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# Speckle observations with PISCO in Merate.

## VII. Astrometric measurements of visual binaries in 2007

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### ABSTRACT

We present relative astrometric measurements of visual binaries made during the first semester of 2007, with the speckle camera 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 226 new measurements of 214 objects, with angular separations in the range  $0''.15 - 4''.5$ , and an average accuracy of  $0''.013$ . The mean error on the position angles is  $0^\circ.7$ . Most of the position angles could be determined without the usual  $180^\circ$  ambiguity with the application of triple-correlation techniques and/or by inspection of the long integration files.

We also present the new orbits we have computed for ADS 7871, 7982 and 8128, for which our measurements lead to large residuals and/or for which the revision is justified by the significant number of observations made since computation of the last orbit.

**Key words:** Stars: binaries: close – binaries: visual — astrometry — techniques: interferometric — stars: individual (ADS 7871, ADS 7982, ADS 8128)

## 1 INTRODUCTION

This paper deals with the results of speckle observations of visual binary stars made in Merate (Italy) during the first semester of 2007 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 seventh of a series (Scardia et al. 2005, 2006, 2007a, 2008d, Prieur et al. 2008, Scardia et al. 2009, herein: Papers I to VI), 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 2004 and used there since.

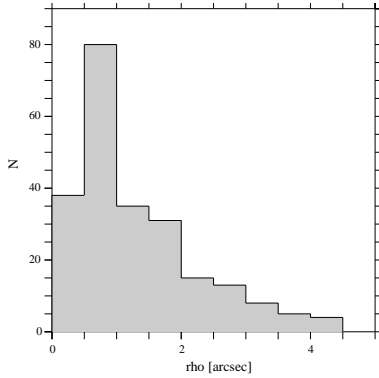
We briefly describe our observations in Sect. 2. Then we present and discuss the astrometric measurements in Sect. 3. Finally in Sect. 4 we propose new revised orbits for ADS 7871, 7982 and 8128, partly derived from those observations and derive estimate values for the component masses.

## 2 OBSERVATIONS

The observations were carried out with the PISCO speckle camera with the ICCD (Intensified Charge Coupled Device) 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). used for resolving the  $180^\circ$  ambiguity (see Sect. 3.1).

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.

The distribution of the angular separations measured in this paper is displayed in Fig. 1 and shows a maximum for  $\rho \approx 0''.7$ . The closest separation that can be measured with PISCO in Merate is of the order of the diffraction limit, which is  $\lambda/D \approx 0''.13$  with the *R* filter (i.e.  $\lambda = 650$  nm) and the Zeiss telescope whose aperture is  $D = 1.02$  m. However, it can be smaller in some favourable cases, and in 2005 we managed to measure a separation down to  $0''.066$  for WRH 28 (Paper IV).



**Figure 1.** Histogram of the angular separations of the 226 measurements reported in this paper.

### 3 ASTROMETRIC MEASUREMENTS

The astrometric measurements of the observations made during the first semester of 2007 are displayed in Table 1. The format of the first ten columns of this table is the same as for the previous papers of this series. It is described for instance in Paper VI. In Col. 11, we report some information about the secondary peaks of the auto-correlation files: diffuse, noisy, elongated, or unresolved. The last three columns are dealing with the residuals and will be presented in Sect. 3.4.

The characteristics of the PISCO  $R$  and  $V$  filters can be found in Table 1 of Paper III. Twenty-two objects were observed without any filter because they were too faint. This is indicated with  $W$  (for “white” light) in the filter column (Col. 5). In this case, the corresponding bandpass is that of the ICCD detector, with a central wavelength of about 650 nm, close to that of the  $R$  filter.

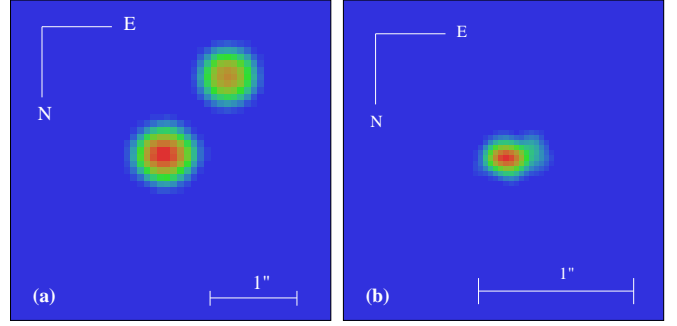
The average values of the errors of the 226 measurements reported in this table are  $0''.013 \pm 0''.009$  and  $0^\circ.67 \pm 0^\circ.47$  for  $\rho$  and  $\theta$ , respectively. Our error determination procedure is described in detail in Paper III.

#### 3.1 Quadrant determination

As our measurements were obtained from the *symmetric* auto-correlation files, the  $\theta$  values first presented a  $180^\circ$  ambiguity. To try resolving 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 non-ambiguous (or “absolute”) angular separation of 146 out of 226 measurements, i.e. 65% of the total. They are marked with an asterisk in Col. 9. Otherwise, our angular measurements were reduced to the quadrant reported in the “Fourth Catalogue of Interferometric Measurements of Binary Stars” (Hartkopf et al. 2008b, hereafter IC4).

Our “absolute”  $\theta$  values are consistent with the values tabulated in IC4, for all objects except for ADS 4208 and MCA 27. In both cases, the corresponding restricted triple-correlation files indicate that the companions are in the South-East quadrant. This is confirmed by the restored



**Figure 2.** Restored images of ADS 4208 (a) and MCA 27 (b), obtained with bispectral methods.

images presented in Fig. 2, that we derived with bispectral techniques from the elementary frames recorded on SVHS (Super Video Home System) tapes.

**ADS 4208:** although in disagreement with the last measures reported in IC4, our quadrant determination in 2007.197 is consistent with our previous determinations made in 2005.215 (Paper III), 2006.198 (Paper V) and with the space-based Tycho measurement (Høg et al. 2000). Two reasons can explain this discrepancy: (i) the two components of ADS 4208 have a small difference in magnitude:  $\Delta m_V = 0.01$ , which explains the difficulty of determining the quadrant, and (ii) the observations in this paper were made in the  $R$  band whilst those in IC4 were made in  $V$ . It is not excluded that the brightest component in  $R$  may be the faintest in  $V$ .

**MCA 27:** our quadrant determination is not in agreement with the latest measurement reported in IC4, but it is consistent with 34 out of 50 measurements, spanning 28 years, from 1976 to 2004, published in this catalogue.

#### 3.2 Unresolved objects

In Table 1, there are three unresolved objects: ADS 6185, ADS 7107 and FIN 349. This was also reported in Paper I for the observations of ADS 6185 and 7107 made in 2004, and in Paper III for the observations of ADS 6185 and FIN 349 made in 2005.

ADS 6185 and FIN 349 have a known orbit, with ephemerides for  $\rho$  equal to  $0''.05$  and  $0''.14$ , respectively (see Table 1). Those values are close to or below the diffraction limit of the Zeiss telescope in  $R$  (i.e.,  $\lambda/D \sim 0''.13$ ), which can account for this non-detection.

Let us add that the observations of ADS 6185 in 2004 and 2005 were first found as unsuccessful (Papers I and III), but an improvement of the data processing led to a positive detection of the companion for both observations (Paper IV). Indeed the model subtraction technique used in Paper IV led to measurements of  $\rho = 0''.110$  in 2004 and  $\rho = 0''.085$  in 2005, in fair agreement with the ephemerides computed with Hartkopf et al. (1989)’s orbit, of  $\rho = 0''.084$  and  $0''.074$ , respectively. Unfortunately, this technique failed for the observations of ADS 6185, ADS 7107 and FIN 349 made in 2007.

As reported in Table 1, we could not measure the position of the companion of ADS 3812 and COU 773 (of 2007.288) because the two auto-correlation peaks, although

**Table 1.** Measurements of binaries with PISCO and residuals with published orbits (begin.).

WDS	Name	ADS	Epoch	Fil.	Eyep.	$\rho$ (mm)	$\sigma_\rho$ (")	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )	Notes	Orbit	$\Delta\rho(O-C)$ (")	$\Delta\theta(O-C)$ ( $^\circ$ )
00134+2659	STT 2AB	161	2007.036	R	10	0.400	0.004	161.9*	0.5		Hartkopf et al. (2008a)	0.01	-0.4
00568+6022	BU 1099AB	784	2007.090	R	10	0.263	0.003	2.0*	1.0		Cole et al. (1992)	-0.02	0.7
00583+2124	BU 302	805	2007.085	R	10	0.323	0.003	202.8	0.7		Cvetkovic&Novakovic (2006)	0.05	-0.4
01006+4719	MAD 1	829	2007.090	R	20	0.789	0.008	2.3*	0.4				
01036+6104	BU 396	868	2007.085	R	20	1.303	0.008	66.8*	0.3				
01095+4715	STT 515AB	940	2007.036	R	10	0.505	0.003	121.1*	0.3		Scardia et al. (2001)	0.00	-0.8
01106+5101	BU 235Aa	963	2007.058	R	20	0.839	0.019	135.1*	0.8		Seymour et al. (2002)	-0.06	1.0
01132+6142	BU 258AB	987	2007.058	R	20	1.529	0.008	262.1*	0.8				
01198-0031	STF 113A-BC	1081	2007.082	R	20	1.626	0.010	18.8*	0.3				
01311+4337	ES 4	1192	2007.082	R	20	2.798	0.014	99.0*	0.3				
01445+3957	STF 149	1368	2007.096	R	20	1.492	0.008	82.8*	0.4				
01467+3310	STF 158AB	1406	2007.096	R	20	2.165	0.026	269.0*	0.3				
01532+1526	BU 260	1503	2007.058	W	20	1.110	0.013	256.5*	0.8		Cvetkovic&Novakovic (2006)	0.01	-2.9
01557+3620	HU 1033	1529	2007.090	W	20	1.216	0.008	217.2*	0.8				
02020+0246	STF 202AB	1615	2007.036	R	20	1.829	0.013	268.4*	0.4		Scardia (1983)	0.04	1.7
02020+7054	BU 513AB	1598	2007.091	R	10	0.707	0.004	286.8*	0.7		Mason et al. (1999)	-0.04	0.3
02039+4220	STT 38BC	1630	2007.082	R	10	0.314	0.003	100.7*	0.5		Docobo&Ling (2007a)	-0.01	-1.1
02062+2507	STF 212	1654	2007.085	R	20	1.933	0.010	162.1*	0.3				
02091+5104	STF 213AB	1670	2007.096	W	20	1.864	0.009	325.4*	0.6				
02174+6121	STF 234AB	1737	2007.085	R	20	0.733	0.011	224.5	1.3		Starikova (1983)	-0.03	-4.1
02270+3117	HO 216	1851	2007.110	R	20	1.337	0.019	3.1*	1.0				
02405+6129	STF 283AB	2014	2007.085	R	20	1.789	0.012	208.8*	0.4				
02407+2637	STT 43	2034	2007.085	R	20	0.710	0.016	351.3	1.2		Scardia et al. (2001)	0.03	3.9
02422+4242	STT 44AB	2052	2007.129	R	20	1.370	0.021	51.1*	0.8				
"	"	"	2007.145	R	20	1.397	0.008	55.1*	0.6				
02511+6025	STF 306AB	2161	2007.145	R	20	2.133	0.029	91.9*	0.3				
03051+2755	STF 342	2331	2007.091	R	20	3.199	0.016	302.4*	0.8				
"	"	"	2007.091	W	20	3.255	0.016	302.7*	0.3				
03058+4342	BU 1175	2334	2007.082	R	20	0.655	0.009	273.1	1.4				
03130+4417	STT 51	2397	2007.082	R	20	0.685	0.011	336.9	0.5				
03158+5057	HU 544	2425	2007.082	R	20	1.559	0.008	101.3*	0.9				
03250+4013	HU 1058	2518	2007.085	R	20	0.829	0.010	113.4*	0.5				
03285+5954	STF 384AB	2540	2007.085	R	20	1.949	0.010	271.8*	0.3				
03287+5026	STF 388	2548	2007.145	R	20	2.764	0.024	213.5*	0.8				
03294+4931	BU 1179	2558	2007.145	R	20	0.608	0.018	145.8*	0.9				
03312+1947	STF 403	2584	2007.145	R	20	2.293	0.017	172.8*	0.3				
03344+2428	STF 412AB	2616	2007.082	R	10	0.720	0.004	354.8	0.3		Scardia et al. (2002a)	0.00	0.5
"	"	"	2007.091	R	10	0.720	0.004	355.0	0.3		"	0.00	0.7
"	"	"	2007.110	R	10	0.705	0.004	353.9	0.6		"	-0.01	-0.4
03362+4220	A 1535	2630	2007.082	W	20	0.716	0.008	339.3*	0.9		Hartkopf et al. (2008a)	-0.01	1.5
03466+2728	COU 694	-	2007.091	W	20	2.485	0.012	134.5*	0.3				
03490+1459	HO 324	2787	2007.096	R	20	1.119	0.011	329.6	0.4				
03503+2241	STF 457AB	2801	2007.156	W	20	0.830	0.012	89.6*	0.3				
03565+3311	BU 263	2873	2007.156	W	20	0.686	0.017	105.1*	0.6				
04059+1058	STF 491	2981	2007.096	W	20	2.849	0.023	96.7*	0.3				
04091+2839	HO 326	3021	2007.096	R	20	0.333	0.043	286.4	2.2	noisy	Hartkopf et al. (2008a)	-0.07	-3.5
04123+0939	STT 74	3053	2007.096	R	20	0.232	0.008	110.8	1.5	noisy	Alzner (2003)	-0.00	2.7
04140+4235	A 1711	3062	2007.156	R	20	0.680	0.018	78.1	1.0				
04159+3142	STT 77AB	3082	2007.091	R	20	0.554	0.010	291.3	0.7	diffuse	Starikova (1985)	-0.03	-0.6
04179+5847	STF 511	3098	2007.159	R	20	0.498	0.010	81.5	1.9		Heintz (1996b)	-0.00	-0.4
04218+5002	STF 521	3141	2007.159	R	20	2.018	0.010	256.8*	0.8				
04224+2049	BU 87	3158	2007.195	R	20	1.909	0.010	167.7*	0.3				
04227+1503	STT 82AB	3169	2007.195	R	20	1.263	0.008	336.8*	0.3		Mason et al. (2004a)	-0.00	-1.9
04239+0928	HU 304	3182	2007.200	R	10	0.243	0.004	16.0*	0.5		Hartkopf (2000)	-0.01	-0.4
04254+5623	A 834AB	3184	2007.203	R	20	0.712	0.014	221.1*	1.0				
04290+1610	HU 1080	3248	2007.145	R	10	0.216	0.008	79.1*	1.1		Söderhjelm (1999)	-0.03	3.2
04316+3739	BU 789	3275	2007.203	R	20	0.914	0.011	322.0*	0.9				
04347+1130	A 2034	3314	2007.200	R	20	0.584	0.017	235.4	1.8				

**Table 1.** Measurements of binaries with PISCO and residuals with published orbits (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep.	$\rho$ (mm)	$\sigma_\rho$ (")	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )	Notes	Orbit	$\Delta\rho(O-C)$ (")	$\Delta\theta(O-C)$ ( $^\circ$ )
04357+3944	HU 1084	3315	2007.096	R	20	0.236	0.009	77.1	1.9	noisy			
04366+1946	STT 86	3329	2007.096	R	20	0.482	0.008	358.8	0.9				
04367+1930	STF 567	3330	2007.096	R	20	2.069	0.011	342.4*	0.3		Seymour et al. (2002)	0.03	0.9
"	"	"	2007.096	W	20	2.011	0.010	342.6*	0.3		"	-0.03	1.1
04400+5328	BU 1295AB	3358	2007.091	R	10	0.235	0.010	146.3*	0.9	diffuse	Heintz (1996a)	-0.01	0.9
"	"	"	2007.197	R	10	0.235	0.006	147.8*	1.1	elong.	"	-0.01	2.7
04400+5328	STF 566AB-C	3358	2007.091	R	10	0.753	0.009	180.0*	0.6	diffuse	Mason et al. (2006)	-0.03	-1.6
"	"	"	"	"	"	"	"	"	"	"	Cvetkovic et al. (2008)	-0.01	-1.9
"	"	"	2007.197	R	10	0.764	0.014	178.8*	0.3	elong.	Mason et al. (2006)	-0.02	-2.7
"	"	"	"	"	"	"	"	"	"	"	Cvetkovic et al. (2008)	0.00	-2.9
04422+3731	STF 577	3390	2007.167	R	20	0.783	0.031	348.7	1.1		Mason et al. (2004a)	0.10	4.5
04433+5931	A 1013	3391	2007.192	R	10	0.346	0.003	290.9	1.1		Docobo&Costa (1990)	-0.02	-1.0
04478+5318	HU 612	3434	2007.197	R	10	0.696	0.003	357.5*	0.3		Novakovic (2007)	0.04	-0.7
04518+1339	BU 552AB	3483	2007.189	R	20	0.664	0.014	249.0*	3.8		Söderhjelm (1999)	0.02	2.0
04549+0836	STT 90AB	3517	2007.197	R	20	1.760	0.017	339.5*	0.3				
04573+6145	STT 88	3526	2007.156	R	20	0.757	0.010	306.7*	1.1				
04574+4204	COU1716	–	2007.195	W	20	0.698	0.008	152.2	0.9				
04581+0141	STF 622	3568	2007.206	R	20	2.520	0.027	163.5	0.3				
05003+3924	STT 92AB	3589	2007.192	R	20	4.094	0.020	281.5*	0.3		Cvetkovic&Novakovic (2006)	0.03	0.7
05005+0506	STT 93	3596	2007.192	R	20	1.540	0.008	244.3*	0.8		Seymour&Mason (1999)	0.08	-0.0
05055+1948	STT 95	3672	2007.225	R	20	0.933	0.008	296.9*	0.5		Jasinta (1996)	-0.02	-1.2
05079+0830	STT 98	3711	2007.167	R	20	0.792	0.011	303.4*	0.3		Scardia et al. (2008a)	-0.05	-1.7
05118+0102	STF 652	3764	2007.091	R	20	1.614	0.011	181.5*	0.6				
05148+1232	HU 1224	3822	2007.195	R	20	1.049	0.009	115.4*	0.6				
05153+4710	A 1031	3812	2007.203	R	20	–	–	–	–	diffuse			
05157+1944	STF 665	3837	2007.197	R	20	1.688	0.008	253.3	1.0				
05159+0345	A 2638	3847	2007.197	R	20	0.991	0.011	277.0	0.8				
05167+1826	STF 670A-Bb	3854	2007.203	R	20	2.540	0.017	165.0*	0.4				
05172+3320	STF 666	3853	2007.203	R	20	3.099	0.032	74.6*	0.4				
05188+5250	STF 657	3870	2007.156	R	20	0.936	0.011	307.6	0.6				
05222+4505	STF 684	3932	2007.192	R	20	1.496	0.008	141.0*	0.3				
05239–0052	WNC 2A-BC	3991	2007.225	R	20	3.062	0.015	159.1*	0.3				
05240+2458	STF 694AB	3981	2007.192	R	20	1.365	0.008	13.7	0.3				
05243+3939	BU 1317	3976	2007.197	R	20	0.712	0.016	17.9	1.1				
05245–0224	DA 5Aa-B	4002	2007.206	R	20	1.794	0.020	76.7*	0.5				
05247+6323	STF 677	3956	2007.083	R	20	1.058	0.008	122.9*	0.4		Hartkopf et al. (2008a)	-0.04	1.0
05248+6444	STF 676	3955	2007.083	R	20	1.388	0.014	267.5	0.3				
05265+0256	STF 712AB	4033	2007.206	R	20	3.207	0.053	66.1*	0.9				
05270+2737	HO 226AB	4032	2007.156	R	20	0.647	0.017	270.4	1.4				
05290+3746	BU 890	4060	2007.197	R	20	1.318	0.012	285.3	0.7				
05297+3523	HU 217	4072	2007.222	R	20	0.659	0.008	252.9	1.5				
05301+2933	STF 719AB	4086	2007.222	R	20	1.255	0.009	332.8*	0.7				
05308+0557	STF 728	4115	2007.206	R	20	1.240	0.008	45.6*	0.7		Seymour&Hartkopf (1999)	-0.00	0.4
05309+1015	STF 726	4113	2007.203	R	20	1.192	0.011	262.1*	0.7				
05371+2655	STF 749AB	4208	2007.197	R	20	1.148	0.015	141.1*	0.6		Scardia et al. (2007a)	-0.01	-0.6 <sup>Q</sup>
05371+4150	STF 736	4204	2007.083	R	20	2.553	0.013	359.7*	0.3				
05436+1300	A 117AB	4304	2007.222	W	20	0.845	0.023	249.3	1.3				
05447+3118	A 1040	4317	2007.222	W	20	0.878	0.018	87.4*	0.6				
05460+2119	STF 787AB	4349	2007.225	R	20	0.734	0.011	57.5	1.4				
05474+2939	BU 560	4371	2007.083	R	20	1.648	0.013	125.6*	0.3		Scardia et al. (2008c)	0.00	-0.4
05479+0758	STT 119	4388	2007.225	R	20	0.730	0.008	351.3*	0.4				
05491+6248	STF3115	4376	2007.189	R	20	0.831	0.019	338.9	2.1		Scardia et al. (2007c)	-0.01	-1.9
"	"	"	"	"	"	"	"	"	"		Novakovic (2007)	0.05	1.2
"	"	"	2007.195	R	20	0.816	0.008	340.6*	0.6		Scardia et al. (2007c)	-0.03	-0.2
"	"	"	"	"	"	"	"	"	"		Novakovic (2007)	0.03	2.9
05500+0952	HEI 670	–	2007.083	R	20	1.069	0.008	263.9*	1.5				
05522+3834	STF 799	4452	2007.083	R	20	0.757	0.008	162.1*	0.3				
05535+3720	BU 1053	4472	2007.156	R	20	1.796	0.015	359.1*	1.0				

**Table 1.** Measurements of binaries with PISCO and residuals with published orbits (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep.	$\rho$ (mm)	$\sigma_\rho$ (")	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )	Notes	Orbit	$\Delta\rho(\text{O-C})$ (")	$\Delta\theta(\text{O-C})$ ( $^\circ$ )
05544+1854	STF 813	4490	2007.192	R	20	3.047	0.023	149.4	0.5				
05597+2228	STT 125	4577	2007.156	R	20	1.388	0.011	0.4	1.2				
06117+1723	STF 867AB	4789	2007.096	R	20	2.184	0.020	158.0	0.3				
06145+1754	KUI 24	–	2007.200	R	10	0.364	0.004	142.8*	0.4				
06221+5922	STF 881Aa-B	4950	2007.195	R	20	0.656	0.008	144.8*	0.4				
06344+1445	STF 932	5197	2007.203	R	20	1.677	0.017	306.6*	0.3		Hopmann (1960a)	0.02	3.2
06347+3832	STF 928AB	5191	2007.195	R	20	3.457	0.021	131.6*	0.3				
06364+2717	STT 149	5234	2007.096	R	20	0.695	0.017	289.3*	0.7		Heintz (1993)	-0.02	-1.8
06384+2859	MCA 27	–	2007.200	R	10	0.157	0.004	96.7*	0.9		Hartkopf&Mason (2000)	-0.02	-3.6 <sup>Q</sup>
06387+4135	STF 941AB	5269	2007.096	R	20	1.885	0.009	82.9*	0.3				
06392+0939	STH 1	5290	2007.097	R	20	0.717	0.017	285.1	0.9				
06404+4058	STF 945	5296	2007.225	R	20	0.465	0.011	329.2*	0.6		Novakovic (2007)	-0.01	-0.7
06410+0954	STF 950Aa,B	5322	2007.260	R	20	2.940	0.035	213.4*	0.4				
06425+6612	MLR 318	–	2007.263	R	20	1.669	0.026	308.0*	0.5		Pavlovic&Todorovic (2005)	0.01	-0.7
06462+5927	STF 948AB	5400	2007.192	R	20	1.885	0.009	69.6*	0.3		Mason et al. (2006)	0.02	-0.2
06474+1812	STT 156	5447	2007.200	R	10	0.246	0.003	187.6	0.7		Scardia et al. (2005a)	-0.01	1.6
06487+0737	A 2731AB	5469	2007.198	R	20	1.301	0.011	63.9*	0.6		Heintz (1998)	-0.06	-1.7
06531+5927	STF 963AB	5514	2007.083	R	10	0.232	0.007	328.4	0.9		Scardia et al. (2008a)	-0.00	0.4
"	"	"	2007.192	R	10	0.237	0.003	329.8*	0.7		"	0.00	1.5
06573+5825	STT 159AB	5586	2007.192	R	10	0.615	0.003	228.8*	0.4		Alzner (2000)	-0.01	0.1
07128+2713	STF1037AB	5871	2007.157	R	20	1.048	0.010	309.4	0.9		Söderhjelm (1999)	-0.02	-1.2
07303+4959	STF1093	6117	2007.195	R	20	0.876	0.010	201.3	2.1		Scardia (1984)	0.08	0.1
07346+3153	STF1110AB	6175	2007.206	V	20	4.481	0.022	59.4*	0.3		Docobo&Costa (1985)	0.04	0.5
07351+3058	STT 175AB	6185	2007.263	R	10	–	–	–	–	unres.	Hartkopf et al. (1989)	(0.05)	(122.9)
07417+3726	STT 177	6276	2007.192	R	20	0.518	0.018	151.0*	0.7		Heintz (1982)	0.00	2.2
07486+2308	WRH 15AB	6378	2007.192	R	10	0.274	0.004	34.8	0.5		Seymour et al. (2002)	0.00	0.8
07556+3630	COU2075	–	2007.157	W	20	0.795	0.010	140.1*	1.5				
07573+0108	STT 185	6483	2007.263	R	10	0.241	0.006	8.2	1.0		Hartkopf&Mason (2001)	-0.10	-5.3
07598+1341	STF1170	6499	2007.198	R	20	2.384	0.014	106.3*	0.3				
08024+0409	STF1175	6532	2007.198	R	20	1.405	0.008	280.5*	0.4		Olevic&Jovanovic (2001)	0.04	-5.1
08033+2616	STT 186	6538	2007.203	R	20	0.974	0.008	73.5*	0.3				
08041+3302	STT 187	6549	2007.200	R	10	0.407	0.006	341.1	0.8		Mason et al. (1999)	0.00	-0.5
08056+2732	STF1177	6569	2007.299	R	20	3.480	0.017	349.4*	0.3				
08061–0047	A 1971	6582	2007.200	W	20	0.937	0.032	6.4	0.4		Olevic et al. (1993)	0.07	3.0
08095+3213	STF1187Aa-B	6623	2007.192	R	20	2.996	0.015	22.5*	0.3		Olevic&Jovanovic (2001)	0.07	0.9
08122+1739	STF1196AB	6650	2007.192	R	10	1.016	0.005	50.0	0.3		Mason et al. (2006)	0.01	1.2
08198+0357	FIN 346	–	2007.225	R	10	0.261	0.003	59.6	0.7				
08213–0136	STF1216	6762	2007.200	R	20	0.512	0.022	298.8*	1.3		Docobo et al. (1994)	0.05	-2.9
08432+3849	BU 209	6946	2007.299	R	20	1.279	0.010	8.2	0.3				
08468+0625	STF1273AB-C	6993	2007.198	R	20	2.767	0.014	301.5*	0.3		Heintz (1996a)	-0.11	-1.4
08468+0625	SP 1AB	6993	2007.198	V	10	0.151	0.004	108.1	0.6		Hartkopf et al. (1996)	0.00	1.3
08507+1800	A 2473	7039	2007.225	R	10	0.268	0.003	77.3	1.0		Hartkopf&Mason (2000)	0.04	-2.8
08508+3504	STF1282	7034	2007.323	R	20	3.525	0.020	278.0*	0.3				
08514+5732	STF1275AB	7033	2007.323	R	20	1.875	0.018	198.7	0.3				
08531+5457	A 1584	7054	2007.192	R	20	0.652	0.008	79.7	1.2		Heintz (1991)	0.02	-3.3
08539+1958	COU 773	–	2007.288	R	10	–	–	–	–	diffuse	Couteau (1999)	(0.19)	(55.4)
"	"	"	2007.293	R	10	0.165	0.003	62.2	1.8		"	-0.03	6.8
08542+3035	STF1291AB	7071	2007.200	R	20	1.509	0.011	310.1*	0.4				
08554+7048	STF1280AB	7067	2007.225	R	20	2.038	0.032	348.6	0.3		Heintz (1997)	0.02	0.1
08580+3014	HO 252	7107	2007.203	R	10	–	–	–	–	unres.			
09006+4147	KUI 37AB	–	2007.203	R	10	0.523	0.003	329.9*	0.7		Hartkopf et al. (1996)	-0.01	0.4
09033+4740	HU 720	7153	2007.299	R	20	0.750	0.014	133.2	0.4				
09036+4709	A 1585	7158	2007.203	R	10	0.208	0.005	297.6*	0.9		Barnaby et al. (2000)	-0.00	0.5
09104+6708	STF1306AB	7203	2007.198	R	20	4.114	0.021	350.8*	0.3		Scardia (1985)	0.06	-0.1
"	"	"	2007.277	R	20	4.177	0.051	350.7*	0.3		"	0.12	-0.1
09127+1632	STF1322	7236	2007.277	R	20	1.770	0.014	53.0*	0.7				
09179+2834	STF3121AB	7284	2007.192	R	20	0.698	0.008	209.1	0.6		Söderhjelm (1999)	-0.01	2.3
09184+3522	STF1333	7286	2007.200	R	20	1.938	0.010	49.0*	0.3				

**Table 1.** Measurements of binaries with PISCO and residuals with published orbits (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep.	$\rho$ (mm)	$\sigma_\rho$ (")	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )	Notes	Orbit	$\Delta\rho(\text{O-C})$ (")	$\Delta\theta(\text{O-C})$ ( $^\circ$ )
09188+3648	STF1334A-Bb	7292	2007.260	R	20	2.667	0.026	224.2*	0.3				
09208+6121	STF1331AB	7300	2007.277	R	20	0.931	0.014	153.0*	0.9				
09210+3811	STF1338AB	7307	2007.260	R	20	1.059	0.014	297.1*	0.9		Scardia et al. (2002b)	0.05	-2.3
09245+0621	STF1348AB	7352	2007.263	R	20	1.926	0.019	313.4	0.8				
09245+1808	A 2477	7341	2007.198	R	10	0.442	0.006	356.2	0.3		Mason&Hartkopf (1998)	-0.03	0.6
"	"	"	"	"	"	"	"	"	"		Aristidi et al. (1999)	0.05	-2.9
09249+5134	STT 200	7348	2007.293	R	20	1.222	0.030	336.6*	0.8				
09273+0614	STF1355	7380	2007.260	R	20	1.869	0.009	352.5*	0.8				
09285+0903	STF1356	7390	2007.288	R	10	0.686	0.005	97.8*	0.3		van Dessel (1976)	-0.01	-1.2
09300+4216	A 1985	7398	2007.293	R	20	1.541	0.010	24.2	0.4				
09327+0152	FIN 349	–	2007.263	R	10	–	–	–	–	unres.	Hartkopf (2000)	(0.14)	(122.5)
09414+3857	STF1374AB	7477	2007.203	R	20	2.815	0.014	308.0*	0.3				
09513+6037	STF1381	7536	2007.293	R	20	0.876	0.014	187.8*	0.5				
09521+5404	STT 208	7545	2007.261	R	10	0.325	0.004	285.4*	0.4		Heintz (1996b)	-0.03	-1.8
10056+3105	STF1406	7632	2007.293	R	20	0.789	0.011	217.3	0.3				
10057+4103	A 2142	7631	2007.198	R	20	1.022	0.010	294.6*	0.3				
10151+1907	STF1417	7695	2007.293	W	20	2.338	0.018	77.4	0.7				
10163+1744	STT 215	7704	2007.288	R	20	1.424	0.010	177.9*	0.3		Zaera (1984)	-0.10	-1.7
10205+0626	STF1426AB	7730	2007.293	R	20	0.916	0.008	309.3*	0.7		Novakovic (2006)	-0.00	-1.3
"	"	"	"	"	"	"	"	"	"		Scardia et al. (2008c)	0.01	-1.2
10250+2437	STF1429	7758	2007.192	W	20	0.746	0.011	160.4	0.4		Zulevic (1981)	0.04	-1.7
10260+5237	STF1428	7762	2007.277	R	20	2.876	0.041	87.4*	0.3				
10269+1713	STT 217	7775	2007.261	R	20	0.737	0.010	145.9*	0.9		Heintz (1975)	0.02	-1.9
10279+3642	HU 879	7780	2007.288	R	10	0.457	0.003	222.1*	0.4		Mason&Hartkopf (2001)	0.01	1.4
10350+0839	STF1450	7837	2007.277	R	20	2.117	0.019	156.4*	0.3				
10397+0851	STT 224	7871	2007.288	R	20	0.498	0.008	142.2	0.6		Heintz (1984)	-0.08	-8.4
"	"	"	"	"	"	"	"	"	"		This paper	0.03	-1.3
10406+4209	STF1460	7878	2007.293	R	20	3.743	0.021	161.7*	0.3				
10426+0335	A 2768	7896	2007.261	R	20	0.579	0.008	253.8*	0.3		Hartkopf et al. (1989)	0.03	-0.1
10480+4107	STT 229	7929	2007.261	R	20	0.685	0.008	265.6	0.6		Alzner (1998)	0.01	1.9
10493–0401	STF1476	7936	2007.277	R	20	2.414	0.013	16.0*	0.3				
10557+0044	BU 1076	7982	2007.323	R	20	1.155	0.012	56.8*	0.8		Scardia et al. (2008b)	0.04	1.5
11000–0328	STF1500	8007	2007.299	R	20	1.370	0.008	300.8	0.5				
11037+6145	BU 1077AB	8035	2007.261	V	10	0.461	0.003	44.2*	0.5		Scardia et al. (2005a)	-0.03	-5.4
11050+3825	HO 378AB	8047	2007.293	R	20	1.034	0.012	236.9	0.6				
11136+5525	A 1353	8092	2007.323	R	20	0.556	0.012	214.9	1.3		Docobo&Ling (1999)	0.01	2.2
11137+2008	STF1517AB	8094	2007.261	W	10	0.603	0.015	317.5	1.1	elong.	Hopmann (1970)	0.37	10.6
11154+2734	STF1521	8105	2007.299	R	20	3.656	0.018	97.3*	0.3				
11182+3132	STF1523AB	8119	2007.288	R	20	1.636	0.008	228.7*	0.6		Mason et al. (1995)	-0.02	-1.9
11190+1416	STF1527	8128	2007.277	R	10	0.288	0.004	147.0	0.3		Mason et al. (2004b)	-0.04	12.5
"	"	"	"	"	"	"	"	"	"		Mason et al. (2006)	-0.15	-200.2
"	"	"	"	"	"	"	"	"	"		This paper	-0.01	0.3
"	"	"	2007.288	R	10	0.284	0.004	146.7	0.5		Mason et al. (2004b)	-0.04	12.0
"	"	"	"	"	"	"	"	"	"		Mason et al. (2006)	-0.16	-200.6
"	"	"	"	"	"	"	"	"	"		This paper	-0.01	-0.1
11239+1032	STF1536AB	8148	2007.288	R	20	1.918	0.011	103.0*	0.3		Söderhjelm (1999)	0.02	-0.0
11308+4117	STT 234	8189	2007.323	R	20	0.543	0.026	168.1	1.7		Docobo&Ling (2001)	0.05	-0.3
11347+1648	STF1552AB	8220	2007.381	R	20	3.531	0.074	207.9*	0.7	elong.			
11363+2747	STF1555AB	8231	2007.324	R	10	0.714	0.014	148.6	0.8		Docobo&Ling (2007b)	0.02	-0.3
11390+4109	STT 237	8252	2007.356	R	20	2.043	0.010	244.8*	0.3		Seymour et al. (2002)	0.04	-0.5
11447–0431	RST4484	–	2007.378	R	20	0.746	0.018	63.8	0.4				
11486+1417	BU 603	8311	2007.356	R	20	0.998	0.008	336.6*	0.6		Brendley&Mason (2006)	-0.08	-0.4
11563+3527	STT 241	8355	2007.356	R	20	1.763	0.009	144.0*	0.4				
12372+2112	STF1663	8611	2007.356	R	20	0.640	0.017	70.1	2.7	faint			
12417–0127	STF1670AB	8630	2007.324	R	10	0.726	0.004	52.9	0.3	elong.	Scardia et al. (2007b)	-0.02	0.4
"	"	"	2007.356	R	10	0.744	0.004	51.9*	0.3	elong.	"	-0.01	0.0
"	"	"	2007.378	R	20	0.754	0.008	51.5*	0.4		"	-0.01	0.1
"	"	"	2007.381	V	20	0.758	0.010	51.4*	0.3	elong.	"	-0.00	0.0
"	"	"	2007.384	R	10	0.749	0.004	51.5*	0.3		"	-0.01	0.2

**Table 1.** Measurements of binaries with PISCO and residuals with published orbits (end).

WDS	Name	ADS	Epoch	Fil.	Eyep.	$\rho$ (mm)	$\sigma_\rho$ (")	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )	Notes	Orbit	$\Delta\rho(O-C)$ (")	$\Delta\theta(O-C)$ ( $^\circ$ )
12564-0057	STT 256	8708	2007.378	W	20	1.049	0.008	98.3	0.5				
12587+2728	STF1699	8721	2007.378	W	20	1.681	0.011	8.3	0.3				
13007+5622	BU 1082	8739	2007.378	R	20	1.173	0.010	94.5*	0.3		Scardia et al. (2005a)	-0.11	1.7
13084+1529	STF1722	8796	2007.378	W	20	2.657	0.013	336.6*	0.4				
13243+0124	STF1742	8890	2007.381	R	20	0.982	0.036	357.8	0.7	elong.			
"	"	"	2007.384	R	20	0.985	0.024	356.1*	0.3				
13258+4430	A 1609AB	8901	2007.384	R	20	0.471	0.008	28.4	1.3		Heintz (1991)	-0.00	1.3
13329+3454	STT 269AB	8939	2007.384	R	10	0.272	0.004	220.0	0.5		Heintz (1997)	-0.02	-1.0
13368+0650	A 1611	8968	2007.384	W	20	0.879	0.008	120.8*	0.4				

Note: In column 9, the exponent \* indicates that the position angle  $\theta$  could be determined without the  $180^\circ$  ambiguity. In column 14, the exponent  $^Q$  indicates discrepant quadrants between our measurements and the published orbits.

present, were too diffuse. We could only repeat the observation for COU 773 two days later, and obtained much smaller peaks which led to an error as small as  $\Delta\rho = 0.''003$ .

### 3.3 New components?

In April 2005, our observations of ADS 7871 indicated the presence of a third (new) very faint component with a separation of  $2''.1$  (Paper III). Unfortunately, the present observations had a worse signal-to-noise ratio than the previous ones, and we are unable to confirm this detection.

New possible components were found in the auto-correlations and measured for ADS 3082 ( $\rho = 2''.216$ ,  $\theta = 97^\circ.5$ ), ADS 6946 ( $\rho = 3''.998$ ,  $\theta = 77^\circ.9$ ) and ADS 7300 ( $\rho = 0''.443$ ,  $\theta = 11^\circ.5$ ). However we have not included those measurements in Table 1, since they may be artefacts. We will try to re-observe those objects in the future to determine whether those components are real or not.

### 3.4 Comparison with published ephemerides

The ( $O - C$ ) (Observed minus Computed) residuals of the measurements for the 97 systems with a known orbit in Table 1 are displayed in Cols. 13 and 14 for the separation  $\rho$  and position angle  $\theta$ , respectively. The orbital elements used for computing the ephemerides were retrieved from the ‘‘Sixth Catalogue of Orbits of Visual Binary Stars’’ (Hartkopf & Mason, 2008, hereafter OC6) and from our publications (Papers I and III, Scardia et al. 2008b, 2008c). For the unresolved objects (see Sect. 3.2), the quantities in brackets in Cols. 13 and 14 are the ephemeris values themselves, not the residuals. For ADS 7871, 7982 and 8128, we also give the residuals obtained with our new orbits presented in Sect. 4, for comparison.

For most of the orbits used for computing the residuals reported in Table 1, the equinox of the node  $\Omega$  was 2000.0, and the correction to be applied to our angular measurements is negligible. Such a correction was only necessary for ADS 1737, 5197 and 7390, for which the tabulated equinox is 1900.0 in OC6.

We noted a  $180^\circ$  discrepancy of the position angle between our measurements and the published ephemerides for

ADS 4208 and MCA 27. This is indicated with the superscript  $^Q$  in Col. 14.

The residuals reported in Table 1 were computed with the most recent orbits found in OC6, but for some objects (i.e., for ADS 3358, 4376, 7341, 7730 and 8128), we also give the  $O - C$  values relative to old orbits found in the previous issues of OC6, when they are still valid. For ADS 4371, 7730, we used our recent orbits published in Scardia et al. (2008c) that were computed using some of the PISCO measurements reported in Table 1.

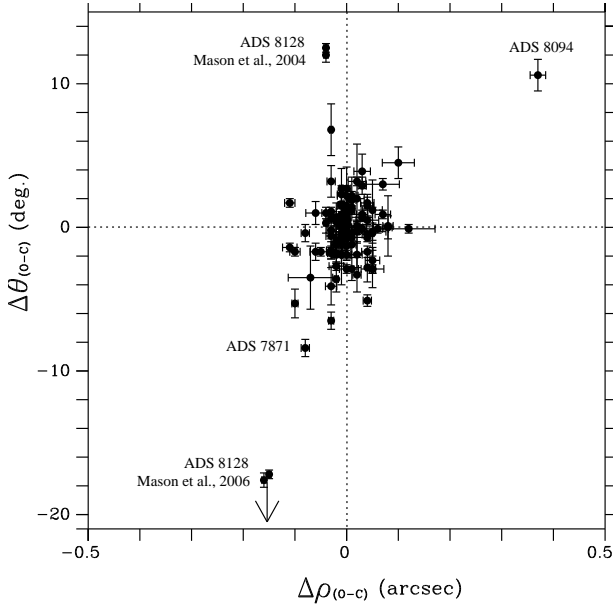
Fig. 3 shows that the residuals are well centered around the origin, with a rather large scatter that can be explained by the (old) age of many orbits. When discarding the two outliers relative to ADS 8094 and 8128, the mean values computed with the residuals of Table 1 are  $\langle \Delta\rho_{O-C} \rangle = 0''.00 \pm 0''.04$  and  $\langle \Delta\theta_{O-C} \rangle = -0^\circ.2 \pm 2^\circ.2$ . The small values obtained for those offsets provide an additional validation of our calibration made with a grating mask (see Paper III), which is thus in good agreement with the measurements made by the other observers. Let us now examine the cases of ADS 7871, 8094 and 8128 that appear with the largest residuals in Fig. 3.

**ADS 7871:** as shown by Fig. 3, the residuals computed with Heintz (1984)’s orbit are rather large. We propose new orbital elements in Sect 4.

**ADS 8094:** Hopmann (1970)’s orbit leads to a large residual of ( $0''.37$ ,  $10^\circ.6$ ) with our measurement of 2007.261. Clearly this orbit is wrong, as already pointed out in Paper III. The motion appears to be rectilinear and is, in any case, too short to attempt a meaningful orbital analysis at present.

**ADS 8128:** our measurements of 2007.277 and 2007.288 have very large residuals of ( $-0''.15$ ,  $-200^\circ.2$ ) and ( $-0''.16$ ,  $-200^\circ.6$ ) respectively, and are thus in complete disagreement with the ephemerides computed with Mason et al. (2006)’s orbit. The residuals are smaller with the previous orbit published by Mason et al. (2004b), but they are still significant with  $\Delta\theta_{O-C} \approx 12^\circ$ . This is surprising since those two orbits are recent. Alzner (2008) also reported position angle and separation values similar to ours, for the same epoch (2007.3). Mason’s orbits clearly need to be revised. We propose a new orbit in Sect. 4.





**Figure 3.** Residuals of our measurements from the published orbits. The data points of the residuals of ADS 8128, computed with Mason et al. (2006)’s orbit, lie outside of this frame.

#### 4 REVISED ORBITS FOR ADS 7871, 7982 AND 8128

In this section we present the new orbits we have computed for ADS 7871 and 8128, which are the two objects with the largest residuals in Fig. 3, and for ADS 7982, whose orbit has not been revised for nearly forty years.

We have followed the same method for the 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), which leads to an improvement of the orbital elements with an estimation of their errors.

The final orbital elements are presented in Table 2 with the same format as for the previous papers (see f.i. its description in Paper VI). The corresponding ( $O-C$ ) residuals, restricted to the last observations for reasons of space, are given in Tables 3, 4 and 5 for ADS 7871, 7982 and 8128, respectively. For each measurement, the date in Besselian years is given in Col. 1, and the ( $O-C$ ) residuals in  $\rho$  and  $\theta$  in Cols. 2 and 3, respectively. In Col. 4, we report the name of the observer, using the US Naval Observatory convention. For ADS 8128, we also add an unpublished speckle measurement made by René Gili with the 76 cm Nice Observatory refractor.

The apparent orbits are shown in Fig. 4 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. 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.

The ephemerides for 2009–2018 are presented in Table 6, with the date in Besselian years in Col. 1, the angular separations  $\rho$  in Cols. 2, 4 and 6, and the position angles  $\theta$  in Cols. 3, 5 and 7.

We present some physical parameters derived for those systems from our orbital elements in Table 7. For each object whose name is given in Col. 1 we report its apparent, combined visual magnitude in Col. 2, its spectral type in Col. 3, the Hipparcos parallax  $\pi_{HIP}$  in Col. 4, the apparent angular extent of the semi major axis  $a$  in arcseconds in Col. 5 (from Table 2), the linear size of  $a$  in AU in Col. 6, and the total mass of the system  $\mathfrak{M}_{total}$  in Col. 7. Both the linear size of  $a$  and  $\mathfrak{M}_{total}$  were computed from our orbital elements and using the Hipparcos parallax.

##### 4.1 New orbit of ADS 7871

**ADS 7871, STT 224 (HIP 52187):** this couple was discovered with the 40-cm refractor of Pulkova Observatory by Otto Struve between August 1841 and December 1842, and noted (Struve 1843) that the pair was “oblonga” (elongated). The first measurement of STT 224 was made on March 16th 1843 by J.H. Madler in Dorpat, with the 25-cm refractor used by F.G.W. Struve for his 1825–1827 large binary survey (Madler, 1845). This couple probably belongs to the Hyades Group (Eggen, 1960). A few orbits of STT 224 have been computed, like that of Ekenberg (1945) which is reported in Worley and Heintz (1983)’s catalogue, or the most recent, from Heintz (1984), which begins to show large residuals with the latest observations (see Fig. 3).

From the 163 measurements obtained since 1843, we derived the new orbital elements reported in Table 2. The standard deviations of the residuals are  $0''.09$  and  $6''.4$  for  $\rho$  and  $\theta$ , respectively. This scatter is explained by the large magnitude difference between the two companions ( $\Delta m_V = 1.14$ ), which makes the measurements difficult to perform.

The total mass of the system derived from our orbit is  $3.6 \pm 2.1 M_{\odot}$  (see Table 7), which is consistent with the value expected for a system of two main sequence stars with this spectral type (F5). The dynamical parallax of  $\pi_{dyn} = 11$  mas is also in good agreement with the Hipparcos measurement.

##### 4.2 New orbit of ADS 7982

**ADS 7982, BU 1076, 55 Leo (HIP 53423):** this couple was discovered by S.W. Burnham in April 1889, with the 91-cm refractor of Lick Observatory (Burnham, 1890). The two components have a very large magnitude difference ( $\Delta m_V = 3.04$  in OC6), which makes them difficult to measure.

To our knowledge, only two orbits were computed for ADS 7982, by P. Baize (1957) and P.J. Morel (1970). Those orbits could not take advantage of the numerous measurements obtained by speckle interferometry and are not longer representative of the observations. All the measurements made after 1999 were obtained with PISCO.

The orbital elements reported in Table 2 were derived from the 51 available measurements obtained since 1889. Convergence was easy to achieve and we are thus able to provide the uncertainties on the orbital elements. As usual

**Table 2.** New orbital elements of ADS 7871, 7982 and 8128.

ADS	$\Omega_{2000}$ ( $^{\circ}$ )	$\omega$ ( $^{\circ}$ )	$i$ ( $^{\circ}$ )	$e$	$T$ (yr)	$P$ (yr)	$n$ ( $^{\circ}/\text{yr}$ )	$a$ ( $''$ )	A ( $''$ )	B ( $''$ )	F ( $''$ )	G ( $''$ )
7871	162.5	81.1	132.2	0.15	2031.69	214.33	1.680	0.550	0.02860	0.37369	0.53542	-0.10889
	$\pm 2.1$	$\pm 4.1$	$\pm 3.8$	$\pm 0.061$	$\pm 5.2$	$\pm 11.9$	$\pm 0.093$	$\pm 0.022$				
7982	44.4	112.4	105.2	0.753	1902.11	128.53	2.801	1.115	-0.11417	-0.49014	-0.81449	-0.64175
	$\pm 5.7$	$\pm 12.5$	$\pm 6.3$	$\pm 0.15$	$\pm 3.6$	$\pm 8.7$	$\pm 0.19$	$\pm 0.066$				
8128	178.2	26.9	62.2	0.889	2010.19	341	1.054	2.300	-2.06537	-0.42065	1.01004	-0.98884
	$\pm 3.9$	$\pm 18.1$	$\pm 6.9$	$\pm 0.04$	$\pm 0.8$	$\pm 53$	$\pm 0.28$	$\pm 0.036$				

**Table 3.** ADS 7871: O-C residuals of our new orbit (after 1990). The symbol  $P$  indicates PISCO measurements.

Epoch	$\Delta\rho$ (O-C) ( $''$ )	$\Delta\theta$ (O-C) ( $^{\circ}$ )	Observer
1991.250	0.023	-1.0	HIP
1991.840	0.031	0.6	TYC
1993.266	0.024	-3.9	Lin
1993.266	-	-7.3	Lcr
1995.910	0.042	-0.7	Alz
1997.071	0.016 $P$	0.5 $P$	Ari
1997.300	-0.064	-0.0	Alz
1999.300	-	1.0	Alz
2000.190	-0.012	1.8	Alz
2002.300	0.008	3.3	Alz
2005.327	0.028 $P$	0.6 $P$	Sca
2006.194	0.044	0.1	Msn
2006.360	0.046 $P$	1.9 $P$	Pru
2007.288	0.033 $P$	-1.3 $P$	This paper

**Table 4.** ADS 7982: O-C residuals of our new orbit (after 1990). The symbol  $P$  indicates PISCO measurements.

Epoch	$\Delta\rho$ (O-C) ( $''$ )	$\Delta\theta$ (O-C) ( $^{\circ}$ )	Observer
1990.216	-0.109	-1.5	Pop
1990.216	-	3.3	Zul
1990.270	-	2.3	Hei
1991.250	-0.036	-1.6	HIP
1991.480	-0.045	-0.6	TYC
1995.330	-0.127	-1.5	Hei
1996.127	-0.034	-1.1	Hor
1999.330	0.042 $P$	-1.7	Alz
2006.308	0.030 $P$	-0.2 $P$	Pru
2007.323	0.049 $P$	1.0 $P$	This paper

for close binaries with a large magnitude difference, the measurements have a large scatter. The mean standard deviation of the residuals is  $6^{\circ}.52$  in  $\theta$ , and  $0''.15$  in  $\rho$ .

Following Morel, we have chosen the geometrical elements according to the convention of visual binary observers (i.e., ascending node in the range  $[0^{\circ}, 180^{\circ}]$ ). But the WDS Index Catalogue Notes report that the radial velocity measurements of the primary obtained in 1919–1930 “would fit the visual motion with an ascending node in the third quadrant.”

The spectral type of this system is F2 III according to the SIMBAD data base, that follows the determination of

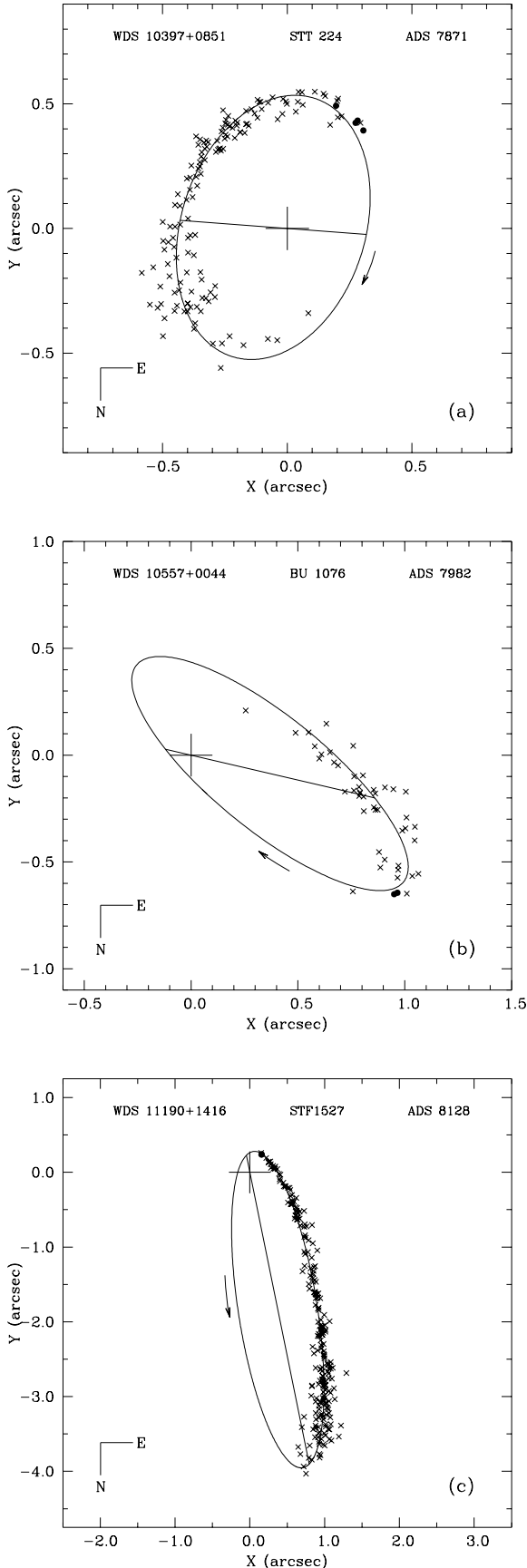
**Table 5.** ADS 8128: O-C residuals of our new orbit (after 2000). The symbol  $P$  indicates PISCO measurements.

Epoch	$\Delta\rho$ (O-C) ( $''$ )	$\Delta\theta$ (O-C) ( $^{\circ}$ )	Observer
2000.119	-0.042	0.6	WSI
2000.250	0.014	-0.9	Alz
2001.310	-0.003	-3.5	Alz
2002.164	0.008	-0.1	WSI
2002.250	0.031	-2.0	Alz
2003.233	-0.058	5.6	WSI
2003.280	0.024	-0.4	Alz
2003.316	-0.015	2.8	WSI
2003.382	-0.023	0.8	WSI
2003.479	-0.001	-1.1	WSI
2004.199	-0.001	-1.4	Hrt
2004.228	0.027	-4.4	WSI
2004.270	-0.022	3.8	Alz
2005.280	-0.025	-2.4	Alz
2005.307	0.005	-2.0	WSI
2005.402	-0.014	-2.4	WSI
2006.300	-0.007	-2.3	Alz
2007.277	-0.007 $P$	0.3 $P$	This paper
2007.288	-0.011 $P$	-0.1 $P$	This paper
2007.290	0.005	3.0	Alz
2008.251	0.018	-0.9	Gili

**Table 6.** New ephemerides of ADS 7871, 7982 and 8128.

Epoch	ADS 7871		ADS 7982		ADS 8128	
	$\rho$ ( $''$ )	$\theta$ ( $^{\circ}$ )	$\rho$ ( $''$ )	$\theta$ ( $^{\circ}$ )	$\rho$ ( $''$ )	$\theta$ ( $^{\circ}$ )
2009.0	0.454	140.8	1.092	54.5	0.283	170.7
2010.0	0.448	139.1	1.078	54.0	0.245	187.5
2011.0	0.441	137.4	1.063	53.5	0.183	214.1
2012.0	0.434	135.7	1.045	52.9	0.156	259.5
2013.0	0.428	133.9	1.026	52.4	0.211	298.0
2014.0	0.421	132.0	1.005	51.8	0.304	316.7
2015.0	0.414	130.0	0.981	51.2	0.403	326.4
2016.0	0.406	128.0	0.955	50.5	0.501	332.3
2017.0	0.399	126.0	0.926	49.8	0.594	336.3
2018.0	0.392	123.8	0.894	49.1	0.683	339.2

Malaroda (1975). In fact, two other classifications have been made for this object, as F3V (Cowley and Bidelman, 1979) and F4V (Abt, 1981). From the Hipparcos parallax and the apparent visual magnitude, we find  $M_V \approx 2.72$  for the system (when neglecting the interstellar absorption, since the



**Figure 4.** New orbits of ADS 7871 (a), ADS 7982 (b) and ADS 8128 (c).

**Table 7.** Physical parameters ( $a$  and  $\mathfrak{M}_{\text{total}}$ ) derived from the new orbital elements.

Name	$m_V$	Spec. type	$\pi_{HIP}$ (mas)	$a$ (")	$a$ (AU)	$\mathfrak{M}_{\text{total}}$ $M_{\odot}$
ADS 7871	7.50	F5	10.04 $\pm 1.84$	0.550 $\pm 0.022$	54.8 $\pm 10.3$	3.6 $\pm 2.1$
ADS 7982	5.93	F3 V	22.85 $\pm 1.13$	1.115 $\pm 0.066$	48.8 $\pm 3.8$	7.0 $\pm 1.9$
ADS 8128	6.95	F9 V	31.17 $\pm 1.55$	2.30 $\pm 0.04$	73.8 $\pm 3.8$	3.4 $\pm 1.3$

distance is only 44 pc). This value can be attributed to the primary only, since the companion has a negligible contribution to the total luminosity (since  $\Delta m_V \approx 3$ ). The theoretical values (e.g. Schmidt-Kaler, 1982) are  $M_V \approx 3.0$  for F2-V stars and  $M_V \approx 1.7$  for F2 III stars. Hence the classification as F3 V is more likely than F2 III. The systemic mass that we obtain, with a reasonable uncertainty, is in excess for stars of this spectral type. From 23 spectroscopic measurements made on a time interval larger than nine years, Abt et al. (1980) did not detect any significant variation of its radial velocity.

Although the period can be considered as well determined, our orbit is not yet definitive. Clearly more observations are needed to improve this orbit.

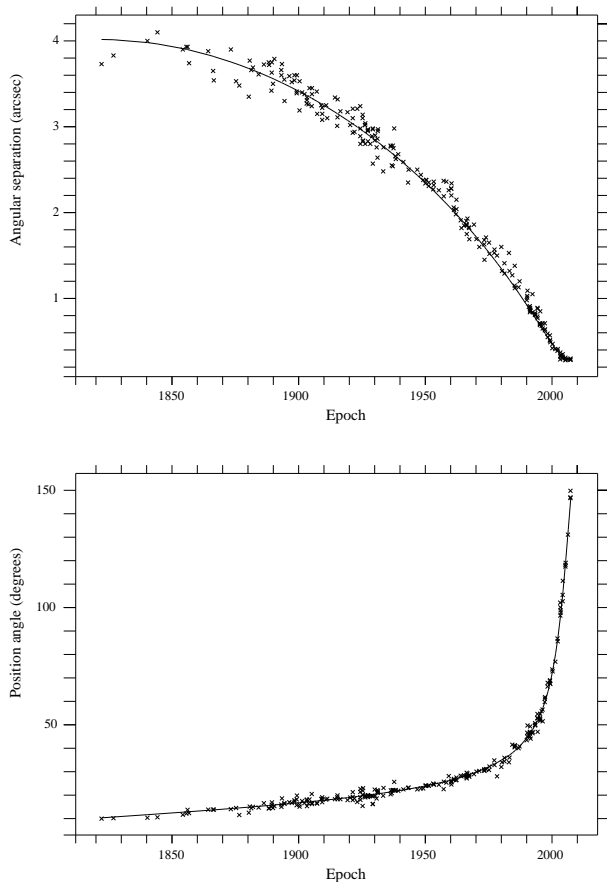
### 4.3 New orbit of ADS 8128

**ADS 8128, STF 1527 (HIP 55254):** this couple was measured for the first time in 1822, by F.G.W. Struve in Dorpat with a 10-cm refractor and a filar micrometer built by J. Fraunhofer. It has been regularly observed since and 250 measurements are now available. The measurements made in the XIXth century have a rather large scatter, especially in the angular separation.

The first orbit was computed by Hopmann (1960b), who proposed a long period orbit. The next measurements suggested a shorter period. The last orbit from Mason et al. (2006) is in complete disagreement with our recent measurements and those obtained by other observers, (see Sect. 3.4). This is not surprising: with an eccentricity of  $e = 0.996$ , this orbit looks unlikely. The residuals are smaller for the previous orbit, computed by Mason et al. (2004b), where  $e = 0.86$ , but are still very large (see Table 1).

Our new orbital elements reported in Table 2 fit much better the observations (see Fig. 5), with mean residuals of  $0''.03 \pm 0''.11$  and  $0^\circ.04 \pm 0^\circ.10$  for  $\rho$  and  $\theta$ , respectively. Although this orbit is still preliminary (grade 3–4) since only part of it has been monitored yet, we do not think it will change much in the future. A first confirmation of its validity was given by the speckle observation made by Gili on 2008.251 with the 76 cm-refractor of Nice Observatory, that he kindly provided us after the submission of this paper (see Table 5).

The spectral type is F9 V according to Harlan et Taylor (1970). The total mass,  $\mathfrak{M}_{\text{total}} = 3.4 M_{\odot}$ , is slightly in excess for a system of type F9 V, but the dynamical parallax of 39.3 mas is in fair agreement with Hipparcos measurement of 31.17 mas (see Table 7).



**Figure 5.** New orbit of ADS 8128 (solid line) compared to data points (crosses) : plot of angular separation (top) and position angle (bottom).

## 5 CONCLUSION

In the first semester of 2007, we obtained 226 new measurements of 214 visual binaries with PISCO in Merate, with an average accuracy of  $0''.013$  for the angular separation and  $0^\circ.7$  for the position angles. The total number of observations made since 2004 now reaches 1312. 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.

We have used the measurements reported here to revise the orbits of ADS 4371, 4376, 7730 (Scardia et al. 2008c) and those of ADS 7871, 7982 and 8128, whose elements are presented in this paper. ADS 8128 will be particularly interesting to observe for the next years, because the companion is close to periastron (see Fig. 4c), the most critical part of the orbit.

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We are indebted to René Gili for sending us his measurement of ADS 8128 with the 76 cm Nice Observatory

refractor, prior to publication.

This work has made use of the “Fourth Catalogue of Interferometric Measurements of Binary Stars” (<http://ad.usno.navy.mil/wds/int4>), the “Sixth Catalogue of Orbits of Visual Binary Stars” (<http://ad.usno.navy.mil/wds/orb6>), the Washington Double Star Catalogue maintained at the U.S. Naval Observatory (<http://ad.usno.navy.mil/wds/wds>) and the SIMBAD data base (<http://simbad.u-strasbg.fr/simbad>) operated by the *Centre de Données Astronomiques de Strasbourg* (France).

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