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Speckle observations with PISCO in Merate – IX. Astrometric measurements of visual binaries in 2008

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ABSTRACT

We present relative astrometric measurements of visual binaries, made in 2008 with the Pupil Interferometry Speckle camera and Coronagraph (PISCO) at the 102 cm Zeiss telescope of Brera Astronomical Observatory, in Merate. Our sample contains orbital couples as well as binaries whose motion is still uncertain. We obtained 240 new measurements of 237 objects with angular separations in the range 0.15–4.6 arcsec, and an average accuracy of 0.014 arcsec. The mean error on the position angles is $0\overset{\circ}{.}6$. Most of the position angles were determined without the usual 180° ambiguity with the application of triple-correlation techniques and/or by inspection of the long integration files.

We have found a new component in ADS 11074. This component was not fully resolved in our previous observations of 2006, but it was clearly separated with the observations presented here.

We also present the new revised orbits we have computed for ADS 11468, 13850 and 16057, for which our measurements lead to large residuals with the last published orbits. For ADS 13850, we propose to extend the quadrant correction that was previously used by the other authors to the first measurements made before 1930. In this way, we obtain an orbit with a longer period which leads to a much more plausible value for the total mass of the system.

Key words: techniques: high angular resolution – techniques: interferometric – astrometry – binaries: close – binaries: visual – stars: individual: ADS 11468 – stars: individual: ADS 13850 – stars: individual: ADS 16057.

1 INTRODUCTION

This paper deals with the results of speckle observations of visual binary stars made in Merate (Italy) in 2008 with the Pupil Interferometry Speckle camera and COronagraph (PISCO) on the 102 cm Zeiss telescope of *INAF – Osservatorio Astronomico di Brera* (OAB, Brera Astronomical Observatory). It is the ninth of a series (Scardia et al. 2005a, 2006, 2007a, 2008a; Prieur et al. 2008; Scardia et al. 2009a; Prieur et al. 2009; Scardia et al. 2010, hereafter Papers I to VIII), whose purpose is to contribute to the determination of binary orbits. PISCO was developed at *Observatoire Midi-Pyrénées* (France) and first used at *Pic du Midi* from 1993 to 1998. It was moved to Merate in 2003 and used there since.

We briefly describe our observations in Section 2. Then, we present and discuss the astrometric measurements in Section 3. Finally, in Section 4 we propose new revised orbits for ADS 11468, 13850 and 16057, partly derived from those observations and infer estimate values for the component masses.

2 OBSERVATIONS AND DESCRIPTION OF THE SAMPLE

The observations were carried out with the PISCO speckle camera with the Intensified Charge Coupled Device (ICCD) detector belonging to Nice University (France). This instrumentation is presented in Prieur et al. (1998) and our observing procedure is described in detail in Paper VI. For the present observations, thanks to an improvement of our software and a faster computer, we were also able to compute in real time the restricted triple correlation (Aristidi et al. 1997) that we use for resolving the 180° ambiguity (see Section 3.2).

The description of our sample can be found in our previous papers (e.g. Paper VI). It basically includes all the visual binaries for which new measurements are needed to improve their orbits, that are accessible with our instrumentation.

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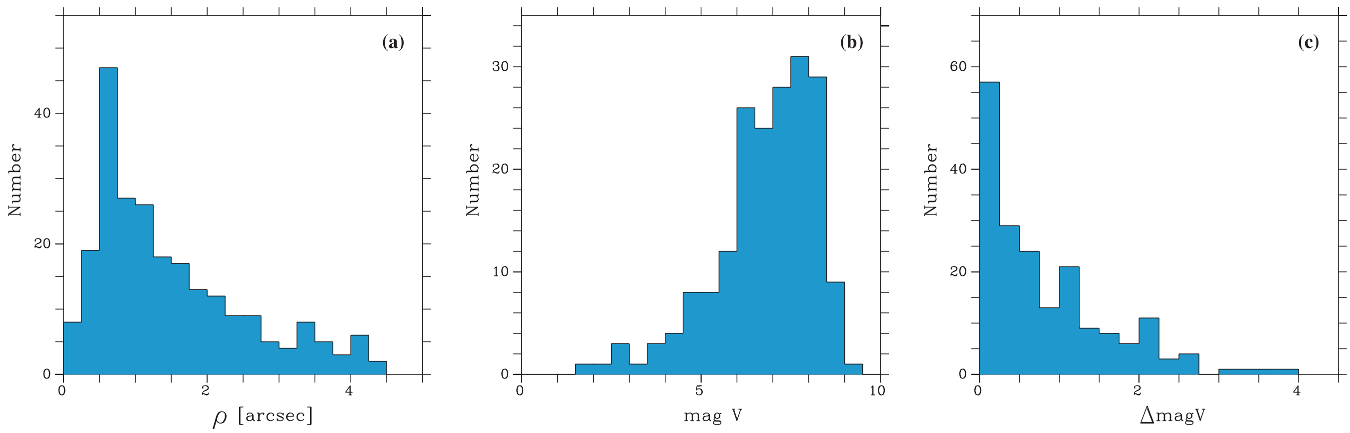

Figure 1. Distribution of the angular separations of the 240 measurements of Table 1 (a), of the total visual magnitudes (b) and of the differences of magnitude between the two components of those binaries (c).

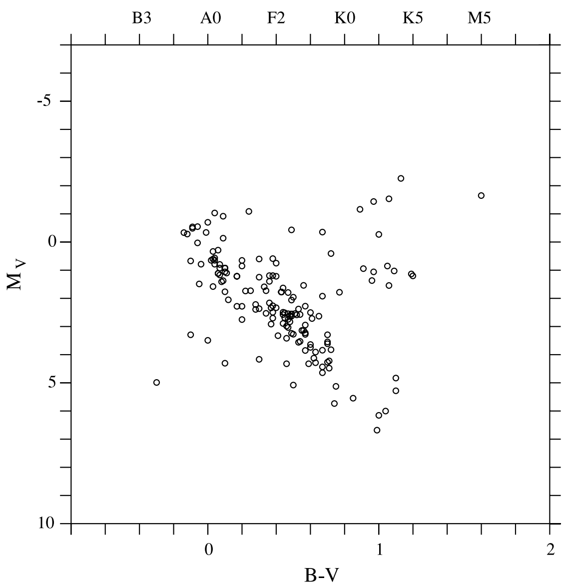

Figure 2. HR diagram of the binaries measured in Table 1, for which *Hipparcos* parallaxes were obtained with a relative error smaller than 50 per cent (i.e. 159 objects).

The distribution of the angular separations measured in this paper is displayed in Fig. 1(a) and shows a maximum for $\rho \approx 0.7$ arcsec. The largest separation of $\rho = 4.6$ arcsec was obtained for ADS 6175. The smallest separation was measured for ADS 16057, with $\rho = 0.15$ arcsec. This is close to the diffraction limit $\rho_d = \lambda/D \approx 0.13$ arcsec for the Zeiss telescope (aperture $D = 1.02$ m) and the *R* filter ($\lambda = 650$ nm).

Likewise, the distribution of the apparent magnitudes m_V and of the difference of magnitudes Δm_V between the two components are plotted in Figs 1(b) and (c), respectively. The telescope aperture and detector sensitivity lead to a limiting magnitude of about $m_V = 9.5$ (Fig. 1b) and a limiting Δm_V of about 4 (Fig. 1c).

Using the *Hipparcos* parallaxes, we were able to construct the HR diagram of those binaries, which is displayed in Fig. 2. We only plotted the objects for which the relative uncertainty on the parallax was smaller than 50 per cent. It can be seen that a large part of the HR diagram is covered by our sample. In the future we would like to acquire a more sensitive detector in order to observe fainter (and cooler) main-sequence stars.

3 ASTROMETRIC MEASUREMENTS

The astrometric measurements of the observations made in 2008 are displayed in Table 1. For each object, we report its WDS name (Washington Double Star Catalogue, Mason, Wycoff & Hartkopf 2010, hereafter WDS Catalogue) 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 observation, we then give the epoch in Besselian years (Column 4), the filter (Column 5) and the focal length of the eyepiece used for magnifying the image (Column 6), the angular separation ρ (Column 7) with its error (Column 8) in arcsec and the position angle θ (Column 9) with its error (Column 10) in degrees. In Column 11, we report some notes and some information about the secondary peaks of the auto-correlation files (e.g. diffuse or elongated). For the systems with a known orbit, the $(O - C)$ (Observed minus Computed) residuals of the ρ and θ measurements are displayed in Columns 13 and 14, respectively. The corresponding authors are given in Column 12, using the style of the Sixth Catalogue of Orbits of Visual Binary Stars (Hartkopf & Mason 2010, hereafter OC6). In Column 14, the symbol † indicates that there was a quadrant inconsistency between our measures and the orbital elements published for this object. The correspondence with the references of this paper is indicated at the end of Table 1. Unless explicitly specified, the measurements refer to the AB components of those systems.

The characteristics of the *V*, *R* and *RL* filters used for obtaining those measurements are given in Table 2. For each filter the central wavelength λ_c and full width at half-maximum $\Delta\lambda$ of the transmission curve are given in Columns 3 and 4, respectively. Some objects were observed with no filter because they were too faint. This is indicated with *W* (for 'white' light) in the filter column (Column 5 of Table 1). The corresponding bandpass and central wavelength correspond to that of the ICCD detector.

Like for the other papers of this series, we interactively processed each auto-correlation file and obtained a series of measurements with different background estimates and simulated noise. The measures and errors displayed in Table 1 were derived from the mean values and the standard deviation of those multiples measurements (see Paper III for more details). The average values of the errors of the 240 measurements reported in this table are 0.014 ± 0.010 arcsec and $0^{\circ}.64 \pm 0^{\circ}.52$ for ρ and θ, respectively.

Table 1. Measurements of binaries with PISCO and residuals with published orbits.

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho(O-C)$ (arcsec)	$\Delta\theta(O-C)$ (°)
00209+1059	BU1093	287	2008.051	*R*	20	0.709	0.020	113.1*	0.6		Lin2007b	−0.04	−4.3
01007+0929	STF82	835	2008.939	*W*	20	1.813	0.009	303.8*	0.3				
01030+4723	STT21	862	2008.939	*R*	20	1.197	0.010	175.3*	0.3		Hei1966	0.09	−0.3
01097+2348	BU303	955	2008.939	*R*	20	0.610	0.011	291.1	0.8				
01106+4917	COU2156	–	2008.939	*R*	20	0.479	0.015	164.5*	0.6				
02020+0246	STF202	1615	2008.939	*R*	20	1.824	0.009	267.0*	0.3		Sca1983f	0.05	1.6
03344+2428	STF412	2616	2008.939	*R*	10	0.719	0.005	353.4	0.6		Sca2002a	−0.01	−0.3
05308+0557	STF728	4115	2008.202	*R*	20	1.237	0.008	45.5*	0.3		Sey1999b	−0.02	0.4
05371+2655	STF749	4208	2008.202	*R*	20	1.149	0.008	141.0*	0.4		Sca2007a	−0.01	−0.5†
06038+1816	HDS824	–	2008.202	*R*	20	2.249	0.011	148.1*	0.5				
06149+2230	BU1008	4841	2008.243	*V*	20	1.787	0.009	257.2*	0.3		Baz1980a	0.19	3.0
06152+0631	A2717	4856	2008.243	*R*	20	0.565	0.016	353.9	4.5				
06250+4233	A2356	5016	2008.251	*R*	20	0.849	0.017	259.8	2.4				
06396+2816	STT152	5289	2008.202	*R*	20	0.851	0.008	35.7*	0.5				
06404+4058	STF945	5296	2008.240	*R*	20	0.428	0.015	329.1*	1.1		Nov2007d	−0.04	−1.7
06452+3050	STF957	5403	2008.251	*R*	20	3.922	0.056	88.5*	1.2				
06474+1812	STT156	5447	2008.240	*R*	10	0.243	0.003	184.7	1.1		Sca2005a	−0.01	2.6
06531+5927	STF963	5514	2008.202	*R*	10	0.225	0.004	331.2*	1.2		Sca2008d	−0.02	−0.1
06555+3010	STF981	5570	2008.202	*R*	20	1.160	0.008	123.4*	0.3		Hop1971	0.05	4.4†
07057+5245	STF1009	5746	2008.243	*R*	20	4.317	0.022	148.3*	0.3				
07128+2713	STF1037	5871	2008.202	*R*	20	1.041	0.008	309.2	0.3		Sca1983e	0.04	0.5
”	”	”	”	”	”	”	”	”	”		Sod1999	−0.01	−0.9
07176+0918	STT170	5958	2008.202	*R*	10	0.229	0.005	355.8	1.5		Doc2007e	−0.02	−1.2
07303+4959	STF1093	6117	2008.202	*R*	20	0.901	0.009	203.5	1.8		Sca1984d	0.11	1.8
”	”	”	”	”	”	”	”	”	”		Hrt2009	0.03	2.4
07345+1218	STF1116	6180	2008.243	*R*	20	1.812	0.047	96.6*	0.4				
07346+3153	STF1110	6175	2008.241	*R*	20	4.593	0.023	58.6*	0.3		Doc1985c	0.08	0.4
”	”	”	”	”	”	”	”	”	”		Hei1988a	0.04	−0.3
07359+4302	STT174	6191	2008.252	*R*	20	2.193	0.012	87.6*	0.3				
07401+0514	STF1126	6263	2008.241	*R*	20	0.872	0.008	173.4*	0.4				
08024+0409	STF1175	6532	2008.202	*R*	20	1.416	0.023	281.2*	0.3		Ole2001	0.05	−5.1
08095+3213	STF1187	6623	2008.243	*R*	20	3.038	0.021	22.3*	0.4		Ole2001	0.11	0.8
08122+1739	STF1196	6650	2008.252	*R*	10	1.059	0.007	45.9*	0.5		Ge1954	0.01	0.5
”	”	”	”	”	”	”	”	”	”		WSI2006b	0.03	1.4
08542+3035	STF1291	7071	2008.243	*R*	20	1.509	0.009	310.2*	0.4				
09104+6708	STF1306	7203	2008.314	*R*	20	4.148	0.023	350.3*	0.3		Sca1985c	0.06	−0.2
09179+2834	STF3121	7284	2008.241	*R*	20	0.627	0.008	212.2	1.5		Sod1999	−0.01	2.9
09210+3811	STF1338	7307	2008.241	*R*	20	1.066	0.017	298.0*	0.3		Sca2002b	0.05	−3.1
09285+0903	STF1356	7390	2008.241	*R*	20	0.689	0.008	99.7*	0.3		vDl1976	−0.02	−0.9
”	”	”	”	”	”	”	”	”	”		Sod1999	−0.01	1.8
09521+5404	STT208	7545	2008.241	*R*	10	0.335	0.003	288.2*	0.4		Hei1996c	−0.03	−1.6
10163+1744	STT215	7704	2008.314	*R*	20	1.459	0.011	178.1*	0.3		Wrz1956c	−0.07	0.1
”	”	”	”	”	”	”	”	”	”		Zae1984	−0.07	−1.3
10205+0626	STF1426	7730	2008.350	*R*	20	0.925	0.009	309.9*	0.7		Sca2008c	0.02	−0.9
10250+2437	STF1429	7758	2008.350	*R*	20	0.769	0.008	161.3	0.7		Zul1981	0.05	0.0
10269+1713	STT217	7775	2008.314	*R*	20	0.749	0.008	146.1	1.0		Hei1975b	0.02	−1.8
10279+3642	HU879	7780	2008.350	*R*	10	0.476	0.005	222.3*	1.1	Elongated	Msn2001c	−0.01	0.7
”	”	”	”	”	”	”	”	”	”		Gon2002b	0.00	0.2
10397+0851	STT224	7871	2008.353	*R*	20	0.512	0.010	140.8*	2.5		Pru2009	0.05	−1.0
10426+0335	A2768	7896	2008.353	*R*	20	0.565	0.015	253.6*	1.0		Hei1988d	0.01	1.4
”	”	”	”	”	”	”	”	”	”		Hrt1989	0.01	1.3
10480+4107	STT229	7929	2008.353	*R*	20	0.687	0.015	262.8	0.3		Alz1998a	0.02	−0.0
12272+2701	STF1643	8553	2008.353	*W*	20	2.699	0.013	6.1*	0.4	Elongated	Ole2003b	0.01	0.7
”	”	”	”	”	”	”	”	”	”		WSI2004a	−0.00	0.6
12349+2238	WRH12	–	2008.353	*R*	10	0.302	0.004	15.5*	0.9		Sey2002	−0.04	0.6
12417−0127	STF1670	8630	2008.353	*R*	20	1.013	0.008	37.3*	0.4		Sca2007c	−0.00	0.3
”	”	”	2008.484	*R*	20	1.046	0.008	35.7*	0.4		Sca2007c	0.00	0.1
13007+5622	BU1082	8739	2008.490	*R*	20	1.132	0.015	96.8*	0.3		Sod1999	−0.01	−2.1
13100+1732	STF1728	8804	2008.493	*R*	10	0.616	0.003	12.2	0.3		Pal2005b	−0.01	0.3†
”	”	”	”	”	”	”	”	”	”		WSI2006b	−0.00	−0.1

Table 1 – *continued*

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho(O-C)$ (arcsec)	$\Delta\theta(O-C)$ (°)
13563+0517	STT273	9060	2008.493	*W*	20	1.001	0.014	112.2*	0.5				
13577+5200	A1614	9071	2008.484	*W*	20	1.385	0.019	302.1*	0.3		Hei2001	−0.06	−1.4†
14135+1234	BU224	9165	2008.484	*W*	20	0.516	0.025	103.5*	0.8		Lin1985c	−0.05	−0.1
14139+2906	STF1816	9174	2008.493	*R*	20	0.465	0.020	94.1*	0.4				
14153+0308	STF1819	9182	2008.490	*R*	20	0.874	0.008	182.1*	0.5		Hou1987	−0.01	−0.3
14203+4830	STF1834	9229	2008.484	*R*	20	1.582	0.017	101.8*	0.3		Sey2000b	0.04	−1.7
14323+2641	A570	9301	2008.509	*R*	10	0.181	0.003	43.4	0.9		Hei1991	−0.01	−2.4
14336+3535	STF1858	9312	2008.509	*R*	20	3.046	0.015	37.9*	0.3				
14369+4813	A347	9324	2008.509	*R*	20	0.556	0.017	244.9	1.6		Doc2004a	−0.02	−0.8
14380+5135	STF1863	9329	2008.484	*R*	20	0.653	0.008	61.9*	1.0				
14407+3117	STF1867	9340	2008.539	*R*	20	0.716	0.008	355.9	2.0				
14411+1344	STF1865	9343	2008.484	*R*	10	0.594	0.004	295.9	0.4		Wrz1956a	−0.00	0.6
”	”	”	”	”	”	”	”	”	”		Msn1999a	0.01	−0.7
14450+2704	STF1877	9372	2008.539	*V*	20	2.838	0.014	343.3*	0.3				
14463+0939	STF1879	9380	2008.490	*W*	20	1.728	0.010	83.6*	0.3		Msn1999a	0.01	−0.7
14489+0557	STF1883	9392	2008.490	*R*	20	0.897	0.014	279.5	0.4		Fei1969	−0.07	−0.6
”	”	”	”	”	”	”	”	”	”		Sey2000b	−0.03	0.7
14515+4456	STT287	9418	2008.490	*W*	20	0.732	0.008	357.5	0.7		Hei1997	−0.06	0.4
14534+1542	STT288	9425	2008.493	*R*	20	1.093	0.008	161.8*	0.3		Hei1998	−0.00	−0.3
15121+1859	COU189	–	2008.509	*R*	20	0.405	0.011	139.8*	1.5				
15210+0043	BU32	9596	2008.564	*R*	20	3.351	0.017	22.3*	0.3				
15245+3723	STF1938BC	9626	2008.493	*R*	20	2.262	0.011	6.3*	0.3		Sod1999	0.01	0.5
15361+5531	A1124	9720	2008.591	*W*	20	1.420	0.008	142.3*	0.3				
15416+1940	HU580	9744	2008.509	*V*	10	–	–	–	–	Unres.			
15492−0314	STF1974	9795	2008.509	*W*	20	2.437	0.012	159.0*	0.3				
15589+2147	STF1990BC	9865	2008.539	*W*	20	4.019	0.020	26.1*	0.3	Elongated			
16009+1316	STT303	9880	2008.564	*R*	20	1.555	0.008	172.6*	0.3				
16280+2632	BU813	10071	2008.539	*W*	20	1.154	0.010	175.5*	0.9				
16289+1825	STF2052	10075	2008.539	*R*	20	2.215	0.011	120.5*	0.3		Sca1984d	−0.00	−1.1
”	”	”	”	”	”	”	”	”	”		Lmp2001a	0.02	−0.1
16326+2314	BU817	10107	2008.588	*W*	20	0.936	0.013	327.8*	1.5				
16413+3136	STF2084	10157	2008.539	*V*	20	1.069	0.008	190.5*	0.5		Baz1976	−0.07	0.7
”	”	”	”	”	”	”	”	”	”		Sod1999	−0.03	−0.4
16442+2331	STF2094	10184	2008.588	*R*	20	1.173	0.011	72.1	0.3				
16511+0924	STF2106	10229	2008.564	*R*	20	0.733	0.008	173.8*	0.7		Sca2001g	−0.01	1.2
16518+2840	STF2107	10235	2008.564	*R*	20	1.427	0.011	100.9*	0.3		Sca2003c	0.04	−0.9
16541+0826	HEI857	–	2008.588	*R*	20	0.558	0.008	142.9	0.8				
16564+6502	STF2118	10279	2008.564	*R*	20	1.051	0.008	66.1*	0.3		Sca2002d	−0.11	−1.2
17020+0827	STF2114	10312	2008.591	*R*	20	1.332	0.008	194.4*	0.3				
17053+5428	STF2130	10345	2008.564	*R*	20	2.384	0.012	9.7*	0.3		Hei1981b	0.05	2.0
17195+5832	KR46	–	2008.640	*W*	20	1.675	0.020	63.2*	0.3				
17239+3627	STF2162	10527	2008.591	*W*	20	1.341	0.008	283.8	0.3				
17240+3835	HU1179	10531	2008.588	*R*	10	0.272	0.003	273.5	0.3		Hrt2000b	0.01	1.5
”	”	”	”	”	”	”	”	”	”		Baz1987b	0.04	1.5
17304−0104	STF2173	10598	2008.588	*R*	10	0.650	0.005	158.1*	0.4		Hei1994a	−0.01	−0.4
”	”	”	”	”	”	”	”	”	”		Pbx2000b	−0.01	−0.9
17358+0100	STF2186	10650	2008.588	*W*	20	3.005	0.015	77.8*	0.3				
17386+5546	STF2199	10699	2008.589	*W*	20	2.004	0.010	56.2*	0.3		Pop1995d	0.08	1.6
17397+7256	H141	10734	2008.648	*R*	20	1.021	0.013	335.4	0.4				
17399+0748	HDS2499	–	2008.591	*R*	20	0.662	0.008	240.7*	0.5				
17400−0038	BU631	10696	2008.665	*R*	10	0.264	0.003	87.3	0.4		Hei1996a	−0.01	2.3
17436+2237	HU1285	10743	2008.591	*W*	20	0.543	0.008	214.1	1.0		Sey2002	0.01	−0.4
17439+0551	STF2200	10741	2008.640	*W*	20	1.566	0.009	162.5*	0.4				
17457+1743	STF2205	10769	2008.591	*W*	20	1.044	0.013	0.3*	0.8		Cve2008a	−0.04	−0.6
17471+1742	STF2215	10795	2008.640	*R*	20	0.503	0.008	252.8*	1.6		Cve2006e	0.03	0.4
17506+0714	STT337	10828	2008.665	*R*	20	0.543	0.020	166.6	1.0		Doc1990a	0.04	0.8
17520+1520	STT338	10850	2008.659	*R*	20	0.821	0.008	165.6*	0.4				
17533+3605	STF2243	10874	2008.640	*W*	20	1.119	0.011	39.7*	0.5				
17571+0004	STF2244	10912	2008.640	*R*	20	0.630	0.008	97.9*	0.8		Hei1997	0.10	−2.0
17571+4551	HU235	10934	2008.649	*R*	20	1.598	0.013	283.8*	0.3				
17590+0202	STF2252	10945	2008.659	*W*	20	3.885	0.029	203.7*	0.3				

Table 1 – *continued*

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho(O-C)$ (arcsec)	$\Delta\theta(O-C)$ (°)
17590+1226	STF2254	10949	2008.659	W	20	3.491	0.017	265.9	0.3				
18003+5251	STF2271	10988	2008.649	W	20	3.371	0.026	267.1*	0.3	Elongated			
18017+4011	STF2267	11001	2008.649	R	20	0.560	0.022	271.9	0.6				
18025+4414	BU1127	11010	2008.640	R	20	0.742	0.008	52.7*	1.0		Cve2006e	−0.07	−2.3
18065+4022	STF2282AB	11074	2008.670	R	20	2.592	0.013	82.2*	0.3	Inner peaks			
18065+4022	STF2282AC	11074	2008.670	R	20	2.744	0.014	80.0*	0.4	Outer peaks			
18065+4022	STF2282BC	11074	2008.670	R	20	0.183	0.015	47.6	3.7	New couple			
18096+0400	STF2281	11111	2008.665	R	20	0.630	0.008	289.4*	0.5		Hei1984b	−0.02	1.3
”	”	”	”	”	”	”	”	”	”		Sod1999	0.00	1.4
18097+5024	HU674	11128	2008.665	R	20	0.747	0.008	216.3*	0.4		Sey2002	0.13	1.6
18101+1629	STF2289	11123	2008.665	R	20	1.212	0.008	219.1*	0.6		Hop1964b	−0.03	2.4
18126+3836	BU1091	11170	2008.665	R	20	0.717	0.015	319.9	0.7				
18146+0011	STF2294	11186	2008.665	W	20	1.321	0.019	92.4*	0.3		Luy1934a	0.12	−0.9
18208+7120	STT353	11311	2008.670	R	10	0.484	0.003	266.4*	0.4		Ole1990	0.03	1.5
18238+5139	ES187	11328	2008.670	W	20	2.583	0.013	205.6*	0.6				
18250−0135	AC11	11324	2008.670	R	20	0.882	0.008	355.3*	0.7		Hei1995	0.04	0.6
18250+2724	STF2315	11334	2008.589	R	20	0.646	0.008	119.6*	0.6		WSI2004b	0.02	−0.1
18097+5024	HU674	11128	2008.665	R	20	0.747	0.008	216.3*	0.4		Sey2002	0.13	1.6
18261+0047	BU1203	11339	2008.692	R	20	0.499	0.020	156.6	1.4		Pop1996b	0.02	1.5
18272+0012	STF2316Aa-B	11353	2008.711	R	20	3.676	0.020	319.7*	0.3				
18338+1744	STF2339AB-C	11454	2008.659	R	20	1.615	0.010	275.8*	0.3	Inner peaks			
”	”	”	2008.733	R	20	1.591	0.017	275.7*	0.4	Inner peaks			
18338+1744	STF2339AB-D	11454	2008.659	R	20	2.079	0.012	272.7*	0.3	Outer peaks			
”	”	”	2008.733	R	20	2.074	0.010	272.7*	0.6	Outer peaks			
18338+1744	WAK 21CD	11454	2008.659	R	20	0.474	0.008	262.4*	0.9				
”	”	”	2008.733	R	20	0.493	0.020	262.9*	1.4				
18339+5221	A1377	11468	2008.711	R	10	0.239	0.003	123.2*	0.4		Sca1984e	−0.00	−4.1
”	”	”	”	”	”	”	”	”	”		This paper	−0.02	0.1
18355+2336	STT359	11479	2008.692	R	20	0.738	0.008	5.2*	1.0		Sym1964b	0.01	0.6
”	”	”	”	”	”	”	”	”	”		Sca2009a	0.00	−0.0
18359+1659	STT358	11483	2008.692	R	20	1.653	0.011	151.1*	0.5		Hei1995	0.11	1.1
18374+7741	STT363	11584	2008.711	R	20	0.455	0.008	339.2*	0.9		Sca2009a	0.02	−1.3
18384+2842	STF2356	11529	2008.660	W	20	1.133	0.008	62.3*	0.9				
18387+0451	STT360	11526	2008.711	W	20	1.674	0.020	281.3*	0.3				
18393+2056	STF2360	11546	2008.660	W	20	2.413	0.012	358.4*	0.3				
18443+3940	STF2382AB	11635	2008.670	R	20	2.344	0.012	347.9*	0.3		Nov2006e	−0.01	−0.1
”	”	”	”	”	”	”	”	”	”		WSI2004b	−0.05	−0.0
18443+3940	STF2383CD	11635	2008.670	R	20	2.370	0.012	78.7*	0.3		Doc1984b	0.00	−0.1
18443+6103	STF2403	11661	2008.660	R	20	1.093	0.014	278.0*	0.3				
18477+4904	HEI72	–	2008.671	R	20	0.642	0.012	232.9*	0.5				
18490+2110	STF2401	11715	2008.777	W	20	4.316	0.103	37.6*	0.3				
18497+1041	STF2402	11722	2008.712	W	20	1.428	0.012	208.2*	0.5				
18502+1131	BU265	11735	2008.747	W	20	1.368	0.014	228.4*	0.7				
18508+1059	STF2404	11750	2008.665	R	20	3.534	0.018	181.1*	0.3				
18520+1047	STF2408	11766	2008.711	W	20	2.275	0.029	90.7*	0.3				
18521+1148	HU199	11769	2008.747	W	20	0.877	0.008	346.8*	0.7				
18526+1400	STF2412	11778	2008.747	W	20	1.448	0.008	55.8*	0.4				
18555+2914	STF2419	11847	2008.777	W	20	3.368	0.056	177.2*	0.5				
18570+3254	BU648	11871	2008.777	R	20	0.989	0.014	259.7*	0.7		Sod1999	0.01	−0.2
”	”	”	”	”	”	”	”	”	”		Doc2008f	−0.01	−1.5
18575+5814	STF2438	11897	2008.777	R	20	0.852	0.008	358.8*	0.3		Hrt2001a	0.02	0.5
19019+1910	STF2437	11956	2008.772	R	20	0.587	0.008	9.5	1.3		Sca2008c	0.01	−0.2
19024+6927	STF2478	12015	2008.772	W	20	0.932	0.008	313.3	0.3				
19030+5135	STF2451	11997	2008.772	W	20	1.972	0.010	82.1*	0.3				
19052+1050	BU466	12021	2008.777	W	20	1.923	0.023	164.8*	0.3				
19055+3352	HU940	12033	2008.774	W	20	0.493	0.011	194.1*	1.0		Doc1997b	−0.01	0.3
”	”	”	”	”	”	”	”	”	”		Hei2001	0.01	2.4
19062+3026	STF2454	12040	2008.774	R	20	1.315	0.014	288.2	0.5		Baz1976	0.00	1.0
19071+7204	STT369	12113	2008.774	R	20	0.701	0.008	10.6*	0.4				
19083+5520	D19	12104	2008.774	R	20	0.481	0.020	347.6*	0.7				

Table 1 – *continued*

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho(O-C)$ (arcsec)	$\Delta\theta(O-C)$ (°)
19114+2116	A151	12140	2008.774	*W*	20	0.611	0.008	158.4*	1.3				
19143+1904	STF2484	12201	2008.665	*W*	20	2.147	0.018	239.0*	0.3	Elongated	Hop1973b	−0.13	0.1
19148+4756	A706	12229	2008.747	*W*	20	1.567	0.011	73.6*	0.4				
19220+2230	BU141	12355	2008.747	*R*	20	0.938	0.009	81.8	0.7				
19251+1839	HU339	12416	2008.747	*W*	20	0.816	0.008	245.2	1.3				
19261+3849	HO450	12446	2008.747	*W*	20	1.005	0.011	263.3*	1.0				
19266+2719	STF2525	12447	2008.747	*R*	20	2.114	0.016	288.8	0.3		Hei1984b	0.01	−1.3
19270+7322	STF2550	12524	2008.780	*R*	20	1.938	0.036	249.5	0.9				
19299+4931	BU143	12535	2008.780	*W*	20	2.192	0.011	192.2*	0.7	Elongated			
19307+2758	MCA55Aa,Ac	12540	2008.802	*V*	10	0.361	0.003	100.8*	1.4		Sca2008a	−0.02	−0.9
19311+0824	A1184	12537	2008.780	*W*	20	0.881	0.016	110.7*	0.5				
19350+2947	A368	12633	2008.780	*W*	20	0.503	0.029	152.9*	1.7				
19357+7308	A864	12729	2008.796	*W*	20	0.734	0.008	15.0*	0.6				
19363+3540	STT377	12667	2008.780	*W*	20	0.926	0.017	34.5*	0.7				
19365+4101	STT378	12687	2008.780	*R*	20	1.396	0.029	285.6*	0.3				
19384+0021	BU249	12708	2008.796	*W*	20	0.810	0.017	109.1*	0.6				
19448+1649	STF2569	12861	2008.780	*W*	20	2.112	0.015	356.3*	0.3				
19450+4508	STF2579	12880	2008.660	*R*	20	2.672	0.013	219.7*	0.3		Sca1983a	0.00	−0.8
19453+3048	AG237	12881	2008.796	*W*	20	2.378	0.014	139.7*	0.5	Elongated			
19464+3344	STF2576	12889	2008.660	*R*	20	2.878	0.014	159.8*	0.3		Sca1981f	−0.03	−0.5
”	”	”	”	”	”	”	”	”	”		Sod1999	−0.01	0.0
”	”	”	”	”	”	”	”	”	”		Lmp2001a	0.02	0.5
19483+3710	STT386	12965	2008.665	*R*	20	0.950	0.008	70.9	0.7				
19487+3519	STT387	12972	2008.802	*R*	20	0.534	0.014	124.2*	0.4		WSI2006b	−0.02	−1.4
19575+2018	BU425	13165	2008.671	*W*	20	1.376	0.008	239.6	0.4				
20011+4816	STF2619	13269	2008.802	*R*	20	4.163	0.021	239.0	0.3				
20014+1045	STF2613	13256	2008.774	*R*	20	3.595	0.018	354.5*	0.3		Hop1973b	−0.57	2.5
20042+1148	STF2620	13320	2008.772	*W*	20	1.851	0.022	286.6*	0.4				
20067+1256	BU428	13384	2008.774	*R*	20	0.785	0.009	356.4	0.3				
20078+0924	STF2628	13403	2008.886	*R*	20	3.019	0.015	338.0*	0.3				
20095+5140	STF2645	13447	2008.774	*W*	20	1.597	0.016	137.5*	0.5				
20102+4357	STT400	13461	2008.772	*R*	20	0.618	0.013	335.4	1.2		Hei1997	0.02	0.0
20106+3452	A281	13465	2008.886	*W*	20	4.152	0.038	172.5*	0.3				
20126+0052	STF2644	13506	2008.747	*R*	20	2.629	0.015	206.0	0.4				
20137+1609	STF2651	13542	2008.747	*W*	20	1.007	0.009	278.6	0.4				
20187+3315	STT405	13682	2008.772	*W*	20	0.795	0.013	147.9*	1.2				
20200+3616	BU431	13719	2008.777	*W*	20	0.540	0.017	30.5*	0.6				
20203+3924	STF2668AB-C	13728	2008.875	*R*	20	3.448	0.017	280.2*	0.5				
20203+3924	A1427AB	13728	2008.875	*R*	20	0.253	0.014	130.0	2.2		Doc1987b	0.01	4.0
20216+2346	STF2672	13750	2008.875	*W*	20	0.682	0.012	345.7	1.2	Elongated			
20229+4259	HO128	13786	2008.777	*R*	20	1.356	0.029	359.8*	1.1				
20244+2923	HO457	13818	2008.780	*W*	20	2.024	0.010	60.2*	0.5				
20248+3545	BU432	13830	2008.802	*R*	20	1.404	0.015	196.5*	0.3				
20251+5936	A730	13850	2008.802	*R*	10	0.157	0.004	283.9*	1.0		Sta1981a	−0.01	−6.5
”	”	”	”	”	”	”	”	”	”		This paper (a)	−0.00	−2.4
”	”	”	”	”	”	”	”	”	”		This paper (b)	0.02	0.6
20255+4006	D22	13847	2008.876	*W*	20	2.934	0.030	162.2*	0.8				
20257+5508	A1429	13857	2008.881	*W*	20	0.630	0.021	187.6*	0.8				
20262+3712	HO130	13856	2008.876	*W*	20	1.910	0.018	287.2*	0.8				
20293+3731	WEI35	13909	2008.802	*R*	20	4.101	0.021	213.6*	0.4				
20295+5604	KUI97	–	2008.886	*R*	20	0.788	0.008	128.6*	1.7				
20337+3835	A1431	14007	2008.802	*W*	20	0.828	0.014	28.2*	1.0	Elongated			
20340+3441	STT408	14016	2008.887	*R*	20	1.581	0.038	192.3*	1.4				
20397+6325	DOB15	14155	2008.712	*W*	20	1.971	0.012	77.6	0.3				
20410+3218	STF2716Aa-B	14158	2008.802	*R*	20	2.750	0.014	45.2*	0.3				
20445+2356	STF2724	14227	2008.876	*W*	20	2.520	0.017	149.2*	0.9				
21021+5640	STF2751	14575	2008.802	*R*	20	1.609	0.008	355.6*	0.3				
21022+0711	STF2742	14556	2008.775	*W*	20	2.847	0.014	214.4*	0.3				
21045+7046	STF2771	14630	2008.802	*W*	20	2.714	0.014	33.2	0.3				
21046+5224	STF2757	14615	2008.936	*R*	20	1.872	0.011	263.4*	0.4				
21055+5340	BU680	14626	2008.936	*W*	20	0.550	0.019	284.1*	0.8				

Table 1 – *continued*

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (arcsec)	σ_ρ (arcsec)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho(O-C)$ (arcsec)	$\Delta\theta(O-C)$ (°)
21068+3408	STF2760	14645	2008.876	*W*	20	4.503	0.028	32.2*	0.3	Diffuse			
21086+3012	STF2762	14682	2008.908	*R*	20	3.397	0.017	302.8*	0.6				
21101+0118	HDO318	–	2008.938	*W*	20	1.050	0.008	313.3*	0.3				
21103+4359	STF2773	14711	2008.938	*R*	20	3.260	0.017	112.5*	0.3				
21105+1958	STF2767	14708	2008.938	*R*	20	2.448	0.020	29.0*	0.3				
1267+1341	STF2797	14977	2008.887	*R*	20	3.504	0.018	217.6*	0.3				
21289+1105	STF2799	15007	2008.887	*R*	20	1.860	0.009	81.0*	0.3		Pop1987	0.12	$1.9^{\dagger}$
21304+3504	HLD45	15039	2008.887	*W*	20	1.257	0.017	197.3	0.9				
21308+4752	A769	15053	2008.936	*W*	20	0.663	0.036	291.3	0.9				
21318+3349	STF2802	15060	2008.936	*W*	20	3.802	0.022	9.5*	0.3				
22094+2233	STF2868	15673	2008.938	*R*	20	1.097	0.008	352.9*	0.5				
22100+2308	COU136	–	2008.938	*R*	20	0.468	0.008	24.3*	0.3		Cou1999b	−0.05	0.2
22122+6344	STF2884	15742	2008.887	*W*	20	2.023	0.050	142.8*	0.3				
22143+3745	STF2882	15766	2008.876	*W*	20	3.449	0.020	147.6*	0.6				
22218+6642	STF2903	15881	2008.887	*R*	20	4.156	0.021	96.0*	0.3				
22295−0012	BU76	15984	2008.938	*R*	20	1.615	0.008	7.5*	0.3				
22312+5052	STF2918	16020	2008.876	*W*	20	1.601	0.008	237.2*	0.9				
22328+2625	HO475	16037	2008.939	*R*	20	0.996	0.022	306.4	0.8				
22330+6955	STF2924	16057	2008.939	*R*	10	0.151	0.004	192.6	1.4		Sod1999	−0.00	−11.6
”	”	”	”	”	”	”	”	”	”		This paper	−0.01	− 0.8
22413+7244	STF2940	16191	2008.802	*W*	20	2.673	0.017	137.3*	0.3				
22514+6142	STF2950	16317	2008.802	*R*	20	1.270	0.008	277.6*	0.3				
22537+4445	BU382	16345	2008.802	*R*	20	0.791	0.009	232.7*	0.3		Sod1999	−0.05	0.7
23244+6917	A789	16738	2008.887	*W*	20	1.888	0.009	83.3*	0.4				
23256+3326	AG292	16744	2008.887	*W*	20	3.737	0.019	233.6*	0.3				
23355+5401	MLR620	–	2008.939	*W*	20	0.614	0.017	227.7*	1.8	Diffuse			
23355+5401	MLR620	–	2008.939	*RL*	20	0.616	0.020	225.7*	2.0	Diffuse			

Notes. In Column 9, the exponent * indicates that the position angle θ could be determined without the 180° ambiguity.
Orbit references in Column 12: Alz1998a = Alzner (1998a), Baz1976 = Baize (1976), Baz1980a = Baize (1980a), Baz1987b = Baize (1987b), Cou1999b = Couteau (1999b), Cve2006e = Cvetkovic & Novakovic (2006e), Cve2008a = Cvetkovic, Novakovic & Todorovic (2008a), Doc1984b = Docobo & Costa (1984b), Doc1985c = Docobo & Costa (1985c), Doc1987b = Docobo & Costa (1987b), Doc1990a = Docobo & Costa (1990a), Doc1997b = Docobo & Ling (1997b), Doc2004a = Docobo & Ling (2004a), Doc2007e = Docobo et al. (2007e), Doc2008f = Docobo & Ling (2008f), Fei1969 = Feierman (1969), Ge1954 = Gasteyer (1954), Gon2002b = Gontcharov & Kiyaeva (2002b), Hei1966 = Heintz (1966), Hei1975b = Heintz (1975b), Hei1981b = Heintz (1981b), Hei1984b = Heintz (1984b), Hei1988a = Heintz (1988a), Hei1988d = Heintz (1988d), Hei1991 = Heintz (1991), Hei1994a = Heintz (1994a), Hei1995 = Heintz (1995), Hei1996a = Heintz (1996a), Hei1996c = Heintz (1996c), Hei1997 = Heintz (1997), Hei1998 = Heintz (1998), Hei2001 = Heintz (2001), Hop1964b = Hopmann (1964b), Hop1971 = Hopmann (1971), Hop1973b = Hopmann (1973b), Hou1987 = Houser (1987), Hrt1989 = Hartkopf, McAlister & Franz (1989), Hrt2000b = Hartkopf (2000b), Hrt2001a = Hartkopf & Mason (2001a), Hrt2009 = Hartkopf & Mason (2009), Lin1985c = Ling (1985c), Lin2007b = Ling (2007b), Lmp2001a = Lampens & Strigachev (2001a), Luy1934a = Luyten (1934a), Msn1999a = Mason, Douglass & Hartkopf (1999a), Msn2001c = Mason & Hartkopf (2001c), Nov2006e = Novakovic & Todorovic (2006e), Nov2007d = Novakovic (2007d), Ole1990 = Olevic & Catovic (1990), Ole2001 = Olevic & Jovanovic (2001), Ole2003b = Olevic & Cvetkovic (2003b), Pal2005b = Pavlovic & Todorovic (2005b), Pbx2000b = Pourbaix (2000b), Pop1987 = Popovic (1987), Pop1995d = Popovic & Pavlovic (1995d), Pop1996b = Popovic & Pavlovic (1996b), Pru2009 = Prieur et al. (2009) Sca1981f = Scardia (1981f), Sca1983a = Scardia (1983a), Sca1983e = Scardia (1983e), Sca1983f = Scardia (1983f), Sca1984d = Scardia (1984d), Sca1984e = Scardia (1984e), Sca1985c = Scardia (1985c), Sca2001g = Scardia et al. (2001g), Sca2002a = Scardia et al. (2002a), Sca2002b = Scardia et al. (2002b), Sca2002d = Scardia et al. (2002d), Sca2003c = Scardia et al. (2003c), Sca2005a = Scardia et al. (2005a), Sca2007a = Scardia et al. (2007a), Sca2007c = Scardia et al. (2007c), Sca2008a = Scardia et al. (2008a), Sca2008c = Scardia (2008c), Sca2008d = Scardia et al. (2008d), Sca2009a = Scardia et al. (2009a), Sey1999b = Seymour & Hartkopf (1999b), Sey2000b = Seymour & Mason (2000b), Sey2002 = Seymour et al. (2002), Sod1999 = Söderhjelm (1999), Sta1981a = Starikova (1981a), Sym1964b = Symms (1964b), vDl1976 = van Dessel (1976), Wrz1956a = Wierzbinski (1956a), Wrz1956c = Wierzbinski (1956c), WSI2004a = Mason et al. (2004a), WSI2004b = Mason et al. (2004b), WSI2006b = Mason et al. (2006b), Zae1984 = Zaera (1984) and Zul1981 = Zulevic (1981).

Table 2. Characteristics of the filters used for the measurements of Table 1.

Name	Identification	λ_c (nm)	Δ_λ (nm)
V	ORIEL/57581	530	57
R	ORIEL/57621	644	70
RL	ORIEL/57661	743	69
W	ICCD alone	650	420

There is only one unresolved object: ADS 9744. This is compatible with the ephemeris of Docobo & Ling (2007d)'s orbit that gives $\rho = 0.06$ arcsec, which is smaller than the diffraction limit of the Zeiss telescope.

3.1 Multiple systems

ADS 11454: this object is known as a quadruple system. We already observed it in 2006.699, 2006.715 and 2006.716, and then managed to restore an image of the AB, C and D components from

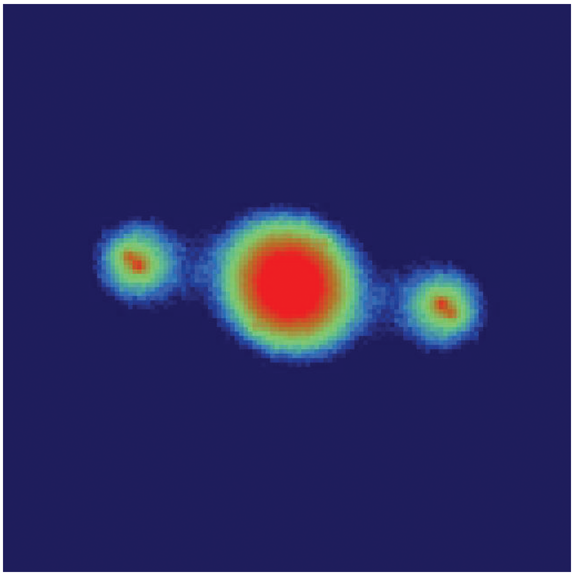

Figure 3. Auto-correlation of the newly discovered triple system ADS 11074.

its bispectrum (see Paper VI). The auto-correlations obtained in 2008.659 and 2008.733 also exhibit double secondary peaks, associated with WAK 21CD. The inner and outer secondary peaks belong to STF 2339AB-C and STF 2339AB-D, respectively. As in 2006, the couple HU 322AB is still unresolved in our images.

ADS 11074 (new discovery): although this star is only catalogued as a binary, the secondary peaks of our auto-correlations are clearly double in the observations made in 2008.670 (see Fig. 3). In our previous observations of 2006.639 (Paper VI), the secondary peaks were very elongated, but not really separated (likely because of insufficient seeing). We propose to call this pair STF 2282BC, where C is the new component. The couples composed by the inner and outer peaks would then belong to STF 2282AB and STF 2282AC, respectively.

ADS 13728: two known couples could be measured in the same auto-correlation frame: A 1427 AB and STF2268 AB-C. The AB components could only be seen after subtracting a model of the background (see Paper IV).

3.2 Quadrant determination

As our measurements were obtained from the *symmetric* auto-correlation files, the θ values first presented a 180° ambiguity. To resolve this ambiguity and determine the quadrant containing the companion, we have used Aristidi et al. (1997)'s method by computing and analysing restricted triple correlation files. For the couples with the largest separations, a straightforward determination could be done when the companions were visible in the long integration files.

As a result, in Table 1, we are able to give the unambiguous (i.e. 'absolute') position angles of 186 out of 240 measurements, i.e. 78 per cent of the total. They are marked with an asterisk in Column 9. Otherwise, our angular measurements were reduced to the quadrant reported in the WDS Catalogue.

Our 'absolute' θ values are consistent with the values tabulated in the WDS Catalogue for all objects except for ADS 5570, 10945 and 15007. However, a clear and high contrast between the two secondary peaks of the restricted triple correlation is observed in all those cases, which is a good indication of the validity of our quadrant determination. In the following, we discuss each case using the usual convention of numbering the quadrants (Q) from 1 to 4 to indicate the North-East, South-East, South-West and North-West quadrants, respectively.

ADS 5570: our quadrant $Q = 2$ is consistent with the space-based *Hipparcos*/Tycho measurements in 1991 and with Douglass et al. (1999)'s measurement of 1997, both published in the 'Fourth Catalogue of Interferometric Measurements of Binary Stars' (Hartkopf et al. 2010, hereafter IC4). Then, after 2002, the quadrant abruptly switches to 4 in IC4, which creates a discontinuity of 180° in the θ measurements. The small difference in magnitude between the two components ($\Delta m_V = 0.25$) can account for the difficulty of determining the quadrant. This pair was observed by us also in 2006.258 but it was then impossible to determine the quadrant because of insufficient signal-to-noise ratio.

ADS 10945: our quadrant $Q = 3$, obtained in W (close to R), is in contrast with the value $Q = 1$ of the other observations published in IC4, all made in V, with the exception of our measurement of 2006.696 in R in Paper VI (for which we were unable to determine the quadrant). The spectral class of the system is A2, and the companion is likely to be much cooler. Indeed, the contrast between the two components decreases from B to V ($\Delta m_B = 1.4$ and $\Delta m_V = 0.5$), which gives a hint of a probable quadrant inversion in R. This would explain why we find a different quadrant value in W.

ADS 15007: our $Q = 1$ seems reliable, but is in disagreement with all 70 observations, spanning 83 years, listed in IC4 and mostly made in V. The very small difference in magnitude between the components ($\Delta m_V = 0.01$) well accounts for the difficulty of determining the quadrant. This case is similar to that of ADS 10945. The spectral class of the system is F4V and a quadrant inversion between V and R is likely. Because of the unfavourable signal-to-noise ratio, we were unable to determine the quadrant for our last observations in 2004.936 (Paper II) and 2006.727 (Paper VI), in R. This is why those two observations were reported with $Q = 3$ in IC4, simply to be in agreement with the other measurements.

3.3 Comparison with published ephemerides

The $(O - C)$ residuals of the measurements for the 65 systems with a known orbit in Table 1 are displayed in Columns 13 and 14 for the separation ρ and position angle θ, respectively. The orbital elements used for computing the ephemerides were retrieved from OC6. The corresponding authors are given in Column 12, using the style of the OC6.

The residuals reported in this table were computed with a selection of valid orbits found in the 'master' file of the OC6 catalogue. We did not always use the most recent orbits since sometimes older orbits led to equivalent or even smaller residuals. We think that the publication of many new orbits is not always scientifically justified. Indeed, a residual difference of 1°–2° in θ and a few hundreds of arcsec in ρ is meaningless, and two orbits leading to residuals in that range can be regarded as equally good.

Fig. 4 shows that the residuals are well centred around the origin, with a rather large scatter that can be explained by the (old) age of many orbits. The mean values computed with the residuals of Table 1 are $\langle \Delta\rho_{O-C} \rangle = 0.00 \pm 0.07$ arcsec and $\langle \Delta\theta_{O-C} \rangle = -0.^\circ1 \pm 1.^\circ9$. The small values obtained for those offsets provide an additional validation of our calibration made with a grating mask (see Paper III). In the following, we examine the cases of ADS 4841, 12201, 13850 and 16057 that appear with the largest residuals in Fig. 4.

ADS 4841 (η Gem): the available observations only cover a small fraction of the full orbit, but the last ones begin to depart from

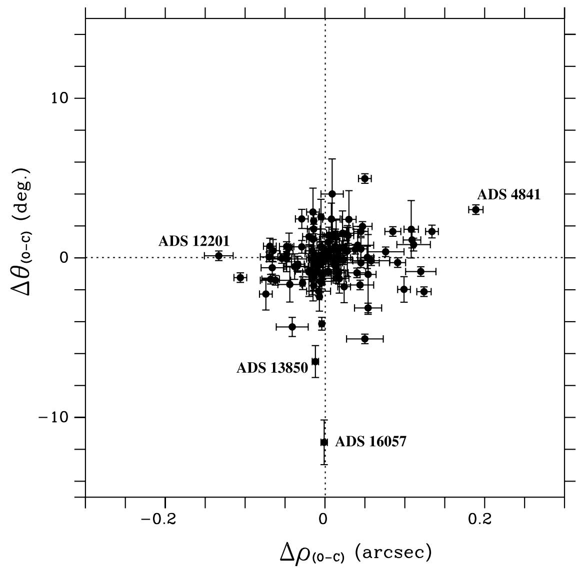

Figure 4. Residuals of the measurements of Table 1 from the published orbits.

Baize (1980a)'s orbit (with residuals of +0.19 arcsec and +3° for our measure). The orbital period is likely to be in the range of 400–600 yr, and it will be impossible to compute a new reliable orbit, for many years. It is a pity, especially because the luminosity class of this complex system is badly known. The spectral type could be M3.5I-II or M3III, according to the WDS or SIMBAD data bases, respectively. The consequence is a complete indetermination of the total mass, that would be 20 $M_\odot$ in the first case, or 6.6 $M_\odot$ in the second case!

ADS 12201: the preliminary orbit computed by Hopmann (1973b) gives large residuals in ρ (−0.13 arcsec). This is not surprising because this orbit is completely undetermined. It is based on a small orbital arc of about 10° only, with a small curvature. Clearly more observations are needed for determining the orbit of this object.

ADS 13850 and ADS 16057: these objects will be discussed in the next section, since new orbits have been computed for both.

4 REVISED ORBITS OF ADS 11468, 13850 AND 16057

In this section we present the new orbits we have computed for ADS 13850 and 16057, which have the largest residuals in Fig. 4, and for ADS 11468, for which our previous orbit (Scardia 1984e) now leads to large residuals in θ.

Table 4. ADS 11468: $O - C$ residuals of our new orbit (after 1998.0). The symbol ^{P} indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ (arcsec)	$\Delta\theta_{(O-C)}$ (°)	Observer
1998.679	-0.007^P	0.5^P	Sca
1999.728	−0.004	2.4	Doc
2000.497	−0.016	−0.3	Doc
2002.574	−0.044	−4.5	WSI
2003.247	−0.012	−0.5	Rtk
2003.288	−0.010	−0.9	Rtk
2003.608	−0.012	0.4	Lne
2003.611	−0.012	0.3	Lne
2003.613	−0.012	0.3	Lne
2003.616	−0.012	0.4	Lne
2004.657	-0.015^P	1.2^P	Sca
2006.677	-0.012^P	-0.3^P	Sca
2008.711	-0.023^P	0.1^P	Sca

We have followed the same method for those three objects. Using our last measurements with PISCO and the other available observations contained in the data base maintained by the United States Naval Observatory, we first computed the preliminary orbital elements with the analytical method of Kowalsky (1873). We then used them as initial values for the least-squares method of Hellerich (1925). When convergence was achieved, Hellerich's method led to an improvement of the orbital elements with an estimation of their errors.

The final orbital elements are presented in Table 3. The description of the format of the tables contained in this section can be found in Papers VI and VII. The errors reported for ADS 11468, 13850a and 16057 were obtained by Hellerich's method. Convergence was not achieved for 'solution b' of ADS 13850 which explains their absence for this orbit. The corresponding $(O - C)$ residuals, restricted to the last observations for reasons of space, are given in Tables 4, 5 and 6 for ADS 11468, 13850 and 16057, respectively. In the last column, we report the name of the observer, using the US Naval Observatory convention.

The apparent orbits are shown in Fig. 5 as solid lines and the observational data used for the calculation of the orbital elements are plotted as small crosses or, in the case of PISCO observations, as filled circles. For ADS 13850, the observations made before 1930, whose quadrant differ in the solutions 'a' and 'b', are drawn with small, unfilled squares. The orientation of the graphs conforms to the convention adopted by the observers of visual binary stars. For each object, the big cross indicates the location of the primary component, and the straight line going through this point is the line of apsides. The sense of rotation of the companion is indicated with an arrow.

Table 3. New orbital elements of ADS 11468, 13850 ('solution a' and 'solution b') and 16057.

ADS	Ω_{2000} (°)	ω (°)	i (°)	e	T (yr)	P (yr)	n (deg yr^{-1})	a (arcsec)	A (arcsec)	B (arcsec)	F (arcsec)	G (arcsec)
11468	55.2	272.0	49.3	0.437	1918.533	228.1	1.5783	0.268	0.15378	−0.09510	0.15293	0.23107
	±4.2	±17	±4.1	±0.05	±3.4	±45	±0.31	±0.013				
13850a	56.6	266.5	129.6	0.818	1932.470	88.44	4.0706	0.197	−0.11128	0.05906	0.10189	0.16829
	±4.0	±2.5	±4.3	±0.02	±0.4	±1.1	±0.05	±0.02				
13850b	152.2	309.2	118.5	0.005	2038.638	175.089	2.0561	0.231	−0.16899	−0.00747	−0.12586	0.14511
16057	81.17	2.52	77.66	0.272	1971.586	218.8	1.6453	0.759	0.10935	0.75037	−0.16525	−0.00810
	±0.41	±2.1	±0.25	±0.02	±1.1	±8.5	±0.064	±0.043				

Table 5. ADS 13850: $O - C$ residuals of our two orbits, 'solution a' and 'solution b' (after 1985.0). The symbol ^{P} indicates PISCO measurements.

Epoch	Solution a $\Delta\rho_{(O-C)}$ (arcsec)	Solution a $\Delta\theta_{(O-C)}$ (°)	Solution b $\Delta\rho_{(O-C)}$ (arcsec)	Solution b $\Delta\theta_{(O-C)}$ (°)	Observer
1985.550	0.017	6.4	0.019	5.9	Hei
1985.552	0.037	−6.5	0.039	−7.0	Sca
1988.660	−0.018	−3.9	−0.014	−4.8	Mlr
1988.663	−0.000	0.2	0.004	−0.7	McA
1989.717	0.000	1.3	0.006	0.4	Hrt
1991.250	−0.005	1.8	0.003	0.8	HIP
1992.680	−0.041	0.6	−0.031	−0.3	Mlr
1997.694	0.001	3.0	0.018	2.3	Pri
2004.717	0.012^P	-2.0^P	0.036^P	-1.0^P	Sca
2008.802	-0.000^P	-2.4^P	0.022^P	0.6^P	Sca

Table 6. ADS 16057: $O - C$ residuals of our new orbit (after 1995.0). The symbol ^{P} indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ (arcsec)	$\Delta\theta_{(O-C)}$ (°)	Observer
1995.856	−0.054	0.6	WSI
1995.940	-0.013^P	0.2^P	Ari
1996.880	−0.017	−1.5	Hei
1998.665	-0.019^P	-3.1^P	Pru
1998.665	-0.013^P	2.0^P	Pru
1999.720	0.029	4.8	Alz
2003.419	−0.006	5.0	Rtk
2003.444	−0.029	−4.8	Rtk
2004.950	0.010^P	2.0^P	Sca
2008.939	-0.013^P	-0.8^P	Sca

The ephemerides for 2010–2020 are presented in Table 7, and some physical parameters derived for those systems are reported in Table 8. In the latter, the *Hipparcos* parallaxes are the revised values from van Leeuwen (2007) and the linear sizes of a and $\mathfrak{M}_{\rm total}$ were computed from our orbital elements and those values.

4.1 New orbit of ADS 11468, A 1377

From the 138 measurements obtained since 1906, we derived the new orbital elements reported in Table 3. The standard deviations of the residuals are 2°.7 and 0.02 arcsec for θ and ρ, respectively.

The total mass of the system derived from our orbit is $2.8 \pm 1.3\,{\rm M}_\odot$ (see Table 8), which is consistent with the value expected for a K0III binary system.

4.2 New orbit of ADS 13850, A 730

This pair was discovered by R.G. Aitken in 1904 June with the big refractor of Lick Observatory (Aitken 1904). The first orbit was computed by Baize (1955) who noted '... The quadrant, in this couple with nearly equally bright components,[1] is practically undetermined, and we had to reverse all the position angles, from 1937 to 1949 included, in order to obtain a representation compatible with Kepler's area law...' The corresponding position angles are displayed in Fig. 6. The last-published orbits from Starikova (1981a) and Heintz (1986) also used this quadrant correction.

[1]There are only two photometric measures of the components of ADS 13850. Wilson (1941) reported $\Delta m_V = 0.2$ only, but *Hipparcos*/Tycho found $\Delta m_V = 0.6$ (ESA 1997).

4.2.1 ADS 13850: solution a

Using Baize's quadrant correction, we obtain the orbital elements of 'solution a', that well fit the corresponding measurements (see Fig. 5a). The mean standard deviation of the residuals for the 58 available measures is 3°.04 for θ and 0.03 arcsec for ρ.

However, using the revised *Hipparcos* parallax of $\pi = 3.98$ mas (Table 8), those orbital elements lead to total mass of $15.5 \pm 6.7\,{\rm M}_\odot$, which is much too large for an A2IV binary system. This was also the case of the previously published orbits (e.g. $\mathfrak{M}_{\rm total} = 11.2\,{\rm M}_\odot$ with Starikova's orbit)

4.2.2 ADS 13850: solution b

In order to obtain a smaller value of $\mathfrak{M}_{\rm tot}$, we propose to extend Baize's correction to the measurements made before 1930 (see Fig. 6). The consequence is a smaller variation of θ, which leads to a less eccentric orbit with a longer period.

Indeed, using Kowalsky's method we obtained the orbital elements reported in Table 3 as 'solution b', with a period nearly twice longer than that of 'solution a'. Unfortunately, Hellerich's method did not converge, which impeded us from computing the errors on those orbital elements. As this orbit is nearly circular, the values of T and ω are not well determined. The mean standard deviation of the residuals is 3°.04 for θ and 0.02 arcsec for ρ.

Using the revised *Hipparcos* parallax we obtain $\mathfrak{M}_{\rm tot} = 6.4\,{\rm M}_\odot$, which is still large, but marginally compatible with the theoretical values when taking into account the error bars. Indeed, Straizys & Kuriliene (1981) give 4.4 ${\rm M}_\odot$ for an A2IV binary system, and the 10 per cent uncertainty on the parallax leads to an error of 30 per cent (i.e. 2 ${\rm M}_\odot$) on the total mass. Furthermore, the radial velocity measurements have a large dispersion (4 measures with a mean of -1 km s^{-1} and a standard deviation of 8 km s^{-1}, in SIMBAD data base), which suggests the presence of a third body that could account for this mass excess.

The ephemerides of Table 7 show that future observations will soon allow us to distinguish between the orbits 'a' and 'b'. Unfortunately, the angular separation for the next years is expected to be smaller than the resolving capabilities of PISCO on the Zeiss telescope. Apertures with diameters larger than 2 m are needed for this purpose.

4.3 New orbit of ADS 16057, STF 2924

This couple was discovered by F.G.W. Struve with the famous 24 cm refractor of Dorpat Observatory. It is reported without any comment in his catalogue 'Stellarum Duplicium et Multiplicium Mensurae Micrometricae ....' (Struve 1837) where he published all his measures. In his 'Catalogus Novus Stellarum Duplicium et Multiplicium' (Struve 1827), where he published the list of his discoveries, he simply qualified this couple as 'vicinissimae' (very close).

Since its discovery, ADS 16057 was rather well monitored, even during the period of 1930–1950 when the separation decreased at around 0.2 arcsec, and when the second world war stopped nearly

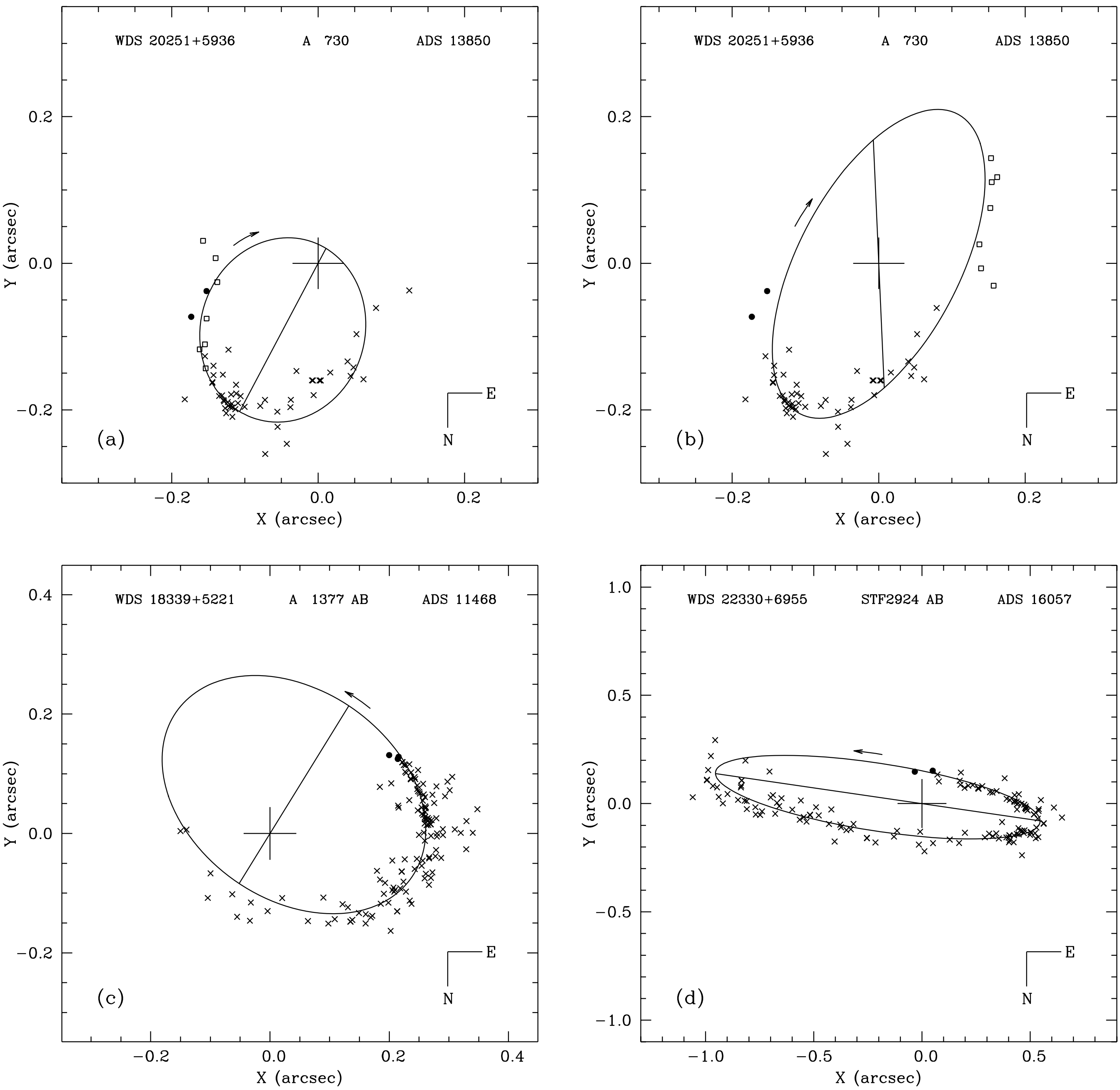

Figure 5. New orbits of ADS 13850 [(a) for 'solution a' and (b) for 'solution b'], ADS 11468 (c) and ADS 16057 (d).

all visual binary scientists from observing. Nevertheless, they are scarce between 1940 and 1950, with one measure made by Rabe (1953) in München and four others by van Biesbroeck (1954) with the 40-inch Yerkes refractor and with the 82-inch McDonald telescope. The first orbit was computed by Arend (1953). The last orbits from Heintz (1991) and Söderhjelm (1999) do not represent the measurements made after 2003.43, especially in θ. This justifies the revision of this orbit.

The new orbital elements we found are reported in Table 3. They well fit all the available observations (148 in θ and 134 in ρ), even the last ones (see Table 6). The mean residuals are 2°.4 for θ and 0.06 arcsec for ρ.

Although the orbital ellipse has not been fully monitored yet (see Fig. 5d), the orbit we obtain seems reliable. Indeed, the total mass of the system (see Table 8) is in good agreement with the theoretical value expected for a system of this spectral type (A9 III).

5 CONCLUSION

In 2008, we obtained 240 new measurements of 237 visual binaries with PISCO in Merate, with an average accuracy of 0.014 arcsec for the angular separation and 0°.6 for the position angles. The total number of measurements made in Merate since 2004 now exceeds 1800. This work is thus a good contribution to the continuing monitoring of long period visual binary systems, which is important for refining systemic stellar masses.

Table 7. New ephemerides of ADS 11468, 13850 (13850a for 'solution a', and 13850b for 'solution b') and 16057.

Epoch	ADS 11468 ρ (arcsec)	ADS 11468 θ (°)	ADS 13850a ρ (arcsec)	ADS 13850a θ (°)	ADS 13850b ρ (arcsec)	ADS 13850b θ (°)	ADS 16057 ρ (arcsec)	ADS 16057 θ (°)
2010.0	0.253	124.5	0.150	283.4	0.130	279.8	0.175	200.7
2011.0	0.253	125.6	0.145	280.7	0.127	276.6	0.188	206.7
2012.0	0.253	126.6	0.138	277.8	0.123	273.3	0.202	211.8
2013.0	0.252	127.6	0.131	274.7	0.120	269.7	0.218	216.2
2014.0	0.252	128.7	0.124	271.1	0.118	266.0	0.234	220.0
2015.0	0.252	129.7	0.115	267.0	0.115	262.2	0.251	223.4
2016.0	0.252	130.8	0.105	262.2	0.113	258.1	0.269	226.2
2017.0	0.252	131.8	0.094	256.4	0.112	254.0	0.287	228.8
2018.0	0.251	132.9	0.080	248.8	0.111	249.8	0.306	231.0
2019.0	0.251	133.9	0.063	237.5	0.110	245.4	0.324	233.0
2020.0	0.251	135.0	0.041	215.5	0.110	241.1	0.343	234.7

Table 8. Physical parameters (a and $\mathfrak{M}_{total}$) derived from the new orbital elements.

ADS	HIP	m_V	Sp. type	π_{HIP} (mas)	a (arcsec)	a (au)	$\mathfrak{M}_{total}$ $M_\odot$	Notes
11468	91013	5.38	K0III	5.12	0.268	52.3	2.8	
				±0.40	±0.013	±4.8	±1.3	
13850	100714	6.44	A2IV	3.98	0.197	49.5	15.5	Solution a
				±0.41	±0.02	±7.2	±6.7	
					0.231	58.0	6.4	Solution b
16057	111314	6.02	A9III	12.89	0.759	58.9	4.3	
				±0.40	±0.043	±3.8	±0.9	

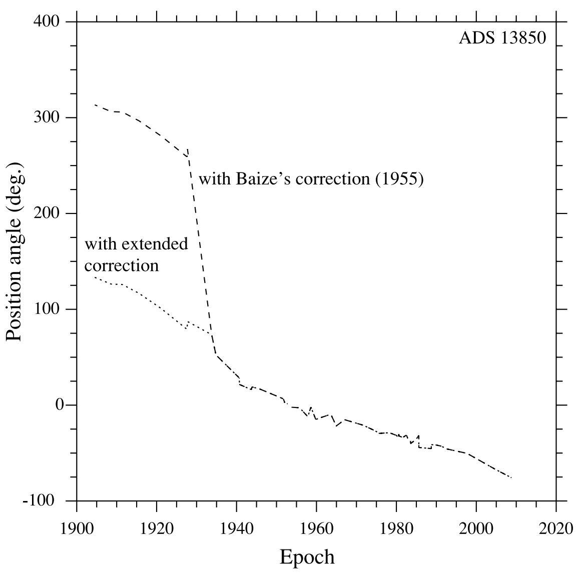

Figure 6. Position angles of ADS 13850 with Baize's quadrant correction (1955) (dashed line) and with our alternative extended correction (dotted line), that led to our two orbits, 'solution a' and 'solution b', respectively. The seven measures made before 1930, that differ by 180° in those two data sets, are plotted as unfilled squares in Figs 5(a) and (b).

We have found a new component for ADS 11074, which is thus a new triple star system.

We have used the measurements reported here to revise the orbits of ADS 11468, 13850 and 16057, whose elements are presented in this paper.

For ADS 13850, we first used the quadrant correction adopted by all the other authors (e.g. Baize 1955; Starikova 1981a; Heintz 1986), and obtained a short period orbit ('solution a') with an unrealistic stellar mass, similarly to what was obtained by those authors. We then proposed an alternative correction which led to a longer orbital period and a much smaller stellar mass ('solution b'), close to theoretical values. Future observations with bigger telescopes than ours should soon allow to distinguish between those two orbits.

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REFERENCES

Aitken R. G., 1904, Lick Obs. Bull., 61, 6
Aitken R. G., 1932, New General Catalogue of Double Stars. Carnegie Institute, Washington
Alzner A., 1998a, A&AS, 132, 253
Arend S., 1953, Bull. Astron. Obs. R. Belgique, 4, 166
Aristidi E., Carbillet M., Lyon J.-F., Aime C., 1997, A&AS, 125, 139
Baize P., 1955, J. Obs. XXXVIII, 3, 37

Baize P., 1976, A&AS, 26, 177
Baize P., 1980a, A&AS, 39, 83
Baize P., 1987b, Inf. Circ. 102
Couteau P., 1999b, Cat. de 2700 Etoiles Doubles 'COU'. Publ. Obs. Côte d'Azur, Nice
Cvetkovic Z., Novakovic B., 2006e, Serbian Astron. J., 173, 73
Cvetkovic Z., Novakovic B., Todorovic N., 2008a, New Astron., 13, 125
Docobo J. A., Costa J. M., 1984b, Inf. Circ. 92
Docobo J. A., Costa J. M., 1985c, Inf. Circ. 96
Docobo J. A., Costa J. M., 1987b, Inf. Circ. 103
Docobo J. A., Costa J. M., 1990a, Inf. Circ. 110
Docobo J. A., Ling J. F., 1997b, Inf. Circ. 132
Docobo J. A., Ling J. F., 2004a, Inf. Circ. 152
Docobo J. A., Ling J. F., 2007d, AJ, 133, 1209
Docobo J. A., Ling J. F., 2008f, Inf. Circ. 165
Docobo J. A., Andrade M., Tamazian V. S., Costado M. T., Lahulla J. F., 2007e, Rev. Mex. Astron. Astron., 43, 141
Douglass G. G., Mason B. D., Germain M. E., Worley C. E., 1999, AJ, 118, 1335
ESA, 1997, The Hipparcos and Tycho Catalogues, ESA SP-1200. ESA Publications Division, Noordwijk
Feierman B. H., 1969, AJ, 74, 244
Gasteyer C., 1954, AJ, 59, 243
Gontcharov G. A., Kiyaeva O. V., 2002b, A&A, 391, 647
Hartkopf W. I., 2000b, Inf. Circ. 141
Hartkopf W. I., Mason B. D., 2001a, Inf. Circ. 143
Hartkopf W. I., Mason B. D., 2009, AJ, 138, 813
Hartkopf W. I., Mason B. D., 2010, 'Sixth Catalogue of Orbits of Visual Binary Stars', http://ad.usno.navy.mil/wds/orb6.html (OC6)
Hartkopf W. I., McAlister H. A., Franz O. G., 1989, AJ, 98, 1014
Hartkopf W. I., Mason B. D., Wycoff G. L., McAlister H. A., 2010, 'Fourth Catalogue of Interferometric Measurements of Binary Stars', http://ad.usno.navy.mil/wds/int4.html (IC4)
Heintz W. D., 1966, Veroff. Sternw. Munchen, 7, 19
Heintz W. D., 1975b, ApJS, 29, 331
Heintz W. D., 1981b, PASP, 93, 90
Heintz W. D., 1984b, A&AS, 56, 5
Heintz W. D., 1986, A&AS, 65, 411
Heintz W. D., 1988a, PASP, 100, 834
Heintz W. D., 1988d, A&AS, 72, 543
Heintz W. D., 1991, A&AS, 90, 311
Heintz W. D., 1994a, AJ, 108, 2338
Heintz W. D., 1995, ApJS, 99, 693
Heintz W. D., 1996a, ApJS, 105, 475
Heintz W. D., 1996c, AJ, 111, 412
Heintz W. D., 1997, ApJS, 111, 335
Heintz W. D., 1998, ApJS, 117, 587
Heintz W. D., 2001, Inf. Circ. 143
Hellerich J., 1925, Astron. Nachr., 223, 335
Hopmann J., 1964b, Ann. Sternw. Wien, 26, 1
Hopmann J., 1971, Astron. Mitt. Wien, 7, 1
Hopmann J., 1973b, Astron. Mitt. Wien, 13
Houser J. L., 1987, PASP, 99, 509
Kowalsky M., 1873, Procès-verbaux de l'Université Impériale de Kasan
Lampens P., Strigachev A., 2001a, A&A, 368, 572
Ling J. F., 1985c, Inf. Circ. 96
Ling J. F., 2007b, Inf. Circ. 162
Luyten W. J., 1934a, AJ, 43, 105
Mason B. D., Hartkopf W. I., 2001c, Inf. Circ. 144
Mason B. D., Douglass G. G., Hartkopf W. I., 1999a, AJ, 117, 1023
Mason B. D. et al., 2004a, AJ, 127, 539
Mason B. D., Hartkopf W. I., Wycoff G. L., Rafferty T. J., Urban S. E., Flagg L., 2004b, AJ, 128, 3012
Mason B. D., Hartkopf W. I., Wycoff G. L., Holdenried E. R., 2006b, AJ, 132, 2219
Mason B. D., Wycoff G. L., Hartkopf W. I., 2010, 'Washington Double Star Catalogue', http://ad.usno.navy.mil/wds/wds.html (WDS)
Novakovic B., 2007d, Chin. J. Astron. Astrophys., 7, 415
Novakovic B., Todorovic N., 2006e, Serbian Astron. J., 172, 21
Olevic D., Catovic Z., 1990, Inf. Circ. 112
Olevic D., Cvetkovic Z., 2003b, Inf. Circ. 150
Olevic D., Jovanovic P., 2001, Serbian Astron. J., 163, 5
Pavlovic R., Todorovic N., 2005b, Serbian Astron. J., 170, 73
Popovic G. M., 1987, Bull. Obs. Astron. Belgrade, 137, 82
Popovic G. M., Pavlovic R., 1995d, Bull. Obs. Astron. Belgrade, 151, 45
Popovic G. M., Pavlovic R., 1996b, Bull. Obs. Astron. Belgrade, 153, 57
Pourbaix D., 2000b, A&AS, 145, 215
Prieur J.-L., Koechlin L., André C., Gallou G., Lucuix C., 1998, Exp. Astron., 8, 297
Prieur J.-L., Scardia M., Pansecchi L., Argyle R. W., Sala M., Ghigo M., Koechlin L., Aristidi E., 2008, MNRAS, 387, 772 (Paper V)
Prieur J.-L., Scardia M., Pansecchi L., Argyle R. W., Sala M., 2009, MNRAS, 395, 907 (Paper VII)
Rabe W., 1953, Erganz. Abd. Astron. Nachr., 12, 50
Scardia M., 1981f, Inf. Circ. 84
Scardia M., 1983a, Inf. Circ. 89
Scardia M., 1983e, Astron. Nachr., 304, 29
Scardia M., 1983f, Astron. Nachr., 304, 257
Scardia M., 1984d, Inf. Circ. 92
Scardia M., 1984e, Inf. Circ. 93
Scardia M., 1985c, Inf. Circ. 96
Scardia M., Prieur J.-L., Koechlin L., Aristidi E., 2001g, Inf. Circ. 145
Scardia M., Prieur J.-L., Koechlin L., Aristidi E., 2002a, Inf. Circ. 146
Scardia M., Prieur J.-L., Koechlin L., Aristidi E., 2002b, Inf. Circ. 147
Scardia M., Prieur J.-L., Koechlin L., Aristidi E., 2002d, Inf. Circ. 148
Scardia M., Prieur J.-L., Koechlin L., Aristidi E., 2003c, Inf. Circ. 149
Scardia M., Prieur J.-L., Sala M., Ghigo M., Koechlin L., Aristidi E., Mazzoleni F., 2005a, MNRAS, 357, 1255 [with erratum in MNRAS 362, 1120] (Paper I)
Scardia M., Prieur J.-L., Pansecchi L., Argyle R. W., Sala M., Ghigo M., Koechlin L., Aristidi E., 2006, MNRAS, 367, 1170 (Paper II)
Scardia M. et al., 2007a, MNRAS, 374, 965 (Paper III)
Scardia M., Argyle R. W., Prieur J.-L., Pansecchi L., Basso S., Law N. M., Mackay C. D., 2007c, Astron. Nachr., 328, 146
Scardia M. et al., 2008a, Astron. Nachr., 329, 54 (Paper IV)
Scardia M., Prieur J.-L., Pansecchi L., Argyle R. W., 2008c, Astron. Nachr., 329, 379
Scardia M., Prieur J.-L., Pansecchi L., Argyle R. W., 2008d, Inf. Circ. 165
Scardia M., Prieur J.-L., Pansecchi L., Argyle R. W., Sala M., 2009a, Astron. Nachr., 330, 1, 55 (Paper VI)
Scardia M., Prieur J.-L., Pansecchi L., Argyle R. W., Sala M., 2010, Astron. Nachr., 331, 286 (Paper VIII)
Seymour D., Hartkopf W., 1999b, Inf. Circ. 139
Seymour D., Mason B., 2000b, Inf. Circ. 141
Seymour D., Mason B. D., Hartkopf W. I., Wycoff G. L., 2002, AJ, 123, 1023
Söderhjelm S., 1999, A&A, 341, 121
Starikova G. A., 1981a, Soviet Astron. Lett., 7, 130
Straizys V., Kuriliene G., 1981, Ap&SS, 80, 353
Struve F. G. W., 1827, in Schuenmann J. C., ed., Catalogus Novus Stellarum Duplicium et Multiplicium. Univ. Dorpat, Tartu
Struve F. G. W., 1837, Stellarum Duplicium et Multiplicium Mensurae Micrometricae. Typographia Academica, Petropoli
Symms L. S. T., 1964b, Inf. Circ. 33
van Biesbroeck G., 1954, Publ. Yerkes Obs. 8, pt. 6
van Dessel E., 1976, A&AS, 26, 415
van Leeuwen F., 2007, Hipparcos, the New Reduction of the Raw Data. Springer, Netherlands
Wierzbinski S., 1956a, Acta Astron., 6, 82
Wierzbinski S., 1956c, Acta Astron., 6, 126
Wilson R. H., 1941, Publ. Univ. Penn., 6, 1
Zaera J. A., 1984, Inf. Circ. 93
Zulevic D. J., 1981, Inf. Circ. 85

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