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ORBITS OF 6 BINARIES

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SUMMARY: In this paper the orbits of binaries WDS 10093+2020 = A 2145, WDS 21074−0814 = BU 368 AB and WDS 22288−0001 = STF 2909 AB are recalculated because of significant deviations of more recent observations from the ephemerides. For binaries WDS 22384−0754 = A 2695, WDS 23474−7118 = FIN 375 Aa and WDS 23578+2508 = McA 76 the orbital elements are calculated for the first time.

Key words. binaries: visual

1. INTRODUCTION

Till the present time about 2000 orbits of visual binaries have been determined (Hartkopf and Mason 2003), but only about 10% of them are 'definite', i.e. marked as grade 1 (Worley and Heintz 1983, Hartkopf et al. 2001).

For this reason every new observation should be compared with the corresponding ephemerides and in the case of significant discrepancies either a differential correction or a recalculation of the orbit is necessary.

Such a case we find for binaries WDS 10093+2020 = A 2145 (last orbit calculated by Tokovinin (1987)), WDS 21074−0814 = BU 368 AB (last orbit calculated by Baize (1985)) and WDS 22288−0001 = STF 2909 AB (last orbit calculated by Heintz (1984)).

Due to the insufficient number of observations the orbital elements for binaries WDS 22384−0754 = A 2695, WDS 23474−7118 = FIN 375 Aa and WDS 23578+0508 = McA 76 have not been calculated so far. Pairs Fin 375 Aa and McA 76 are interferometric so that a higher precision of their measurements can be expected.

2. THE METHOD, RESULTS AND DISCUSSION

2.1. Method

The pair A 2145 (ADS 7662) according to Tokovinin's calculation has an inclination of 180°, whereas BU 368 AB (ADS 14648) according to Baize's calculation has an inclination of 90°. Therefore, the changes of the position angle are insignificant or within the measuring errors. The indication of a Keplerian motion is a characteristic changing of the apparent radius vector. For very close pairs as a consequence of this fact the observations are grouped at those parts of the orbit where ρ cannot be measured for geometrical reasons, because in these special cases the components are almost mutually eclipsed. If a smaller part of the orbit is covered by observations, the orbit calculation becomes difficult and the results have large errors.

The present authors apply the Kovalski-Olević method (Olević and Cvetković 2004) which yields a solution for all cases of grouping of observations along the arc of the apparent orbit, as well as for the cases of the apparent-orbit inclination of 90° or 180°. This method has been in use from 1995 on. The programme was written by P. Jovanović. The part concerning the calculation of formal errors was added in 2002. The programme was written by Z. Cvetković.

2.2. Results

The orbital elements (equinox J2000) are listed in Table 1.

Table 2 contains the observational data and their residuals. The asterisk indicates observations where the quadrant is changed (rotation by 180°) in the orbit calculation. Double asterisk (**) indicate the mesurements not used in the orbit calculation. In the parentheses one gives the ephemerides of the coordinates as computed with the calculated orbital elements.

Finally, Table 3 gives the ephemerides for the interval 2004-2008.

Figs. 1 to 6 give the fitted orbit, the line of nodes, the observed position (dots) and their corresponding ephemeris positions (open circles) for the pairs dealt with in this paper.

2.3. Discussion

WDS 10093+2020 = A 2145: The orbit of this pair has been calculated by several authors. The last of them (Tokovinin 1987) found for the period 71.1 years, 180.0° for the inclination and $a = 0''.129$ for the semimajor axis. The last measurement at 1995.1438 yields $(O-C)_{\theta,\rho}$: (−144°, $-0''.025$). Our orbital elements are significantly different from the afore mentioned ones (period P=119.25, inclination $i = 118.0°$ and $a = 0''.184$) and with them a better fit is achieved for all existing observations. Difficulties in the measuring of this pair could arise due to the fact that it is a variable (NSV 4757) star with an amplitude of 0.2 mag. There is also a problem concerning the spectrum determination. In WDS one finds F5+A2, but F5 according to SIMBAD 1985. In his thesis Markowitz concludes that the spectrum of this star is G2III+A2V, whereas the magnitude change can be as large as 1.1 (Hartkopf et al. 2003). Furthermore, from the Hipparcos parallax $0''.00215 \pm 0''.00088$ one finds an unexpectedly high total mass of $41M_{\odot}$. Assuming that this system belongs to the Main Sequence, Angelov's (1993) relation results in a dynamical parallax of $0''.0044$, i.e. in a total mass of about $5M_{\odot}$. In any case this is an interesting system requiring additional observations both astrometric and astrophysical.

WDS 21074−0814 = BU 368 AB: According to the preliminary orbital elements P=160, $a = 0''.49$ and $i = 90°$ (Baize 1985) for the measurement at 1997.7620 we obtain $(O-C)_{\theta,\rho}$: (+24°, $0''.098$). Our orbit implies P=173.8, $a = 0''.479$ and $i = 94.3°$. In the calculation an entire group of observations covering 1954-1959 is rejected because it is uncertain whether they refer to this system. For an A0 spectral type and π_{hip} of $0''.00750 \pm 0''.00109$ we find an expected total mass of about $7M_{\odot}$.

WDS 22288−0001 = STF 2909 AB: This wide and bright pair discovered by W. Struve in 1821 has been a subject of observers' attention permanently. In recent times it has been observed several times a year. The orbital elements have been calculated many times. The last who did it before us was Heintz (1984) (P=760 i $a = 4''.51$). Our elements enable a somewhat better fit, but they are, nevertheless, significantly different from those by Heintz. According to our calculations the dynamical parallax is equal to $0''.0366$, this value being in a good accordance with the Hipparcos value of $0''.03153 \pm 0''.00150$. The individual masses of the components are $1.720M_{\odot}$ and $1.65M_{\odot}$ as expected for the given spectrum F3IV-V. By analysing the residuals one finds a periodicity of about 23 years in both polar coordinates. In our opinion this fact deserves a more thorough study.

WDS 22384−0754 = A 2695: In the Hipparcos Catalogue one finds for the spectral type of this pair G1IV-V. In WDS it is F2+K0III. It is a suspected variable, amplitude < 2 mag. The Hipparcos parallax is $0''.00710 \pm 0''.00130$. From Third Kepler's law one obtains a total mass of $2.0M_{\odot}$.

WDS 22474−7118 = FIN 375 Aa: According to the Michigan Spectral Survey, Vol. 1, the spectral type of the pair is K0III. From six interferometric measurements and the Hipparcos parallax $0''.00546 \pm 0''.00074$ one finds the orbital elements (P and a) yielding a total mass of $1.42M_{\odot}$.

WDS 23578+2508 = McA 76: In the Hipparcos Catalogue for the spectral type of the pair one finds M3III. It is known as a variable with an amplitude < 0.2 mag. The orbital elements are calculated from five interferometric measurements. There are three observations whereat Bonneau failed to measure the position angle, while the separations are unreliable. Our solution and the Hipparcos parallax of $0''.00754 \pm 0''.00069$ yield a total mass of $3.8M_{\odot}$. However, the errors in the period (±11.3 years), semimajor axis ($\pm 0''.18$) and π_{hip} also allow the value of $2.0M_{\odot}$ for the total mass.

Table 1. Orbital elements.

Name	A 2145	BU 368 AB	STF 2909 AB	A 2695	FIN 375 Aa	McA 76
WDS	10093+2020	21074−0814	22288−0001	22384−0754	23474−7118	23578+2508
HIP	49747	104272	110960	111761	117326	118131
m_A-m_B	7.30-7.50	7.02-7.70	4.36-4.57	6.23-7.70	7.08-8.35	4.66
Sp.	F5+A2	A0	F3IV-V	F2+K0III	K0III	M3III
$P(yr)$	119.25±3.62	173.82±13.42	587.18±1.09	147.07±8.09	143.32±15.81	55.06±11.31
T	2001.46±2.98	1996.08±11.40	1973.39±1.09	2018.84±6.15	2038.07±10.11	2001.83±8.81
$a('')$	0.184±0.006	0.479±0.040	3.847±0.147	0.249±0.051	0.168±0.017	0.170±0.016
e	0.32±0.02	0.51±0.05	0.40±0.01	0.44±0.37	0.42±0.16	0.19±0.10
$i(^o)$	118.1±1.2	94.3±0.2	138.2±0.2	73.6±6.2	63.6±5.4	65.6±2.2
$\Omega(^o)$	28.2±1.1	92.2±0.3	129.8±0.3	110.3±3.3	20.6±7.2	46.6±2.3
$\omega(^o)$	319.4±3.6	218.8±4.5	255.9±1.2	191.9±14.7	284.6±36.3	159.7±11.9

Table 2. Observations and residuals.

WDS 10093+2020 = A 2145

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1910.36*	195.3	0.15	3	A	54.9	.052
1921.18*	89.2	0.14	1	A	−2.9	.026
1923.56*	77.0	0.15	3	A	−7.3	.027
1925.34*	66.6	0.12	2	A	−12.6	−.010
1937.06	229.5	0.22	2	Vbs	−7.0	.039
1941.19	229.4	0.22	3	Vbs	−1.8	.024
1944.27	228.5	0.24	4	Vbs	.8	.034
1949.97	224.4	0.20	3	Vbs	2.5	−.019
1950.172	223.7	0.20	2	Mrz	1.9	−.019
1951.04	216.6	0.17	1	Vbs	−4.3	−.051
1951.054	222.2	0.24	1	Mrz	1.3	.019
1952.136	222.0	0.23	1	Mrz	2.1	.008
1952.26	216.2	0.20	4	Vbs	−3.6	−.022
1953.32	206.3	0.228	2	Fin	−12.5	.004
1954.40	207.9	0.211	1	Fin	−9.9	−.014
1955.93	210.4	0.18	5	Vbs	−6.0	−.045
1957.28	217.4	0.19	4	Vbs	2.2	−.036
1958.003	215.9	0.24	3	B	1.4	.015
1958.01	214.6	0.20	2	Vbs	.1	−.025
1958.022	216.8	0.24	3	B	2.3	.015
1962.30	213.4	0.23	3	Vbs	2.8	.008
1964.99	210.0	0.22	3	Vbs	1.9	.003
1972.571	197.1	0.20	3	Wor	−2.7	.008
1973.27	198.2	0.19	2	Cou	−.7	.002
1975.9598	195.5	0.181	1	McA	.3	.007
1976.0389	194.5	0.182	1	McA	−.5	.009
1976.260	197.0	0.18	2	Wor	2.3	.008
1976.27	201.6	0.16	3	hz	6.9	−.012
1977.9147	190.6	0.171	1	McA	−1.4	.009
1978.1468	191.4	0.171	1	McA	−.2	.010
1980.1564	187.4	0.151	1	McA	−.3	.004
1981.2365	187	0.126	1	Bag	1.7	−.013
1982.2916	181.8	0.138	1	McA	−.8	.006
1983.0698	180.5	0.128	1	McA	.0	.002
1983.9372	185.0	0.148	1	Bnu	7.2	.029
1983.9371	184.0	0.150	1	Bnu	6.2	.031
1984.0527	177.8	0.117	1	McA	.4	−.001
1984.0555	177.1	0.126	1	McA	−.3	.008
1984.1861	173.5	0.100	1	Bnu	−3.5	−.017
1984.26	163	0.1	2	hz	−13.7	−.016
1984.2814	182.0	0.127	1	Bnu	5.3	.011
1984.285	193.5	0.12	1	Cou	16.8	.004
1984.3750	176.9	0.113	1	McA	.6	−.003
1984.3778	176.2	0.115	1	McA	−.1	−.001
1984.3832	175.2	0.113	1	McA	−1.1	−.002
1985.3832	175.2	0.107	1	Bnu	2.6	−.001
1986.22	159.5	0.10	2	Cou	−9.6	−.001
1986.397	163.1	0.085	1	Tok	−5.2	−.015
1987.2638	161.3	0.082	1	McA	−2.8	−.011

Table 2. (continued)

WDS 10093+2020 = A 2145

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1988.8712	138.0	0.091	1	Ism	−16.4	.009
1989.2296	142.0	0.057	1	McA	−9.9	−.023
1990.4293	136.1	0.069	1	Ism	−6.3	−.004
1994.8708	287.6	0.059	1	Hrt	11.2	−.007
1995.1438	290.7	0.071	1	Hrt	17.1	.004

WDS 21074−0814 = BU 368 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1878.11	449.9	0.69	3	Dem	−0.8	.052
1879.24	449.6	0.67	4	Cin	−1.0	.030
1881.63	450.4	0.63	3	Bu	−0.0	−.013
1886.69	450.1	0.70	2	LM	0.0	.057
1886.60	453.3	0.66	2	LV	3.2	.017
1890.64	448.7	0.58	3	Bu	−1.1	−.059
1892.10	450.2	0.58	4	Sp	0.5	−.056
1892.68	452.1	0.60	3	T	2.4	−.034
1898.58	449.0	0.61	1	A	−0.2	−.007
1900.73	447.6	0.70	6	Doo	−1.5	.092
1907.72	455.0	0.64	6	MCO	6.5	.067
1935.292	450.2	0.24	4	Fin	5.7	−.097
1937.762	453.9	0.20	4	Fin	10.1	−.110
1978.051	278.5	0.24	2	McA	.2	.030
1978.6177	270.6	0.257	1	McA	−7.3	.042
1978.785	269.4	0.24	2	McA	−8.4	.023
1979.56	277.6	0.23	3	hz	.3	.006
1981.63	273.4	0.21	3	hz	−2.8	−.031
1981.6978	270.8	0.255	1	McA	−5.3	.013
1982.7627	272.6	0.240	1	McA	−3.0	−.009
1983.4259	276.9	0.239	1	McA	1.6	−.014
1983.4833	273.4	0.257	1	McA	−1.9	.004
1983.6334	271.4	0.254	1	McA	−3.8	.000
1983.6364	270.7	0.252	1	McA	−4.5	−.002
1983.6390	272.1	0.254	1	McA	−3.1	.000
1983.7400	273.8	0.255	1	McA	−1.3	.000
1983.8029	273.6	0.249	1	McA	−1.5	−.006
1983.8057	275.1	0.250	1	McA	−.0	−.005
1983.8083	275.8	0.248	1	McA	.7	−.007
1984.4445	271.8	0.244	1	McA	−3.0	−.014
1984.4526	271.0	0.237	1	McA	−3.8	−.021
1984.8405	271.8	0.237	1	McA	−2.8	−.022
1984.8541	271.5	0.257	1	McA	−3.1	−.003
1985.6542	271.3	0.247	1	McA	−3.0	−.015
1987.5326	276.7	0.235	1	McA	3.2	−.029
1991.25	273.	0.212	1	HIP	1.2	−.037
1991.7152	271.3	0.213	1	Hrt	−.3	−.032
1991.7262	274.4	0.206	1	Hrt	2.8	−.039
1994.7081	275.7	0.193	1	Hrt	5.9	−.015
1995.6011	278.0	0.188	1	Hrt	8.9	−.005
1995.7649	277.0	0.189	1	Hrt	8.0	−.001
1997.762	276.7	0.18	1	WSI	9.8	.031

Table 2. (continued)

WDS 22288−0001 = STF 2909 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1821.	357.	3.8	4	H	−3.7	.112
1825.73	359.8	3.60	2	STF	1.3	−.075
1832.81	355.3	3.46	5	STF	0.1	−.194
1839.77	350.1	3.73	6	Da	−1.8	.100
1842.39	350.3	3.67	5	Chl+Gsh	−.3	.050
1846.95	347.5	3.48	3	Da	−.9	−.122
1853.94	345.6	3.61	3	Wr	.6	.040
1858.15	341.5	3.57	9	Dem	− 1.4	.022
1863.14	339.0	3.52	15	Dem	−1.4	.000
1867.53	336.9	3.34	9	Dem	−1.3	−.152
1872.15	335.3	3.41	6	Dem	−.5	−.050
1876.40	334.4	3.31	6	Dem	.8	−.118
1878.12	334.0	3.56	11	Hl	1.4	.146
1882.68	331.1	3.33	8	Hl	.9	−.044
1886.30	328.3	3.30	6	Hl	.2	−.040
1887.50	328.9	3.51	12	Gnd and al.	1.4	.182
1888.34	325.8	3.29	6	Hl	−1.2	−.029
1890.08	324.6	3.15	89	Cel and al.	−1.4	−.151
1890.24	324.9	3.36	8	Hl	−1.0	.061
1893.78	323.2	3.14	9	Maw	−.6	−.120
1895.73	322.9	3.12	3	See	.2	−.117
1895.79	322.1	3.20	4	Com	−.5	−.036
1897.72	321.7	3.31	2	Hu	.2	.098
1900.12	318.1	3.26	7	Doo	−1.9	.079
1901.02	320.3	3.22	51	Cel and al.	.8	.050
1902.86	320.5	3.24	3	Do	2.2	.095
1903.68	319.2	3.01	3	Vbs	1.4	−.123
1903.81	319.5	3.10	6	Jouffrray	1.8	−.031
1905.54	317.0	2.95	4	Bu	.4	−.156
1906.83	316.5	3.21	31	Dob and al.	.7	.123
1909.71	312.4	3.05	36	UrO	−1.4	.007
1909.73	314.2	3.16	3	Gui	.4	.117
1912.95	309.6	2.98	57	Fox	−2.0	−.011
1916.09	307.2	2.91	70	Acs and al	−2.2	−.027
1920.06	305.1	2.90	36	Sto and al.	−1.3	.035
1922.30	303.7	2.90	58	Prz and al	−1.0	.078
1925.53	302.5	2.84	52	ZSO and al.	.4	.082
1926.72	299.8	2.96	5	Bz	−1.3	.226
1939.778	287.3	2.35	1	Fin	−1.6	−.094
1941.088	284.8	2.46	1	Mull	−2.7	.046
1942.729	284.2	2.403	1	C.A.Wirtanen	−1.6	.028
1944.91	283.4	2.17	2	Vbs	.1	−.153
1945.562	281.1	2.331	1	H.M.Jeffers	−1.4	.024
1949.88	278.5	2.26	2	Dubois	1.3	.056
1952.41	275.6	1.94	8	Vbs	1.7	−.205
1954.0	272.3	2.11	?	Rabe	.6	.002
1954.60	275.3	1.95	1	hz	4.4	−.145
1955.56	271.8	1.92	4	Wor	2.3	−.153
1956.54	268.8	1.85	3	Wor	.9	−.201

Table 2. (continued)

WDS 22288−0001 = STF 2909 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1958.0	266.0	2.01	?	Rabe	.2	−.009
1958.572	265.0	1.94	3	B	.0	−.067
1958.705	264.4	1.94	4	B	−.4	−.064
1958.71	263.8	1.82	4	hz	−.9	−.184
1959.23	263.7	2.05	3	GrO	−.2	.057
1959.75	263.4	1.89	5	Vbs	.3	−.093
1960.616	263.28	1.78	10	Mourao	1.5	−.185
1960.84	259.6	1.95	3	Cou	−1.8	−.011
1961.525	259.4	1.93	4	B	−.8	−.017
1961.95	257.1	1.89	4	hz	−2.4	−.049
1962.72	259.9	1.90	4	Vbs	1.6	−.024
1962.928	257.0	2.116	16	hz	−.9	.196
1964.74	255.3	1.99	3	Vbs	.5	.102
1964.75	252.7	1.88	3	hz	−2.1	−.008
1965.554	252.1	1.76	5	Walk	−1.3	−.114
1967.02	248.5	1.92	3	hz	−2.2	.069
1967.287	248.6	1.69	8	Walk	−1.6	−.157
1968.678	248.2	1.83	7	Wor	.5	.004
1968.91	245.6	1.86	5	hz	−1.6	.037
1969.710	247.2	1.88	6	Wor	1.5	.067
1970.744	245.2	1.88	6	Wor	1.4	.080
1971.737	243.2	1.82	6	Wor	1.3	.031
1971.78	242.2	1.82	3	hz	.4	.031
1972.75	240.6	1.71	3	hz	.7	−.069
1972.752	241.1	1.80	6	Wor	1.3	.021
1973.663	238.9	1.80	6	Wor	.8	.029
1973.706	237.4	1.98	3	Walk	−.6	.209
1973.79	238.5	1.73	3	hz	.7	−.040
1974.707	235.6	1.86	3	Walk	−.4	.097
1974.77	237.0	1.78	3	hz	1.2	.017
1974.800	236.6	1.74	6	Wor	.8	−.022
1975.67	234.7	1.81	3	hz	.7	.053
1975.7153	235.8	1.766	1	McA	1.8	.009
1975.794	235.3	1.78	1	Wor	1.5	.024
1976.610	234.1	1.71	1	Walk	2.0	−.042
1976.6163	237.5	1.751	1	McA	5.3	−.001
1976.6246	233.1	1.807	1	McA	1.0	.055
1976.72	233.8	1.80	3	hz	1.9	.048
1976.798	235.2	1.79	6	Wor	3.4	.039
1976.8594	233.5	1.789	1	McA	1.9	.038
1977.59	231.8	1.64	3	hz	1.6	−.108
1977.757	233.8	1.78	5	Wor	4.0	.032
1978.56	229.7	1.77	3	hz	1.5	.025
1978.629	229.9	1.87	3	Walk	1.9	.125
1978.881	231.9	1.75	5	Wor	4.4	.005
1979.60	228.1	1.69	3	hz	2.1	−.054
1979.861	229.3	1.70	8	Wor	3.8	−.044
1980.66	224.2	1.72	3	hz	.3	−.024
1980.749	226.2	1.64	6	Wor	2.5	−.104

Table 2. (continued)

WDS 22288−0001 = STF 2909 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1981.62	220.6	1.75	3	hz	−1.3	.005
1981.7034	218.3	1.648	1	McA	−3.4	−.097
1981.734	218.3	1.648	6	Wor	−3.4	−.097
1981.893	221.8	1.66	8	Wor	.4	−.086
1982.378	218.5	1.672	1	Ebe	−1.8	−.075
1982.5059	217.6	1.638	1	McA	−2.5	−.109
1982.69	216.7	1.82	3	hz	−3.0	.072
1982.7544	217.4	1.704	1	McA	−2.2	−.044
1982.7654	217.5	1.696	1	McA	−2.1	−.052
1983.525	217.5	1.65	3	Wor	−.5	−.101
1984.812	214.7	1.75	4	Wor	−.7	−.008
1985.8483	211.5	1.774	1	McA	−1.8	.009
1986.675	210.1	1.88	9	Wor	−1.6	.108
1990.835	202.5	1.94	1	WSI	−1.1	.123
1990.849	202.3	1.87	1	WSI	−1.3	.052
1990.854	202.0	1.83	1	WSI	−1.6	.012
1990.868	202.2	1.88	1	WSI	−1.4	.062
1990.871	202.1	1.93	1	WSI	−1.5	.112
1990.881	201.7	1.94	1	WSI	−1.8	.122
1990.884	203.1	1.89	1	WSI	−.4	.072
1990.914	202.4	1.89	1	WSI	−1.1	.072
1990.944	202.4	1.88	1	WSI	−1.0	.061
1990.953	203.3	1.89	1	WSI	−.1	.071
1991.25	201.9	1.877	1	HIP	−.9	.054
1991.7126	201.6	1.872	1	Hrt	−.4	.042
1991.7208	200.9	1.879	1	Hrt	−1.1	.049
1991.747	201.5	1.89	1	WSI	−.4	.060
1991.769	201.6	1.88	1	WSI	−.3	.050
1991.804	201.1	1.89	1	WSI	−.7	.059
1991.81	202.1	1.901	1	TYC	.3	.070
1991.815	201.7	1.89	1	WSI	−.1	.059
1991.8154	201.9	1.89	1	WSI	.1	.059
1991.826	201.4	1.89	1	WSI	−.4	.059
1991.845	201.3	1.88	1	WSI	−.4	.049
1991.878	200.7	1.86	1	WSI	−1.0	.028
1991.903	200.8	1.89	1	WSI	−.8	.058
1991.933	201.9	1.93	1	WSI	.3	.097
1991.941	202.2	1.88	1	WSI	.6	.047
1992.700	199.9	1.89	1	WSI	−.3	.046
1992.705	200.6	1.90	1	WSI	.5	.056
1992.708	200.0	1.89	1	WSI	−.1	.046
1992.714	200.	1.833	1	Sow	−.1	−.011
1992.719	199.	1.869	1	Sow	−1.1	.025
1992.7194	200.	1.903	1	Sow	−.1	.059
1992.728	199.	1.867	2	Sow	−1.1	.022
1992.752	200.7	1.89	1	WSI	.6	.045
1992.766	199.5	1.89	1	WSI	−.5	.045
1992.785	200.6	1.89	1	WSI	.6	.045
1992.812	199.8	1.91	1	WSI	−.2	.064

Table 2. (continued)

WDS 22288−0001 = STF 2909 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1992.823	200.3	1.91	1	WSI	.4	.064
1992.842	200.0	1.91	1	WSI	.1	.064
1992.877	199.7	1.92	1	WSI	−.1	.073
1993.697	197.6	1.91	1	WSI	−.7	.050
1993.809	197.0	1.90	1	WSI	−1.1	.038
1993.817	197.3	1.92	1	WSI	−.8	.058
1993.860	197.6	1.90	1	WSI	−.5	.037
1993.891	196.1	1.86	1	WSI	−1.9	−.003
1993.893	196.9	1.90	1	WSI	−1.1	.037
1993.915	196.3	1.88	1	WSI	−1.7	.016
1993.921	197.2	1.90	1	WSI	−.7	.036
1993.937	197.4	1.91	1	WSI	−.5	.046
1994.5249	197.5	1.986	1	Hor	.6	.112
1994.680	195.4	1.96	1	WSI	−1.2	.084
1994.781	195.7	1.94	1	WSI	−.7	.062
1994.824	195.4	1.90	1	WSI	−.9	.021
1994.860	195.5	1.90	1	WSI	−.8	.020
1994.863	195.4	1.91	1	WSI	−.9	.030
1995.526	194.2	1.92	2	WSI	−.9	.029
1995.529	194.3	1.91	1	WSI	−.8	.019
1995.643	194.2	1.93	1	WSI	−.7	.037
1995.649	195.7	1.90	1	WSI	.8	.006
1995.663	195.8	1.91	1	WSI	.9	.016
1995.682	195.4	1.91	1	WSI	.6	.016
1995.695	195.1	1.93	1	WSI	.3	.036
1995.739	194.7	1.91	1	WSI	−.0	.015
1995.742	194.7	1.91	1	WSI	−.0	.015
1995.750	195.0	1.91	1	WSI	.3	.015
1995.753	194.6	1.92	1	WSI	−.1	.025
1995.772	194.9	1.87	1	WSI	.2	−.026
1995.777	195.0	1.91	1	WSI	.3	.014
1995.799	195.1	1.87	1	WSI	.5	−.026
1995.810	195.4	1.88	1	WSI	.8	−.017
1995.9261	194.0	1.920	1	Hrt	−.4	.021
1996.651	193.2	1.94	1	WSI	.0	.028
1996.736	193.0	1.94	1	WSI	−.0	.026
1996.749	193.2	1.96	1	WSI	.2	.046
1996.8682	192.3	1.916	1	WSI	−.5	.000
1997.5179	192.2	1.902	1	Hor	.5	−.027
1997.669	191.4	1.89	1	WSI	−.1	−.042
1997.678	191.7	1.92	1	WSI	.3	−.012
1997.760	191.5	1.89	1	WSI	.2	−.044
1997.762	190.8	1.91	1	WSI	−.5	−.024
1997.765	191.1	1.91	1	WSI	−.2	−.024
1997.771	191.7	1.88	1	WSI	.4	−.054
1997.880	191.2	1.87	1	WSI	.1	−.066
1997.882	191.2	1.86	1	WSI	.1	−.076
1998.614	189.4	1.89	1	WSI	−.5	−.061
1998.644	190.0	1.89	1	WSI	.2	−.062

Table 2. (continued)

WDS 22288−0001 = STF 2909 AB

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1998.679	190.1	1.935	1	Sca	.3	−.017
1998.776	189.7	1.89	3	WSI	.1	−.064
1998.793	189.7	1.87	1	WSI	.1	−.085
1998.813	189.4	1.89	1	WSI	−.2	−.065
1998.830	189.8	1.89	2	WSI	.3	−.065
1998.865	189.8	1.81	1	WSI	.3	−.146
1998.874	189.4	1.84	1	WSI	−.1	−.116
1998.879	189.5	1.96	2	WSI	.0	.004
1998.882	189.5	1.91	7	WSI	.0	−.046
1998.892	189.9	1.91	5	WSI	.5	−.047
1998.893	189.7	1.88	4	WSI	.3	−.077
1998.895	189.3	1.92	5	WSI	−.1	−.037
1998.907	189.8	1.91	3	WSI	.4	−.047
1998.953	189.9	1.90	1	WSI	.6	−.058
1998.964	190.1	1.91	1	WSI	.8	−.048
1999.7169	187.6	1.94	2	WSI	−.5	−.034
1999.7255	188.2	1.919	1	Doc	.1	−.055
1999.7591	187.8	1.98	1	Hor	−.2	.005
1999.7648	188.0	1.95	1	Hor	−.0	−.025
1999.7648	187.9	1.94	1	Hor	−.1	−.035
1999.7728	188.1	1.95	1	Hor	.1	−.025
1999.7756	187.9	1.95	1	Hor	−.1	−.025
1999.8209	188.0	1.925	2	Msn	.1	−.051
1999.9284	187.3	1.94	3	WSI	−.5	−.039
2000.7510	186.6	1.89	2	WSI	.1	−.106
2001.6821	185.1	1.91	1	WSI	.1	−.107

WDS 22384−0754 = A 2695

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1913.70	117.5	0.22	3	A	14.9	−.057
1921.07	101.8	0.30	4	A	−4.0	−.013
1924.66	108.6	0.31	4	A	1.4	−.016
1936.827	111.0	0.27	1	Fin	−.3	−.080
1938.497	116.7	0.33	4	B	4.9	−.021
1944.84	111.2	0.30	3	Vbs	−2.6	−.050
1945.46	111.6	0.34	4	Vou	−2.4	−.009
1951.84	115.7	0.31	2	B	−.4	−.029
1959.	116.	0.3	–	IDS	−2.7	−.018
1975.749*	310.9	0.19	3	Wor	3.6	−.038
1977.78	136.4	0.25	3	hz	7.4	.036
1984.7065	135.5	0.143	1	McA	−1.4	−.015
1985.5151	137.6	0.138	1	McA	−.6	−.013
1985.8398	136.8	0.135	1	Hrt	−2.0	−.013
1990.9210	152.2	0.113	1	Hrt	.4	.010
1991.25	146.	0.099	1	HIP	−7.0	−.001
1991.7208	159.2	0.118	1	Hrt	4.3	.022
1995.7598	178.0	0.082	1	Hrt	−2.1	.016

Table 2. (continued)

WDS 23474−7118 = Fin 375 Aa

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1960.96	131.3	0.113	5	Fin	2.7	.003
1961.98	:138.8	:0.117	1	Fin	7.8	.005
1962.93	:124.0	:0.115	3	Fin	−9.2	.002
1962.90**	–	<0.123	1	Fin	(133.5	.113)
1963.898**	–	<0.114	1	Fin	(135.8	.115)
1964.932	136.6	0.123	3	Fin	−1.0	.006
1990.9238	178.3	0.181	1	Hrt	2.4	.014
1991.25	174.	0.131	1	Hip	−2.2	.037

WDS 23578+2508 = McA 76

t	$\theta°$	ρ''	n	Obs.	$\Delta\theta°$	$\Delta\rho''$
1980.7287	54.1	0.191	1	McA	3.6	.007
1983.9362**	–	<0.07	1	Bnu	(57.9	.174)
1984.8454**	–	<0.022	1	Bnu	(60.3	.165)
1984.9303**	–	<0.058	1	Bnu	(60.6	.164)
1988.6606	243.4	0.136	1	McA	−11.5	.015
1988.8981	250.	0.136	1	McA	− 6.2	.019
1993.9249	354.7	0.07	1	Hrt	30.8	.006
1995.9235	351.4	0.081	1	Hrt	1.8	.010

Table 3. Ephemerides.

	A 2145		BU 368 AB		STF 2909 AB		A 2695		FIN 375 Aa		McA 76	
t	$\theta°$	ρ''	$\theta°$	ρ''	$\theta°$	ρ''	$\theta°$	ρ''	$\theta°$	ρ''	$\theta°$	ρ''
2004.0	40.6	.118	160.3	.022	181.6	2.071	250.6	.079	188.5	.175	226.8	.140
2005.0	37.5	.123	123.1	.040	180.2	2.095	256.2	.086	189.5	.175	230.8	.140
2006.0	34.5	.127	111.3	.064	178.8	2.120	261.0	.093	190.4	.174	234.8	.137
2007.0	31.8	.130	106.0	.089	177.4	2.144	265.2	.100	191.4	.173	239.0	.132
2008.0	29.1	.133	103.0	.114	176.1	2.170	268.8	.106	192.3	.172	243.7	.126

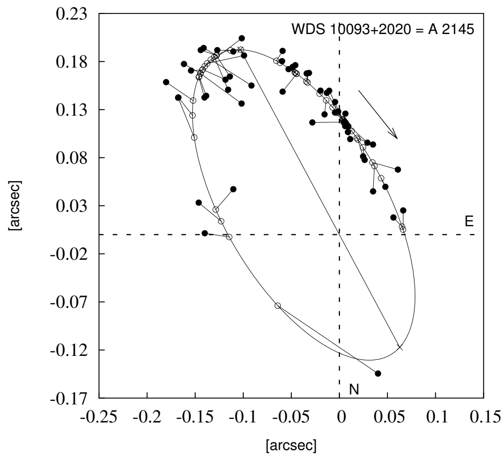

Fig. 1. *Orbit of A 2145.*

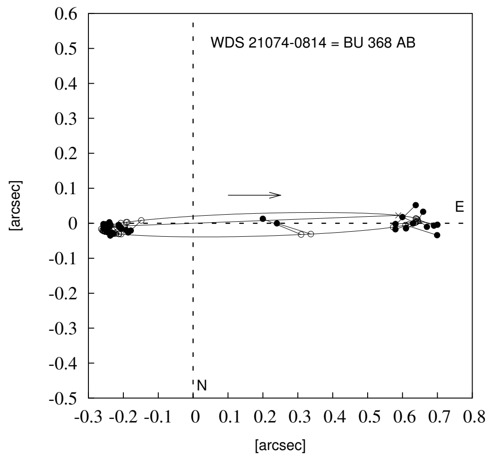

Fig. 2. *Orbit of BU 368 AB.*

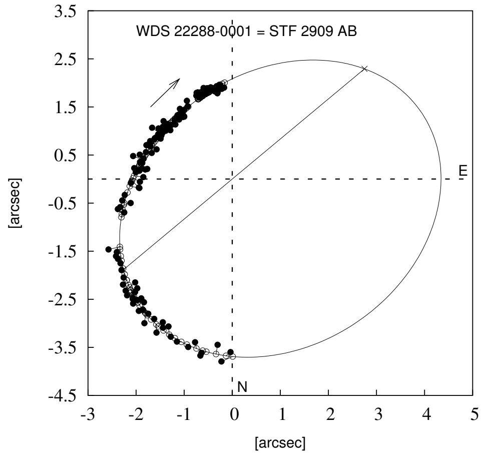

Fig. 3. *Orbit of A 2909 AB.*

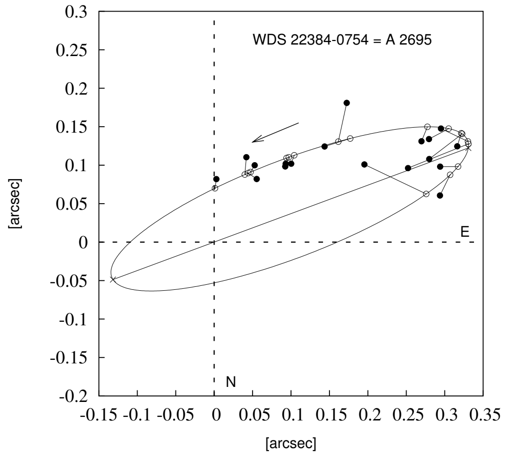

Fig. 4. *Orbit of A 2695.*

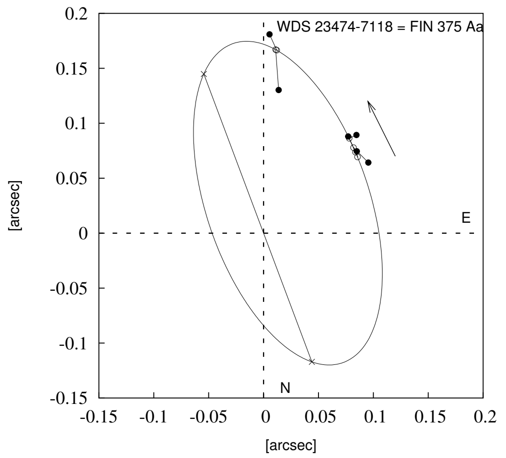

Fig. 5. *Orbit of FIN 375 Aa.*

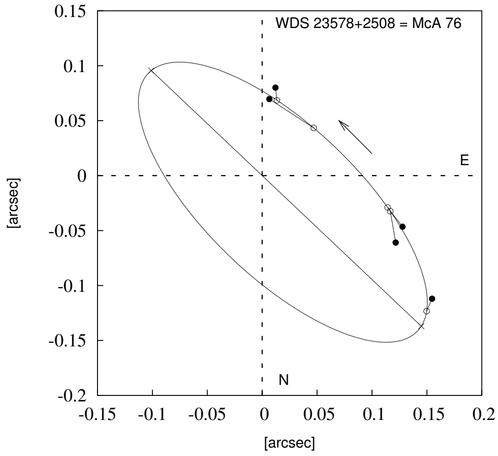

Fig. 6. *Orbit of McA 76.*

3. CONCLUSION

Our solutions offer in all cases an improvement of the previous orbits. The new orbits confirming Keplerian motion should draw attention of the observers.

In our opinion it will be very interesting to keep under study the evolution of a variable system McA 76, as well as of a system containing a giant or a subgiant.

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ОРБИТЕ 6 ДВОЈНИХ ЗВЕЗДА

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У раду су поново израчунате орбите за двојне звезде WDS 10093+2020 = A 2145, WDS 21074−0814 = BU 368 AB и WDS 22288−0001 = A 2909 AB због знатнијих одступања последњих посматрања од ефемериде. Такође, први пут су израчунати путањски елементи за двојне звезде WDS 22384−0754 = A 2695, WDS 23474−7118 = FIN 375 Aa и WDS 23578+2508 = McA 76.