Revista Mexicana de Astronomía y Astrofísica, **46**, 263–277 (2010)

ORBITAL ELEMENTS FOR EIGHT BINARIES. STUDY OF THE NATURE OF WIDE COMPONENTS. I

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Received 2010 March 25; accepted 2010 June 5

RESUMEN

Se calcularon nuevos parámetros orbitales y masas para ocho binarias. Las órbitas, en la mayoría de estas binarias, mostraron grandes residuos que aconsejaban obtener nuevos parámetros orbitales. Para determinar los parámetros orbitales iniciales se usó el método de Thiele-van den Bos modificado, para posteriormente usar el método de corrección diferencial de Heintz para obtener los parámetros orbitales finales. El método Thiele-van den Bos fue modificado para que un valor aproximado de la constante areal permitiera obtener buenos resultados. La naturaleza de las componentes distantes fue estudiada mediante fotometría $BVIJHK$ y datos cinemáticos y astrométricos. Se realizó una búsqueda de nuevas compañeras alrededor de las binarias estudiadas.

ABSTRACT

New orbital parameters and masses for eight binaries were determined. Most of these were noted as being in need of correction due to large residuals to the previous best orbit. A modified Thiele-van den Bos method was used to obtain initial orbits which were improved using the differential correction method of Heintz. The Thiele-van den Bos method was modified so that an approximate value of the areal constant allowed good results to be obtained. The nature of wide components was studied using $BVIJHK$ photometry, historical astrometry and kinematical data. A search for new unreported companions around the binaries was carried out.

Key Words: binaries: general — binaries: visual — instrumentation: high angular resolution — techniques: high angular resolution

1. INTRODUCTION

As a result of part of the work on visual double stars carried out by the Double Star Section of Liga Iberoamericana de Astronomía (LIADA) I present orbital parameters and other data (residuals, ephemerides, masses, parallaxes, apparent orbits, etc.) for eight visual binary systems: WDS03272+0944 (HDS 433), WDS 04070-1000 (HDS 521), WDS06345-1114 (HO 234), WDS09228-0950 AB (A 1342 AB), WDS12274-2843 (B 228), WDS18410+2450 (A 2988), WDS 21459+1153 AB (A 1223 AB) and WDS 23026+4245 AB (BU 1147 AB). For HDS 433 this is the first orbit published.

Initial orbits were calculated using the method of Thiele-van den Bos and were then improved using the differential correction method of Heintz (1978). Dynamical parallaxes were calculated using the Baize-Romani algorithm (1946). Bolometric corrections were taken from Allen's tables (1973). The nature of wide components was studied using $BVIJHK$ photometry, historical astrometry and kinematical data.

The astrophysical properties of the binaries were determined and discussed. All the orbits presented here, except that of HDS 521, have previously been announced in the Information Circulars of IAU Commission 26 (hereafter IAUDS). The orbital parameters listed in this paper are the final corrected versions and are slightly different from those announced in IAUDS.

2. METHOD OF ORBITAL CALCULATION

Before using any analytical method θ was corrected for precession and proper motion. θ and ρ

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TABLE 1

ORBITAL PARAMETERS, PARALLAXES AND RESIDUALS

Name	HDS 433	HDS 521	HO 234	A1342
WDS	03272+0944	04070-1000	06345-1114	09228-0950
ADS	...	...	5212	7334
HIP	16083	19206	31356	45999
Disc. date	1983.7134	1991.25	1888.64	1905.99
P [years]	51.923 ± 15.054	22.467 ± 1.812	374.882 ± 153.887	53.199 ± 0.193
T [BY]	2008.282 ± 0.502	1996.723 ± 0.230	1912.738 ± 1.133	1957.346 ± 0.572
e	0.568 ± 0.077	0.678 ± 0.044	0.345 ± 0.068	0.038 ± 0.037
a [$''$]	0.441 ± 0.027	0.221 ± 0.017	0.694 ± 0.048	0.165 ± 0.011
i [$^\circ$]	22.7 ± 5.1	123.1 ± 5.1	55.8 ± 3.0	67.1 ± 4.1
ω [$^\circ$]	3.0 ± 6.3	255.0 ± 4.6	179.3 ± 1.7	173.6 ± 4.6
Ω [$^\circ$]	112.1 ± 4.4	37.0 ± 3.1	35.9 ± 3.4	23.7 ± 3.6
Residuals:				
RMS(θ)[$^\circ$]	1.06	2.83	1.35	3.59
RMS(ρ) [$''$]	0.007	0.006	0.013	0.009
MA(θ)[$^\circ$]	0.77	0.57	0.92	1.86
MA(ρ)[$''$]	0.005	0.001	0.005	0.005
a^3/P^2	7.21370×10^{-5}	10.59844×10^{-5}	4.42712×10^{-6}	9.61969×10^{-6}

Name	B 228	A 2988	A 1223 AB	BU 1147
WDS	12274-2843	18410+2450	21459+1153	23026+4245
ADS	8555	11574	15300	16467
HIP	60775	91609	107461	113788
Disc. date	1926.77	1916.43	1905.53	1889.54
P [years]	44.483 ± 6.249	57.172 ± 1.168	44.046 ± 1.374	73.997 ± 0.509
T [BY]	1952.295 ± 1.251	1941.464 ± 1.520	1972.549 ± 1.175	1870.280 ± 0.595
e	0.666 ± 0.077	0.688 ± 0.101	0.324 ± 0.107	0.800 ± 0.056
a [$''$]	0.173 ± 0.107	0.102 ± 0.019	0.123 ± 0.018	0.225 ± 0.011
i [$^]circ$]	63.6 ± 12.0	154.7 ± 19.0	160.7 ± 40.4	21.7 ± 46.0
ω [$^\circ$]	164.9 ± 12.6	306.8 ± 11.5	154.1 ± 8.8	356.4 ± 3.0
Ω [$^\circ$]	137.8 ± 10.6	329.6 ± 9.7	14.8 ± 8.3	159.5 ± 2.0
Residuals:				
RMS(θ)[$^\circ$]	4.15	4.54	4.89	2.40
RMS(ρ) [$''$]	0.011	0.018	0.023	0.016
MA(θ)[$^\circ$]	2.73	3.27	3.71	1.48
MA(ρ)[$''$]	0.007	0.011	0.011	0.007
a^3/P^2	1.51253×10^{-5}	3.18298×10^{-6}	7.78058×10^{-6}	9.24564×10^{-6}

were plotted against time which allowed the detection of measures with important errors or quadrant problems. Measures with the largest errors were assigned zero weight.

Preliminary orbits were determined by the method of Thiele-van den Bos which was then improved by the author. Three base points and a crude value of the areal constant c are needed. A set of Keplerian orbits changing the initial value of the areal constant in an appropiate range (i.e., 50 percent of the initial value of c) was calculated. All the apparent orbits pass through the three given points. Only periodic orbits were considered. The step size and the search range for c are customizable by the user.

The orbit with minimum RMS residuals was retained. In the next iteration the search range and

TABLE 2

EPHEMERIDES

	03272+0944		04070-1000		06345-1114		09228-0950	
DATE	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)
2010.0	160.9	0.207	357.7	0.240	0.8	0.597	199.6	0.156
2011.0	182.5	0.231	278.6	0.169	1.4	0.604	202.5	0.158
2012.0	199.5	0.262	6.2	0.236	2.1	0.611	205.3	0.158
2013.0	212.7	0.296	294.6	0.179	2.8	0.617	208.2	0.156
2014.0	223.1	0.332	15.5	0.220	3.4	0.624	211.2	0.152
2015.0	231.5	0.367	308.8	0.191	4.0	0.630	214.5	0.146
2016.0	238.4	0.401	27.3	0.182	4.6	0.637	218.0	0.138
2017.0	244.3	0.434	321.2	0.204	5.2	0.643	222.0	0.129
2018.0	249.4	0.464	52.4	0.098	5.8	0.650	226.7	0.118
	12274-2843		18410+2450		21459+1153		23026+4245	
DATE	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)	θ (deg)	ρ (arcsec)
2010.0	254.8	0.036	236.7	0.113	312.5	0.105	13.3	0.207
2011.0	108.1	0.146	233.5	0.118	301.9	0.099	16.8	0.190
2012.0	127.1	0.265	230.5	0.123	289.9	0.093	20.8	0.172
2013.0	137.5	0.271	227.8	0.128	276.4	0.088	25.6	0.154
2014.0	156.2	0.138	225.2	0.132	261.6	0.084	31.6	0.135
2015.0	67.6	0.062	222.8	0.136	245.6	0.082	39.9	0.114
2016.0	121.1	0.226	220.6	0.140	229.2	0.082	53.8	0.089
2017.0	132.9	0.283	218.4	0.143	212.8	0.083	82.3	0.062
2018.0	144.8	0.220	216.4	0.146	197.1	0.085	137.7	0.046

the step size for the new value of c were reduced. The process was repeated until the result for two iterations did not show a significant difference. Two or three iterations were sufficient for most of the binaries. The difference between the initial estimate of c and the final value of c was less than 15 percent for most binaries.

If a set of Keplerian orbits showed a flat gradient for the RMS residuals then those orbits were rejected by comparing of the mass calculated by dynamical parameters, with that determined using spectral types.

The three base points have to be chosen carefully where the observational data seem most reliable considering instrumentation, data density, or critical arc coverage. I also tried to cover as much of the observed arc as possible. This may allow the area around a single observation to represent a base point without additional observational coverage.

Initial orbits determined by the Thiele-van den Boss method were improved using the Heintz differential correction method (1978). The initial weights for measures were assigned using a data weighting scheme based on Hartkopf, McAlister, & Franz (1989), Mason, Douglass, & Hartkopf (1999a), Seymour et al. (2002), Docobo & Ling (2003). The initial θ weights were 5 times larger than the ρ weights (Heintz 1978) for visual measures. After several iterations in the differential correction process the measures with residuals larger than 3σ were assigned zero weight. Later, the non-zero weight measures were reassigned following the work of Irwin, Yang, & Walker (1996).

3. RESULTS

Table 1 lists, for each binary, the date of its discovery, the final orbital elements, the root mean square (RMS) residuals and the mean absolute (MA) residuals. These are in both cases weighted averages calculated using the data-weighting scheme described in § 2.

TABLE 3

STELLAR DATA

Star		WDS			Present Work	Hipparcos			
WDS	HIP	m_A	m_B	Spectral Type	π (Dynamical) (arcsec)	H_{pA}	H_{pB}	π (Trigonometric) (arcsec)	$\sum M_\odot$
03272+0944	16083	3.74	7.55	B9Vn	...	3.74	7.55	0.01468 ± 0.00101	10.1 ± 6.4
04070-1000	19206	7.29	8.60	G0	0.0240	7.29	8.60	0.02400 ± 0.00092	1.55 ± 0.43
06345-1114	31356	7.73	9.05	F0	0.0093	8.22	8.31	0.01046 ± 0.00200	2.08 ± 2.11
09228-0950	45999	6.99	7.84	A3V	0.0069	6.99	7.84	0.00720 ± 0.00080	4.25 ± 1.66
12274-2843	60775	8.18	8.39	A9V	0.0095	8.18	8.39	0.00988 ± 0.00096	2.71 ± 5.15
18410+2450	91609	8.08	9.08	F0V	0.0042	8.08	9.08	0.00441 ± 0.00085	3.79 ± 3.07
21459+1153	107461	9.77	9.60	G0	0.0071	9.77	9.60	0.00723 ± 0.00135	2.54 ± 6.78
23026+4245	113788	5.19	7.70	A3Vn	0.0070	5.26	7.43	0.00774 ± 0.00051	4.49 ± 1.11

TABLE 4

STATISTICAL RESULTS

Star		Authors	RMS		MA	
WDS	Name		$\delta\theta(^\circ)$	$\delta\rho('')$	$\delta\theta(^\circ)$	$\delta\rho('')$
03272+0944	HDS 433	Rica (this paper)	1.06	0.007	0.77	0.005
04070-1000	HDS 521	Rica (this paper)	2.83	0.006	0.57	0.001
		Balega et al. (2006)	4.29	0.007	0.97	0.002
06345-1114	HO 234	Rica (this paper)	1.35	0.013	0.96	0.005
		Heintz (1979)	5.85	0.099	3.06	0.088
		Baize (1958)	45.38	0.177	39.44	0.170
09228-0950	A 1342 AB	Rica (this paper)	3.59	0.009	1.86	0.005
		Starikova (1981)	5.00	0.022	4.12	0.019
		Finsen (1976)	45.52	0.018	21.14	0.015
		Ekenberg (1945)	121.04	0.032	107.12	0.023
12274-2843	B 228	Rica (this paper)	4.15	0.011	2.73	0.007
		Heintz (1981)	42.89	0.069	18.72	0.058
18410+2450	A 2988	Rica (this paper)	4.54	0.018	3.27	0.011
		Starikova (1981)	5.69	0.033	4.40	0.028
		Baize (1955)	85.88	0.036	61.84	0.032
21459+1153	A 1223 AB	Rica (this paper)	4.89	0.023	3.71	0.011
		Baize (1955)	6.17	0.043	3.89	0.018
		Voronov (1934)	103.49	0.077	92.39	0.030

The a^3/P^2 values are also listed. Errors for the elements were calculated from the covariance matrix and the residuals of all observations.

Table 2 presents ephemerides for the period 2010–2018. Table 3 lists stellar data for binaries: WDS magnitudes in Columns (3) and (4) and WDS spectral types in Column (5); in Column (6), the dynamical parallaxes calculated using the orbital periods and semimajor axes obtained in this work; in Columns (7) and (8) the apparent magnitudes published in the *Hipparcos* and *Tycho* catalogs (ESA 1997), in Column (9) the corresponding trigonometric parallaxes (with their standard errors); and in Column (10) the total mass of the binary (with an estimated standard error), as calculated from the *Hipparcos* parallax. I summarize in Table 4 some statistical results concerning the orbits computed in this work and other orbits previously calculated. The RMS and MA residuals for θ and ρ also are listed.

Figures 1–8 show the new apparent orbits drawn together with the observational data; the x and y scales are arcseconds. The solid ellipse represents

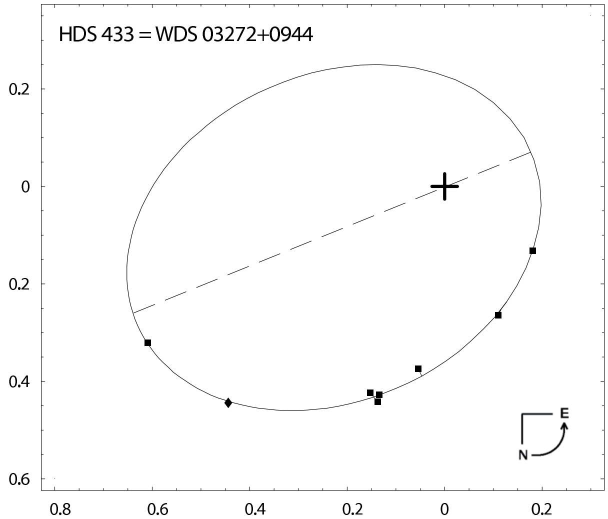

Fig. 1. Apparent orbit for HDS 433.

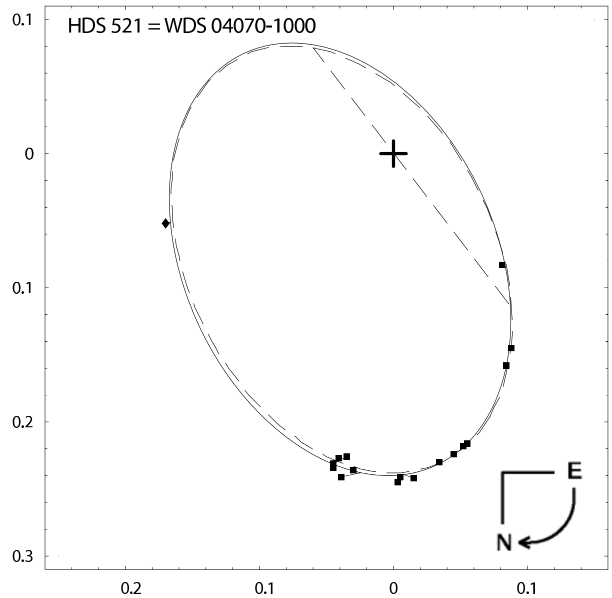

Fig. 2. Apparent orbit for HDS 521.

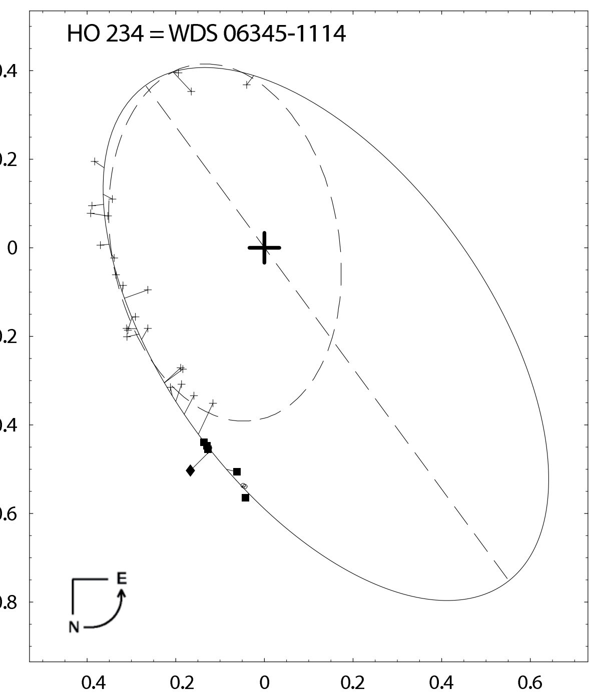

Fig. 3. Apparent orbit for HO 234.

the newly determined orbit, while the dashed ellipse represents previous orbit. The line passing through the origin is the line of nodes. Speckle measures are shown as filled squares, visual interferometric observations as open circles, visual measures as plus signs, and measures from the ESA *Hipparcos* instrument as filled diamonds. The rejected observations are shown as crosses. All measures were connected to their predicted positions on the new orbit by O-C lines.

The absolute magnitudes were calculated using the tables published by Zombeck (1990), which relate the spectral types to the absolute magnitudes. For red stars Henry et al.'s (1997) work was used, which relates optical-infrared colors to absolute magnitudes. I expect that most of these stars have near solar metallicity

4. NOTES FOR INDIVIDUAL SYSTEMS

Next, photometric, astrometric, spectroscopy and kinematical data were analysed. Spectral types and luminosity classes, masses and dynamical parallaxes were obtained. The dynamical parallaxes were calculated using the Baize-Romani method (1946).

The tables published in Montes et al. (2001) and Soderblom & Mayor (1993) were consulted to check the membership of the binaries included in this paper to young kinematic groups.

In the next paragraphs we adopt the grading scheme used in the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf & Mason 2001).

4.1. *WDS 03272+0944 = HDS 433*

Since the first measure in 1983.7134 (Mason et al. 1999b) 8 additional measures for this binary have been obtained, which cover an arc of about 116 degrees. The orbit presented in this work is the first orbit published.

HDS 433 (2 Tau, ξ Tau) is composed of stars of magnitudes 3.74 and 7.55 (ESA 1997). The main

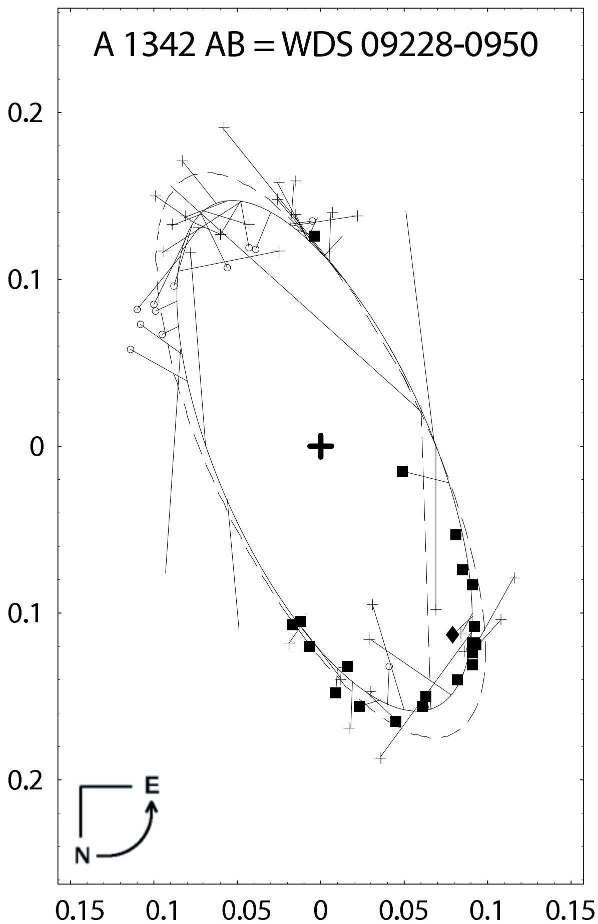

Fig. 4. Apparent orbit for A 1342 AB.

component is a short period triple spectroscopic system. There are several unresolved observations of this system. The high Δm undoubtedly is the reason for the many unsuccessful attempts at resolution (Mason et al. 1999b). The *Hipparcos* catalog lists a proper motion of $+53.61 \pm 1.02$ mas yr^{-1} in RA and -38.12 ± 1.01 mas yr^{-1} in DEC and a trigonometric parallax of 14.68 ± 1.01 mas, which corresponds to a distance of $68.11^{+5.1}_{-4.4}$ pc.

In the astronomical literature HDS 433 has been classified as a B9V star (Jaschek 1978; Kennedy 1983; Buscombe & Foster 1995). From the apparent magnitudes and the *Hipparcos* parallax, the absolute magnitude for the secondary is +3.4 which corresponds to a spectral type F5V.

Tokovinin (1997) obtained masses of 3.20 $M_\odot$ for Aa, 3.10 $M_\odot$ for Ab, 5.50 $M_\odot$ for Ac and 1.24 $M_\odot$ for B. The sum of the masses is 13.04 $M_\odot$. A total mass of 10.1 ± 6.4 $M_\odot$ was obtained, using the orbit of this work and the errors in the trigonometric parallax, P and a.

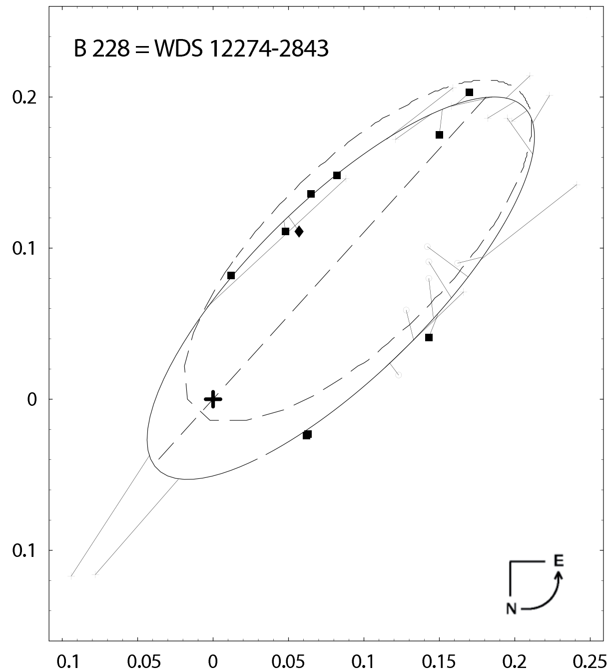

Fig. 5. Apparent orbit for B 228.

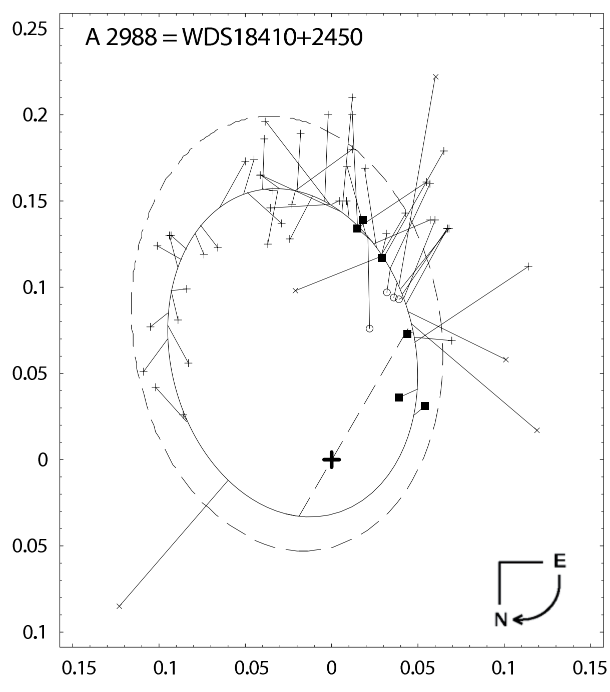

Fig. 6. Apparent orbit for A 2988.

Age and Stellar Population. Using the *Hipparcos* proper motion, parallax and a radial velocity of $+22.0 \pm 6.6$ km s^{-1} as given by Duflot, Figon, & Meyssonnier (1995), in this work a peculiar velocity

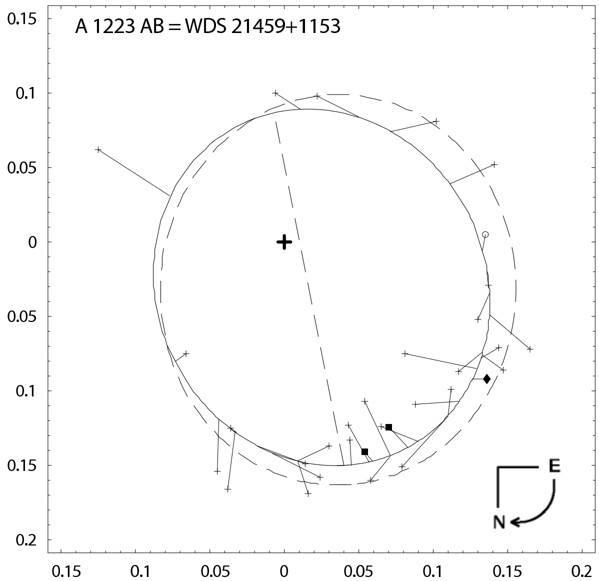

Fig. 7. Apparent orbit for A 1223 AB.

$(U,V,W) = (-5,\ +4,\ -30)$ km s^{-1} was calculated. According to Eggen's diagrams (1969a,b) this system is a member of the young galactic disk. A value of 0.19 for the kinematic age parameter of Grenon (1987), fG, was obtained in this work, corresponding to young-middle age thin disk stars of age $3-4$ Gyr. However, Strom, Wolff, & Dror (2005) determined an age of only $12-15$ Myr.

4.2. *WDS 04070-1000 = HDS 521*

The *Hipparcos* satellite discovered this system in 1991.25. HDS 521 has 18 measures which cover an arc of 295 degrees.

Balega et al. (2002) used the 6 m telescope at the Special Astrophysical Observatory in Celenchuk to obtain a measure in 1998. B. Mason et al. (in preparation) used a 4 m telescope to perform a measure in 2001. Balega et al. (2006) recently calculated the orbital parameters for this binary. Later, Horch et al. (2008) obtained 11 speckle measures in 2002 to 2004, which cover 12–13 degrees. HDS 521 is composed of stars of magnitudes 7.29 and 8.60 with a combined spectral type of G1/2V (Houk & Swift 1999).

The *Hipparcos* satellite determined a high proper motion of -127.56 ± 1.02 mas yr^{-1} in RA and -141.56 ± 1.05 mas yr^{-1} in DEC, and a trigonometric parallax of 24.00 ± 0.92 mas (which corresponds to a distance of $41.6^{+1.7}_{-1.4}$ pc).

Using the orbital parameters calculated in this work, masses were calculated taking into account

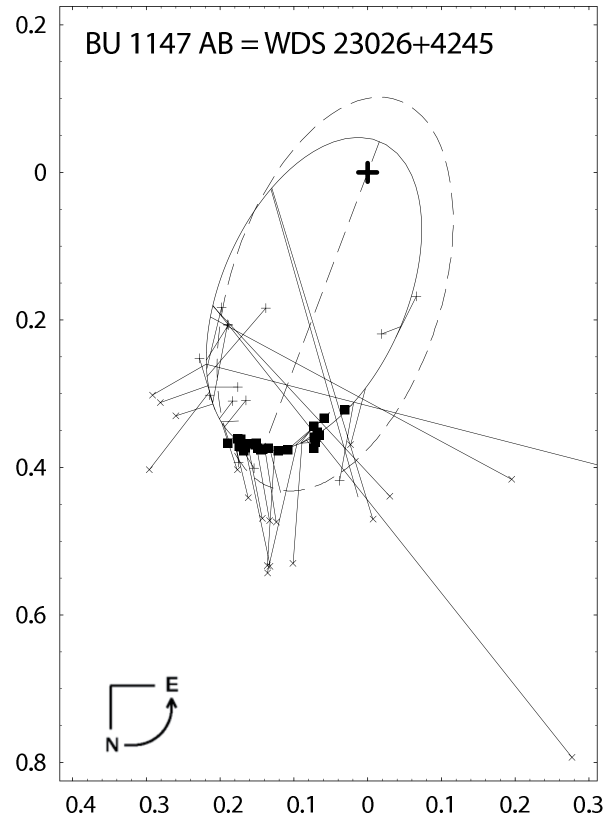

Fig. 8. Apparent orbit for BU 1147 AB.

the standard deviation for the *Hipparcos* trigonometric parallax, and for P and a. A total mass of $1.55 \pm 0.43\ M_{\odot}$ was obtained. The dynamical parallax turns out to be 24.00 mas, in excellent agree with the *Hipparcos* data.

Differential photometry from *Hipparcos* gives $\Delta m = +1.31$. The individual spectral types inferred from the differential photometry are F9V and G8V. In this work, individual spectral types of F7V and G6V were also obtained using $BVIJHK$ photometry and a combined proper motion.

From the spectral types, stellar masses of $1.14\ M_{\odot}$ and $0.84\ M_{\odot}$ were calculated using Allen's tables (1973). If the spectral types determined in this work are used, then stellar masses of $1.23\ M_{\odot}$ and $0.90\ M_{\odot}$ are obtained. So the sum of the masses ranges from $1.98\ M_{\odot}$ to $2.13\ M_{\odot}$, consistent within the error margins.

Absolute magnitudes of $+4.20$ and $+5.40$ were determined using the apparent magnitudes and the *Hipparcos* trigonometric parallax. These values correspond to F9V and G7/8V stars.

Age and Stellar Population. Nordstrom et al. (2004) obtained a metallicity [Fe/H] $= -0.27$, an age of 8.0 ± 1.2 Gyr, a radial velocity of +10.2 ± 3.3 km s^{-1} and a peculiar heliocentric velocity (U,V,W) = (+34, −2, −20) km s^{-1}. Nordstrom et al. (2004) determined that HDS 521 describes a galactic orbit with an excentricity of 0.13, a periastron of 7,700 pc and an apoastron of 9,360 pc.

According to Eggen's diagrams (1969a,b) HDS 521 is a member of the young Galactic disk. A value of 0.17 for Grenon's (1987) parameter fG was obtained in this work, corresponding to young-middle age thin disk stars of age 3 − 4 Gyr.

4.3. *WDS 06345-1114 = HO 234*

Hough (1890) discovered this binary in 1888.64 and it has 33 measures which cover about 170 degrees. Baize (1958) calculated the first orbit with a period of 169 years (a = 0.38″; e = 0.18) more than twice shorter that the orbit calculated in this work. Heintz (1979) calculated the next orbit which is a grade 4 orbit. At the same time of my publication in IAU Circ. Inf. of the orbit published in this work, Hartkopf, Mason, & Rafferty (2008) published new orbital parameters with residuals slightly smaller than those for the orbit presented in this work. Hartkopf et al. used a new measure not used in this work. HO 234 is composed by stars of 8.22 and 8.31 magnitudes (ESA 1997). *Tycho*-2 catalog proper motions are −27.4 mas yr^{-1} in RA and −1.5 mas yr^{-1} in DEC. The *Hipparcos* trigonometric parallax of 10.46 ± 2.00 mas corresponds to a distance of $95.6^{+22.6}_{-15.3}$ pc.

The orbit calculated in this work has a period more than two times larger and a major semiaxis about 60 percent greater than the previous orbit. A total mass of 2.08±2.11 $M_{\odot}$ was obtained. In the astronomical literature HO 234 has been classified as a F3V star (Buscombe 1998) and F2V (Houk & Swift 1999). In this work a combined spectral type of F4V (F4V+F5V) was obtained using $BVIJHK$ photometry and the combined proper motion. From the apparent magnitudes and the *Hipparcos* parallax, the absolute magnitudes for the components were determined, which correspond to spectral types F4/5V. Using the historical measures, the photometric difference is 0.13 magnitudes. Stellar masses of 1.39 and 1.35 $M_{\odot}$ were calculated using Allen's tables (1973). The sum of the masses is 2.74 $M_{\odot}$.

The dynamic parallax obtained, 9.3 mas, is in agreement with the *Hipparcos* parallax. Nordstrom et al. (2004) obtained a metallicity [Fe/H] = −0.30, and an age of $1.9^{+0.4}_{-0.3}$ Gyr. The projected rotational velocity is 20 km s^{-1} (Glebocki, Gnacinski, & Stawikowski 2000). However these data were not useful to estimate the age for the stellar system. The orbital elements have previously been announced in the Information IAUDS No. 162 (Rica 2007).

4.4. *WDS 09228-0950 = A 1342 AB*

This system is KU Hya, a magnetic αCVn variable star in which brightness changes of 0.05 magnitudes in a period of 33.97 days have been observed (Hensberge et al. 1981). Aitken (1929) discovered this binary in 1905.99 and it has 72 measures which cover two revolutions.

Ekenberg (1945) calculated the first orbit (P = 15.0 yr; e = 0.10; a = 0.166″). Finsen (1976) calculated another orbit with a period of 25.4 years (e = 0.962; a = 0.28″). Starikova (1981) also calculated an orbit, graded 2. Since then, 15 new measures have been made, covering about 161 degrees.

Using the historical measures listed in the WDS database, the photometric difference is 0.04 magnitudes. So the *Hipparcos* apparent magnitudes were not used for this system. A 1342 AB is composed of stars of 7.3 and 7.3 magnitudes (this work). According to the *Tycho*-2 catalog the proper motion is −28.8 mas yr^{-1} in RA and −16.0 mas yr^{-1} in DEC. The *Hipparcos* trigonometric parallax of 7.20± 0.80 mas corresponds to a distance of $138.9^{+17.4}_{-13.9}$ pc.

Using the orbital parameters, a total mass of 4.25 ± 1.66 $M_{\odot}$ was obtained. In the astronomical literature A 1342 AB has been classified as an A5 star (Cowley et al. 1969; Buscombe & Foster 1995), an A3V star (Abt 1981) and an F1 star (Abt & Morrell 1995). In this work, a combined spectral type of A5V was obtained using $BVIJHK$ photometry and a combined proper motion. From the apparent magnitudes and *Hipparcos* parallaxes the absolute magnitudes for the components were determined, which correspond to spectral types A3/4V.

Grenier et al. (1999) calculated a radial velocity of +19.6 ± 5.0 km s^{-1}.

Stellar masses of 2.07 and 2.05 $M_{\odot}$ were calculated from Allen's tables (1973) using the absolute magnitudes. The sum of the masses is 4.12 $M_{\odot}$. The dynamic parallax obtained is 6.9 mas, in agreement with the *Hipparcos* parallax.

Age and Stellar Population. In this work a peculiar velocity of (U,V,W) = (−15, −22, −6) km s^{-1} was calculated. According to Eggen's diagrams (1969a,b) A 1342 AB is a member of the young galactic disk. A value of 0.13 for Grenon's fG was obtained in this work, corresponding to young-middle age thin disk stars of age 3 − 4 Gyr.

4.5. *WDS 12274-2843 = B 228*

Van den Bos (1928) discovered this double in 1926.77. B 228 has 28 measures which cover about two revolutions. Van den Bos and Finsen obtained more than half of the historical measures.

The only existing orbit for B 228 was calculated by Heintz (1981) and it is of grade 4. Since then, 11 new measures have been made (9 of them were speckle measures, one measure is micrometrical, and the other measure was made by *Hipparcos*) covering about 326 degrees. B 228 is composed of stars of 8.18 and 8.39 magnitudes (ESA 1997). *Tycho*-2 determined a proper motion of -53.8 mas yr^{-1} in RA and -5.7 mas yr^{-1} in DEC. The *Hipparcos* trigonometric parallax of 9.88 ± 0.96 mas corresponds to a distance of $101.2^{+10.9}_{-9.0}$ pc.

The orbit calculated in this work is less excentric and more inclined than the previous orbit. The semimajor axis is larger by about 14 percent. A total mass of 2.71 ± 5.15 $M_\odot$ was obtained.

Cannon & Pickering (1918-1924) classified B 228 as an F0 star and Houk (1982) as an A9V star. In this work a combined spectral type of F3V was obtained using $BVIJHK$ photometry and a combined proper motion.

From *Tycho*-2 apparent magnitudes and *Hipparcos* parallaxes, the absolute magnitudes for the components were determined, which correspond to individual spectral types F3V and F4V.

Stellar masses of 1.45 and 1.38 $M_\odot$ were calculated using Allen's tables (1973). The sum of the masses is 2.83 $M_\odot$ is good agreement with the sum of masses obtained by the use of dynamical parameters.

The dynamic parallax obtained is 9.5 mas, in good agreement with the *Hipparcos* parallax.

4.6. *WDS 18410+2450 = A 2988*

Aitken (1918) discovered this system in 1916.43. A 2988 has 60 measures which cover nearly two revolutions.

Baize (1955) calculated an orbit with a dynamic parallax of 0.0074″. Starikova (1981) also calculated an orbit with a dynamic parallax of 0.006″. Since then, 27 new measures have been obtained (nearly half of the historic measures).

A 2988 is composed of stars of 8.08 and 9.08 magnitudes (ESA 1997). *Tycho*-2 lists a proper motion of $+1.9$ mas yr^{-1} in RA and $+8.5$ mas yr^{-1} in DEC. The *Hipparcos* trigonometric parallax of 4.41 ± 0.85 mas, corresponds to a distance of $226.8^{+54.1}_{-36.6}$ pc.

The orbit calculated in this work is more excentric and inclined than the previous one. The semimajor axis is smaller by about 22 percent. A total mass of 3.79 ± 3.07 $M_\odot$ was obtained.

In the astronomical literature A 2988 has been classified as an A5 star (Cannon & Pickering 1918–1924), an A7 star (Grenier et al. 1999), an A8V (Christy & Walker 1969) and an F0V star (Cowley & Cowley 1965; Kennedy 1983). In this work a combined spectral type of F1V was obtained using $BVIJHK$ photometry and a combined proper motion. From the apparent magnitudes and *Hipparcos* parallaxes the absolute magnitudes for the components were determined, which correspond to spectral types F0V.

Rufener (1981) determined that A 2988 is a Delta Scuti variable star. It is catalogued as NSV 24547. Grenier et al. (1999) calculated a radial velocity of -36.3 ± 7 km s^{-1}.

Using the historical measures listed in the WDS, the photometric difference is 0.0. *Hipparcos* obtained a difference in magnitude of 1.0. A more accurate value for the differential photometry is needed.

Assuming a zero photometric difference, stellar masses of 1.64 $M_\odot$ and 1.64 $M_\odot$ were calculated using Allen's tables (1973) and spectral types F1V for both components. The sum of the masses is 3.28 $M_\odot$.

The dynamic parallax obtained is 4.2 mas, in excellent agreement with the *Hipparcos* parallax. The orbital elements have previously been announced in the Information IAUDS No. 160 (Rica 2006b).

Age and Stellar Population. Bartkevicius & Gudas (2002) calculated a peculiar velocity (U,V,W) = ($-19.9, -16.9, -0.8$) km s^{-1} and classified it as a intermediate age thin disk star.

4.7. *WDS 21459+1153 = A 1223 AB*

Since Aitken (1906) discovered it in 1905.53, A 1223 AB has been measured on 32 occasions. These measures cover more than two revolutions. Tokovinin (1985) performed an interferometric measure and two speckle measures were made (Hartkopf et al. 2000; Scardia et al. 2000). *Hipparcos* obtained a measure in 1991.

Voronov (1934) calculated the first orbit (P = 23.9 yrs; e = 0.21; a = 0.12″). Another orbit was calculated by Baize (1955) and graded 4. Since then 13 measures have been made covering nearly a revolution.

A 1223 AB is composed of stars of 9.77 and 9.60 magnitudes (ESA 1997) with a combined spectral type of G0V (Kennedy 1983).

Tycho-2 (Høg et al. 2000) determined a proper motion of -83.4 mas yr^{-1} in RA and -85.6 mas yr^{-1}

in DEC. The *Hipparcos* trigonometric parallax of 7.23 ± 1.35 mas corresponds to a distance of $138.3^{+31.8}_{-21.8}$ pc.

Masses were calculated taking into account the standard deviation for the *Hipparcos* trigonometric parallax and the errors of P and a. A total mass of $2.54 \pm 6.78\ M_\odot$ was obtained.

Eggen (1969c) obtained a spectral type of G2V while Christy & Walker (1969) obtained G1V with individual spectral types of G0V and G2V. In this work, a spectral type of G3V was obtained using $BVIJHK$ photometry and a combined proper motion. From the apparent magnitudes and *Hipparcos* parallaxes the absolute magnitudes for the components were determined, which correspond to spectral types of F7/8V and F8/9V.

Differential photometry from *Hipparcos* yields −0.17. A mean differential photometry using the five last historical results from WDS catalog yields +0.14. From the spectral types of the literature, stellar masses of 1.09 and 1.09 $M_\odot$ were calculated using Allen's tables (1973). The sum of the masses is 2.18 $M_\odot$ in agreement, within errors, with the total mass obtained using orbital parameters.

The dynamic parallax is 7.1 mas in excellent agreement with the *Hipparcos* parallax. Individual masses of 1.13 and 1.12 $M_\odot$ were determined using the Baize-Romani method (1946).

The orbital elements have previously been announced in the Information IAUDS No. 159 (Rica 2006a).

Age and Stellar Population. Bartkevicius & Gudas (2002) obtained a peculiar velocity of (U,V,W) = (+73, −45, +24) km s^{-1}.

According to Eggen's diagrams (1969a,b) A 1223 AB is a member of the old Galactic disk. A value of 0.37 for fG was obtained in this work corresponding to old age thin disk stars, or to thick disk stars of age about 10 Gyr.

4.8. *WDS 23026+4245 = BU 1147 AB*

Since Burnham (1894) discovered it in 1889.54, BU 1147 AB (= 2 And = HD 217782 = BD+41 4665) it has collected 66 measures which cover nearly two revolutions. A previous orbit was calculated by Baize (1974) and graded 4. Since the previous orbit, 39 measures, many of which are speckle measurements, have been made, covering 26 degrees.

BU 1147 AB is composed of stars of 5.26 and 7.43 magnitudes (ESA 1997) with a combined spectral type of A0V (Kennedy 1983).

The *Tycho*-2 catalog (Høg et al. 2000) proper motion is $+58.9 \pm 1.0$ mas yr^{-1} in RA and $+6.3 \pm 1.0$ mas yr^{-1} in DEC. The *Hipparcos* trigonometric parallax (van Leeuwen 2007) of 7.74 ± 0.51 mas corresponds to a distance of $129.2^{+9.1}_{-8.0}$ pc.

The total stellar mass was calculated taking into account the standard deviation for the *Hipparcos* trigonometric parallax and the errors of the orbital parameters. A total mass of $4.49 \pm 1.11\ M_\odot$ was obtained.

According to different references, the combined spectral type is A0V (Palmer et al. 1968; Kennedy 1983; Bartkevicius & Lazauskaite 1997), A1V (Abt & Morrell 1995) or A3Vn (Cowley et al. 1969). Since in the literature the individual spectral types were not found, I determined them from the differential magnitude (+2.17 from *Hipparcos*) and the combined spectral type of Cowley et al. (1969) using the tables published by Christy & Walker (1969) and Edwards (1976). Spectral types of B8V/A2V and F1V/F4V were determined for the primary and secondary.

From *Hipparcos* apparent magnitudes and parallaxes, the absolute magnitudes, corrected for the reddening calculated in this paper ($E(B-V) = 0.06$) were determined (-0.48 ± 0.14 and $+1.49 \pm 0.14$). The primary component could be a subgiant star of an age of about 500 Myr and it has been suspected to be a spectroscopic binary but not confirmed. The absolute magnitude of the secondary is about 1.5 magnitudes brighter than that of an F1V/F4V star.

From the spectral types of the literature, stellar masses of 2.61 and 1.40 $M_\odot$ were calculated using Allen's tables (1973). The sum of the masses is 4.01 $M_\odot$ in agreement, within errors, with the total mass calculated using orbital parameters and the *Hipparcos* parallax.

The dynamic parallax is 7.0 mas. Individual masses of 3.32 and 1.87 $M_\odot$ were determined using the Baize-Romani method (1946).

The secondary component is catalogued as the suspected variable star NSV14396. Frolov (1970) included it in a list of Delta Scuti stars, although is not clear if the variable is the main or the secondary component.

Age and Stellar Population. Bartkevicius & Gudas (2002) obtained a peculiar velocity of (U,V,W) = (−13.94, −1.26, −7.44) km s^{-1}. According to Eggen's diagrams (1969a,b) BU 1147 AB is a member of the young Galactic disk. A value of 0.07 for fG corresponds to young-medium age thin disk stars about 3 − 4 Gyr old.

5. STUDY OF WIDE COMPANIONS

The astronomical literature was consulted in order to obtain photometric, astrometric and kinematic data. VizieR, Simbad (Wenger et al. 2003) and the "services abstract" tools were used from the website of Centre De Données Astronomiques de Strasbourg. Photometry in the B, V and I bands came from the *Hipparcos* (ESA 1997) and *Tycho*-2 catalogs (Høg et al. 2000). Infrared J, H and K photometry came from the Two Micron All Sky Catalogue (Cutri et al. 2000), hereafter 2MASS. The proper motions were taken from the *Tycho*-2 Catalogue. This catalog was chosen because the *Hipparcos* proper motions could be affected by Keplerian motion due to its smaller baseline. Historical astrometric data were kindly supplied by Mason. Spectral types and other astrophysical data were taken from other sources.

The details about the process to estimate spectral types and luminosity classes for the companions, the calculation of interstellar reddening, determination of the nature for the stellar systems, the expected semiaxis major and the orbital period were explained in detail in Rica (2008) and Benavides et al. (2010).

5.1. *The criterion of Halbwachs*

Several criteria were used to determine if the wide components are gravitationally bound. These criteria were commented in detail in Rica (2008) and Benavides et al. (2010). In this paper we use also the criterion of Halbwachs (1986) who presented a search of common proper motion systems among AGK 3 star. The selection of physical systems was based upon the ratio between the angular separation (ρ), and the proper motion (μ), which he called T. T is the time after which a system has covered on the sky a distance equal to ρ. Because of the inaccuracy in proper motion of the AGK 3 catalog, Halbwachs studied pairs with $\mu \geq +50$ mas yr^{-1} and listed all the pairs with $T < 1000$ years in a table, where optical pairs were estimated to be 1 percent.

5.2. *A 1223 C*

The component C is a star with a 13.5 magnitude (Rapaport et al. 2001) which was measured for the first time by Aitken (1906) in 1905 when the angular separation was 1.60″ (in direction of 349°) from the AB close pair. Since 1905 it has been measured on 10 occasions, last in 2000 from the 2MASS catalog when the angular separation was 11.87″ (in direction of 39.4°).

Using magnitude r from the Carlsberg Meridian Catalog Number 14 (CMC 2006, hereafter CMC14) and JHK from 2MASS, I determined the V magnitude for C using the following relation (John Greaves, private communication):

$$V = 0.6 \times (J - K) + r'_{\rm CMT} - 0.03\,. \qquad (1)$$

Greaves took a large number of V magnitudes from the catalog "$UBVRI$ photometry of faint field stars" (Skiff 2007),[3] and matched them against CMC14 plotting $V - r'_{\rm CMT}$ and $J - K_{\rm s}$. The expression (1) is only valid for $-0.2 < J - K < 1.2$ and $9 < r'_{\rm CMT} < 14$. The standard deviation for V calculated in this way is 0.06 magnitudes. A V magnitude of 13.32 was calculated for component C in agreement with Rapaport's value.

The Catalog of Rectilinear Elements (Hartkopf et al. 2006) lists a relative motion of C with respect to AB of $\Delta x = +87.9 \pm 0.7$ mas yr^{-1} and $\Delta y = +79.5 \pm 1.0$ mas yr^{-1}. The proper motion of C is not listed in the literature so I calculated it using the proper motion of AB and the relative motion of C: $\mu(\alpha) = +4.5 \pm 1.4$ mas yr^{-1} and $\mu(\delta) = -6.1 \pm 1.6$ mas yr^{-1}.

In this work a spectral type of F2 was obtained based on $VJHK$ photometry. No spectral type information was founded in literature.

According to the very different proper motions (much greater than 3σ) of C and AB, this component is not gravitationally bound to AB system and so it is an optical companion. This pair must be flagged with "U" code ("*Proper motion or other technique indicates that this pair is non-physical*") in the Note column of the WDS Index Catalog.

5.3. *RST 5568 C*

This is a star with 11.66 magnitude (average of historical photometries from WDS catalog) at about 2.0″ from A 1342 AB. It was measured first in 1938 by van den Bos (1938) when the angular separation was 1.88″ from the AB close pair. Since then, it has been measured 12 times, last in 1976 by Worley (1978) when the angular separation was 1.96″.

I calculated the relative motion of C with respect to AB: $\Delta x = -2.8 \pm 1.3$ mas yr^{-1} and $\Delta y = -0.8 \pm 1.3$ mas yr^{-1}. The baseline of the 12 measures used was only 38 years. The proper motion of C was not listed in the literature so we calculated it using the proper motion of AB and the relative motion: $\mu(\alpha) = -31.6 \pm 2.4$ mas yr^{-1} and $\mu(\delta) = -16.8 \pm 2.5$ mas yr^{-1}.

No spectral type was found in the literature and I did not estimate it due to the lack of photometric and astrometric data. If this wide companion were gravitationally bound to AB then it would be a K2V star.

In order to determine the nature of the wide C component, two tests, based on probability theory were used. Using the work of Ciardullo et al. (1999)

[3] `http://cdsarc.u-strasbg.fr/viz-bin/Cat?II/277`.

the probability P that a star of 11.66 magnitude could be located by chance at a distance of 1.9″ from another star is 0.003 percent. In a list of optical pairs studied by LIADA, no optical double was found with $P < 0.09$, so component C is likely bound to the AB pair.

Grocheva & Kiselev (1998) propose to use the real distribution of proper motions for estimating P. In this work if $P < 0.01$ the pair is considered physical. The value of P for RST 5568 AB-C is 0.002, and so the component C is surely bound to the AB close pair.

Based on a normal distribution there is a probability of 55 percent that RST 5568 AB-C is a common proper motion pair. The parameter T of Halbwachs is 56 years and so this system is likely be physical according to this criterion.

I calculated a hypotetical parallax, $\pi_{\rm hyp}$, for the stellar system of 0.0062 mas (160.2 pc) in good agreement with the *Hipparcos* parallax of 0.0072 ± 0.0008 mas ($138.9^{+17.4}_{-13.9}$ pc). So the C component is likely bound to the AB close binary.

The expected semimajor axis would be 260 UA and the orbital period $\sim 1,900$ yrs (assuming a circular and face-on orbit). The expected semimajor axis was calculated using the expression obtained by Fischer & Marcy (1992) The arc covered by this component is only 2.7 degrees. If we take into account this angular motion this binary completes a orbit in about $\sim 5,000$ yrs.

5.4. *BU 1147 C*

The component C was added to the system BU 1147 AB in 1911 by Burnham (1913) when he observed a star of 13.6 magnitude at 90.55″ from the close pair, in direction 191.6°. Since 1911 it has been measured only 4 times, last in 1998 (195.1° and 91.53″, from 2MASS).

In order to obtain a modern estimate for the magnitude of C, photographic catalogs were used. The photometric data of the Guide Star Catalogue 1.2 (hereafter GSC) was calibrated, using *Tycho*-2 stars for the region of the sky where the component C is located. In this part of the sky, GSC photometry is 0.15 magnitude brighter than the V band. A magnitude $V = 13.17 \pm 0.16$ was calculated. From B and R photometric data of the USNO-B1.0 catalog, a value of $V = 13.35 \pm 0.30$ was obtained using the expression

$$V = B_j - 0.46 \times (B_j - R_f)\,, \qquad (2)$$

cited in Lépine, Rich, & Shara (2005). From $B1$ and $R1$ photometry of USNO-B1.0 a magnitude $V = 13.0 \pm 0.5$ was obtained. In this case I used the expression determined by Greaves (2008),[4]

$$V = 0.444 \times B1 + 0.556 \times R1\,. \qquad (3)$$

A weighted mean gave a $V = 13.19 \pm 0.21$.

No spectral type information was found in the literature. From the V magnitude and the J, H and K magnitudes listed in 2MASS, I determined a spectral type of K2-4. A giant nature was rejected because then the tangential velocity would be about 280 km s^{-1} and this is an unlikely value. So I conclude that the C component is a K3V dwarf at about 175 pc. I estimated an interstellar reddening of 0.08 for the $B - V$ color. The spectral type of K3V is corrected for this effect.

The proper motion of C listed in the UCAC-2 catalog is $\mu(\alpha) = -5.3 \pm 5.6$ mas yr^{-1} and $\mu(\delta) = -5.1 \pm 5.6$ mas yr^{-1}. The USNO-B1.0 catalog lists $\mu(\alpha) = -6 \pm 1$ mas yr^{-1} and $\mu(\delta) = -4 \pm 2$ mas yr^{-1}.

Using historical measures, a weighted linear fit was performed to calculate a relative motion of C with respect to AB of $\Delta x = -70.7 \pm 2.7$ mas yr^{-1} and $\Delta y = -2.9 \pm 2.3$ mas yr^{-1}. The baseline of the 4 measures used was 87 years. From the proper motion of AB and relative motion of C, I calculated a proper motion $\mu(\alpha) = -11.8 \pm 2.9$ mas yr^{-1} and $\mu(\delta) = -9.2 \pm 2.5$ mas yr^{-1} for C.

In view of the very different proper motions (much greater than 3σ) of C and AB, this component is not gravitationally bound to the AB system and so it is an optical companion. This pair must be flagged with "U" code (*"Proper motion or other technique indicates that this pair is non-physical."*) in the Note column of the WDS Index Catalog.

5.5. *LYS 25 D*

The component D was added to the system BU 1147 AB in 1984 by Louys (1987) when he took a photograph with an astrograph and observed a star of 12.1 magnitude (inferred from the differential magnitude obtained by Louys) at 142.79″ from the close pair, in direction 282.7°. Three more measures were added to WDS from the Washington Fundamental Catalog (WFC) and 2MASS. The most recent measure has an epoch of 1998.78 (282.9° and 142.48″).

In order to obtain a more accurate estimate for the magnitude of D, the photometric data from the GSC catalog were calibrated using *Tycho*-2 stars, for the region of the sky where component D is located.

[4]http://www.aerith.net/astro/color_conversion.html.

In this part of the sky, GSC photometry is 0.15 magnitude brighter than V band and thus a magnitude $V = 10.68 \pm 0.16$ was calculated.

From the magnitude r from CMC14 and JHK from 2MASS, I determined the V magnitude for D using the relation of John Greaves (private communication) commented in this work for A 1223 C. A V magnitude of 10.87 ± 0.06 was calculated for component D.

The *TASS Mark IV Photometric Survey of the Northern Sky* (Droege et al. 2006) lists 30 photometric points in the V and I bands for component D with mean magnitudes $V = 10.97 \pm 0.21$ and $I = 9.57 \pm 0.26$. From the three values for V, a weighted mean gave $V = 10.85 \pm 0.08$.

No spectral type information was found in the literature. From the V and I magnitudes from TASS and the J, H and K magnitudes listed in 2MASS (in addition to kinematic data), I determined that component D is a K1III giant located at a distance of about 950 pc. This spectral type was corrected for the reddening ($E(B-V) = 0.19$) which was calculated in this work.

The TASS catalog lists a Welch-Stetson (Welch & Stetson 1993, hereafter WS) variability index of 40.28. The WS index is a normalized measure of the degree of correlation of V-band and I-band variations from their mean values. The variability index will be close to zero for stars with random variations which are independent in each passband, or stars which vary by less than the uncertainty of each measurement. It will be a large (greater than 2 or 3) positive value for stars which really do change significantly in brightness. Nothing is listed in *The International Variable Star Index (VSX)* so component D is likely to be an uncatalogued variable star.

The proper motion of D listed in the UCAC-2 catalog is $\mu(\alpha) = +6.8 \pm 1.0$ mas yr^{-1} and $\mu(\delta) = -1.4 \pm 0.8$ mas yr^{-1}.

Tycho-2 lists for the close AB pair a proper motion of $\mu(\alpha) = +58.9 \pm 1.0$ mas yr^{-1} and $\mu(\delta) = -6.3 \pm 1.0$ mas yr^{-1}. In view of the very different proper motions (much greater than 3σ) D is not gravitationally bound to the AB system and so it is an optical companion. This pair must be flagged with "U" code (*"Proper motion or other technique indicates that this pair is non-physical."*) in the Note column of the WDS Index Catalog.

6. SEARCH FOR NEW BOUND COMPANIONS

SIMBAD and VizieR tools were used to find uncatalogued bound companions consulting astrometric catalogs and photographics plates. First I searched for common proper motion companions. For nearby stars I searched for bound companions by plotting the neighbour stars in a color-magnitude diagram where apparent 2MASS $J-K$ and K data are plotted. A dwarf sequence at the distance of the target was also plotted. So dwarf companion candidates must be located on or near this dwarf sequence. Subdwarf or white dwarf companions will not be detected unless we use reduced proper motion diagrams. Giant companions will be bright enough to be detected and they will be located well above the dwarf sequence.

The expression of Abt (1988) which relates stellar masses of the primary with the maximum projected separation (in AU) was used to define the sky region to search. I selected companion candidates consulting 2MASS where only stars located within the search region and with a $S/N > 10$ were selected.

6.1. *Two Stars in the Vicinity of HDS 433*

In the search for uncatalogued companions I found two red dwarfs with high proper motion. Although these two stars are not bound to HDS 433 AB I studied their astrophysical properties. At coordinates AR = $03^h\,26^m\,59.66^s$ and DEC = $+9^\circ\,49'\,04''$ I found an M1.5V dwarf of magnitude $V = 15.36$ (from the catalog GSC-2.3) located at 125 pc. Using astrometry from USNO-A2.0 and 2MASS for the epochs 1949.882 and 1999.935 I calculated a proper motion $\mu(\alpha) = +16$ mas yr^{-1} and $\mu(\delta) = +94$ mas yr^{-1}. At coordinates AR = $03^h\,27^m\,40.17^s$ and DEC = $+09^\circ\,44'\,58''$ I found a M3V dwarf of magnitude $V = 14.84$ (from the catalog GSC-2.3) located at 46 pc. The USNO-B1.0 catalog lists a proper motion $\mu(\alpha) = +44 \pm 1$ mas yr^{-1} and $\mu(\delta) = -112 \pm 2$ mas yr^{-1}.

7. CONCLUSIONS

I have presented the first orbital solution for HDS 433 (8 measures covering 116 degrees) and updated orbital solutions for 7 binaries in addition to the masses.

Data from the literature were consulted and an astrophysical study was carried out. The B9V primary component of HDS 433 is a short period triple spectroscopic system. The sum of the masses for this young stellar system is 13.4 $M_\odot$. Strom et al. (2005) determined an age of only $12-15$ Myr.

A 1342 AB is the magnetic α CVn variable star cataloged as KU Hya while A 2988 is a Delta Scuti cataloged as NSV 24547.

Wide components were studied astrophysically. For A 1223 C, a value for the V magnitude of 13.32

was obtained. The proper motion and spectral type (F2) of C were determined for the first time. Based in the large difference in the proper motions, the component C is not bound to AB close binary.

RST 5568 C, the wide component of A 1342 AB, has not been resolved since 1976. The relative motion of C with respect AB was calculated. The proper motion of C was determined for the first time. According to the same tests, I concluded that C is likely to be bound to the AB close binary. The orbital period ranges from 1900 − 5000 years.

I searched for new bound companions to the close binaries. No new companion was detected. However, two uncatalogued red dwarfs with high proper motion were discovered.

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