Astron. Nachr. / AN **332**, No. 5, 501 – 516 (2011) / **DOI** 10.1002/asna.201011553

Speckle observations with PISCO in Merate: X. Astrometric measurements of visual binaries in 2009

M. Scardia[1], **J.-L. Prieur**[2,3,⋆], **L. Pansecchi**[1], **R.W. Argyle**[4], and **M. Sala**[1]

[1] INAF – Osservatorio Astronomico di Brera, Via E. Bianchi 46, 23807 Merate, Italy
[2] Université de Toulouse – UPS-OMP – IRAP, Toulouse, France
[3] CNRS – IRAP, 14 avenue Edouard Belin, 31400 Toulouse, France
[4] Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA, UK

Received 2010 Nov 12, accepted 2011 Mar 21
Published online 2011 May 26

Key words astrometry – binaries: close – binaries: visual – stars: individual (ADS 2377, ADS 8035, ADS 9982, ADS 11484, MLR 198) – techniques: interferometric

We present relative astrometric measurements of visual binaries, made in 2009 with the speckle camera PISCO at the 102 cm Zeiss telescope of Brera Astronomical Observatory, in Merate. Our observing list contains orbital couples as well as binaries whose motion is still uncertain. We obtained 345 new measurements of 259 objects, with angular separations in the range $0\farcs18$–$4\farcs6$, and an average accuracy of $0\farcs011$. The mean error on the position angles is $0\fdg6$. 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 possible new close component for ADS 2377, which would be a new quadruple star system. We also present new revised orbits for ADS 8035, 9982, 11484, and MLR 198, partly derived from those observations, and infer estimated values for the masses of those systems that are compatible with the spectral types.

1 Introduction

This paper deals with the results of speckle observations of visual binary stars made in Merate (Italy) in 2009 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 tenth of a series (Scardia et al. 2005, 2006, 2007, 2008a; Prieur et al. 2008; Scardia et al. 2009; Prieur et al. 2009; Scardia et al. 2010; Prieur et al. 2010, herein: Papers I to IX), 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 Sect. 2. Then we present and discuss the astrometric measurements in Sect. 3. Finally, in Sect. 4 we propose new revised orbits for ADS 8035, 9982, 11484, and MLR 198, partly derived from those observations, and discuss the estimated values for the masses of those systems.

⋆ Corresponding author: prieur@ast.obs-mip.fr

2 Observations and description of the observing list

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.

The description of our observing list 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. 1a and shows a maximum for $\rho \approx 0\farcs7$. The largest separation of $4\farcs6$ was obtained for ADS 6175. The smallest separation was measured for HU 66AB (ADS 11344), with $\rho = 0\farcs18$. This is rather close to the diffraction limit $\rho_{\rm d} = \lambda/D \approx 0\farcs13$ 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. 1b and 1c, respectively. The telescope aperture and detector sensitivity lead to a limiting magnitude of about $m_V = 9$ (Fig. 1b) and a limiting Δm_V of about 4.0 (Fig. 1c).

Using the Hipparcos parallaxes, we were able to construct the HR diagram of those binaries, which is displayed

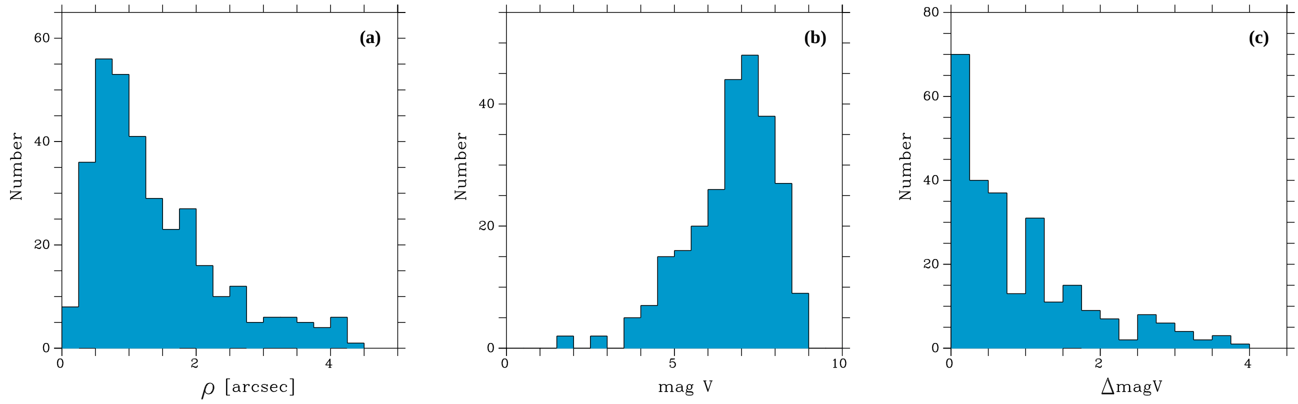

Fig. 1 (online colour at: www.an-journal.org) Distribution of the angular separations of the 345 measurements of Table 1 (*a*), of the total visual magnitudes (*b*), and of the differences of magnitude between the two components of those binaries (*c*).

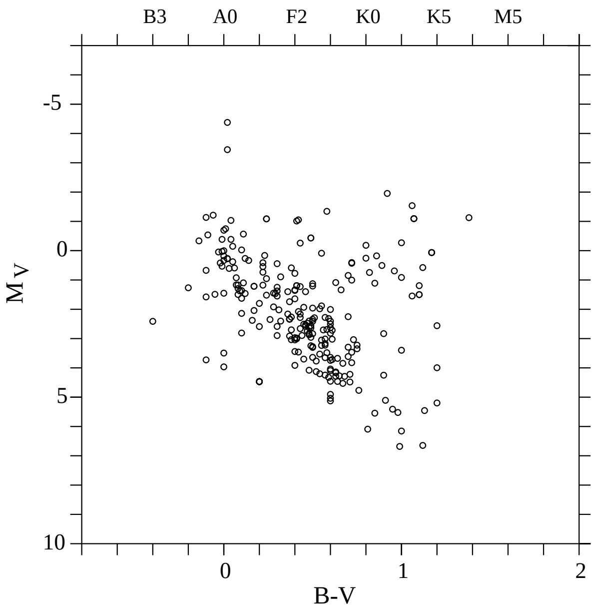

Fig. 2 HR diagram of the binaries measured in Table 1, for which Hipparcos parallaxes were obtained with a relative error smaller than 50 % (i.e., 251 objects).

in Fig. 2. We only plotted the objects for which the relative uncertainty on the parallax was smaller than 50 %. It can be seen that a large part of the HR diagram is covered by our observation program. 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 2009 are displayed in Table 1. For each object, we report its WDS name (Washington Double Star Catalogue, Mason et al. 2010, hereafter WDS Catalogue) in Col. 1, the official double star designation in Col. 2 (sequence is "discoverer-number"), and the ADS number in Col. 3 (Aitken, 1932) when available. For each observation, we then give the epoch in Besselian years (Col. 4), the filter (Col. 5) and the focal length of the eyepiece used for magnifying the image (Col. 6), the angular separation ρ (Col. 7) with its error (Col. 8) in arcseconds, and the position angle θ (Col. 9) with its error (Col. 10) in degrees. In Col. 11, we report some notes and some information about the secondary peaks of the auto-correlation files (e.g. diffuse, faint 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 Cols. 13 and 14, respectively. The corresponding authors are given in Col. 12, using the bibliographic style of the "Sixth Catalogue of Orbits of Visual Binary Stars" (Hartkopf & Mason, 2010, hereafter OC6). Unless explicitly specified, the measurements refer to the AB components of those systems. In Col. 14, the symbol ^{Q} indicates that there was a quadrant inconsistency between our measures and the orbital elements published for this object.

The characteristics of the V, R and RL filters used for obtaining those measurements are given in Table 2 of Paper IX. Some objects were observed with no filter because they were too faint. This is indicated with W (for "white" light) in the filter column (Col. 5 of Table 1). In that case, the bandpass and central wavelength correspond to that of the ICCD detector (see Prieur et al., 1998).

As for the other papers of this series, we interactively processed all the auto-correlation files computed in real time during the observations 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 345 measurements reported in this table are $0\farcs011 \pm 0\farcs007$ and $0\fdg57 \pm 0\fdg39$ for ρ and θ, respectively.

There is only one unresolved object: COU 773. This is not really surprising since the ephemeris of Couteau's orbit (1999) gives $\rho = 0\farcs189$, which is close to the diffraction limit of the Zeiss telescope. In this data set, the closest separation we managed to resolve was 0.″18, for HU 66AB (see Sect. 2).

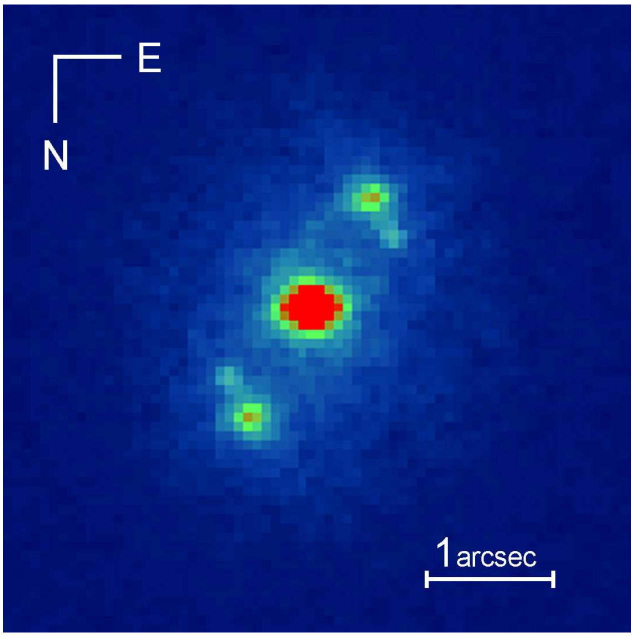

Fig. 3 (online colour at: www.an-journal.org) Auto-correlation showing the possible new component (small peaks) in the multiple system ADS 2377 (see text for details).

3.1 Multiple systems

ADS 719: This object is known as a wide triple system. In 2009, we measured the AB and AC pairs, with $\rho = 1.''53$ and $\rho = 3.''95$, respectively.

ADS 2377 (new discovery): In the WDS catalogue there are two couples associated to ADS 2377: STT 50 AB (our target) and HJ 2172 AC, much wider (28″) and out of the field of view of our detector. Furthermore, the C component is very weak ($m_V = 14$). The secondary peaks of the auto-correlation are clearly double in our observations made in 2009.081 (see Fig. 3). This suggests the presence of a new component, not visible in our previous observations of 2005 (Paper III). Since the auto-correlation peaks are symmetric, and since it was not possible to reconstruct the image with bispectral methods (see an example in Paper VI), we cannot decide whether the new component is associated to A or B. Therefore, we provisionally assume that it is orbiting A and propose to call the new couple SCA 171Aa,Ab. The R magnitude of this component is estimated at 9.0–9.2.

ADS 11344: This object is known as a triple system. We already observed it in 2004.690 (Paper II), and in 2007.671, when we obtained an image of the auto-correlation with clear double secondary peaks (Paper VIII). In 2009, we also obtained similar peaks and could measure the AB and AC components. The innermost peaks correspond to STT 351AC and the outermost ones to HU 66BC. Finally, each couple composed by the big and small secondary peaks correspond to HU 66AB. (see Paper VIII).

ADS 11635: Two known couples could be measured for this object: STF2382 AB and STF2383 Cc-D.

ADS 11077: In 2005 we discovered a new component with $\rho = 0.228$ and $\theta = 50.2$ (Paper IV), which was confirmed in 2007 (Paper VIII). This pair is now reported as "SCA170Aa,Ab" both in the WDS and in the "Fourth Catalogue of Interferometric Measurements of Binary Stars" (Hartkopf et al. 2010, hereafter IC4). Unfortunately, we cannot detect this companion in the data obtained in August 2009, which are of poor quality, with a fuzzy autocorrelation.

ADS 10270 and ADS 13572: The auto-correlation files show extra secondary peaks in both cases, which suggest the existence of possible new components. However we cannot rule out yet that there are mere artefacts. Further observations are needed to confirm those findings.

Table 2 Objects with discrepant quadrants

Name	Q	Filter	Δm_V	Spectral Type
ADS 710	1	W	0.01	A2
ADS 2980	2	R	0.01	G5
ADS 8820	3	W	0.01	K0
ADS 9498	2	W	0.01	G0
ADS 9530	3	W	0.2	A9 V
ADS 10905	2	R	0.1	A0 III
ADS 11558	2	R	0.1	F2
ADS 14839	3	W	1.6	G0

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 analysing the restricted triple correlation (RTC hereafter) files that were computed in real time during the observations. 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 280 out of 345 measurements, i.e. 81% of the total. They are marked with an asterisk in Col 9. Otherwise, our angular measurements were reduced to the quadrant reported in the WDS catalogue, which is extracted from the IC4.

Our "absolute" θ values are consistent with the values tabulated in WDS for all objects except for ADS 710, 2980, 8820, 9498, 9530, 10905, 11558, and 14839. We display

Table 1 Measurements of binaries with PISCO in 2009.

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (″)	σ_ρ (″)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho_{(O-C)}$ (″)	$\Delta\theta_{(O-C)}$ (°)
00134+2659	STT2	161	2009.960	R	10	0.415	0.003	161.3*	0.4		Sca2000b	−0.03	−1.3
00210+6740	HJ1018	283	2009.960	R	20	1.683	0.008	86.8*	0.3		Mlr1957b	0.09	0.2
00218+6628	STT7	296	2009.960	W	20	0.886	0.008	126.9*	0.7				
00442+4614	STF52	616	2009.957	W	20	1.373	0.008	3.0*	0.3				
00481+2533	HO306	662	2009.034	R	20	1.458	0.015	159.3*	0.6				
00504+5038	BU232	684	2009.034	R	20	0.880	0.008	250.4	0.9		Sca2008a	0.02	−1.5
00516+6859	BU781	692	2009.062	W	20	1.058	0.009	23.0*	0.8				
00521+1036	STF67	709	2009.957	W	20	2.241	0.011	349.9*	0.4				
00527+6852	STF65	710	2009.062	W	20	3.292	0.034	39.5*	0.8				
00528+5638	BU1AB	719	2009.062	W	20	1.530	0.020	81.3*	0.4				
00528+5638	BU1AC	719	2009.062	W	20	3.949	0.032	133.4*	0.3				
01004+1803	BRT1927	–	2009.957	W	20	1.908	0.010	171.8*	0.3				
01197+6135	KR11	1062	2009.081	W	20	1.975	0.010	57.9*	0.9				
01198–0031	STF113A-BC	1081	2009.081	R	20	1.647	0.008	20.4*	0.6				
01201+4357	DA8	1079	2009.081	W	20	2.642	0.013	141.1*	0.3				
01208+5612	BU782	1089	2009.081	W	20	3.171	0.016	82.0*	0.3				
01283+4247	AC14	1161	2009.034	R	20	0.780	0.008	91.1*	2.1				
01355+3118	STF137	1243	2009.081	W	20	3.381	0.019	85.0*	0.3				
01493+4754	STF162	1438	2009.034	R	20	1.944	0.034	199.2*	0.3				
01559+0151	STF186	1538	2009.081	R	20	0.858	0.008	245.5	0.4		Bdl2007b	−0.01	−0.7^{Q}
02037+2556	STF208	1631	2009.111	R	20	1.275	0.008	340.9*	0.3		Pop1969b	0.05	−2.0
02123+2357	STF226	1696	2009.111	R	20	1.761	0.013	231.9*	0.6				
02140+4729	STF228	1709	2009.108	R	20	0.844	0.015	290.2*	0.4		Sca1981d	−0.06	−0.9
02213+3726	STF250	1790	2009.108	W	20	3.174	0.035	135.7*	0.3				
02313+4703	A968	1908	2009.075	W	20	1.694	0.028	26.2*	0.4				
02331+5828	STF272	1933	2009.075	W	20	1.941	0.047	215.7*	1.2				
02471+3533	BU9	2117	2009.111	R	20	1.006	0.008	209.6*	0.7				
03054+2515	STF346	2336	2009.081	R	10	0.406	0.003	253.6	0.7	Elong.	Hei1981a	−0.04	−2.8
03127+7133	STT50AB	2377	2009.081	R	20	1.037	0.008	150.6	0.5		Sca2001g	0.10	0.9
03127+7133	SCA 171Aa,Ab	2377	2009.081	R	20	0.369	0.008	27.0	0.8	New pair			
03177+3838	STT53	2446	2009.144	R	20	0.676	0.010	240.4	1.5		Alz1998a	0.03	−1.7
03280+5511	STF386	2537	2009.144	W	20	2.635	0.013	58.4*	1.4				
03306+4947	HLD8	2574	2009.144	W	20	2.311	0.062	176.6*	1.3				
03344+2428	STF412	2616	2009.081	R	10	0.712	0.004	353.7	0.3		Sca2002a	−0.01	0.1
03350+6002	STF400	2612	2009.138	R	20	1.568	0.008	266.4*	0.8		Sca1981e	0.03	−1.9
03356+3141	BU533	2628	2009.138	R	20	1.049	0.010	221.6*	0.4				
03372+0121	A2419	2647	2009.163	W	20	0.770	0.008	99.9*	0.3				
03401+3407	STF425	2668	2009.139	R	20	1.970	0.010	61.9*	0.3				
03443+3217	BU535	2726	2009.139	R	20	1.046	0.008	22.8*	0.3				
03446+3551	HO504	2729	2009.144	W	20	1.108	0.029	192.4	0.3				
03520+0632	KUI15	–	2009.139	R	20	0.785	0.011	207.2*	0.4				
04041+3931	STF483	2959	2009.163	R	20	1.409	0.013	56.6*	0.5		Bdl2006b	−0.02	0.0
04064+4325	A1710	2980	2009.139	R	20	0.636	0.008	132.8*	0.9		Hei1982c	0.02	0.1^{Q}
04139+0916	BU547	3072	2009.139	R	20	1.231	0.009	340.7*	0.6	Faint			
04159+3142	STT77	3082	2009.081	R	20	0.540	0.016	292.4	0.3		Sca1983c	−0.04	0.1
04182+2248	STF520	3114	2009.081	R	20	0.590	0.010	77.0	1.8		Hrt2001b	0.03	−1.7
04225+5136	STF522	3147	2009.081	W	20	1.491	0.020	211.5	0.9				
04301+1538	STF554	3264	2009.163	R	20	1.535	0.008	16.6*	0.5		Baz1980a	−0.12	0.7
05010+1430	D6	3600	2009.163	W	20	1.103	0.011	101.8*	0.4				
05055+1948	STT95	3672	2009.163	R	20	0.903	0.009	297.1*	0.3		Jas1996b	−0.05	−0.6
05103+3718	STF644	3734	2009.199	R	20	1.625	0.012	221.4*	0.3				
05135+0158	STT517	3799	2009.199	R	20	0.700	0.022	240.0	1.4		Msn1999a	0.05	−0.9
05177+0441	STF678	3873	2009.207	W	20	3.625	0.018	102.6*	1.2				
05238+5334	A1560	3952	2009.207	W	20	1.152	0.011	219.3	1.1				

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ (″)	σ_ρ (″)	θ (°)	σ_θ (°)	Notes	Orbit	$\Delta\rho_{(O-C)}$ (″)	$\Delta\theta_{(O-C)}$ (°)
05247+6323	STF677	3956	2009.199	R	20	1.095	0.034	119.1*	1.7	Diffuse	Hrt2008	−0.02	−0.4
05302+4117	STF715	4083	2009.207	W	20	0.840	0.008	202.8*	0.5	Elong.			
05307+1154	A2705	4109	2009.207	W	20	0.962	0.022	249.3*	0.7				
05308+0557	STF728	4115	2009.081	R	20	1.238	0.012	45.0*	0.4		Sey1999b	−0.02	0.0
05312+0318	STF729	4123	2009.139	R	20	1.890	0.029	27.3*	0.4				
05339+4447	STF727	4137	2009.081	W	20	2.191	0.011	58.0*	0.3				
05352+3358	AG97	4165	2009.163	W	20	2.075	0.024	269.7*	0.3				
05364+2200	STF742	4200	2009.139	R	20	4.124	0.026	273.4*	0.3		Hop1973b	0.00	−1.4
05371+2655	STF749	4208	2009.081	R	20	1.109	0.018	141.4*	0.3		Sca2007a	−0.05	0.1[Q]
05371+4150	STF736	4204	2009.139	R	20	2.560	0.015	359.7*	0.3				
05399+3757	STT112	4243	2009.081	R	20	0.866	0.011	50.0*	0.4				
05474+2939	BU560	4371	2009.139	R	20	1.661	0.011	125.0*	0.4		Sca2008c	0.01	−0.6
05480+0627	STF795	4390	2009.139	R	20	1.030	0.008	219.0*	0.5				
06228+1734	STF899	4991	2009.081	R	20	2.142	0.021	17.9*	0.3				
06277+1822	COU41	–	2009.207	W	20	1.187	0.015	40.6	1.2				
06289+4007	STF905	5088	2009.207	W	20	1.948	0.014	128.1*	0.3				
06462+5927	STF948	5400	2009.081	R	20	1.875	0.012	68.8*	0.3		WSI2006b	0.00	−0.2
06573+5825	STT159	5586	2009.139	R	10	0.625	0.003	229.6*	0.6		Alz2000a	−0.02	−0.4
07128+2713	STF1037	5871	2009.139	R	20	1.015	0.008	308.8	0.4		Sca1983e	0.03	0.7
"	"	"	"	"	"	"	"	"	"		Sta1981a	−0.03	−0.1
07176+0918	STT170	5958	2009.267	R	10	0.236	0.004	341.5*	1.0		Doc2007e	−0.02	−4.5
07303+4959	STF1093	6117	2009.264	W	20	0.860	0.008	201.1*	0.5		Hrt2009	−0.01	−0.5
"	"	"	"	"	"	"	"	"	"		Sca1984d	0.07	−1.1
07346+3153	STF1110	6175	2009.264	V	20	4.615	0.023	58.1*	0.3		Doc1985c	0.02	0.6
07417+3726	STT177	6276	2009.267	R	20	0.528	0.014	150.3	1.6		Hei1982c	0.01	2.6
07486+2308	WRH15	6378	2009.267	R	10	0.273	0.003	32.2*	1.0		Sey2002	0.00	−0.4
08024+0409	STF1175	6532	2009.267	R	20	1.395	0.008	282.5*	0.3		Ole2001	0.03	−4.5
08041+3302	STT187	6549	2009.267	R	10	0.410	0.003	340.0	0.3		Msn1999a	0.00	−0.5
08095+3213	STF1187Aa-B	6623	2009.207	R	20	3.042	0.030	22.1*	0.7		Ole2001	0.11	0.8
08507+1800	A2473	7039	2009.265	R	10	0.256	0.003	81.7	0.7		Hrt2000c	0.05	−3.3
08531+5457	A1584	7054	2009.139	R	20	0.627	0.008	83.4*	0.3		Hei1981a	0.00	−1.0
08539+1958	COU773	–	2009.267	R	20	–	–	–	–	Unres.			
08554+7048	STF1280	7067	2009.207	R	20	2.315	0.012	350.3*	0.3		Hei1997	0.03	−0.7
09006+4147	KUI37	–	2009.265	R	10	0.456	0.005	289.0*	0.5		Hrt1989	0.00	0.1
09104+6708	STF1306	7203	2009.207	R	20	4.167	0.022	350.0*	0.3		Sca1985c	0.05	−0.2
09179+2834	STF3121	7284	2009.207	R	20	0.547	0.009	213.9	0.5		Sod1999	−0.01	1.6
09210+3811	STF1338	7307	2009.139	R	20	1.070	0.012	299.2	0.5		Sca2002b	−0.04	−0.7
09245+0621	STF1348	7352	2009.267	R	20	1.936	0.010	314.3	0.3				
09245+1808	A2477	7341	2009.207	R	20	0.419	0.008	358.1	1.8		Msn1998c	−0.06	0.9
09273+0614	STF1355	7380	2009.267	R	20	1.803	0.032	353.1*	0.4				
09285+0903	STF1356	7390	2009.267	R	10	0.722	0.008	101.8*	0.5		vDl1976	−0.00	−0.4
"	"	"	"	"	"	"	"	"	"		Mut2010b	−0.00	0.1
09521+5404	STT208	7545	2009.265	R	10	0.342	0.007	290.8*	0.8		Hei1996c	−0.03	−1.5
10163+1744	STT215	7704	2009.265	R	20	1.459	0.008	177.2*	0.5		Wrz1956c	−0.07	−0.7
10205+0626	STF1426	7730	2009.349	R	20	0.916	0.008	310.3*	0.7		Sca2006b	0.01	−0.8
"	"	"	"	"	"	"	"	"	"		Nov2006	−0.00	−0.8
10227+1521	STT216	7744	2009.330	R	20	2.194	0.014	234.2*	0.3		Sca2009c	0.05	−0.2
10250+2437	STF1429	7758	2009.330	W	20	0.755	0.008	160.2*	0.6		Zul1981	0.03	−0.4
10269+1713	STT217	7775	2009.330	R	20	0.749	0.008	149.1*	0.5		Hei1975b	0.02	1.0
10397+0851	STT224	7871	2009.330	R	20	0.505	0.008	142.9*	0.6		Hrt2010a	−0.01	0.5
11037+6145	BU1077	8035	2009.207	V	10	0.549	0.003	26.8*	1.3		Sca2005a	−0.02	−5.6
"	"	"	"	"	"	"	"	"	"		Hei1963a	0.01	0.6
"	"	"	"	"	"	"	"	"	"		This paper	−0.01	−0.1
"	"	"	2009.382	R	10	0.565	0.007	26.8*	1.9		Sca2005a	−0.01	−4.2
"	"	"	"	"	"	"	"	"	"		Hei1963a	0.03	2.1
"	"	"	"	"	"	"	"	"	"		This paper	−0.00	1.3

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Notes	Orbit	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)
11037+6145	BU1077	8035	2009.385	V	10	0.557	0.004	25.9*	1.2		Sca2005a	−0.02	−5.1
”	”	”	”	”	”	”	”	”	”		Hei1963a	0.02	1.2
”	”	”	”	”	”	”	”	”	”		This paper	−0.01	0.4
11136+5525	A1353	8092	2009.207	R	20	0.577	0.008	211.4*	0.4		Hei1997	0.02	0.2
11137+2008	STF1517	8094	2009.396	R	10	0.638	0.003	317.6	0.9		Hop1970	0.40	15.5
11182+3132	STF1523	8119	2009.265	R	20	1.594	0.008	215.0*	0.3		Hei1996b	−0.00	−0.2
11190+1416	STF1527	8128	2009.207	R	10	0.316	0.007	172.6	0.6		Pru2009	0.04	−1.3
”	”	”	2009.265	R	10	0.311	0.003	174.6	0.6		Pru2009	0.03	−0.2
”	”	”	2009.330	R	10	0.317	0.005	174.9	0.3		Pru2009	0.04	−0.9
”	”	”	2009.349	R	10	0.302	0.003	175.4*	0.3		Pru2009	0.03	−0.7
”	”	”	2009.382	R	10	0.319	0.004	175.2	0.9		Pru2009	0.05	−1.4
”	”	”	2009.385	R	10	0.323	0.003	175.3	0.6		Pru2009	0.05	−1.4
”	”	”	2009.390	R	10	0.313	0.003	175.1	0.7		Pru2009	0.04	−1.6
”	”	”	2009.396	R	10	0.322	0.005	175.5*	0.3		Pru2009	0.05	−1.3
11239+1032	STF1536	8148	2009.331	R	20	1.930	0.014	100.9*	0.3		Sod1999	−0.03	−0.1
11308+4117	STT234	8189	2009.265	R	20	0.489	0.008	171.2	1.1		Doc2001f	0.01	0.3
11323+6105	STT235	8197	2009.265	R	20	0.770	0.008	20.5*	0.3		Hei1990c	−0.01	2.0
11363+2747	STF1555	8231	2009.390	R	10	0.729	0.004	148.9*	0.4		Doc2007i	0.03	−0.3
11388+6421	STF1559	8249	2009.391	R	20	1.957	0.010	322.9*	0.3				
11390+4109	STT237	8252	2009.391	R	20	2.024	0.014	244.1*	0.5		Sey2002	0.02	−0.9
11486+1417	BU603	8311	2009.396	R	20	1.025	0.017	335.0*	0.9		Sta1980a	−0.05	1.5
11520+4805	HU731	8325	2009.391	W	20	1.094	0.008	308.6*	0.3	Elong.	Hrt2008	−0.02	−0.1
11537+7345	BU794	8337	2009.391	R	20	0.524	0.011	50.3*	1.0		Sod1999	0.03	0.1
12108+3953	STF1606	8446	2009.396	R	20	0.444	0.014	157.3*	1.2		Msn1999a	−0.02	2.5
12244+2535	STF1639	8539	2009.396	R	20	1.788	0.009	323.9*	0.3		Ole2000b	0.00	0.2
”	”	”	”	”	”	”	”	”	”		All1951	0.05	1.1
12306+0943	STF1647	8575	2009.396	W	20	1.279	0.011	246.7*	0.6		Hop1970	0.02	−3.2
12409+0850	STF1668	8625	2009.382	R	20	1.131	0.008	187.1	0.6				
12417–0127	STF1670	8630	2009.330	R	20	1.231	0.008	28.6*	0.3		Sca2006b	−0.01	0.7
”	”	”	2009.382	R	20	1.244	0.008	28.3*	0.7		Sca2006b	−0.01	0.8
”	”	”	2009.385	R	20	1.258	0.009	28.6*	0.6		Sca2006b	−0.00	1.1
”	”	”	2009.448	RL	20	1.258	0.009	27.2*	0.5		Sca2006b	−0.01	0.1
12592+8256	STF1720	8738	2009.385	W	20	1.622	0.014	329.3*	0.5	Elong.			
13007+5622	BU1082	8739	2009.382	R	20	1.098	0.008	99.0*	0.3		Sca2005a	−0.13	2.3
”	”	”	”	”	”	”	”	”	”		Sod1999	−0.01	−2.3
13048+7302	BU799	8772	2009.385	R	20	1.367	0.012	265.7*	0.3				
13064+2109	COU11	–	2009.385	R	20	1.693	0.008	315.8*	0.4				
13128+4030	A1606	8820	2009.391	W	20	1.290	0.008	196.3*	0.4				
13375+3618	STF1768	8974	2009.391	R	20	1.750	0.010	96.7*	0.3		Sod1999	0.02	0.0
”	”	”	”	”	”	”	”	”	”		Sta1976b	−0.01	0.9
14131+5520	STF1820	9167	2009.505	R	20	2.694	0.013	119.7*	0.3		Kiy1998	0.06	−1.4
14531+7811	HU908	9445	2009.541	R	20	1.536	0.008	237.4*	0.4				
14568+7050	STF1905	9460	2009.541	W	20	2.826	0.014	161.0*	0.3				
15038+4739	STF1909	9494	2009.538	R	20	1.695	0.008	58.9*	0.4		Sod1999	0.04	−0.3
15056+1138	STF1907	9498	2009.538	W	20	0.886	0.008	169.9*	1.7				
15116+1007	A1116	9530	2009.538	W	20	0.843	0.018	233.0*	1.1				
15232+3017	STF1937	9617	2009.391	R	10	0.564	0.003	160.6*	0.3		Msn1998c	−0.01	−0.1
”	”	”	”	”	”	”	”	”	”		Mut2010b	−0.00	−0.1
15245+3723	STF1938Ba,Bb	9626	2009.391	R	20	2.276	0.011	5.9*	0.3		Sca1986b	0.05	0.2
15246+5413	HU149	9628	2009.541	R	20	0.658	0.011	270.8	0.4				
15264+4400	STT296	9639	2009.599	W	20	2.099	0.019	274.8*	0.3	Elong.			
15278+2906	JEF1	–	2009.541	R	10	0.203	0.008	131.4*	1.7	Diffuse	Sod1999	−0.01	−1.6
”	”	”	”	”	”	”	”	”	”	”	Mut2010b	−0.00	−0.3
15329+3122	COU610	–	2009.599	R	20	0.825	0.008	198.7*	0.7				
15360+3948	STT298	9716	2009.541	R	20	1.058	0.008	177.9*	0.5		Cou1966c	0.01	0.0
16133+1332	STF2021Aa-B	9969	2009.593	R	20	4.091	0.020	356.1*	0.3		Hop1964b	0.01	1.0

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Notes	Orbit	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)
16137+4638	A1642	9975	2009.539	W	20	0.747	0.008	182.0*	1.2		Hrt2001b	0.00	−0.1
16145+0531	STF2023	9974	2009.615	W	20	1.902	0.010	224.0*	0.3				
16160+0721	STF2026	9982	2009.593	W	20	3.407	0.017	17.6*	0.3		Hei1963a	−0.01	−0.5
”	”	”	”	”	”	”	”	”	”		This paper	0.03	−0.3
16231+4738	STF2047	10038	2009.599	W	20	1.830	0.009	324.6*	0.3				
16238+6142	STF2054	10052	2009.599	R	20	0.979	0.008	351.0*	0.5				
16279+2559	STF2049	10070	2009.612	R	20	1.125	0.008	195.1*	0.3				
16289+1825	STF2052	10075	2009.541	R	20	2.236	0.017	120.2*	0.3		Sca1984d	−0.00	−1.0
16309+0159	STF2055	10087	2009.612	R	20	1.418	0.008	36.9*	0.5		Hei1993b	−0.03	0.1
16309+3804	STF2059	10093	2009.612	W	20	0.373	0.016	181.9	2.1	Elong.			
16326+4007	STT313	10111	2009.615	R	20	0.934	0.008	129.9*	0.3				
16362+5255	STF2078	10129	2009.637	R	20	3.113	0.016	104.1*	0.3				
16420+7353	MLR198	–	2009.637	R	10	0.221	0.013	69.3	1.8		Hrt2001b	−0.05	44.3
”	”	”	”	”	”	”	”	”	”		Sey2002	−0.05	47.7
”	”	”	”	”	”	”	”	”	”		This paper	−0.03	0.8
16448+3544	STF2097	10193	2009.637	W	20	1.924	0.015	79.3*	0.3				
”	”	”	”	”	”	”	”	”	”		This paper	−0.03	0.8
16448+3544	STF2097	10193	2009.637	W	20	1.924	0.015	79.3*	0.3				
”	”	”	”	”	”	”	”	”	”		This paper	−0.03	0.8
16448+3544	STF2097	10193	2009.637	W	20	1.924	0.015	79.3*	0.3				
16458+3538	STF2101	10203	2009.670	R	20	4.115	0.021	47.5*	0.3				
16483+0244	BU43	10217	2009.645	R	20	1.392	0.008	54.9	0.5				
16514+0113	STT315	10230	2009.645	R	10	0.643	0.003	313.3*	0.3	Elong.	Doc1991f	−0.02	0.5
16518+2840	STF2107	10235	2009.593	R	20	1.426	0.008	100.8*	0.5		Sca2003c	0.04	−1.5
16540+2906	A350	10253	2009.656	W	20	0.594	0.010	148.7*	1.1				
16564+6502	STF2118	10279	2009.541	R	20	1.037	0.008	66.5*	0.5		Sca2002d	−0.12	−0.8
16567+1408	STT318	10270	2009.656	R	20	2.840	0.026	242.3*	0.3				
16567+1408	STT318	10270	2009.656	R	20	0.209	0.009	301.1	2.0	Artefacts?			
16581+1509	STT319	10277	2009.656	R	20	0.846	0.008	64.3*	0.4				
17020+0827	STF2114	10312	2009.593	R	20	1.318	0.009	194.4*	0.3				
17053+5428	STF2130	10345	2009.541	R	20	2.394	0.012	8.5*	0.3		Hei1981b	0.04	1.9
17082–0105	A1145	10355	2009.659	R	20	0.663	0.008	346.5*	0.3		WSI2006b	0.02	−0.5
17131+5408	STF2146	10410	2009.593	W	20	2.664	0.013	224.4*	0.3				
17166–0027	A2984	10429	2009.599	R	20	0.810	0.008	14.7*	0.5		Ole1993	−0.22	1.5
17240+3835	HU1179	10531	2009.689	R	10	0.271	0.003	274.6*	0.4		Hrt2000b	0.01	3.0
17246+1536	STF2160	10528	2009.667	R	20	3.813	0.019	65.9*	0.3				
17266+3546	STF2168	10558	2009.612	W	20	2.295	0.011	201.4*	0.3				
17290+5052	STF2180	10597	2009.612	R	20	3.047	0.019	259.2	0.3				
17304–0104	STF2173	10598	2009.713	R	10	0.722	0.004	155.7*	0.3		Hei1994a	−0.03	−0.2
17320+0249	STT331	10614	2009.637	W	20	1.000	0.021	350.4*	1.5				
17350+6153	BU962	10660	2009.593	R	20	1.055	0.011	317.2*	0.5		Sod1999	−0.03	−1.1
”	”	”	”	”	”	”	”	”	”		Baz1965	−0.07	1.1
17386+5546	STF2199	10699	2009.686	W	20	2.030	0.010	56.0*	0.3		Pop1995d	0.11	1.8
17400–0038	BU631	10696	2009.689	R	10	0.255	0.003	90.3	1.1		Baz1981b	−0.03	0.7
”	”	”	”	”	”	”	”	”	”		Hei1996a	−0.03	6.2
17403+6341	STF2218	10728	2009.541	R	20	1.466	0.008	311.8*	0.3				
17412+4139	STF2203	10722	2009.541	R	20	0.741	0.017	293.2	0.3				
17434+3357	HO560	10742	2009.637	W	20	1.334	0.015	263.1*	0.3				
17436+2237	HU1285	10743	2009.686	W	20	0.596	0.012	214.9	1.1		Sey2002	0.07	0.7
17464+0542	STF2212	10779	2009.659	W	20	3.220	0.020	341.0	0.4				
17512+4454	STF2242	10849	2009.637	R	20	3.352	0.017	325.8	0.3				
17520+1520	STT338	10850	2009.615	R	20	0.811	0.008	165.3*	0.4				
17533+4000	BU130	10875	2009.637	R	20	1.574	0.027	110.1	0.7				
”	”	”	2009.645	V	20	1.585	0.011	110.3*	0.5				
”	”	”	2009.645	RL	20	1.567	0.020	110.1*	0.6				
17541+2949	AC9	10880	2009.615	W	20	1.067	0.008	241.0*	0.5				

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Notes	Orbit	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)
17564+1820	STF2245	10905	2009.656	R	20	2.613	0.013	111.1*	0.3				
17571+0004	STF2244	10912	2009.683	R	10	0.631	0.003	98.4	0.3		Hei1997	0.10	−1.8
18014+6557	STF2284	11016	2009.667	W	20	3.589	0.018	191.6*	0.3				
18018+0118	BU1125	10990	2009.659	R	10	0.488	0.007	139.6*	0.3		Hrt2009	0.00	1.2
18025+4414	BU1127	11010	2009.683	R	20	0.740	0.010	53.0*	0.8		Cve2006e	−0.07	−1.1
18070+3034	AC15	11077	2009.659	RL	20	1.089	0.012	311.8*	0.4		Sta1981a	−0.03	−0.1
18078+2606	CHR67Aa,Ab	11089	2009.656	R	10	0.242	0.007	316.1	1.0		Msn2001a	−0.04	−6.4
18096+0400	STF2281	11111	2009.713	R	10	0.633	0.003	288.4*	0.3		Hei1984b	−0.03	1.1
18096+0609	STF2283	11110	2009.615	W	20	0.646	0.013	55.9*	1.0				
18097+5024	HU674	11128	2009.683	R	20	0.736	0.008	215.9*	0.7		Sey2002	0.14	1.9
18101+1629	STF2289	11123	2009.686	R	20	1.231	0.008	219.4*	0.5		Hop1964b	−0.01	2.9
18113+6915	STF2307	11178	2009.667	W	20	4.349	0.022	205.5*	0.3				
18118+3327	HO82AB-C	11149	2009.656	RL	20	0.686	0.010	218.3*	0.8				
18121+2739	STF2292	11155	2009.615	W	20	0.867	0.022	274.7*	0.5				
18126–0329	A83	11154	2009.670	W	20	0.739	0.010	303.3*	0.4	Elong.			
18126+3836	BU1091	11170	2009.593	W	20	0.710	0.011	319.9*	0.5				
18146+0011	STF2294	11186	2009.686	W	20	1.307	0.010	93.2*	0.3		Luy1934a	0.10	−0.0
18208+7120	STT353	11311	2009.683	R	10	0.491	0.003	266.5*	0.4		Ana2005	−0.00	−1.1
18218+2130	BU641	11287	2009.615	R	20	0.775	0.011	341.1	1.1				
18239+5848	STF2323	11336	2009.656	R	20	3.728	0.019	348.3*	0.3		Nov2006e	−0.02	−0.4
18250–0135	AC11	11324	2009.689	R	20	0.883	0.008	355.8*	0.3		Hei1995	0.05	1.1
18250+2724	STF2315	11334	2009.684	R	20	0.657	0.008	118.7*	0.4		WSI2004b	0.03	−0.6
18253+4846	HU66AB	11344	2009.656	R	20	0.179	0.013	220.8	1.9		Sey2002	−0.00	2.5
18253+4846	HU66BC	11344	2009.656	R	20	0.941	0.012	27.7*	0.4		Nov2008b	0.04	0.3
18253+4846	STT351AC	11344	2009.656	R	20	0.768	0.008	24.6*	0.3				
18261+0047	BU1203	11339	2009.689	R	20	0.479	0.020	157.3*	1.1		Pop1996b	−0.00	1.9
18269+0625	STT350	11349	2009.659	W	20	1.827	0.009	166.3*	0.3				
18272+0012	STF2316Aa-B	11353	2009.689	R	20	3.679	0.018	319.6*	0.3				
18272+0012	STF2316Aa,Ab	11353	2009.689	R	10	0.216	0.015	297.8	4.0	Elong.			
18278+2442	STF2320	11373	2009.659	R	20	1.110	0.014	359.6	0.7				
18295+2955	STF2328	11397	2009.667	W	20	3.689	0.018	71.5*	0.3	Elong.			
18310+0123	STF2324	11410	2009.667	W	20	2.366	0.012	148.2*	0.3				
18314+0628	STF2329	11420	2009.667	W	20	4.229	0.021	43.0*	0.3				
18320+0647	STT354	11432	2009.659	W	20	0.616	0.012	211.7*	1.4				
18339+5221	A1377	11468	2009.714	R	10	0.240	0.003	125.2*	0.7		Sca2010a	−0.01	1.0
”	”	”	”	”	”	”	”	”	”		Mut2010e	−0.01	0.3
18355+2336	STT359	11479	2009.684	R	20	0.740	0.008	5.5*	1.0		Sca2009a	0.00	0.4
18359+1659	STT358	11483	2009.684	R	20	1.641	0.009	150.6*	0.3		Hei1995	0.10	1.1
18360+1144	STT357	11484	2009.670	R	20	0.386	0.008	82.5	1.3		Val1981d	0.03	7.1
”	”	”	”	”	”	”	”	”	”		This paper	0.01	5.5
18374+7741	STT363	11584	2009.714	R	20	0.447	0.012	338.9*	0.6	Elong.	Sca2009a	−0.00	−1.9
18384+0850	HU198	11524	2009.670	R	20	0.461	0.008	125.8*	1.3		Nov2007d	0.00	−4.2
18389+5221	STF2368	11558	2009.670	R	20	1.888	0.009	140.3*	0.3				
18413+3018	STF2367	11579	2009.659	R	10	0.392	0.008	74.3	0.3		Pbx2000b	−0.00	−0.4
18443+3940	STF2382AB	11635	2009.612	R	20	2.329	0.012	347.7*	0.3		WSI2004b	−0.06	0.0
18443+3940	STF2383Cc-D	11635	2009.612	R	20	2.372	0.012	78.6*	0.3		Doc1984b	0.00	0.2
18455+0530	STF2375	11640	2009.659	RL	20	2.562	0.013	119.7*	0.3	Elong.			
18458+3431	STF2390	11669	2009.670	R	20	4.213	0.021	154.9*	0.3				
18469+5920	STF2410	11697	2009.615	W	20	1.691	0.009	85.7*	0.3				
18472+3125	STF2397	11685	2009.670	W	20	3.896	0.021	267.0*	0.3				
18540+3723	BU137	11811	2009.615	W	20	1.552	0.008	162.4*	0.3				
18545+2037	STF2415	11816	2009.670	RL	20	1.999	0.010	289.4*	0.4				
18549+3358	STT525	11834	2009.741	RL	20	1.779	0.012	129.7*	0.6				
18559+0323	A2193	11844	2009.746	W	20	0.884	0.008	355.0*	0.7				
18570+3254	BU648	11871	2009.741	RL	20	1.052	0.011	257.4*	0.5		Doc2008f	0.01	−0.3

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Notes	Orbit	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)
18571+2606	STF2422	11869	2009.667	R	20	0.767	0.008	70.9	0.6				
18575+5814	STF2438	11897	2009.741	R	20	0.843	0.010	358.3*	0.6		Hrt2001a	0.01	0.1
18576+3209	A260	11879	2009.746	W	20	0.895	0.008	245.1*	0.3				
18581+4711	AG366	11899	2009.667	R	20	1.459	0.008	190.1	0.3				
18588+0207	MIL6	11891	2009.817	W	20	0.546	0.009	86.5*	0.7	Elong.			
18594+2936	STF2430	11914	2009.667	W	20	1.537	0.008	187.1*	0.4				
19019+1910	STF2437	11956	2009.744	W	20	0.600	0.011	9.8*	1.0		Sca2008c	0.03	0.8
19037+3545	STF2448	12002	2009.667	W	20	2.445	0.012	191.1*	0.3				
19042+3245	BRD4	12008	2009.714	W	20	2.535	0.013	310.1*	0.3				
19055+3352	HU940	12033	2009.689	W	20	0.488	0.008	191.3*	1.2		Hei2001	0.01	0.2
19062+3026	STF2454	12040	2009.744	W	20	1.324	0.011	289.2*	0.8		Sta1982b	−0.01	0.3
19070+1104	HEI568	–	2009.689	R	10	0.298	0.004	271.2	0.8		Zirm2010	−0.01	1.8
19078+3856	STF2469	12075	2009.714	W	20	1.230	0.008	125.6*	0.3				
19079+2948	STF2466	12071	2009.714	W	20	2.398	0.012	101.9*	0.3	Elong.			
19126+1651	BU139	12160	2009.744	R	20	0.650	0.008	135.4*	0.5				
19159+2727	STT371	12239	2009.744	R	20	0.866	0.008	159.8*	0.4				
19160+1610	STT368	12236	2009.746	R	20	1.143	0.008	218.7*	0.5				
19169+6312	STF2509	12296	2009.746	R	20	1.810	0.009	328.1*	0.3				
19177+2302	BU248	12287	2009.746	RL	20	1.695	0.008	128.3*	0.3				
19186+2157	STF2499	12298	2009.757	W	20	2.600	0.013	323.6*	0.3				
19186+5358	A1393	12315	2009.746	W	20	0.701	0.008	253.0*	0.8				
19202+3411	HU1300	12334	2009.741	W	20	0.727	0.008	181.8*	0.5				
19252+0227	STF2513	12414	2009.741	W	20	1.984	0.010	328.8*	0.3				
19252+3708	HJ1395	12427	2009.741	W	20	2.802	0.017	63.0*	0.3				
19266+2719	STF2525	12447	2009.615	W	20	2.126	0.019	289.4*	0.3		Hei1984b	0.02	−0.6
”	”	”	”	”	”	”	”	”	”		Job1969a	−0.05	−0.7
19269+1204	A1181	12452	2009.684	W	20	0.716	0.011	199.4*	1.3				
19334+6203	STF2553	12626	2009.684	W	20	0.973	0.008	128.6*	0.3				
19346+1808	STT375	12623	2009.684	W	20	0.648	0.021	183.5*	1.8				
19389+5150	BU656	12758	2009.741	W	20	0.888	0.011	271.1*	0.4				
19406+6240	STF2574	12803	2009.820	R	20	0.510	0.008	89.5	1.3		Zir2010	−0.00	−3.6
19413+3043	BU145	12786	2009.684	W	20	0.809	0.027	271.7*	0.8				
19426+1150	STT380	12808	2009.817	R	10	0.394	0.003	75.9*	0.3				
19429+4043	STT383	12831	2009.757	R	20	0.795	0.008	14.9*	0.6				
19438+3819	STT384	12851	2009.757	R	20	1.049	0.008	196.3	0.5				
19450+4508	STF2579	12880	2009.656	RL	20	2.679	0.013	219.1*	0.3		Sca1983a	0.00	−1.0
19458+4033	STT385	12904	2009.820	W	20	1.261	0.008	50.5*	0.4				
19464+3344	STF2576FG	12889	2009.656	R	20	2.868	0.018	159.2*	0.3		Sca1981f	−0.07	−0.7
19471+3321	HU758	12930	2009.818	W	20	0.897	0.010	144.2*	0.7				
19487+1149	STF2583	12962	2009.714	R	20	1.458	0.008	104.7*	0.3				
19535+2405	DJU4	–	2009.744	RL	20	1.385	0.012	244.8*	0.7		Cve2008d	0.06	−1.6
19540+1518	STF2596	13082	2009.757	W	20	2.019	0.010	299.3*	0.3				
19556+5226	STF2605	13148	2009.757	RL	20	2.876	0.014	175.4*	0.3				
19576+1524	A1663	13166	2009.757	W	20	1.291	0.008	236.3*	0.5				
19585+3317	STF2606	13196	2009.757	R	20	0.714	0.010	145.1*	1.1				
19594+3206	A378	13212	2009.861	R	20	0.907	0.008	292.3*	0.4				
20020+2456	STT395	13277	2009.757	R	10	0.800	0.004	125.0*	0.3				
20040+1221	A1194	13314	2009.741	W	20	1.028	0.013	316.5	0.5				
20043+3033	STF2626	13329	2009.741	W	20	0.975	0.010	127.7*	0.5				
20056+6342	STF2642	13392	2009.746	W	20	1.793	0.009	189.1*	0.3				
20074+3543	STT398	13405	2009.741	W	20	0.938	0.012	81.4*	1.0				
20080+4223	A382	13415	2009.746	RL	20	1.682	0.011	96.1*	0.3				
20102+4357	STT400	13461	2009.746	R	20	0.643	0.011	335.4	0.6		Hei1997	0.03	0.9
20144+4206	STT403	13572	2009.746	R	20	3.395	0.030	154.3	0.3	Artefacts?			
20144+4206	STT403	13572	2009.746	R	20	0.942	0.008	170.1	0.5				

Table 1 Measurements of binaries with PISCO in 2009 (cont.).

WDS	Name	ADS	Epoch	Fil.	Eyep. (mm)	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Notes	Orbit	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)
20198+4522	STT406	13723	2009.818	R	20	0.289	0.008	102.1	1.4		Hei1976	-0.12	-1.5
20303+1054	BU63	13920	2009.818	R	20	0.907	0.008	349.6*	0.4				
20370+1203	STF2701	14063	2009.757	W	20	2.042	0.010	221.1*	0.4				
20375+1436	BU151	14073	2009.757	R	10	0.374	0.003	21.7*	0.5		Alz1998a	-0.01	-0.2
”	”	”	”	”	”	”	”	”	”		Mut2010e	-0.01	-0.0
20423+5723	BU152	14196	2009.861	R	20	1.180	0.008	82.4*	0.6				
20449+1219	STF2723	14233	2009.818	R	20	1.038	0.009	136.1*	0.5				
20450+1244	BU64	14238	2009.818	W	20	0.664	0.010	353.1	0.5		Bdl2007a	0.01	-0.4
20471+2525	BU364	14286	2009.818	W	20	0.788	0.008	70.4	0.3				
20478+0600	BU65	14293	2009.818	RL	20	1.491	0.008	198.9*	0.5				
20481+2727	BU66	14312	2009.747	W	20	1.051	0.012	168.3*	0.3				
20486+5029	BU366	14331	2009.747	W	20	1.481	0.008	129.6*	0.3				
20511+0623	STF2730	14359	2009.741	W	20	3.307	0.020	333.2*	0.3				
20531+2909	STT417	14397	2009.741	W	20	0.882	0.008	27.5*	0.6	Elong.			
20591+0418	STF2737	14499	2009.747	R	10	0.535	0.003	284.8	0.4		Zel1965	0.02	1.2
20595+5013	BU68	14520	2009.861	W	20	1.922	0.010	148.5*	0.3				
20598+6152	BU472	14540	2009.861	W	20	0.775	0.008	15.3*	0.5				
21015+6643	HU959	14578	2009.861	W	20	1.291	0.008	161.3*	0.3	Elong.			
21055+6210	HU765BC	14634	2009.861	W	20	0.787	0.008	28.0*	0.8				
21183+3456	BU289	14837	2009.820	W	20	0.795	0.012	127.0*	0.3				
21186+1134	BU163	14839	2009.757	W	20	0.801	0.008	257.4*	1.5		Fek1997	0.00	-1.4^{Q}
”	”	”	”	”	”	”	”	”	”		Ces1991	0.02	0.3
21199+4307	COU2439	–	2009.820	W	20	0.722	0.011	265.4*	0.9				
21227+5214	HU591	14931	2009.820	W	20	0.725	0.008	128.1*	0.3				
21237+5518	A1892	14945	2009.820	W	20	0.752	0.008	348.6*	0.5				
21268+4228	A619	14992	2009.960	W	20	0.747	0.013	59.6*	0.7				
21446+2539	BU989	15281	2009.940	R	10	0.262	0.003	115.5*	0.5		Ces1990	-0.01	-0.0
21523+6306	STF2845	15417	2009.943	W	20	1.974	0.010	173.0*	0.3				
21555+1053	BU75	15447	2009.861	W	20	0.962	0.008	22.6*	0.4		Hei1996a	-0.01	0.3
22257+5631	A1463	15933	2009.957	W	20	0.917	0.008	333.0*	0.3				
22288–0001	STF2909	15971	2009.820	R	20	2.109	0.011	169.2*	0.3		Sca2009c	-0.02	-2.5
”	”	”	2009.941	RL	20	2.137	0.011	168.9*	0.3		Sca2009c	0.00	-2.6
”	”	”	2009.957	R	20	2.123	0.011	168.9*	0.3		Sca2009c	-0.01	-2.6
22419+2126	STF2934	16185	2009.818	W	20	1.361	0.008	57.6*	0.3		Hei1981a	0.14	0.7
22425+3917	BU176	16198	2009.820	W	20	2.565	0.013	53.7*	0.3				
22485+5409	AG424	16280	2009.818	W	20	2.234	0.011	134.6*	0.3				
22509+5303	BU1332	16310	2009.821	W	20	1.505	0.008	128.8*	0.3				
22557+1547	HU987	16373	2009.941	W	20	1.139	0.010	78.0*	0.3		Bdl2007a	0.05	-1.0
22569+1151	STF2958	16389	2009.957	RL	20	3.893	0.019	13.9*	0.3				
23079+7523	STT489	16538	2009.957	RL	20	1.111	0.008	353.1*	0.9		Sca2009a	-0.01	-2.4
23133+2205	STF2990	16602	2009.941	W	20	2.536	0.013	55.9*	0.3	Diffuse			
23340+3120	BU720	16836	2009.957	R	10	0.559	0.003	100.0*	0.3		Mut2010e	-0.00	-0.7
23375+4426	STT500	16877	2009.957	R	10	0.464	0.003	10.3	0.7		Zul1981	0.04	-4.3

Notes: In Col. 9, the exponent * indicates that the position angle θ could be determined without the 180° ambiguity. In Col. 14, the exponent ^{Q} indicates discrepant quadrants between our measurements and the published orbits.

some parameters of all those objects in Table 2. In Col. 2, we indicate the quadrant (Q) we found with the RTC, using the usual convention of numbering them from 1 to 4 to indicate the North-East, South-East, South-West and North-West quadrants, respectively. In Col. 3 we recall the filter we have used (W indicates the absence of filter: the corresponding central wavelength is close that of the R filter). In Cols. 4 and 5, we give the differences of magnitude between the two components and the global spectral types found in the WDS catalogue, and the French SIMBAD astronomical data base.

For all the discrepant objects, there is a good contrast between the two secondary peaks of the RTC, which is a good indication of the validity of our quadrant determination.

Except for ADS 14839, the small value of Δm_V can account for the difficulty of measuring the quadrant for those binaries. However, the measurements from other observers reported in IC4 were all obtained in B or V, whereas we observed in R (or W which is similar). A quadrant inversion between V and R is likely, when the two stars have a different spectral type (e.g. blue primary and red secondary). This would well explain a different quadrant measurement in V (in the IC4) and in R (with PISCO).

For ADS 14839, there is instead a rather large difference of magnitude between the components (1.6 mag). Our estimation of Q = 3 seems reliable in the RTC and is consistent with 23 out of the 26 measurements made since 2000, reported in IC4, and with our previous quadrant determination of 2004.950.

3.3 Comparison with published ephemerides

The $(O - C)$ (observed minus computed) residuals of the measurements for the 155 systems with a known orbit in Table 1 are displayed in Cols. 13 and 14 for the separation ρ and position angle θ, respectively.

Those residuals 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. For ADS 8035, 9982, 11484, and MLR 198, we also give the residuals obtained with our new orbits presented in Sect. 4, for comparison.

Figure 4 shows that the residuals have 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 $\langle \Delta\rho_{O-C} \rangle = 0.''00 \pm 0.''04$ and $\langle \Delta\theta_{O-C} \rangle = -0.^\circ2 \pm 2.^\circ1$ (rejecting the two outliers of ADS 8094 and MLR 198). 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 MLR 198, ADS 8094 and ADS 10429 that appear with the largest residuals in Fig. 4.

ADS 8094: Hopmann's orbit (1970) leads to large residuals of (0.''40, 15.°5) with our measurement of 2009.396. Clearly this orbit is wrong, as already pointed out in Papers III and VIII. The motion appears to be rectilinear, and is, in any case, too short to attempt a meaningful orbital analysis at present.

ADS 10429 Olevic et al.'s orbit (1993) leads to rather large residuals of (−0.''22, 1.°5). The arc of orbit is still short and the measurements have a large dispersion. The derivation of new valid orbital parameters is not yet possible.

MLR 198: The last orbits, either from Hartkopf & Mason (2001) or from Seymour et al. (2002), lead to very large residuals in θ (see Fig. 4). We propose a new orbit in the next section.

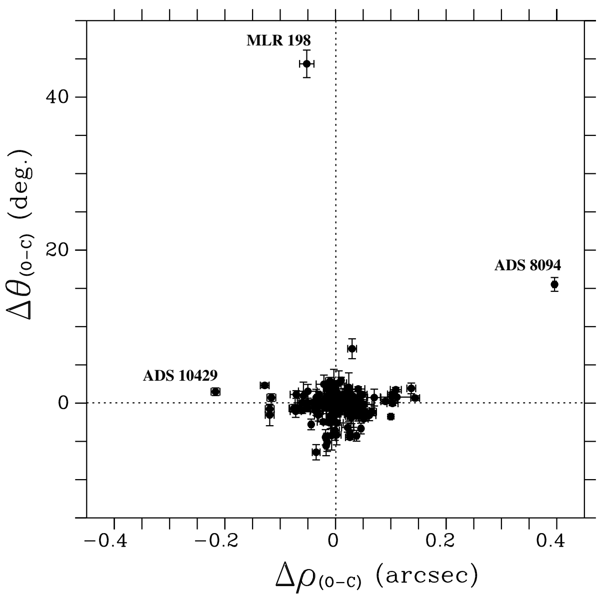

Fig. 4 Residuals of the measurements of Table 1 computed with the published orbits.

4 Revised orbits of ADS 8035, 9982, 11484 and MLR 198

In this section we present the new orbits we have computed for ADS 8035, 11484 and MLR 198, which have large residuals in Table 1, and for ADS 9982, to take advantage of all the observations made after 1962.

We have followed the same method for those four objects. Using our last measurements with PISCO and the other available observations contained in the data base maintained by the United States Naval Observatory (USNO), 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 the exception of the major axis) and to an estimation of the corresponding errors. The final value of the major axis was then set to the value that minimized the residuals in separation of Hellerich's solution.

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 8035, 9982 and MLR 198 were obtained by Hellerich's least-squares method. For ADS 11484, this method failed to converge, which explains the absence of errors for this orbit.

The corresponding $(O - C)$ residuals, restricted to the last observations for reasons of space, are given in Tables 4, 5, 6 and 7 for ADS 8035, 9982, 11484 and MLR 198, respectively. In the last column, we report the name of the observer, using the US Naval Observatory convention.

Table 3 New orbital elements of ADS 8035, 9982, 11484, and MLR 198.

ADS	Ω_{2000} (°)	ω (°)	i (°)	e	T (yr)	P (yr)	n (°/yr)	a (″)	A (″)	B (″)	F (″)	G (″)
ADS 8035	9.3 ± 8.2	232.8 ± 7.9	159.9 ± 3.5	0.4392 ± 0.004	2002.170 ± 0.094	44.448 ± 0.11	8.0994 ± 0.020	0.590 ± 0.026	-0.42335	0.37788	0.40964	0.40653
ADS 9982	14.31 ± 0.9	194.74 ± 0.8	133.04 ± 0.5	0.8104 ± 0.007	1907.053 ± 0.06	441.8 ± 25	0.8148 ± 0.05	2.380 ± 0.04	-2.33241	-0.16843	0.19848	1.67184
ADS 11484	93.8	321.9	124.8	0.317	1968.324	411.1	0.87570	0.511	-0.20620	0.38931	0.20810	0.32982
MLR 198	169.7 ± 8.2	299.4 ± 7.0	147.7 ± 10.0	0.657 ± 0.04	1992.918 ± 0.04	54.4 ± 4.6	6.61370 ± 0.56	0.195 ± 0.065	-0.11986	-0.12417	-0.15268	0.10999

The ephemerides for 2010–2021 are presented in Table 8. The apparent orbits are shown in Fig. 5 as solid lines. 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 location of the primary component is indicated with a big cross. The straight line going through this point is the line of apsides. An arrow shows the sense of rotation of the companion.

In Table 9, we present some physical parameters of those systems. The visual magnitudes (Col. 3) and the spectral types (Col. 4) were extracted from the SIMBAD data base. For ADS 8035, we also added the classification K0 III + F0 V from Eggleton & Tokovinin (2008). The dynamical parallaxes derived from our orbital elements are presented in Col. 5. Except for ADS 8035 (see in Sect. 4.1), those values were obtained with Baize & Romani (1945)'s method, using our revised formulae presented in Scardia et al. (2008b). In Col. 6, we report either the Hipparcos parallaxes from ESA (1997) or the revised values from van Leeuwen (2007), as indicated in Col. 10. In Cols. 8 and 9, we give the corresponding linear sizes of a and $\mathfrak{M}_{\rm total}$, respectively, that were computed from our orbital elements and the Hipparcos parallaxes.

4.1 New orbit of ADS 8035, BU 1077

This couple was discovered by S.W. Burnham in 1889 with the 36-inch Lick refractor. The primary component of ADS 8035 is a famous bright star (Dubhe, α UMa, HR 4301). In visual observations, this object appears as a triple system, with a faint C component (with $m_V = 7.1$) at 380″ from the A-B pair. Spectroscopic measurements have shown that the C component was a spectroscopic binary (F8, $P = 6.035$ d, $e = 0.09$). The A component is a red giant, with a significant proper motion. Its spectral classification shows some uncertainties: it is K0Iab in SIMBAD, G9III in the WDS, and K0III in De Medeiros & Mayor (1999). It is a slow rotator with $v \sin i = 3.7$ km s^{-1} (Fekel 1997). Its diameter was estimated at ∼7 mas, corresponding to 0.25 AU, with long-base interferometry by Nordgren et al. (2001) and Mozurkewich et al. (2003).

Table 4 ADS 8035: $O - C$ residuals of our new orbit (after 2000.0). The symbol $^{\rm P}$ indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ (″)	$\Delta\theta_{(O-C)}$ (°)	Observer
2004.213	$0.026^{\rm P}$	$-1.4^{\rm P}$	Sca
2004.397	$0.025^{\rm P}$	$0.7^{\rm P}$	Sca
2005.259	$0.011^{\rm P}$	$-0.2^{\rm P}$	Sca
2005.382	$0.007^{\rm P}$	$0.2^{\rm P}$	Sca
2005.385	$0.006^{\rm P}$	$0.5^{\rm P}$	Sca
2006.270	$0.009^{\rm P}$	$1.4^{\rm P}$	Pru
2006.310	$0.003^{\rm P}$	$0.7^{\rm P}$	Pru
2007.261	$-0.004^{\rm P}$	$-0.7^{\rm P}$	Pru
2009.207	$-0.001^{\rm P}$	$-0.1^{\rm P}$	Sca
2009.382	$0.008^{\rm P}$	$1.3^{\rm P}$	Sca
2009.385	$-0.000^{\rm P}$	$0.4^{\rm P}$	Sca
2010.264	$-0.006^{\rm P}$	$-1.6^{\rm P}$	Sca
2010.324	$-0.003^{\rm P}$	$-1.9^{\rm P}$	Sca
2010.327	$-0.001^{\rm P}$	$-1.1^{\rm P}$	Sca
2010.384	$-0.004^{\rm P}$	$-0.8^{\rm P}$	Sca

Our new orbit was computed using our measures made in 2009 (see Table 1) and in 2010 (four measures not yet published), and the 63 other measures available in the USNO data base. It should be mentioned that 18 out of the 19 observations made after 1994 were obtained by our group. The standard deviations of the residuals are 2.°5 and 0.″05 for θ and ρ, respectively.

Since the primary star is a giant star, the dynamical parallax cannot be computed with Baize-Romani's method which is based on the mass-luminosity relation. So we derived it in Table 9 from Kepler's third law,

$$\varpi_{\rm dyn} = \frac{a}{(\mathfrak{M}_1 + \mathfrak{M}_2)^{1/3} P^{2/3}}, \tag{1}$$

where $\mathfrak{M}_1$ and $\mathfrak{M}_2$ are the component masses in $M_\odot$, P the period in years, and a the semi major axis in arcseconds.

In Table 9, we have reported the two values of $\varpi_{\rm dyn}$ obtained when using the spectral classification of K0 III + F0 V given by Eggleton & Tokovinin (2008) or the alternative combination of K0 Iab + F0 V that was derived from the K0Iab classification found in SIMBAD. We assumed theoretical masses of 1.1 $M_\odot$, 1.6 $M_\odot$ and 6 $M_\odot$, for K0 III, F0 V, and K0 Iab stars, respectively (Drilling & Landolt

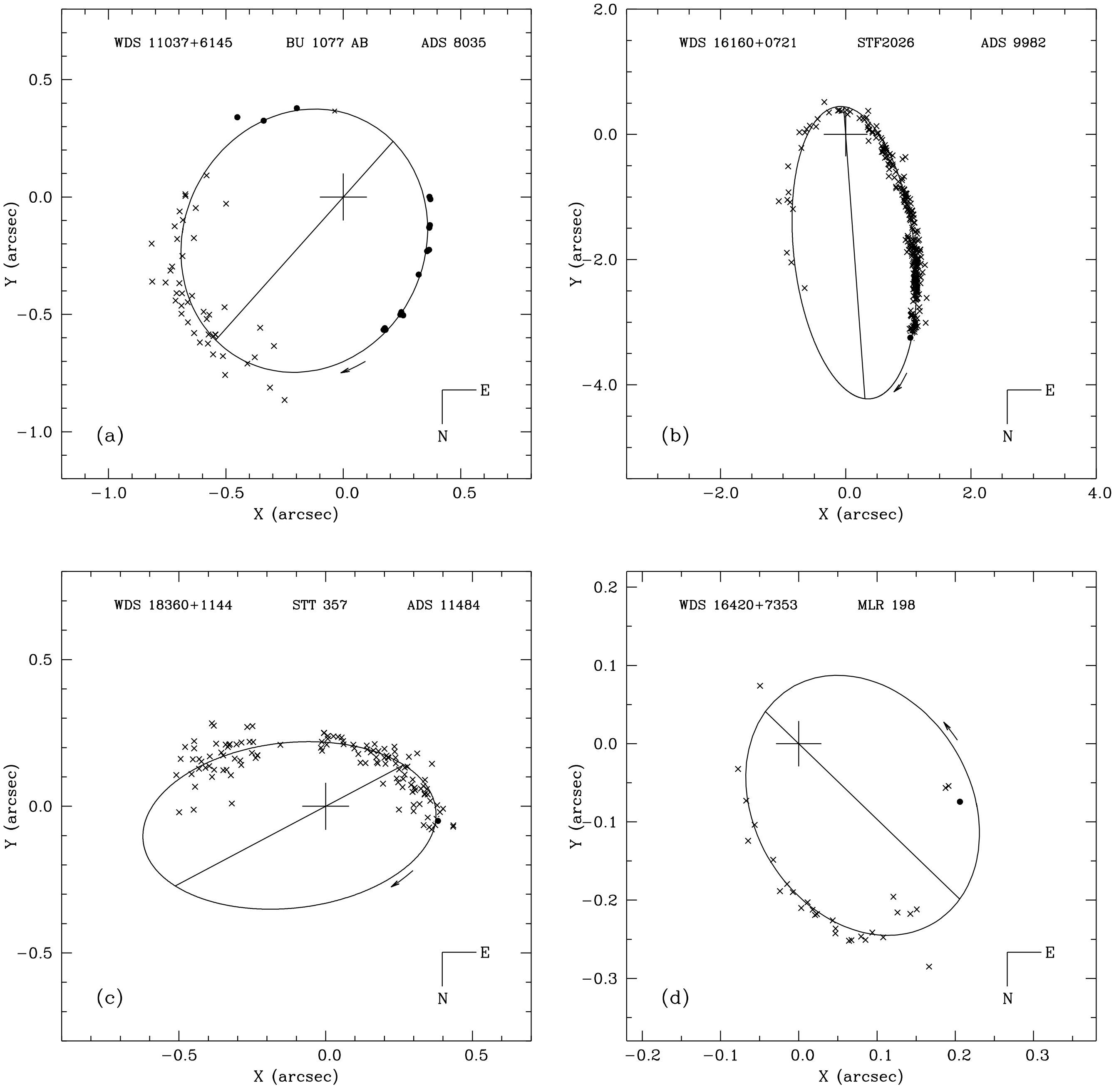

Fig. 5 New orbits of ADS 8035 (*a*), ADS 9982 (*b*), ADS 11484 (*c*), and MLR 198 (*d*).

1999). The Hipparcos parallax is close to the average of those two values, which suggests an intermediary combination such as K0 II + F0 V for this binary system.

Similarly, the systemic mass of about 5.6 ± 0.8 $M_\odot$ derived from Eq. (1) with our orbital elements and the Hipparcos parallax (see Table 9) lies in the middle of the interval bounded with 2.7 $M_\odot$ and 7.6 $M_\odot$, that correspond to the combinations of K0 III + F0 V and K0 Iab + F0 V, respectively.

A classification as K0 II for the primary star would also be supported by the photometry. Indeed, from the Hipparcos parallax and $m_V = 1.8$ (from SIMBAD), we derive an absolute magnitude of $M_V \approx -1.1$ for the primary star (the contribution of the companion is negligible since $\Delta m_V \approx 3.0$, as reported in the WDS). This value is also intermediary between the values of $M_V = -6.0$ and $M_V = 0.7$ that are expected for typical K0 Iab and K0 III stars, respectively.

4.2 New orbit of ADS 9982, STF 2026

This couple was measured for the first time by F.G.W. Struve, on 1829 May 18, but was well observed only

Table 9 Physical parameters ($\varpi_{\rm dyn}$, a and $\mathfrak{M}_{\rm total}$) derived from the new orbital elements.

Name	HIP	m_V	Spectral Type	$\varpi_{\rm dyn}$ (mas)	$\varpi_{\rm HIP}$ (mas)	a ($''$)	a (AU)	$\mathfrak{M}_{\rm total}$ ($M_\odot$)	Source of $\varpi_{\rm HIP}$
ADS 8035	54061	1.79	K0 Iab + F0 V	24.0 ±4	26.38 ±0.53	0.590 ±0.026	22.4 ±1.1	5.7 ±0.8	ESA 1997
"	"	"	K0 III + F0 V	33.8 ±4	26.54 ±0.48	0.590 ±0.026	22.2 ±1.1	5.6 ±0.8	van Leeuwen 2007
ADS 9982	79702	8.74	K4 V	39.5 ±4	38.84 ±2.96	2.380 ±0.042	61.3 ±4.7	1.2 ±0.3	ESA 1997
"	"	"	"		38.46 ±1.95	2.380 ±0.042	61.9 ±3.1	1.2 ±0.2	van Leeuwen 2007
ADS 11484	91167	7.66	A2	5.6 ±2	5.59 ±1.94	0.511	91.4 ±32	4.5 ±4.7	ESA 1997
"	"	"	"		4.49 ±1.04	0.511	114 ±26	8.7 ±6.1	van Leeuwen 2007
MLR 198	81757	6.8	A2	8.3 ±2	8.26 ±0.59	0.195 ±0.065	23.6 ±8.1	4.4 ±4.6	ESA 1997
"	"	"	"		9.27 ±0.41	0.195 ±0.065	21.0 ±7.1	3.1 ±3.2	van Leeuwen 2007

Table 5 ADS 9982: $O-C$ residuals of our new orbit (after 2000.0). The symbol $^{\rm P}$ indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)	Observer
2001.357	0.108	−0.9	WSI
2002.386	0.059	−0.4	WSI
2002.496	0.017	−0.5	Dal
2003.309	0.073	0.2	WSI
2004.365	−0.006	0.9	WSI
2005.460	−0.035	−0.4	WSI
2006.328	0.010	0.3	WSI
2007.440	0.031	−0.5	WSI
2008.398	0.045	−0.5	WSI
2009.521	0.046	−0.0	WSI
2009.593	$0.032^{\rm P}$	$-0.3^{\rm P}$	Sca

Table 6 ADS 11484: $O-C$ residuals of our new orbit (after 1998.0). The symbol $^{\rm P}$ indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)	Observer
1999.504	0.063	−4.9	Pri
1999.504	0.063	−4.3	Lin
2000.570	−0.017	−6.4	Alz
2001.520	−0.038	−4.9	Alz
2001.690	0.002	−0.4	WSI
2002.550	−0.028	0.6	Alz
2006.564	0.002	0.6	Hrt
2007.600	−0.007	−1.1	Alz
2009.670	$0.010^{\rm P}$	$5.6^{\rm P}$	Sca

Table 7 MLR 198: $O-C$ residuals of our new orbit (after 1986.0). The symbol $^{\rm P}$ indicates PISCO measurements.

Epoch	$\Delta\rho_{(O-C)}$ ($''$)	$\Delta\theta_{(O-C)}$ ($^\circ$)	Observer
1987.267	−0.007	−0.4	Hrt
1987.510	0.026	8.9	Mlr
1988.443	0.004	−6.7	Cou
1989.228	−0.002	−0.0	McA
1990.263	0.002	0.2	Hrt
1991.328	0.011	−0.2	Hrt
1993.198	0.027	0.1	Hrt
2007.607	−0.035	−1.8	Msn
2008.461	−0.038	1.7	Msn
2009.637	$-0.026^{\rm P}$	$0.9^{\rm P}$	Sca

Table 8 New ephemerides of ADS 8035, 9982, 11484, and MLR 198.

Epoch	ADS 8035 ρ ($''$)	ADS 8035 θ ($^\circ$)	ADS 9982 ρ ($''$)	ADS 9982 θ ($^\circ$)	ADS 11484 ρ ($''$)	ADS 11484 θ ($^\circ$)	MLR 198 ρ ($''$)	MLR 198 θ ($^\circ$)
2010.0	0.582	21.0	3.418	17.9	0.376	76.7	0.247	68.3
2011.0	0.619	14.4	3.435	17.8	0.375	75.8	0.253	65.8
2012.0	0.653	8.5	3.451	17.6	0.374	74.9	0.258	63.3
2013.0	0.683	3.2	3.467	17.5	0.373	74.0	0.263	61.0
2014.0	0.710	358.3	3.483	17.3	0.372	73.1	0.268	58.7
2015.0	0.734	353.7	3.499	17.2	0.372	72.2	0.272	56.5
2016.0	0.754	349.4	3.514	17.0	0.370	71.3	0.276	54.4
2017.0	0.772	345.3	3.530	16.9	0.369	70.4	0.279	52.3
2018.0	0.786	341.4	3.545	16.7	0.368	69.5	0.282	50.3
2019.0	0.798	337.6	3.560	16.6	0.367	68.6	0.284	48.2
2020.0	0.807	334.0	3.575	16.4	0.366	67.7	0.286	46.3
2021.0	0.813	330.3	3.589	16.3	0.364	66.8	0.287	44.3

after the end of the 19th century. It is made of two K4 V stars with similar magnitudes: $m_V = 9.5$ and 9.9. This system has a significant proper motion and is close to the sun (distance of about 26 pc). Only a few orbits have been computed for this system: Aitken (1914), Comstock (1918), Woolley & Symms (1937), and Heintz (1963). Heintz' orbit is still good, but very old.

From the 301 measurements obtained since 1830, we derived the new orbital elements reported in Table 3. The standard deviations of the residuals are $1\overset{\circ}{.}7$ and $0\overset{\prime\prime}{.}08$ for θ and ρ, respectively.

Our new orbit well fit the data, and the uncertainties on the elements are small. The systemic mass is compatible with the theoretical value of 1.4 $M_\odot$ (Drilling & Landolt 1999) expected for a couple of two K4 V stars. The dynamical parallax computed with our formula of Scardia et al. (2008b) is also in good agreement with Hipparcos parallax (both with ESA, 1997 and with van Leeuwen 2007).

4.3 New orbit of ADS 11484, STT 357

This binary was discovered by O. Struve with the 38 cm Merz-Mahler refractor of Poulkovo Imperial Observatory between August 1841 and December 1842. From then, its motion was well monitored, except during the period 1925–1935, but the measures have generally a large scatter. To our knowledge, only two orbits have been computed for ADS 11484, by Florsch (1956) and Valbousquet (1981). The orbit of Valbousquet (1981) is still valid, but becomes to be old now.

We computed a new orbit from the 124 available measures. On average, those measures were of poor quality, which impeded the convergence of Hellerich's least-square method. The solution we found seems satisfactory but is still preliminary. The mean standard deviation of the residuals is $3\overset{\circ}{.}3$ for θ and $0\overset{\prime\prime}{.}06$ for ρ.

With the Hipparcos parallax of ESA (1997), the systemic mass of 4.5 $M_\odot$ is in good agreement with the theoretical value of 5 $M_\odot$ for a system of two A2 V stars. With van Leeuwen's revised parallax, the mass would be 8.7 $M_\odot$, which is slightly too large (but the uncertainties are also very large).

The dynamical parallax is 5.6 mas is in very good agreement with the Hipparcos parallax of ESA (1997).

4.4 New orbit of MLR 198, HD 151746

This couple was discovered by P. Muller with the 50 cm refractor of Nice Observatory in 1971 during his survey of the northern hemisphere between $+52°$ and $+90°$ in declination (Muller 1971).

This object is also known as an Am star, that we studied as such in Prieur et al. (2006), where we found that HD 151746 was an SB1 spectroscopic binary and determined its spectroscopic orbit. This orbit has a very short period (4.8 days) and a zero eccentricity.

From the 31 available measures of MLR 198 made since 1971, we derived an orbit with a long period, about twice as long as the period of Seymour et al.'s orbit (2002). Convergence was achieved with Hellerich's least-square method. Our solution well fit the data and the mean standard deviation of the residuals is $2\overset{\circ}{.}9$ for θ and $0\overset{\prime\prime}{.}02$ for ρ.

Our solution leads to a plausible value of 4.4 $M_\odot$ for the systemic mass with the Hipparcos parallax of ESA (1997), since the theoretical mass value of an A2 star is about 2.5 $M_\odot$ (Drilling & Landolt 1999). With van Leeuwen (2007)'s revised parallax, the systemic mass would be only 3.1 $M_\odot$, which is slightly underestimated. The dynamical parallax derived from our orbital parameters is in very good agreement with the Hipparcos parallax of ESA (1997).

5 Conclusion

In 2009, we obtained 345 new measurements of 259 visual binaries with PISCO in Merate, with an average accuracy of $0\overset{\prime\prime}{.}011$ for the angular separation and $0\overset{\circ}{.}6$ for the position angles. The total number of measurements made in Merate since 2004 now exceeds 2100. 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 found a possible new close component for ADS 2377, which would be a new quadruple star system.

We used then the measurements reported here to find some orbits that needed to be revised. We then presented the new orbital elements that we obtained for ADS 8035, 9982, 11484 and MLR 198. The values of the masses derived from those elements are compatible with the theoretical values. For ADS 8035, our orbital elements suggest a spectral classification of K0II+F0V for this system. The dynamical parallaxes derived from those elements are also in good agreement with the Hipparcos parallaxes.

Acknowledgements. We thank the members of the United States Naval Observatory, Washington DC, for kindly sending on request some lists of measurements of visual binaries. We also thank W.I. Hartkopf for his useful report on this paper. 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), and the Washington Double Star Catalogue (http://ad.usno.navy.mil/wds/wds) maintained at the U.S. Naval Observatory, and the SIMBAD astronomical data base (http://simbad.u-strasbg.fr/simbad) operated by the *Centre de Données Astronomiques de Strasbourg* (France).

References

Aitken, R.G.: 1914, Publ. Lick Obs. 12, 1
Aitken, R.G.: 1932, *New General Catalogue of Double Stars*, Carnegie Institute, Washington
Aristidi, E., Carbillet, M., Lyon, J.-F., Aime, C.: 1997, A&AS 125, 139
Baize, P., Romani, L.: 1945, Ann. Astrophys. 9, 13

Comstock, G.C.: 1918, AJ 31, 33
Couteau, P.: 1999, *Catalogue de 2700 Etoiles Doubles "COU"*, Publ. obs. Côte d'Azur, Nice, France
De Medeiros, J.R., Mayor, M.: 1999, A&AS 139, 433
Drilling, J.S., Landolt, A.U.: 1999, in: A.N. Cox (ed.), *Allen's Astrophysical Quantities*, 4th Edition, p. 381
Eggleton, P.P., Tokovinin, A.A.: 2008, MNRAS 389, 869
ESA: 1997, *The Hipparcos and Tycho Catalogues*, ESA SP-1200, ESA Publications Division, Noordwijk
Fekel, F.C.: 1997, PASP 109, 514
Florsch, A.: 1956, J. Obs. 39, 71
Hartkopf, W.I., Mason, B.D.: 2001, Commission 26 Inf. Circ. 145
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., 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.: 1963, Veröff. Sternwarte München 5, 260
Hellerich, J.: 1925, AN 223, 335
Hopmann, J.: 1970, Astron. Mitt. Wien #5
Kowalsky, M.: 1873, Procès-verbaux de l'Université Impériale de Kasan
Mason, B.D., Wycoff, G.L., Hartkopf, W.I.: 2010, *Washington Double Star Catalogue*, http://ad.usno.navy.mil/wds/wds.html (WDS)
Mozurkewich, D., Armstrong, J.T., et al.: 2003, AJ 126, 2502
Muller, P.: 1971, IAU Commission 26 Inf. Circ. 54
Nordgren, T.E., Sudol, J.J., Mozurkewich, D.: 2001, AJ 122, 2707
Olevic, D., Popovic, G.M., Zulevic, D.J., Catovic, Z.: 1993, Bull. Obs. Astron. Belgrade 148, 49
Prieur, J.-L, Koechlin, L., André, C., Gallou, G., Lucuix, C.: 1998, Experimental Astronomy 8, 297
Prieur, J.-L., Carquillat, J.-M., Imbert, M.: 2006, MNRAS 372, 703
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)
Prieur, J.-L., Scardia, M., Pansecchi, L., Argyle, R.W., Sala, M., 2010, MNRAS 407, 1913 (Paper IX)
Scardia, M., Prieur, J.-L., Sala, M., Ghigo, M., Koechlin, L., Aristidi, E., Mazzoleni, F.: 2005, 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., Prieur, J.-L., Pansecchi, L., Argyle, R.W., Basso, S., Sala, M., Ghigo, M., Koechlin, L., Aristidi, E.: 2007, MNRAS 374, 965 (Paper III)
Scardia, M., Prieur, J.-L., Pansecchi, L., Argyle, R.W., Sala, M., Basso, S., Ghigo, M., Koechlin, L., Aristidi, E.: 2008a, AN 329, 1, 54 (Paper IV)
Scardia, M., Prieur, J.-L., Pansecchi, L., Argyle, R.W.: 2008b, AN 329, 379
Scardia, M., Prieur, J.-L., Pansecchi, L., Argyle, R.W., Sala, M.: 2009, AN 330, 1, 55 (Paper VI)
Scardia, M., Prieur, J.-L., Pansecchi, L., Argyle, R.W., Sala, M., 2010, AN 331, 286 (Paper VIII)
Seymour, D.M., Mason, B.D., Hartkopf, W.I., Wycoff, G.L.: 2002, AJ 123, 1023
Valbousquet, A.: 1981, Commission 26 Inf. Circ. 83
van Leeuwen, F.: 2007, *Hipparcos, the New Reduction of the Raw Data*, Springer, Dordrecht
Woolley, R., Symms, L.S.T.: 1937, MNRAS 97, 168

