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The first orbital elements for eight binaries

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Abstract. The orbital elements, masses and orbital parallaxes are communicated for the first time for the following eight double stars: WDS 04089+4614 = ADS 3007 = A 998 = HD 25987, WDS 04275+1113 = ADS 3228 = BU 1186 = HD 28217, WDS 04400+2301 = ADS 3370 = HU 442 = HD 29538, WDS 18018+0118 = ADS 10990 AB = BU 1125 AB = HD 164577, WDS 18033+3921 = ADS 11023 = STF 2275 = HD 88432, WDS 18054+6216 = ADS 11073 = HU 1290 = HD 166206, WDS 19389+3514 = ADS 12746 = HU 953 = HD 185696, WDS 20176+2622 = ADS 13649 = BU 984 = HD 193095.

Key words: astrometry — binaries: visual

1. Introduction

The orbital elements for double stars A 998, BU 1186, HU 442, BU 1125, STF 2275, HU 1290, HU 953, BU 984 have not been derived as yet. In spite of significant uncertainties in their distances, usual in the case of the visual measurements, the observed arcs allow a sufficiently reliable determination of their elliptical orbits.

The orbital elements are derived by using the procedure proposed by Popović & Pavlović (1995), the absolute magnitudes of the components, the masses and parallaxes are obtained by applying Angelov's (1993) relations, and the errors of the fitting parameters are obtained by using the Eichhorn & Xu algorithm (1990). The elements are given for the epoch J2000.0. All elements have been published in the "Information Circular 135 and 136, IAU, Comm. 26".

The orbital elements and the corresponding astrophysical quantities are given in Table 1, the O − C measurements in Table 2. The authors of the orbits are given at the bottom of Table 1. The ephemeris are calculated for

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Table 1. Orbital elements, absolute magnitudes, masses and parallaxes

Name	A 998	BU 1186	HU 442	BU 1125AB
WDS	04089+4614	04275+1113	04400+2301	18018+0118
ADS	3007	3228	3370	10990
HD	25987	28217	29538	164577
m	7.7 − 8.0	6.0 − 8.0	9.3 − 9.9	4.4 − 9.2
Sp.	A0V	B8IV	A2	A2Vn
P(yr)	158.245	410.671	248.149	264.378
	±7.794	±67.796	±55.058	±40.621
$n(^\circ/\mathrm{yr})$	2.2749	0.8766	1.4507	1.3617
	±0.1120	±0.1445	±0.3219	±0.2092
T	2010.16	1948.17	1988.71	2070.67
	±2.03	±3.71	±10.07	±19.19
$a(''')$	0.2814	0.7736	0.4537	0.7974
	±0.0103	±0.0770	±0.0614	±0.0315
e	0.6922	0.2104	0.1294	0.2642
	±0.0522	±0.0856	±0.0532	±0.1390
$i(^\circ)$	123.76	102.16	69.34	53.29
	±2.18	±0.40	±0.84	±1.87
$\Omega(^\circ)$	170.76	170.23	177.93	7.10
	±3.17	±0.45	±0.46	±5.25
$\omega(^\circ)$	46.91	27.19	259.92	232.48
	±5.84	±4.73	±21.05	±7.68
$A(''')$	−0.17142	−0.66548	0.08503	−0.43521
$B(''')$	0.14357	0.19014	0.15460	−0.43521
$F(''')$	0.21999	0.37295	−0.44539	0.66351
$G(''')$	0.07244	0.08281	0.04411	−0.20988
$C(''')$	±0.17086	±0.34556	∓0.41798	∓0.50704
$H(''')$	±0.15984	±0.67266	∓0.07429	∓0.38937
T_u(yr)	2007.18	1928.13	2047.49	2144.45
T_s(yr)	2031.86	2107.92	1943.48	2047.73
M_A(mag)	1.7	0.7	4.0	−0.2
M_B(mag)	2.0	3.6	4.6	4.6
$\mathfrak{M}_\mathrm{A}(\odot)$	1.9	2.4	1.1	3.0
$\mathfrak{M}_\mathrm{B}(\odot)$	1.8	1.3	1.0	1.0
$\pi(''')$	0.006	0.009	0.009	0.012
Author	Pavlović	Popović & Pavlović	Pavlović & Živkov	Popović & Živkov

Table 1. continued

Name	STF 2275	HU 1290	HU 953	BU 984
WDS	18033+3921	18054+6216	19389+3514	20176+2622
ADS	11023	11073	12746	13649
HD	88432	166206	185696	193095
m	$9.3-9.5$	$9.2-9.5$	$8.8-9.2$	$9.0-9.3$
Sp.	G0	F8	G0	F8
P(yr)	525.460	294.940	300.8386	286.5759
	±22.316	±10.030	±41.540	±28.928
$n(^\circ/\mathrm{yr})$	0.6851	1.2206	1.19666	1.2562
	±0.0291	±0.0415	±0.1652	±0.1268
T	2012.872	1985.026	2009.729	2080.014
	±42.54	±44.81	±4.97	±9.62
$a(''')$	0.6786	0.4755	0.7364	0.8000
	±0.2007	±0.0528	±0.1963	±0.0523
e	0.4767	0.2567	0.4491	0.0885
	±0.0339	±0.0514	±0.0450	±0.0774
$i(^\circ)$	77.95	120.35	54.70	70.19
	±10.16	±0.48	±4.05	±7.45
$\Omega(^\circ)$	131.60	110.45	8.52	43.99
	±2.84	±6.40	±8.58	±3.16
$\omega(^\circ)$	142.76	80.56	314.66	2.98
	±76.34	±12.50	±42.04	±14.60
$A(''')$	0.29367	0.19481	0.55672	0.56502
$B(''')$	−0.46149	0.15584	−0.22269	0.56502
$F(''')$	0.35655	0.20080	0.47373	−0.21789
$G(''')$	−0.23298	−0.42572	0.37341	0.16591
$C(''')$	∓0.40168	±0.40478	∓0.42750	±0.03907
$H(''')$	∓0.52835	±0.06727	∓0.42241	±0.75167
T_u(yr)	1870.48	1941.82	2023.48	2078.04
T_s(yr)	2030.61	2042.22	1936.30	2220.49
M_A(mag)	3.8	3.7	4.3	4.8
M_B(mag)	4.0	4.0	4.7	5.1
$\mathfrak{M}_\mathrm{A}(\odot)$	1.2	1.2	1.1	1.0
$\mathfrak{M}_\mathrm{B}(\odot)$	1.2	1.1	1.0	0.9
$\pi(''')$	0.008	0.008	0.013	0.015
Author	Popović	Živkov & Pavlović	Živkov & Popović	Pavlović & Popović

the next 10 years, beginning with 1999, the step length is one year.

The final part contains the figures with the orbits.

2. Comments

Notes to individual binary systems follow, sorted in order of WDS designation (the 2000–epoch right ascension– and declination–based designation used in the *Washington Visual Double Star Catalog* of Worley & Douglass 1996).

WDS 04089+4614 = ADS 3007 = A 998 = HD 25987 For the purpose of orbit calculating the position angle is corrected for 180° in four cases as follows: 1981.01, 1982.06, 1983.84, 1985.00.

The obtained orbital elements yield a parallax value in good agreement with the trigonometric parallax given in the Hipparcos Catalogue ($0''.00665 \pm 0''.00096$).

The measuring of this pair grows in its difficulty and at the epoch of periastron passage in 2010 the component separation will be $\sim 0''.07$ only.

WDS 04275+1113 = ADS 3228 = BU 1186 = HD 28217 This pair, visible by the naked eye in the constellation of *Taurus*, was discovered in 1890 by Burnham S.W. The separation of the components was about $0''.6$ then. From Aitkin's measurement in 1898 the pair grew closer and more unfavourable for the measurements (McAlister & Hartkopf 1988).

The elements are based on a change in θ of about 60°, but one should take into account that the pair has a high inclination ($i = 120^\circ$) and that already 1/4 of the orbital plane has been defined by the observations.

For the purpose of obtaining the parallax and absolute magnitude we use the empirical relation concerning the stars above the main sequence in the HR diagram (luminosity class – LC – B8 IV). The Hipparcos Catalogue yields for this pair $0''.00670 \pm 0''.00096$ as its trigonometrical parallax, whereas the orbital parallax obtained by us is somewhat higher $0''.009$.

WDS 04400+2301 = ADS 3370 = HU 442 = HD 29538 The orbital elements for this Hussey W.L. pair, discovered in 1901, are based on a change in the position angle of 103°. Due to its faint components and the separation not exceeding $0''.5$ the pair has not been much observed. Nevertheless, the available observations allow to define the orbit position sufficiently well.

The spectral type and the obtained absolute magnitude indicate that the system belongs to LC VI (subdwarfs). By applying the mass-luminosity relation to the stars below the main sequence one obtains a parallax significantly higher ($0''.009$) than that given in the Tycho Catalogue ($0''.0016 \pm 0''.0009$).

WDS 18018+0118 = ADS 10990 = BU 1125 = HD 164577 The orbital elements are obtained from a position-angle change of 104°. The measurements have a large scatter.

The pair is on the main sequence of HR diagram. The obtained orbital parallax $0''.0012$ agrees well with the one given in the Hipparcos Catalogue ($0''.001231 \pm 0''.000083$).

Popović and Pavlović failed in noticing the duplicity of this system on May 27, 1998 when they tried to measure this pair. The cause is, most probably, in the magnitude difference $\triangle m = 4^\mathrm{m}.8$. For this moment, according to the ephemeris, ρ is $0''.56$.

WDS 18033+3921 = ADS 11023 = STF 2275 = HD 88432 In the calculation of the elements the position angle is corrected for 180° in the case of two Baize's observations from 1954.70 and 1956.70 and also for one Worley's observation from 1961.43.

The orbital parallax derived here agrees fully with the trigonometric parallax given in the Hipparcos ($0''.00836 \pm 0''.00092$).

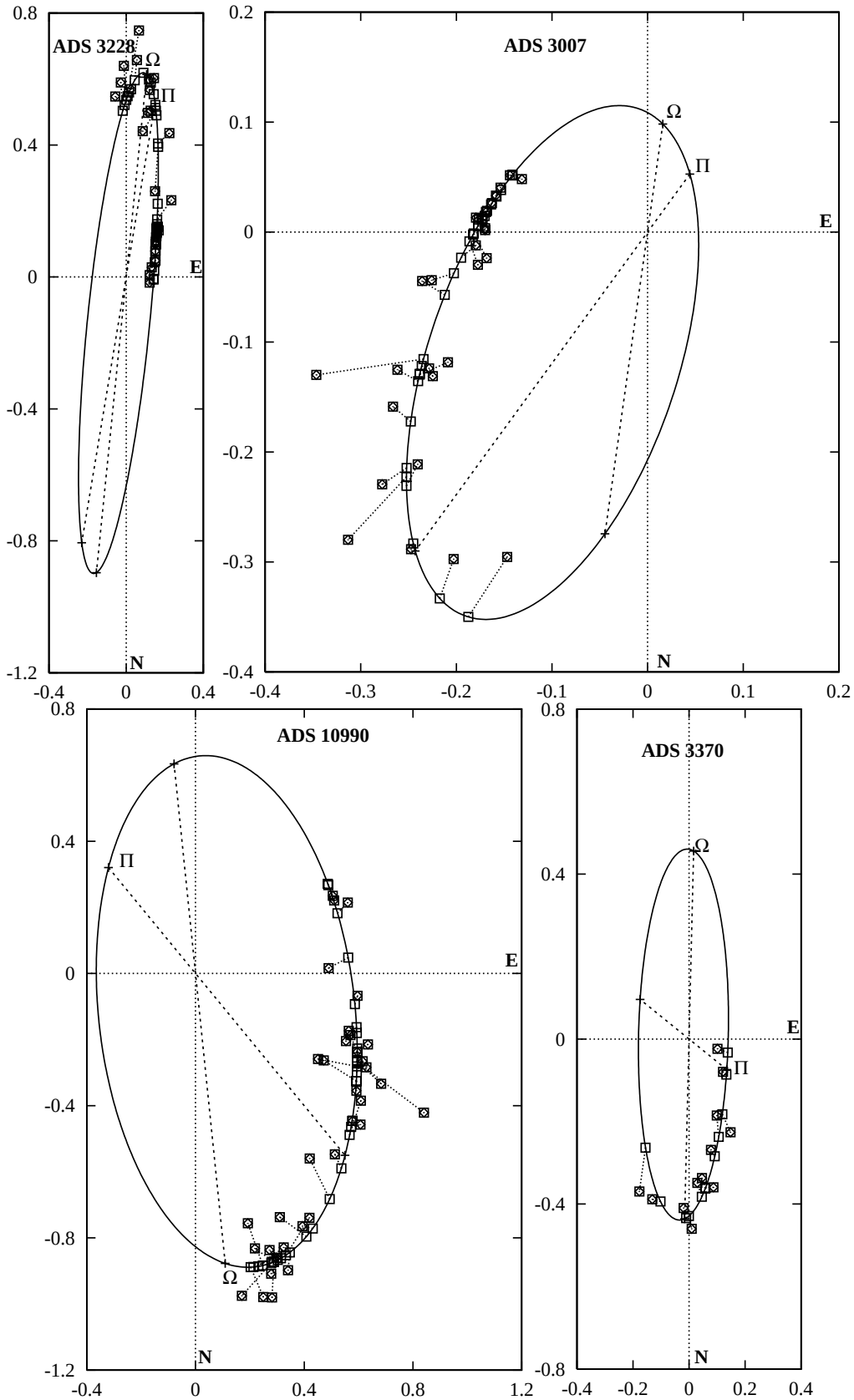

Fig. 1. Observed positions (⊠) and the ones emanating from the orbit calculation (□). The periastron position (Π) and the line of nodes (Ω) are given as well. The unit on both axes is second of arc

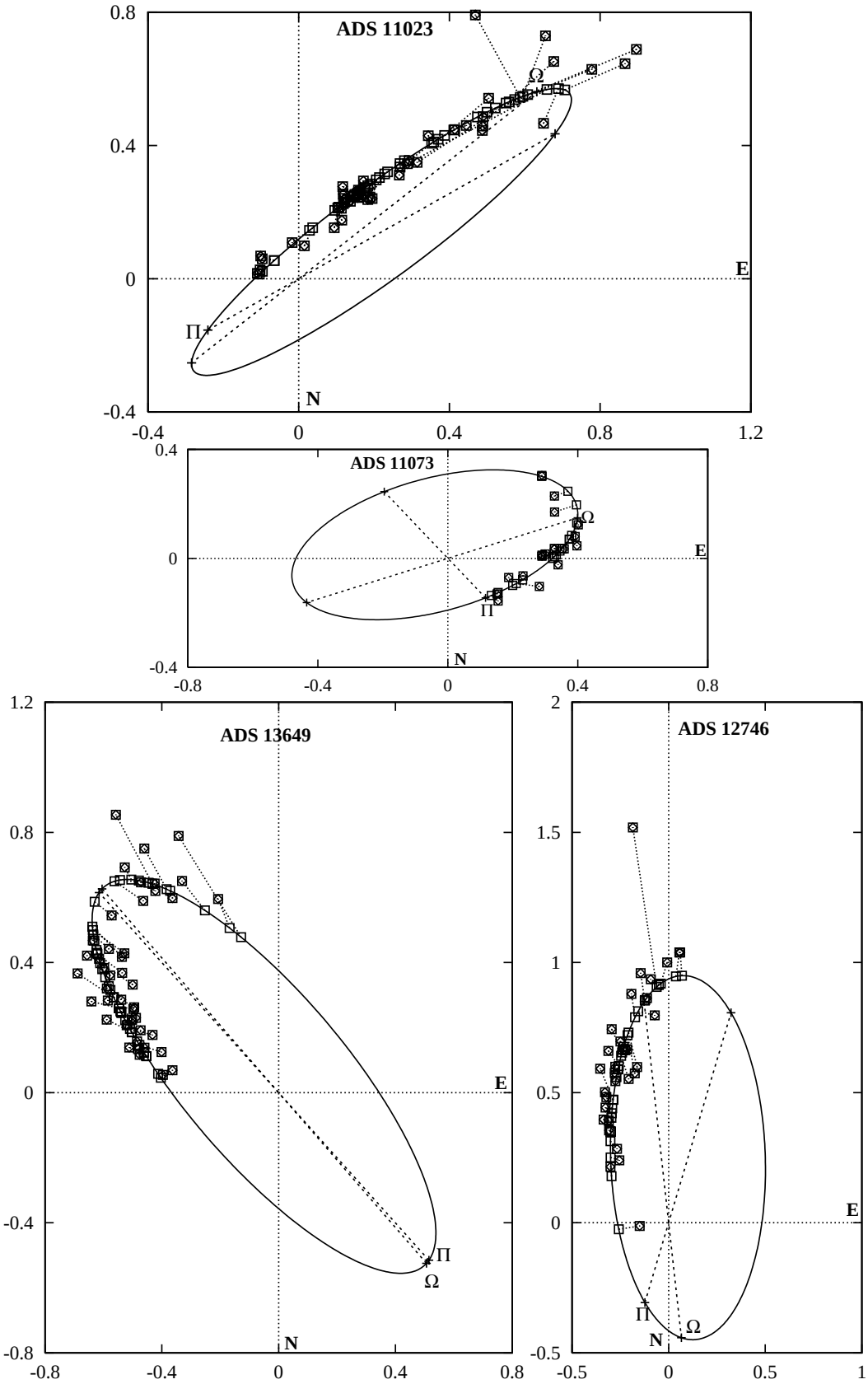

Fig. 1. continued

Table 2. Measurements and (O − C)

WDS 04089+4614 = A 998 = ADS 3007 = HD 25987

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1905.81	332.°9	0.″33	3	A	1.°75	−0.″07
1916.65	325.1	0.36	2	A	−1.20	−0.04
1932.84	318.9	0.38	2	A	0.25	0.01
1944.72	310.9	0.32	4	Voûte	−1.17	−0.02
1946.35	311.4	0.42	6	VBs	0.34	0.08
1947.93	309.2	0.36	4	Bz	−0.84	0.03
1955.68	300.5	0.31	4	Bz	−4.01	0.01
1961.85	295.3	0.29	1	Cou	−3.90	0.01
1962.816	299.3	0.24	4	Bos	1.03	−0.03
1962.945	298.2	0.26	4	Wor	0.05	−0.01
1964.10	300.0	0.26	1	Cou	3.00	−0.01
1965.06	110.3	0.37	4	hz	−5.71	0.11
1973.95	100.5	0.24	4	hz	−4.40	0.02
1976.837	280.8	0.23	4	Wor	0.49	0.02
1978.88	273.7	0.18	3	hz	−2.98	−0.02
1981.01	99.4	0.18	2	Morel	6.91	−0.01
1981.90	268.7	0.17	3	hz	−1.91	−0.01
1982.06	97.9	0.17	3	Cou	7.64	−0.01
1983.0472	266.2	0.177	1	McA87b	−1.86	−0.00
1983.0637	269.3	0.170	1	McA87b	1.28	−0.01
1983.84	85.7	0.18	2	Cou	−0.51	0.01
1984.0521	265.0	0.171	1	McA87b	−0.70	−0.00
1985.00	83.7	0.17	2	Cou	0.34	0.00
1985.8405	260.7	0.165	1	McA87b	−0.50	−0.00
1986.8862	258.1	0.162	1	McA89	−0.28	0.00
1987.7599	255.2	0.159	1	McA89	−0.70	0.00
1989.7068	250.2	0.153	1	Har92	0.19	0.00
1989.813	249.8	0.14	1	Cou, Ling	0.13	−0.01

WDS 04275+1113 = BU 1186 = ADS 3228 = HD 28217

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1890.92	182.°1	0.″59	3	β	0.°71	0.″05
1893.61	185.3	0.55±	2	Sp	4.96	0.00
1896.09	180.5	0.64	5	Sp	1.07	0.07
1898.03	174.4	0.75	3	A	−4.34	0.17
1900.06	176.9	0.57	1	See	−1.15	−0.02
1908.70	174.7	0.66	6	Doo3, GrO3	−0.65	0.04
1922.60	167.4	0.58	2	GrO	−4.03	−0.07
1936.65	166.2	0.62	4	Bz	−1.27	0.00
1943.74	168.5	0.61	3	Voûte	3.24	0.02
1948.731	165.6	0.52	1	VBs	2.08	−0.04
1951.052	168.7	0.45	1	Markowitz	6.06	−0.09
1952.870	166.9	0.51	1	Markowitz	4.99	−0.02
1962.13	152.6	0.49	2	Bz	−4.86	0.04
1963.110	149.8	0.30	3	Wor	−7.09	−0.14
1978.118	129.8	0.22	4	Wor	−13.40	−0.07
1981.91	134.7	0.33	3	hz	−2.24	0.08
1983.0500	132.7	0.224	1	McA et al.	−1.95	−0.01
1983.7162	132.3	0.213	1	McA et al.	−0.90	−0.02
1984.0522	131.4	0.211	1	McA et al.	−1.04	−0.01
1984.7072	130.4	0.206	1	McA et al.	−0.49	−0.01
1984.9968	129.8	0.204	1	McA et al.	−0.38	−0.01
1985.8488	127.6	0.196	1	McA et al.	−0.37	−0.01
1986.8890	124.3	0.188	1	McA et al.	−0.73	−0.01
1987.7600	122.5	0.181	1	McA et al.	0.14	−0.01

Table 2. continued

WDS 04400+2301 = HU 442 = ADS 3370 = HD 29538

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1901.86	333.°8	0.″41	3	Hu	4.°90	0.″10
1921.33	340.9	0.41	3	VBs	−4.13	0.00
1944.76	357.0	0.41	4	Voûte	−1.32	−0.02
1947.07	0.9	0.46	4	BVs	1.27	0.03
1958.08	4.6	0.35	3	Cou	−1.96	−0.04
1961.19	7.6	0.34	3	Bz	−1.27	−0.03
1961.37	13.4	0.37	5	BVs	4.39	0.00
1970.507	16.1	0.28	3	Wor	−1.63	−0.02
1975.10	28.0	0.21	2	Mul	4.07	−0.05
1979.97	33.1	0.27	3	hz	0.13	0.05
1987.7574	56.8	0.145	1	McA et al.	−0.25	−0.01
1991.9022	76.8	0.104	1	McA et al.	0.18	−0.04

WDS 18018+0118 = BU 1125AB = ADS 10990 = HD 164577

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1889.39	14.°9	1.″01	5	β	1.°43	0.″10
1890.47	19.7	0.91	3	β	5.59	0.00
1892.37	22.0	0.89	4	β	6.77	−0.03
1894.13	14.9	0.78	4	Sp	−1.37	−0.14
1897.51	10.5	0.99	3	A	−7.75	0.07
1898.52	15.3	0.86	3	β	−3.54	−0.06
1898.53	16.6	1.02	3	A	−2.25	0.10
1900.14	18.6	0.88	2	Lewis	−1.19	−0.04
1901.49	17.6	0.95	3	Doo	−2.99	0.03
1903.67	30.1	0.85	1	VBs	8.23	−0.06
1905.39	21.3	0.96	4	Doo	−1.59	0.05
1913.21	23.3	0.80	3	A2, GrO1	−4.32	−0.09
1916.50	27.7	0.86	2	Fox	−1.98	−0.02
1926.48	37.3	0.70	1	Fur	1.01	−0.14
1935.14	43.5	0.75	4	Bz	0.83	−0.05
1943.46	58.0	0.72	6	VBs	8.42	−0.03
1945.32	53.3	0.76	3	Voûte	2.05	0.02
1946.72	52.7	0.73	3	Bz	0.16	0.00
1957.405	66.9	0.67	4	Bos	3.40	0.01
1958.633	60.4	0.52	4	Bos	−4.50	−0.14
1959.53	63.6	0.94	3	Wor	−2.34	0.29
1959.69	64.2	0.76	2	Wor	−1.93	0.11
1959.91	68.5	0.64	3	VBs	2.12	−0.01
1961.521	72.1	0.60	5	Bos	3.80	−0.04
1961.69	65.9	0.69	4	Bz	−2.61	0.05
1962.462	simple		1	Cou	−	−
1965.51	73.1	0.59	3	Cou	−0.19	−0.03
1966.69	69.9	0.59	4	Bz	−4.93	−0.02
1971.342	83.7	0.60	4	Wor	2.53	0.01
1980.603	92.0	0.49	4	Wor	−3.01	−0.07

Table 2. continued

WDS 18033+3921 = STF 2275 = ADS 11023 = HD 88432

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1832.20	127.°9	1.″08	3	Σ	−1.°95	0.″17
1844.35	126.8	0.8±	1	Ma	−3.83	−0.10
1859.89	141.1	0.45	1	Se	9.43	−0.42
1878.59	128.4	1.13	1	OΣ	−4.64	0.31
1882.54	138.9	0.98	1	OΣ	5.54	0.17
1884.50	150.2	0.92	5	En	16.68	0.12
1888.64	138.8	0.47	2	Sp	4.93	−0.32
1892.60	134.7	0.94	2	Big	0.48	0.17
1894.57	135.6	0.69	6	Com	1.20	−0.07
1901.46	133.1	0.66	3	Lewis	−1.96	−0.07
1906.42	129.6	1.00	1	Frm	−5.98	0.29
1911.74	133.8	0.67	9	GrO6, Neuj3	−2.39	−0.01
1923.54	136.5	0.64	3	Fur	−1.25	0.03
1927.816	137.6	0.74	2	GΣ	−0.83	0.16
1930.651	137.7	0.61	3	GΣ	−1.21	0.05
1932.559	141.8	0.55	5	GΣ	2.54	0.00
1933.45	140.9	0.46	2	VBs	1.47	−0.08
1944.39	139.8	0.41	4	Voute	−2.14	−0.04
1946.08	141.6	0.43	5	VBs	−0.82	−0.01
1950.652	148.7	0.31	1	Markowitz	4.79	−0.09
1951.660	142.7	0.30	1	Markowitz	−1.58	−0.09
1953.54	147.6	0.29	2	VBs	2.58	−0.08

WDS 18033+3921 = STF 2275 = ADS 11023 = HD 88432

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1954.70	322.7	0.31	4	Bz	−2.81	−0.05
1956.70	321.3	0.31	3	Bz	−5.13	−0.03
1957.60	150.0	0.34	2	VBs	3.12	0.01
1958.618	149.5	0.31	3	Bos	2.09	−0.01
1958.62	155.4	0.28	2	VBs	7.98	−0.04
1960.72	145.3	0.30	2	Bz	−3.33	−0.00
1960.99	157.4	0.30	5	VBs	8.60	−0.00
1961.43	329.7	0.27	3	Wor	0.62	−0.03
1961.502	single		2	Dju	–	–
1962.102	151.5	0.27	4	Bos	1.97	−0.02
1942.49	152.1	0.24	3	Cou	2.30	−0.05
1962.71	153.5	0.27	3	Bz	3.55	−0.01
1965.72	152.3	0.26*e*	2	Bz	−0.03	0.01
1967.478	148.6	0.18	2	Walker Jr.	−5.41	−0.06
1967.55	153.9	0.24	3	Morel	−0.18	0.00
1968.54	147.2	0.21	2	Cou	−7.94	−0.02
1975.493	171.5	0.10	1	Walker Jr.	5.10	−0.06
1976.50	189.2	0.11	3	hz	20.31	−0.04
1987.529	238.3	0.114	1	C	8.52	0.03
1987.529	236.0	0.122	1	L	6.22	0.04
1991.3192	255.4	0.106	1	Har94	−1.39	0.01
1992.3132	266.6	0.111	1	Har94	−0.72	0.01
1905.44	137.°6	0.″42	2	Hu1, A1	0.°31	0.″00
1922.77	125.8	0.40	2	VBs	1.17	−0.04
1933.49	118.2	0.37	4	VBs	1.02	−0.07
1944.86	107.7	0.42	3	VBs	−1.11	0.00
1953.69	102.1	0.40	2	Mul	0.84	0.02
1953.71	97.2	0.40	4	Bz	−4.04	0.02

Table 2. continued

WDS 19389+3514 = HU 953 = ADS 12746 = HD 185696

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1958.552	96.7	0.33	3	Bos	0.36	−0.02
1958.63	92.0	0.29	2	VBs	−4.26	−0.06
1959.78	96.8	0.33	2	Cou	1.82	−0.02
1961.71	86.5	0.34	4	Bz	−6.20	0.01
1963.526	93.5	0.30	4	Wor	3.09	−0.02
1974.524	74.8	0.24	4	Wor	3.40	0.00
1976.49	70.2	0.30	4	Mul	3.56	0.07
1977.54	69.7	0.20	3	hz	5.84	−0.02
1981.653	49.4	0.20	3	Wor	−1.86	0.00
1983.50	44.9	0.22	3	Mul	0.22	0.03
1904.47	177.°3	1.″04	3	Hu	0.°87	0.″09
1909.46	177.5	1.04	5	Bow2, Dob3	−0.76	0.09
1922.09	180.9	1.00	2	VBs	−2.12	0.08
1923.69	186.1	0.94	3	Chan1, Plq2	2.46	0.03
1925.55	187.4	1.53	1	Schem	3.02	0.62
1935.36	187.8	0.87	3	Bz	−0.70	0.01
1935.68	189.0	0.97	2	VBs	0.36	0.11
1941.555	185.5	0.80	1	Arend	−5.86	−0.03
1944.42	192.7	0.90	3	Voute	−0.08	0.09
1950.751	195.6	0.62	1	Markowitz	−0.59	−0.14
1951.706	197.3	0.60	1	Markowitz	0.56	−0.15
1955.796	198.09	0.70	6	Rabe	−1.18	−0.01
1956.54	200.0	0.74	3	Bos	0.25	0.03
1956.78	199.0	0.70	3	Bz	−0.91	−0.01
1957.60	201.9	0.80	3	VBs	1.43	0.10
1958.684	200.8	0.59	2	Dju, Dac	−0.42	−0.10
1961.727	205.5	0.73	3	Wor	2.04	0.07
1962.60	207.1	0.61	3	Cou	2.95	−0.04
1962.66	205.0	0.66	5	VBs	0.80	0.01
1964.78	206.1	0.64	4	hz	0.14	0.02
1970.472	211.1	0.69	1	Ole	−0.36	0.14
1970.552	213.5	0.60	2	Pop	1.96	0.05
1972.473	213.9	0.58	1	Ole	0.16	0.05
1973.628	216.6	0.55	1	Pop	1.44	0.04
1974.636	218.4	0.50	4	Wor	1.93	−0.00
1977.55	221.1	0.47	3	hz	0.42	0.01
1977.556	220.5	0.52	2	Holden	−0.19	0.06
1979.52	223.4	0.39	3	hz	−0.56	−0.04
1982.721	226.9	0.35	3	Massone	−3.35	−0.04
1986.216	234.5	0.37	2	Zul	−4.40	0.02
1995.62	274.7	0.15	3	hz	−0.89	−0.11

WDS 20176+2622 = BU 984 = ADS 13649 = HD 193095

t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1880.47	204.°1	0.″86	2	β	8.°43	0.″37
1883.70	199.8	0.63	3	Ho	0.83	0.10
1888.49	203.1	–	1	Lv	0.01	–
1890.85	207.5	0.73	7	Sp	2.66	0.12
1901.78	211.8	0.70	2	A	0.38	−0.02
1903.02	212.0	0.88	4	Doo	−0.05	0.15
1908.10	213.6	1.02	2	Moth	−0.85	0.25
1909.55	213.9	0.77	15	Dob3, Lv2, GrO10	−1.19	−0.01
1913.43	214.7	0.75	14	Fox3, GrO11	−2.03	−0.06
1916.68	217.7	0.87	3	Ptt	−0.33	0.04

Table 2. continued

WDS 20176+2622 = BU 984 = ADS 13649 = HD 193095						
t	θ_t	ρ	n	Obs.	$\Delta\theta$	$\Delta\rho$
1922.24	216.5	0.80	8	Lv5, GrO3	−3.65	−0.05
1925.28	218.6	0.75	17	Lv3, Bail2, Plq2, Berm10	−2.66	−0.11
1942.37	226.7	0.79	3	Voûte	−0.64	−0.07
1953.56	232.4	0.68	2	VBs	0.83	−0.14
1954.87	231.2	0.68	2	Mul	−0.90	−0.13
1958.73	233.9	0.79	4	hz	0.17	0.00
1961.82	236.4	0.74	4	hz	1.29	−0.02
1962.74	237.5	0.78	4	Bz	1.96	0.02
1965.955	236.6	0.60	4	Walker Jr.	−0.50	−0.13
1970.116	241.6	0.67	3	Wor	2.28	−0.02
1972.63	242.8	0.56	4	hz	2.02	−0.11
1973.677	244.3	0.65	1	Ole	2.88	−0.01
1975.648	242.2	0.61	3	Holden	−0.49	−0.03
1975.72	242.1	0.78	1	Zul	−0.64	0.14
1978.57	246.5	0.70	1	Zul	1.77	0.09
1978.570	242.2	0.56	1	Pop	−2.53	−0.05
1979.355	244.9	0.54	4	Walker Jr.	−0.42	−0.06
1979.54	246.0	0.55	3	hz	0.54	−0.04
1979.817	248.4	0.56	4	Wor	2.73	−0.03
1981.64	246.1	0.55	2	hz	−1.03	−0.02
1982.804	248.0	0.51	1	Massone	−0.12	−0.05
1983.860	247.75	0.467	3	Scardia	−1.30	−0.08
1984.631	249.2	0.63	4	Zul	−0.56	0.09
1984.719	252.1	0.51	3	Wor	2.25	−0.03
1987.81	252.8	0.42	3	Beau	−0.17	−0.08
1989.636	254.5	0.50	1	Doc	−0.54	0.02
1989.636	254.9	0.53	1	Lin	−0.14	0.05
1990.553	253.3	0.48	1	Pri	−2.85	0.01
1990.553	256.3	0.49	1	Lap	0.15	0.02
1994.80	262.2	0.40	3	hz	0.15	−0.02

Table 3. Ephemerides

WDS	04089+4614		04275+1113		04400+2301		18018+0118	
ADS	3007		3228		3370		10990	
t	θ_t	ρ	θ_t	ρ	θ_t	ρ	θ_t	ρ
1999.0	214.°37	0.″13	70.°49	0.″14	113.°00	0.″15	123.°46	0.″56
2000.0	209.84	0.13	65.45	0.15	117.33	0.16	125.03	0.56
2001.0	205.19	0.12	60.66	0.15	121.35	0.16	126.58	0.57
2002.0	200.38	0.12	56.15	0.16	125.08	0.17	128.12	0.57
2003.0	195.40	0.12	51.95	0.16	128.53	0.18	129.65	0.57
2004.0	190.19	0.12	48.07	0.17	131.69	0.19	131.17	0.57
2005.0	184.68	0.11	44.50	0.18	134.61	0.19	132.67	0.58
2006.0	178.72	0.11	41.23	0.19	137.29	0.20	134.15	0.58
2007.0	172.07	0.10	38.23	0.19	139.76	0.21	135.62	0.58
2008.0	164.36	0.09	35.49	0.20	142.04	0.22	137.08	0.58

WDS	18033+3921		18054+6216		19389+3514		20176+2622	
ADS	11023		11073		12746		13649	
t	θ_t	ρ	θ_t	ρ	θ_t	ρ	θ_t	ρ
1999.0	285.°44	0.″16	344.°71	0.″21	292.°89	0.″25	269.°30	0.″37
2000.0	287.52	0.17	341.82	0.22	298.02	0.26	271.33	0.36
2001.0	289.39	0.18	339.10	0.22	303.05	0.26	273.48	0.35
2002.0	291.07	0.19	336.53	0.23	307.93	0.26	275.75	0.34
2003.0	292.59	0.20	334.11	0.24	312.61	0.27	278.16	0.33
2004.0	293.98	0.21	331.83	0.25	317.08	0.28	280.71	0.32
2005.0	295.24	0.22	329.67	0.25	321.31	0.29	283.39	0.31
2006.0	296.41	0.23	327.64	0.26	325.31	0.29	286.23	0.31
2007.0	297.48	0.24	325.72	0.27	329.07	0.30	289.20	0.30
2008.0	298.47	0.25	323.90	0.28	332.60	0.31	292.32	0.29

At the time of periastron passage in 2012 the component separation will be $\sim 0.''3$.

WDS 18054+6216 = ADS 11073 = HU 1290 = HD 166206 The elements are obtained from a position-angle change exceeding 90°.

The value obtained for the absolute magnitude and the F8 spectrum indicates that the system belongs to subgiants (LC IV). The orbital parallax obtained here is $0.''008$. The agreement with the trigonometric one following from the Hipparcos Catalogue ($0.''00779 \pm 0.''00075$) is complete.

WDS 19389+3514 = ADS 12746 = HU 953 = HD 185696 This pair grows in its measuring suitability and the component separation at the time of intersecting the node line will be $\sim 0.''3$. The obtained orbital parallax is $0.''013$ whereas in the Tycho Catalogue one finds $0.''029 \pm 0.''006$.

WDS 20176+2622 = ADS 13649 = BU 984 = HD 193095 The significant number of measurements for this pair, in spite of a modest change of its position angle −60°, permits a good orbit determination.

The parallax and the absolute magnitude are calculated following the empirical mass-luminosity relation concerning the HR main sequence. According to the absolute magnitude from the Tycho Catalogue this pair would be a subgiant (LC IV). Our parallax ($0.''015$) is within the parallax-error limits indicated by the Tycho Catalogue ($0.''011 \pm 0.''005$).

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