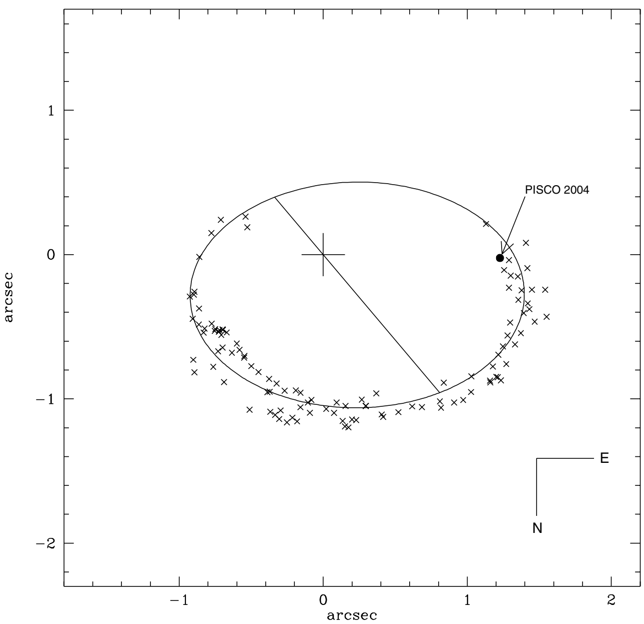

Figure 5. BU 1082–ADS 8739.

Tables 6, 7 and 8 of the new $(O - C)$ residuals were restricted for reasons of space to the observations made since 1980. For each observation, the date in Besselian years is given in column 1, the observed separation ρ in arcseconds in column 2, the $\Delta\rho_{(O-C)}$ residual in column 3, the observed position angle θ (reduced to 2000) in degrees in column 4, the $\Delta\theta_{(O-C)}$ residual in column 5, the number of nights used for obtaining this measurement in column 6 and the name of the observer in column 7, as given by the Washington Double Stars Catalog (Mason et al. 2001), where the reader can find the full bibliographic references of those measurements. In this column, WSI means Washington Speckle Interferometer.

Figs 3, 4 and 5 show the apparent orbit obtained by us (solid line) and the observational data used for the calculation of the orbital elements (with small crosses, x, for the visual measurements and black filled circles for speckle measurements). Our measurements are indicated with the label PISCO 2004. The big cross (+) indicates the location of the primary component, whereas the straight segment contained in the orbit is the line of absids. The orientation of the orbit conforms with the convention adopted by the observers of visual binary stars.

For the calculation of the dynamical parallax, the method of Baize–Romani (Couteau 1978) was implemented. The uncertainty ϵ concerning the sum of the masses of the components was derived from the following expression (Scardia 1984):

$$\epsilon_{\%} = 100 * \sqrt{\left(3\frac{\Delta a}{a}\right)^2 + \left(3\frac{\Delta \pi}{\pi}\right)^2 + \left(2\frac{\Delta P}{P}\right)^2}, \quad (1)$$

where a is the semimajor axis, Δa its error, π the measured trigonometrical parallax, $\Delta\pi$ its error, P the period and ΔP its error.

5.1 WDS 06474+1812–STT 156–ADS 5447

The orbit computed by Baize (1992) leads now to systematic discrepancies both for the separation and for the position angle. The actual period of the system is shorter than expected by Baize. Since its discovery, the companion has moved along a small portion only of the orbit, close to its apastron. This explains why the orbit is still badly defined. Although numerous, the measurements present a large scatter, especially those concerning the separation angle.

Our new computation leads to the orbital elements given in Table 4 and the orbit displayed in Fig. 3. For this object, we could only use Kowalsky's method. The least-squares method of Hellerich did not converge, and prevented us from improving the solution and computing the errors. This is why the errors of orbital elements are not displayed in Table 4. Fortunately, this was not the case for the two other systems (ADS 8035 and 8739).

The parallax measured by the *Hipparcos* satellite is 0.00756 ± 0.00141 arcsec, which leads to a semimajor axis of 56.5 au and a sum of the masses of the components of 3.6 $M_{\odot}$, slightly underestimated for a double star of a spectral type A2V. The dynamical parallax is 0.0063 arcsec, which well agrees with *Hipparcos* measurement.

5.2 WDS 11037+6145–BU 1077 AB–ADS 8035

Although recent, the orbits of Soderhjelm (1999) and Aristidi et al. (1999) are in complete disagreement with our determination of the position angle (residuals of 25° and −13°, respectively!).

This bright double star has a short period, but is very difficult to observe as a result of the large luminosity contrast between its two components ($\Delta m_V = 2.93$). It has already done three revolutions since its discovery. Unfortunately, the angular separation measurements have a large scatter, which is well explained by the difficulties for separating this binary. For the first time, speckle techniques have permitted the observation of the companion motion close to the periastron passage (which occurred in 2001). Note that PISCO provided five measurements out of the six made during this passage.

The geometrical elements of the orbit, in particular node and omega, still have a great uncertainty (Fig. 4), but the dynamical elements are now well determined and will certainly change very little in the future. Abt (1981) attributed the spectral type G9III to this object. The *Hipparcos* parallax is 0.02638 ± 0.00053 arcsec, to which corresponds a semimajor axis of 22.7 au and a sum of

Table 6. ADS 5447: residuals with new orbit.

Epoch	ρ (arcsec)	$\Delta\rho_{(O-C)}$ (arcsec)	θ (°)	$\Delta\theta_{(O-C)}$ (°)	N	Author
1980.144	0.56	0.12	243.3	0.7	2	Zulevic, D.J.
1980.156	0.441	0.002	242.7	0.1	1	McAlister, H.A.
1980.888	0.437	0.003	241.8	0.1	1	McAlister, H.A.
1982.933	0.420	−0.002	239.1	0.0	1	McAlister, H.A.
1983.015	0.416	−0.005	238.9	−0.1	1	McAlister, H.A.
1983.067	0.410	−0.011	239.9	1.0	1	McAlister, H.A.
1983.145	0.43	0.01	237.9	−0.9	3	Scardia, M.
1984.061	0.410	−0.004	238.1	0.5	1	McAlister, H.A.
1985.000	0.407	−0.001	236.8	0.5	1	Hartkopf, W.I.
1985.240	0.45	0.04	234.7	−1.2	2	Le Beau, J.
1985.835	0.407	0.004	235.5	0.4	1	McAlister, H.A.
1985.838	0.437	0.034	235.6	0.5	1	Bonneau, D.
1986.884	0.397	0.001	233.6	0.0	1	McAlister, H.A.
1987.275	0.397	0.004	233.3	0.3	1	McAlister, H.A.
1987.932	0.38	−0.01	231.3	−0.7	4	Worley, C.E.
1988.140	0.45	0.06	230.5	−1.1	1	Gili, R.
1988.170	0.391	0.004	231.8	0.2	2	McAlister, H.A.
1988.255	0.386	−0.001	231.4	−0.1	1	McAlister, H.A.
1989.238	0.384	0.004	230.6	0.7	1	McAlister, H.A.
1990.832	0.42	0.05	228.0	0.8	2	Prieto, C.
1991.250	0.366	0.000	226.1	−0.4	1	*Hipparcos* Cat.
1991.800	0.65	0.29	230.0	4.5	1	Tobal, T.
1992.312	0.357	−0.002	223.8	−0.7	1	Hartkopf, W.I.
1994.129	0.32	−0.03	217.6	−3.5	1	WSI
1994.130	0.40	0.05	224.4	3.3	2	Alzner, A.
1994.194	0.31	−0.04	216.5	−4.5	1	WSI
1994.194	0.32	−0.03	216.7	−4.3	1	WSI
1995.188	0.33	−0.01	215.9	−3.1	1	WSI
1995.188	0.32	−0.02	219.9	0.9	1	WSI
1995.202	0.34	0.00	213.8	−5.2	1	WSI
1995.205	0.31	−0.03	217.1	−1.9	1	WSI
1995.210	0.33	−0.01	218.3	−0.6	1	WSI
1995.210	0.33	−0.01	218.6	−0.3	1	WSI
1995.221	0.38	0.04	215.7	−3.2	1	WSI
1995.924	0.342	0.009	216.9	−0.6	1	Hartkopf, W.I.
1995.951	0.345	0.013	218.0	0.6	1	Aristidi, E.
1997.071	0.318	−0.006	217.6	2.6	1	Aristidi, E.
2000.146	0.30	−0.00	206.0	−1.6	2	WSI
2004.211	0.274	0.001	198.3	2.2	1	Scardia, M.

Table 7. ADS 8035: residuals with new orbit.

Epoch	ρ (arcsec)	$\Delta\rho_{(O-C)}$ (arcsec)	θ (°)	$\Delta\theta_{(O-C)}$ (°)	N	Author
1980.000	0.80	−0.01	317.1	−2.0	3	Comellas, J.L.
1983.150	0.69	−0.10	312.8	6.0	3	Heintz, W.D.
1985.003	0.789	0.012	297.7	−1.7	1	McAlister, H.A.
1986.249	0.80	0.04	293.0	−1.2	1	Tobal, T.
1986.404	0.787	0.038	292.1	−1.4	1	Hartkopf, W.I.
1989.238	0.729	0.017	279.8	−0.8	1	Hartkopf, W.I.
1990.046	0.70	0.01	275.0	−1.6	1	Tobal, T.
1991.250	0.672	0.005	269.6	−0.6	1	*Hipparcos* Cat.
1991.324	0.673	0.008	269.0	−0.7	1	Hartkopf, W.I.
1993.334	0.590	−0.019	261.0	3.5	1	Miura, N.
1995.940	0.565	0.046	233.0	−4.2	1	Aristidi, E.
1997.074	0.470	−0.004	226.2	0.4	1	Aristidi, E.
1998.430	0.427	0.008	207.6	−1.3	1	Prieur, J.-L.
1999.889	0.368	0.005	185.7	0.7	1	Horch, E.
2004.213	0.367	−0.003	90.2	−1.0	1	Scardia, M.
2004.397	0.371	−0.005	88.6	0.7	1	Scardia, M.

Table 8. ADS 8739: residuals with new orbit.

Epoch	ρ (arcsec)	$\Delta\rho_{(O-C)}$ (arcsec)	θ (°)	$\Delta\theta_{(O-C)}$ (°)	N	Author
1980.000	1.40	0.08	43.9	−5.5	3	Comellas, J.L.
1980.230	1.46	0.13	52.6	2.8	3	Heintz, W.D.
1982.344	1.41	0.06	56.7	3.2	3	Worley, C.E.
1983.378	1.45	0.08	53.0	−2.2	3	Scardia, M.
1984.461	1.47	0.09	54.8	−2.1	3	Scardia, M.
1985.200	1.48	0.09	59.2	1.1	2	Heintz, C.E.
1985.394	1.51	0.12	54.8	−3.6	5	Scardia, M.
1986.431	1.48	0.08	55.0	−5.1	3	Scardia, M.
1986.450	1.47	0.07	65.0	4.9	4	Worley, C.E.
1988.900	1.40	−0.02	63.0	−0.9	4	Muller, P.
1990.079	1.40	−0.03	60.3	−5.4	1	Tobal, T.
1991.250	1.397	−0.035	66.4	−1.0	1	*Hipparcos* Cat.
1991.620	1.476	0.043	68.4	0.4	1	*Tycho-2* Cat.
1994.570	1.38	−0.06	70.1	−2.3	3	Alzner, A.
1995.390	1.61	0.17	74.5	0.9	2	Heintz, C.E.
1997.350	1.45	0.02	73.8	−2.7	3	Alzner, A.
1998.520	1.31	−0.12	79.9	1.6	5	Argyle, R.W.
1999.360	1.39	−0.03	77.0	−2.5	3	Alzner, A.
1999.493	1.47	0.05	80.5	0.8	1	Tobal, T.
1999.499	1.56	0.14	81.0	1.3	1	Tobal, T.
2000.310	1.40	−0.01	79.8	−1.2	3	Alzner, A.
2001.320	1.36	−0.04	83.6	1.1	2	Alzner, A.
2002.360	1.31	−0.08	83.6	−0.6	3	Alzner, A.
2004.396	1.227	−0.126	88.8	1.3	1	Scardia, M.

the masses of the components of 5.9 $M_{\odot}$, with an uncertainty of 20.4 per cent, in good agreement with the total mass of a G9III system expected by the theory (e.g. Straizys & Kuriliene 1981). Note that the CDS of Strasbourg reports a different classification of K0Iab for this object. This spectral type is close to the one determined by Abt, but the luminosity class of I seems ruled out by our results.

5.3 WDS 13007+5622–BU 1082–ADS 8739

This is also a bright double star, with a large luminosity contrast between the two components. As already stressed by Baize (1938), this object was observed during the 13 yr following its discovery and then left out for more than 20 yr, which was unfortunately the most interesting period of its passage at the periastron. We are now again in the position of observing in the next few years this crucial part of the orbit, that was forsaken by the observers of the early 1900s. Our observation is the first ever performed with speckle techniques.

The orbit of Scardia (1980) leads now to systematic residuals both for separation and position angles, whereas the orbit of Heintz (1981), although better, gives a large residual for the separation angle of our speckle observation (see Table 3).

We used the observations of the last 25 yr to improve the orbit of Heintz and recalculated the orbital elements given in Table 4. From now on, its orbit is reasonably well defined and should not change much in the future (see Fig. 5).

ADS 8739 is an object rather close to the Earth, with a distance of ∼25 pc. The *Hipparcos* parallax, of good quality, is 0.04006 ± 0.0006 arcsec. The sum of the masses of the components, corresponding to this measurement, is 2.7 $M_{\odot}$, with an uncertainty of 11.2 per cent, in very good agreement with the sum of masses of a pair of spectral type F2V. With this parallax, the semimajor axis is 31 au.

6 CONCLUSION

This article inaugurates a new series of papers that will be devoted to the speckle measurements of visual binaries with the 1-m Zeiss telescope of the OAB. The instrument PISCO, which was designed for the 2-m TBL telescope, has proved to be well adapted to the Zeiss telescope too. Its installation has not required any hardware changes and then it has functioned well on the Zeiss telescope.

Although the limiting magnitude is smaller and the minimum angular separation is larger than what can be reached with a 2-m telescope like the TBL, this work shows that a significant contribution can be provided with PISCO on a 1-m telescope. The astrometric measurements presented here have an accuracy comparable to those obtained with the TBL.

It is also certain that a significant light pollution is present on this site, since it is located 30 km north-east of Milano city, and that the average image quality in Merate is worse than at the Pic du Midi, but this is counterbalanced by the possibility of observing with PISCO during every clear night through the year, which was not possible on the TBL. This advantage may prove invaluable for observing binaries at crucial periods, e.g. close to their periastron passages.

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