

CCD measurements of visual double stars at Calar Alto

J.A. DOCOBO and C. ALVAREZ, Santiago de Compostela, Spain

Observatorio Astronómico "Ramón María Aller"

J.F. LAHULLA, Madrid, Spain

Observatorio Astronómico Nacional

V. LANCHARESI, Logroño, Spain

Dpto. Matemáticas y Computación, Universidad de La Rioja

A. AGUIRRE, Almeria, Spain

Centro Astronómico Hispano-Aleman

Received 1999 December 14; accepted 2000 January 15

342 CCD measurements of relative positions and magnitude differences for 145 visual double stars are presented. Observations were carried out at the 1.23m telescope of the German-Spanish Astronomical Center at Calar Alto (Spain), all of them in V and R photometric bands.

Key words: Visual double stars – CCD measurements: V and R band, separation, position angle, magnitude difference

1. Introduction

The CCD technique has revealed as a useful tool in astrometry and photometry of visual double stars, as it has been fully demonstrated in the recent years. A good evidence of that is, for example, the contribution of the European Network of Laboratories "Visual Double Stars" (Oblak *et al.*, 1999) where a detailed description of both intermediate and wide binaries observations based on 50 observing runs carried out in both hemispheres since 1991 is given.

In Spanish professional astronomy the double stars measurements are being performed mainly by the team of investigators from Astronomical Observatory "Ramón María Aller" and their collaborators. While the program is focused preferably on close binaries, the numerous micrometric and photographic observations of pairs with an angular separation of more than two arcsec have been performed both at the observational site in Santiago de Compostela and at the Centro Astronómico de Yebes (Observatorio Astronómico Nacional, Spain).

Since 1994 the scientific collaboration with the Center of Investigations in Astronomy (CIDA, Venezuela) allowed us to obtain the relative positions using the CCD measurements carried out with 1m telescope of Llano de Hato Observatory belonging to CIDA (Abad *et al.*, 1998). As its continuation we report here the measurements obtained in two observing runs in August and September of 1997 with the 1.23m telescope of the Spanish-German Center of Astronomy at Calar Alto (Almería, Spain). For simultaneous CCD astrometry and photometry of binary stars this telescope was first used eight years before by Sinachopoulos and Seggewiss (1990).

2. Observations and data reduction

The telescope has been equipped with TEK 6 1024×1024 pix CCD camera built into a Dewar filled liquid Nitrogen and cooled to -120°C . The pixel size is $24\mu\text{m}$ which is equivalent to $0''502$ in the focal plane. The following filters have been used:

V	BG	18 (2mm)	+GG	495 (2mm)
R	OG	570 (2mm)	+KG	3 (2mm)

In total 145 program stars have been selected mainly because of few observations reported for these stars as well as some others because of a special interest. Hipparcos data (Perryman *et al.*, 1997) are known for 33 of them.

85 of the program stars have separations between 1 and 5 arcsec, 56 between 5 and 15 arcsec and 4 more than 15 arcsec. As regards the magnitude differences between components, 106 are between 0 and 1, 27 between 1 and 2 and 12 between 2 and 3.

Observations in R and V bands have been carried out for each star. The exposure time depends on the system brightness but in average it was about 20 seconds. Seeing conditions were moderately favorable, generally about $1''.5 - 2''.0$.

The standard reduction procedure (flat field, bias, etc.) using MIDAS version 97NOV has been applied usually in ROMAPHOT (Bounanno *et al.*, 1983) environment. In order to resolve mostly overlapped stellar images the latter has been mainly used in semiautomatic mode.

Dark current of the camera may be neglected since it was very weak (a few counts per hour per pixel).

3. Results

In Table 1 data of 342 terms of position angle (θ), separation (ρ) and magnitude difference (Δm) values are presented. Each star is identified by its WDS number (Worley & Douglass, 1996), name (with the component letter, if any) and ADS number (Aitken, 1932). The next columns provide the observation epoch, the photometric passband letter, θ , ρ and Δm values. For the stars WDS 00255+6129, 19523+6222, and 20167+4335 the data on three components have been obtained. The letter H indicates the stars observed by Hipparcos while the stars having at least one calculated orbit are marked by an asterisk. For these latter stars we include in Table 2 the corresponding residuals with the orbits whose references are given too. The position angles measured with two filters differ in less than $0^\circ 5$ for 137 measurements are between $0^\circ 5$ and $0^\circ 9$ for 9 of them and between $1^\circ 0$ and $2^\circ 5$ in just 16 cases. Regarding the angular distances, their difference is less than $0''.05$ in 149 cases, between $0''.06$ and $0''.1$ in 8 cases and is greater than $0''.1$ in 5 cases solely. The estimated errors are in order of $\pm 0''.4$ in position angle and $\pm 0''.03$ in separation.

Acknowledgements. We are grateful for the observing time allocation to the German-Spanish Astronomical Center which is operated by the Max-Planck-Institut für Astronomie (Heidelberg) jointly with the Spanish National Commission for Astronomy.

This work has been co-financed by the spanish institutions, Xunta de Galicia and DGES under investigation projects XUGA 24301B96, PGIDT 99PXI 24301B and PB 97-0514, respectively.

References

- Abad, C., Docobo, J.A., Della Prugna, F.: 1998, *Astron. Astrophys. Suppl.* 133, 71
 Aitken, R.G.: 1932, *New General Catalogue of Double Stars (A.D.S.)*, Carnegie Institution of Washington No. 417
 Bounanno et al.: 1983, *Astron. Astrophys.* 126, 278
 Heintz, W.D.: 1960, *Astron. Nachr.* 285, 349
 Heintz, W.D.: 1984, *Astron. Astrophys. Suppl.* 56, 7
 Heintz, W.D.: 1993, *Astron. Astrophys. Suppl.* 98, 20
 Heintz, W.D.: 1996, *Astron. J.* 111, 412
 Hopmann, J.: 1960, *Mitt. Sternw. Wien* 10, 201
 Hopmann, J.: 1973, *Mitt. Sternw. Wien* 13
 Josties, F.J.: 1981, *IAU Coll. No.* 62
 Oblak, E., Lampaens, P., Cuyppers, J., Halbwegs, J.L., Martin, E., Seggewiss, W., Sinachopoulos, D., Van Dessel, E.L., Chareton, M., Duval, D.: 1997, *Astron. Astrophys.* 346, 523
 Perryman, M.A.C., Lindgren, L., Kovalevsky, J., Hoeg, E., Bastian, U., Bernacca, P.L., Creze, M., Donati, F., Grenon, M., Van Leeuwen, F., et al.: 1997, *Astron. Astrophys.* 323, 49
 Popovic, G.M.: 1964, *IAU Commission 26 Information Circular No.* 33
 Scardia, M.: 1981, *Astron. Nachr.* 302, 349
 Sinachopoulos, D., Seggewiss, W.: 1990, *Astron. Astrophys. Suppl.* 83, 245
 Worley, C.E., Douglas, G.G.: 1996, *The Washington Visual Double Star Catalogue Electronic Version*, <http://aries.usno.navy.mil/ad/wds>.

Table 1: Data for the observed visual binaries

WDS	Name	ADS	t	f	θ°	ρ''	Δm	WDS	Name	ADS	t	f	θ°	ρ''	Δm
00032+4508	HJ 1927	14	1997.603 R 1997.603 V	73.5 73.5	10.58 10.60	1.02 0.95		17222+3609	ES 2227	10507	1997.600 R 1997.600 V	356.1 356.3	4.80 4.79	0.12 0.11	
00055+6513	MLB 242	45	1997.603 R 1997.603 V	73.4 73.3	4.07 4.05	0.02 0.16		17225+0422	BU 1248	10501	1997.597 R 1997.597 V	174.6 174.6	8.29 8.28	1.98 2.53	
00057+4549 ^{H*}	STT 547AB	48	1997.603 R 1997.603 V	180.7 180.6	6.07 6.08	0.05 0.05		17372+3124 ^H	SEI 544	10672	1997.600 R 1997.600 V	276.0 276.0	9.68 9.68	1.89 2.11	
00059+1805 ^H	STF 3060AB	60	1997.603 R 1997.603 V	132.0 132.0	3.45 3.44	0.29 0.31		17377+6323	HO 559	10694	1997.600 R 1997.600 V	298.9 298.8	4.34 4.29	1.14 1.18	
00133+4636	ES 1194	159	1997.603 R 1997.603 V	292.0 292.0	5.21 5.21	1.23 1.01		17378+2257 ^H	AG 210	10675	1997.600 R 1997.600 V	186.1 186.3	4.23 4.22	0.17 0.17	
00152+2722	J 868	195	1997.701 R 1997.701 V	227.4 227.3	5.44 5.44	0.55 0.63		17401+2646	BRT 3320	10704	1997.597 R 1997.597 V	102.9 102.9	4.62 4.62	0.52 0.35	
00228+4614	ES 1199	308	1997.603 R 1997.603 V	10.5 10.9	2.65 2.64	1.20 1.33		17484+2942	BRT 30	10811	1997.597 R 1997.597 V	227.0 227.2	4.34 4.32	0.97 1.06	
00235+6030	FOX 2	315	1997.597 R 1997.597 V 1997.603 R 1997.603 V	154.5 154.4 154.2 154.0	4.16 4.18 4.19 4.16	0.46 0.42 0.36 0.34		17494+2651	BRT 3322	10818	1997.597 R 1997.597 V	162.2 162.1	4.42 4.37	2.35 2.05	
00235+2709	CHE 18	318	1997.597 R 1997.597 V 1997.603 R 1997.603 V	12.6 12.6 12.6 12.7	7.46 7.46 7.49 7.49	1.56 1.38 1.58 1.42		17511+5523	HO 71	10854	1997.597 R 1997.597 V	227.0 226.8	3.81 3.84	0.56 0.65	
00250+2726	CHE 24	335	1997.608 R 1997.608 V	339.3 339.6	4.88 4.95	0.71 0.80		17512+2946 ^H	BRT 31	10840	1997.597 R 1997.597 V	144.0 144.1	7.12 7.11	0.62 0.48	
00251+1824	HJ 621	337	1997.608 R 1997.608 V	357.6 356.5	4.47 4.43	1.17 1.38		17519+0300 ^H	HWE 41	10843	1997.597 R 1997.597 V	217.8 218.0	3.18 3.20	0.07 0.07	
00255+6129	STI 57AB	340	1997.603 R 1997.608 V	358.5 358.7	6.52 6.52	0.32 0.40		18000+2544	BRT 32	10965	1997.597 R 1997.597 V	172.2 172.1	5.39 5.40	1.00 1.34	
00255+6129	STI 57AC	340	1997.603 R 1997.608 V	309.0 308.4	4.98 4.98	2.05 2.38		18046+5053	STF 2279	11053	1997.594 R 1997.594 V 1997.597 R 1997.597 V	179.8 179.8 179.8 179.9	13.26 13.25 13.27 13.25	0.39 0.42 0.40 0.42	
00255+6129	STI 57BC	340	1997.603 R 1997.608 V	227.6 226.5	5.01 5.06	1.74 1.99		18105+0354	DOO 70	11124	1997.594 R 1997.594 V	135.3 135.2	7.72 7.73	0.69 0.74	
00268+4051	MLB 1	358	1997.608 R 1997.608 V	324.3 324.5	5.38 5.37	0.85 0.65		18110+3124	ES 345	11139	1997.597 R 1997.597 V	14.8 14.9	2.69 2.71	0.28 0.26	
00302+5929	STI 79	402	1997.603 R 1997.603 V	31.8 32.4	4.15 4.14	0.85 0.84		18111+3258	ES 185	11142	1997.597 R 1997.597 V	284.3 284.3	11.19 11.18	1.66 1.16	
00324+4455	HJ 1029	445	1997.701 R 1997.701 V	287.9 287.8	14.46 14.44	1.99 2.32		18112+0559	J 805	11134	1997.605 R 1997.605 V	95.4 94.3	3.74 3.67	0.28 0.23	
00360+2959 ^H	STF 42AB	497	1997.701 R 1997.701 V	22.1 22.2	6.19 6.21	0.80 0.82		18129+2800	ES 472	11171	1997.597 R 1997.597 V	11.0 11.0	3.53 3.52	0.97 1.08	
00481+1252	HJ 8	665	1997.701 R 1997.701 V	312.5 312.9	5.03 5.03	0.73 0.77		18149+1516	ROE 122	11198	1997.605 R 1997.605 V	267.7 267.9	6.73 6.77	0.92 1.09	
01030+5952	STI 163	855	1997.605 R 1997.605 V	91.7 91.6	4.70 4.71	0.23 0.21		18190+1315	ROE 111	11251	1997.605 R 1997.605 V	60.1 61.8	2.61 2.84	0.19 0.46	
01048-0528	STF 86AB	888	1997.608 R 1997.608 V	139.5 139.5	16.19 16.18	0.46 0.45		18248+2724	HO 84	11331	1997.594 R 1997.594 V 1997.600 R 1997.600 V	321.2 321.2 321.3 321.4	4.37 4.40 4.38 4.36	1.27 1.76 1.25 1.65	
01055+6253	MLB 247	885	1997.605 R 1997.605 V	296.6 295.6	3.42 3.38	0.24 0.26		18377+0946	J 523	11514	1997.605 R 1997.605 V	23.9 24.6	4.11 4.06	0.39 0.18	
01088+6145 ^H	ES 1945	932	1997.693 R 1997.693 V	163.9 163.9	3.76 3.76	0.18 0.18		18384+3603	STF 2362	11534	1997.605 R 1997.605 V	184.8 185.7	4.35 4.23	1.18 1.12	
01289+6003	STI 222	1166	1997.685 R 1997.685 V	74.8 75.2	5.49 5.46	0.39 0.54		18386+2937	J 525	11532	1997.597 R 1997.597 V	69.0 68.8	3.06 3.07	0.22 0.27	
01419+4646	ES 1211	1330	1997.693 R 1997.693 V 1997.701 R 1997.701 V	223.4 223.2 223.5 223.3	5.70 5.69 5.69 5.69	0.19 0.25 0.18 0.25		18386+3043	STF 2358	11535	1997.605 R 1997.605 V	224.2 221.8	2.58 2.55	0.57 0.92	
17040+4212	ES 634	10325	1997.600 R 1997.600 V	94.9 95.3	2.16 2.18	1.16 1.17		18455+0530 ^H	STF 2375	11640	1997.603 R 1997.603 V	118.8 118.6	2.57 2.57	0.35 0.34	
17063+2205	HO 556	10343	1997.682 R 1997.682 V 1997.685 R 1997.685 V	139.6 139.5 139.6 139.7	8.44 8.45 8.52 8.49	2.34 2.70 2.43 2.72		18497+1041	STF 2402Aa-Bb	11722	1997.603 R 1997.603 V	213.1 213.6	1.43 1.42	0.50 0.25	
17161+5854	ES 1794	10446	1997.600 R 1997.600 V	139.3 139.3	4.04 4.04	0.15 0.17		18598+3246	HLM 13	11924	1997.605 R 1997.605 V	30.1 30.1	12.54 12.63	2.10 1.85	
17205+6315	ES 1909	10503	1997.600 R 1997.600 V	252.8 252.7	6.22 6.22	0.04 0.13		19011+2204	J 1280	11939	1997.600 R 1997.600 V	107.8 108.0	3.88 3.88	0.41 0.00	
17210+2416	HJ 1298	10492	1997.600 R 1997.600 V	229.2 229.3	9.56 9.56	0.57 0.81		19037+3545 ^H	STF 2448	12002	1997.603 R 1997.603 V	191.2 191.2	2.49 2.48	0.05 0.02	
17222+3010	ROE 108	10506	1997.600 R 1997.600 V	0.8 0.9	5.95 5.96	0.01 0.01		19041+1106 ^H	AG 371	12000	1997.597 R 1997.597 V 1997.600 R 1997.600 V	159.3 159.1 159.2 159.2	5.48 5.50 5.48 5.48	1.49 1.40 1.51 1.42	

WDS	Name	ADS	<i>t</i>	<i>f</i>	θ°	ρ''	Δm	WDS	Name	ADS	<i>t</i>	<i>f</i>	θ°	ρ''	Δm
19052+5201	ES 978	12036	1997.603	R	199.1	5.07	0.23	20164+5542	KR 49	13639	1997.603	R	114.7	1.68	0.15
			1997.603	V	199.1	5.08	0.16				1997.603	V	113.4	1.68	0.20
19054+3803	AG 227	12031	1997.603	R	27.3	6.83	0.16	20165+3739	BU 422Aa	13626	1997.594	R	154.8	4.20	1.36
			1997.603	V	27.4	6.84	0.25				1997.594	V	154.3	4.09	1.13
19060+4549	STF 2463AB	12047	1997.603	R	0.4	9.68	1.89	20167+4335	FOX 251AB	13634	1997.603	R	279.5	5.55	0.57
			1997.603	V	0.4	9.68	1.90				1997.603	V	279.5	5.55	0.66
19069+2210 ^H	STF 2455AB	12050	1997.600	R	29.6	8.38	2.04	20167+4335	FOX 251AC	13634	1997.603	R	173.1	10.84	1.56
			1997.600	V	29.6	8.47	2.28				1997.603	V	173.0	10.85	2.69
			1997.603	R	29.4	8.46	1.95	20167+4335	FOX 251BC	13634	1997.603	R	149.9	13.50	0.99
			1997.603	V	29.6	8.55	2.12				1997.603	V	149.8	13.52	2.03
19078+0928 ^H	J 812	12063	1997.603	R	120.2	2.42	0.65	20168+3942	STF 2663	13636	1997.603	R	322.3	5.38	0.61
			1997.603	V	120.0	2.39	0.70				1997.603	V	322.4	5.39	0.58
19079+2948 ^H	STF 2466AB	12071	1997.603	R	103.1	2.39	0.48	20168+4158	ES 1568BC	13635	1997.603	R	188.6	2.84	0.03
			1997.603	V	103.1	2.39	0.53				1997.603	V	188.7	2.86	0.05
19079+3656	HJ 1369	12076	1997.600	R	152.1	9.51	0.19	20170+3153	SEI 1061	13638	1997.603	R	101.2	6.05	0.73
			1997.600	V	152.1	9.51	0.16				1997.603	V	101.1	6.07	0.65
19106+3701	A 152AB	12135	1997.605	R	2.9	2.58	0.40	20177-1550	HO 123	13633	1997.603	R	227.9	3.04	0.05
			1997.605	V	2.7	2.57	0.38				1997.603	V	228.3	3.03	0.05
19113+3850	HLM 17	12149	1997.605	R	203.1	5.89	0.48	20244+2923	HO 457AB	13818	1997.603	R	60.6	2.03	0.18
			1997.605	V	202.7	5.86	0.12				1997.603	V	60.8	2.01	0.25
19117+2712	J 1206	12152	1997.605	R	331.8	2.96	0.11	20255+4006	D 22AB	13847	1997.603	R	158.8	2.93	1.32
			1997.605	V	332.3	2.96	0.10				1997.603	V	160.1	2.94	1.24
19118+2615 ^H	STF 2480	12153	1997.605	R	22.7	15.15	2.49	20435+1657 ^H	STF 2770	14206	1997.597	R	178.2	3.91	0.28
			1997.605	V	22.7	15.21	2.81				1997.597	V	178.6	3.93	0.32
19121+4951 ^H	STF 2486AB	12169	1997.603	R	206.8	7.53	0.17				1997.603	R	178.4	3.92	0.32
			1997.603	V	206.7	7.53	0.18	20462+1554 ^{H*}	STF 2725	14270	1997.597	R	10.0	6.01	0.82
19155+2002	STF 2488	12228	1997.688	R	348.0	1.77	0.83				1997.597	V	10.2	6.01	0.83
			1997.688	V	349.7	1.76	0.94				1997.603	R	9.9	6.00	0.67
			1997.696	R	348.0	1.78	0.94				1997.603	V	10.4	5.95	0.84
			1997.696	V	348.8	1.79	0.98	20467+1607 ^H	STF 2727	14279	1997.603	R	267.5	9.28	0.45
19169+6312 ^H	STF 2509	12296	1997.688	R	328.0	1.76	0.55				1997.603	V	265.8	9.25	0.79
			1997.688	V	327.5	1.79	0.75	20538+3702 ^H	SEI 1300	14406	1997.696	R	298.9	1.76	0.19
			1997.696	R	327.1	1.73	0.60				1997.696	V	297.1	1.77	0.18
			1997.696	V	326.8	1.78	0.70	20541+1402	J 846	14405	1997.603	R	155.2	3.67	0.46
19252+0227 ^H	STF 2513	12414	1997.605	R	12.7	3.44	0.30				1997.603	V	155.3	3.64	0.49
			1997.605	V	13.3	3.41	0.13	21031+0132 ^{H*}	STF 2744AB	14573	1997.696	R	116.6	1.37	0.99
19260+3555	BU 1286AB	12443	1997.600	R	286.4	6.22	2.61				1997.696	V	114.8	1.34	0.66
			1997.600	V	286.3	6.22	3.09	21069+3845 [*]	STF 2758AB	14636	1997.605	R	149.0	30.44	0.51
19266+2530 ^H	STF 2524	12448	1997.600	R	84.8	5.55	0.39				1997.605	V	149.0	30.50	0.98
			1997.600	V	84.8	5.55	0.36				1997.693	R	149.1	30.38	0.99
19266+2719 [*]	STF 2525	12447	1997.696	R	290.7	2.02	0.19				1997.693	V	149.1	30.47	0.93
			1997.696	V	290.1	2.04	0.18	21124-1500 ^H	H 47	14736	1997.597	R	310.2	4.08	0.01
19316+1747 ^{H*}	STF 2536	12557	1997.603	R	112.3	1.88	2.62				1997.597	V	310.5	4.10	0.00
			1997.603	V	112.2	1.84	2.92				1997.603	R	310.1	4.10	0.08
19351+4124 ^H	ES 1665	12642	1997.605	R	91.0	3.92	1.19				1997.603	V	310.3	4.05	0.06
			1997.605	V	93.0	3.90	1.01	21189+3909	AG 270	14851	1997.608	R	112.2	5.63	0.97
19435+3450	AG 236	12839	1997.594	R	149.7	4.25	0.05				1997.608	V	112.4	5.62	0.99
			1997.594	V	150.0	4.26	0.22	21322+3850	ES 259	15068	1997.608	R	319.0	3.86	1.04
			1997.600	R	149.9	4.28	0.11				1997.608	V	320.7	3.98	1.26
			1997.600	V	149.8	4.29	0.29	21370+8255	STF 2837	15229	1997.701	R	272.5	3.12	0.15
19456+3337 ^{H*}	STF 2576AB	12889	1997.603	R	165.3	2.64	0.12				1997.701	V	272.2	3.12	0.37
			1997.603	V	165.1	2.66	0.16	21464+6250	STI 1049	15328	1997.608	R	90.1	4.49	0.70
19474+2716	BAR 51	12936	1997.600	R	150.2	4.35	1.41				1997.608	V	90.3	4.52	0.79
			1997.600	V	150.1	4.34	0.70	21523+4025	ES 261	15404	1997.597	R	164.8	5.08	0.13
19523+6222	VBS 29AB	13077	1997.600	R	218.1	4.75	0.05				1997.597	V	164.9	5.12	0.16
			1997.600	V	218.2	4.75	0.00				1997.603	R	164.8	5.12	0.15
19523+6222	VBS 29AC	13077	1997.600	R	262.3	6.29	0.23				1997.603	V	164.7	5.12	0.19
			1997.600	V	262.3	6.29	0.27	21561+2701	J 854	15463	1997.701	R	303.1	2.85	0.74
19523+6222	VBS 29BC	13077	1997.600	R	311.2	4.39	0.18				1997.701	V	304.0	2.83	0.75
			1997.600	V	311.2	4.39	0.27	22014+3243	HJ 951	15554	1997.597	R	62.1	12.34	0.64
19551+3721	ES 2117	13126	1997.603	R	333.0	2.87	0.79				1997.597	V	62.1	12.35	0.98
			1997.603	V	333.0	2.87	0.23				1997.603	R	62.1	12.35	0.68
19584+3830	J 1070	13195	1997.603	R	70.8	3.72	0.41				1997.603	V	62.1	12.36	1.04
			1997.603	V	70.8	3.73	0.41	22026+6238	STI 1081	15582	1997.603	R	91.6	3.74	0.09
20001+1111	HJ 1458	13228	1997.594	R	132.6	16.23	0.12				1997.603	V	91.8	3.74	0.10
			1997.594	V	132.6	16.24	0.12	22173-0042	STF 2887	15804	1997.608	R	29.7	7.83	0.06
20057+0434	J 603	13346	1997.594	R	126.4	2.96	0.16				1997.608	V	29.7	7.84	0.04
			1997.594	V	126.6	2.95	0.11	22282+2332 ^H	STF 910	15966	1997.597	R	333.5	5.49	0.53
20122+3810	SEI 9986	13516	1997.594	R	104.5	3.83	0.73				1997.597	V	333.6	5.49	0.62
			1997.594	V	104.3	3.88	0.91				1997.603	R	333.5	5.50	0.54
			1997.603	R	104.4	3.91	0.90				1997.603	V	333.4	5.50	0.62
			1997.603	V	104.3	3.90	0.91	22320+2847	BRT 228	16026	1997.608	R	87.8	4.42	0.01
											1997.608	V	88.3	4.43	0.07

WDS	Name	ADS	t	f	θ°	ρ''	Δm	WDS	Name	ADS	t	f	θ°	ρ''	Δm			
22236+0725 ^H	STF 2915	16030	1997.597	R	128.2	14.61	0.01	23293+2949	ES 400	16786	1997.605	V	91.0	3.86	0.29			
			1997.597	V	128.2	14.62	0.02				1997.690	R	91.3	3.89	0.41			
			1997.603	R	128.3	14.59	0.01				1997.690	V	91.3	3.86	0.32			
			1997.603	V	128.2	14.60	0.03				1997.603	V	211.0	6.09	1.17			
22327+6737	MLB 272	16050	1997.605	R	272.6	4.03	0.51	23301+3337	ES 2206	16796	1997.605	R	351.3	2.30	1.21			
			1997.605	V	272.7	4.02	0.59				1997.605	V	351.2	2.32	1.19			
22367+5723	DOO 19	16110	1997.605	R	192.3	3.22	0.78	23305+0844	J 298	16801	1997.597	R	122.3	4.89	1.08			
			1997.605	V	191.9	3.18	0.72				1997.597	V	122.3	4.89	1.06			
22373+6015	ES 1763	16124	1997.605	R	213.2	2.15	0.36	23317+1021	HJ 3198	16815	1997.603	R	122.4	4.88	1.03			
			1997.605	V	213.2	2.15	0.19				1997.603	V	122.3	4.88	1.05			
22396-1237	STF 2928AB	16145	1997.597	R	288.7	3.31	0.16	23317+1021	HJ 3198	16815	1997.597	R	75.7	9.79	1.38			
			1997.597	V	287.5	3.30	0.06				1997.597	V	75.9	9.80	1.51			
			1997.603	R	286.9	3.23	0.01				1997.603	R	75.8	9.79	1.43			
			1997.603	V	286.8	3.24	0.05				1997.603	V	75.8	9.84	1.63			
22427+6835	MLB 316AB	16218	1997.605	R	121.6	3.00	0.00	23335+4919	ES 110AB	16833	1997.605	R	36.5	5.28	2.12			
			1997.605	V	121.6	2.98	0.02				1997.605	V	36.5	5.27	1.83			
22438+7831 ^H	STT 481	16243	1997.597	R	36.3	1.97	0.43	23460-1841 ^H	H 24	16979	1997.603	R	135.4	6.91	0.87			
			1997.597	V	37.3	1.94	0.03				1997.603	V	135.5	6.81	1.00			
22442+4105	J 857	16229	1997.605	R	321.8	3.19	0.23	23564-0930	STF 3046AB	17107	1997.603	R	266.2	3.81	0.25			
			1997.605	V	321.7	3.21	0.20				1997.603	V	266.2	3.81	0.39			
23050+6014	STI 1138	16499	1997.597	R	75.5	5.22	0.20	23570+5643	HJ 1921	17113	1997.603	R	234.9	3.44	0.28			
			1997.597	V	75.4	5.27	0.19				1997.603	V	234.9	3.42	0.25			
			1997.603	R	75.4	5.23	0.21				23595+3343*	STF 3050AB	17149	1997.605	R	327.7	1.99	0.28
			1997.603	V	75.3	5.23	0.19							1997.605	V	325.9	2.01	0.23
23192+5945	STI 1166	16678	1997.605	R	91.3	3.86	0.37											

Table 2: Residuals

WDS	$\Delta\theta^\circ$	$\Delta\rho''$	Author
00057+4549	-0.2	0.000	Heintz (1993)
	-0.3	+0.010	
19266+2719	-0.3	+0.026	Heintz (1984)
	-0.9	+0.046	
19316+1747	-6.4	0.000	Heintz (1960)
	-6.5	-0.040	
19456+3337	-0.6	-0.008	Scardia (1981)
	-0.8	+0.012	
20462+1554	-0.5	+0.040	Hopmann (1973)
	-0.3	+0.010	
	-0.6	-0.050	
	-0.1	0.000	
21031+0132	-1.9	-0.076	Hopmann (1960)
	-3.7	-0.106	
	+1.6	+0.134	
21069+3845	-0.2	+0.104	Popovic (1964)
	-0.3	+0.004	
	-0.3	+0.064	
23595+3343	-0.2	-0.056	Josties (1981)
	-0.2	+0.034	
	-1.2	+0.146	
	-3.0	+0.166	
23595+3343*	-1.2	+0.146	Heintz (1996)
	-3.0	+0.166	

Addresses of the authors:

J.A. Docobo, C. Alvarez, Observatorio Astronómico "Ramón María Aller", Universidade de Santiago de Compostela
e-mail: oadoco@usc.es

J.F. Lahulla, Observatorio Astronómico Nacional, Alfonso XII, 3, 28014 Madrid, Spain
e-mail: lahulla@oan.es

V. Lanchares, Dpto. Matemáticas y Computación, Universidade de La Rioja, 26004 Logroño, La Rioja, Spain
e-mail: vlanca@dmc.unirioja.es

A. Aguirre, Centro Astronómico Hispano-Alemán, P.O. Box 511, 04004 Almería, Spain
e-mail: aguirre@caha.es