

Double Star Observations with a 150mm Refractor in 2014

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Abstract: In the following article, 166 observations of 84 doubles made with a 150mm refractor in 2014 are presented. Residuals were calculated for selected pairs.

For all observations in 2014, a 150 mm folded refractor with filter 11 (yellow – green) was used. Cameras used were the Imaging Source DMK 21 and the Phillips SPC 900 NC (NC in Table 1). As in previous years, teleconverters 1.4 (TK1,4 in Table 1) and 2x (TK2 in Table 1) were used for pairs with smaller separations. Wider pairs were observed at direct focus (f in Table 1). The observing technique was the same as described in Maiwald (2013) and Maiwald (2014).

The image scales with the DMK 21 are:

f: 0.384 a.s. per pixel

TK 1.4: 0.297322 a.s. per pixel

TK 2: 0.19876 a.s. per pixel

For the SPC 900 NC with TK2, the image scale was determined to be 0.2091 a.s. per pixel.

For some of the measured pairs, weighted averages were calculated and compared with the ephemeris. Calculation was done with *Binary Star Calculator* (Workman, 2013) using data from the “Sixth Catalog of Orbits of Visual Binary Stars”. The residuals are listed in Table 2.

As exemplified by the measurements of STF 73, STF 1196 AB, and STF 1338 (see remarks 1, 4, and 5 to Table 2 and Maiwald, 2014, p. 191), the error in θ for small distances can be rather large. A detailed discussion of the errors in double star measurements with *Reduc* can be found in Napier–Munn and Jenkinson (2014).

Acknowledgements

This paper made extensive use of the Washington Double Star Catalog and the Sixth Catalog of Orbits of Visual Binary Stars, both maintained at the U.S. Naval Observatory. Noncommercial software used was: *Binary Star Calculator* by Brian Workman; *Reduc 3.88* by Florent Losse, *Registax 4* by Cor Berrevoets and *Sharp-Cap* by Robin Glover.

References

- Alzner, Andreas, "Micrometer Measurements from 2006.21 to 2008.12", The Webb Society Double Star Section Circular No. 16, 2008, 7 - 15.
<http://www.webbdeepsky.com/>
- Argyle, Bob, "Micrometer measurements from 2006.0 to 2007.0", The Webb Society Double Star Section Circular No. 15, 2007, 1 – 6.
<http://www.webbdeepsky.com/>
- Argyle, Bob, "Micrometer measures of double stars in 2012", The Webb Society Double Star Section Circular No. 21, 2013, 1 – 4.
<http://www.webbdeepsky.com/>
- Argyle, Bob, "Micrometer measures of double stars in 2014", The Webb Society Double Star Section Circular No. 22, 2014, 1 – 4.
<http://www.webbdeepsky.com/>

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Table 1. Double star observations in 2014

Designation	WDS ident	θ	ρ	Date	No	Name	Notes
STF 60AB	00491+5749	324.3	13.25	2014.751	43	η Cas	TK2; NC
		324	12.78	2014.757	35		TK2
		324.3	12.9	2014.784	26		TK2
		324.3	12.78	2014.834	32		TK2
STF 73AB	00550+2338	326.3	1.1	2014.836	41	36 And	TK2
		327.5	1.08	2014.861	66		TK2
		328.9	0.96	2014.869	82		TK2
H 5 12AB	01579+2336	47.5	37.41	2014.007	44	λ Ari	TK1, 4
STF 262AB	02291+6724	229.7	2.67	2014.773	35	ι Cas	TK2
		228.6	2.69	2014.784	41		TK2
STF 262AC	02291+6724	115.5	6.99	2014.773	32	ι Cas	TK2
		115.9	7.02	2014.784	31		TK2
STF 299	02433+0314	298.2	2.04	2014.910	98	γ Cet	TK2
		299	1.91	2014.954	127		TK2
STF 559	04335+1801	277.6	2.99	2014.157	31		TK2
		277.2	3.11	2014.165	27		TK1, 4
STF 572AB	04385+2656	8.6	4.35	2014.097	36		TK1, 4
STF 616	04593+3753	4.6	4.75	2014.061	36	ω Aur	TK1, 4
STF 644AB	05103+3718	222.6	1.47	2014.012	25		TK1, 4
STF 653AC	05154+3421	224.6	14.23	2014.012	39	14 Aur	TK1, 4
STF 698AB	05252+3451	347.2	31.26	2014.968	29		f
STF 716AB	05293+2509	208.9	4.77	2014.081	36	118 Tau	TK1, 4
		208.7	4.76	2014.097	37		TK1, 4
STF 742	05364+2200	273.8	4.18	2014.097	34		TK1, 4
		272.7	3.94	2014.157	18		TK2
STF 845	06116+4843	358.3	7.56	2014.061	36	41 Aur	TK1, 4
STF 958AB	06482+5542	256.6	4.55	2014.226	16		TK1, 4
STF 982AB	06546+1311	143.2	7.38	2014.13	41	38 Gem	TK1, 4
		143.5	7.33	2014.144	35		TK1, 4
STF1062AB	07229+5517	315.8	14.97	2014.226	47	19 Lyn	TK1, 4
STF1083	07256+2030	45.5	6.76	2014.13	32		TK1, 4
STF1110AB	07346+3153	55.2	5.03	2014.13	36	α Gem	TK1, 4
		55	5.02	2014.144	45		TK1, 4
		55.2	5	2014.152	39		TK1, 4
STF1196AB	08122+1739	25	1.06	2014.168	39	ζ Cnc	TK2
		24	1.08	2014.171	53		TK2
		25.7	1.05	2014.176	38		TK2
		22.1	1.1	2014.179	38		TK2
STF1196AC	08122+1739	62.6	6.29	2014.168	42	ζ Cnc	TK2
		62.7	6.28	2014.171	72		TK2
		62.6	6.27	2014.176	38		TK2
		62.6	6.26	2014.179	32		TK2
STF1223	08268+2656	218.4	5.24	2014.179	31	Φ^2 Cnc	f
STF1268	08467+2846	307.6	30.55	2014.168	36	ι Cnc	f
STF1282	08508+3504	279.9	3.55	2014.223	25		TK1, 4
STF1291	08542+3035	310.1	1.46	2014.176	32	57 Cnc	TK2
		312.4	1.45	2014.179	28		TK2
STF1333	09184+3522	50.4	1.88	2014.231	30		TK2
		50	1.86	2014.291	11		TK2

Table 1 continues on the next page.

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Table 1 (continued). Double star observations in 2014

Designation	WDS ident	θ	ρ	Date	No	Name	Notes
STF1334AB	09188+3648	223.8 223.6	2.52 2.54	2014.231 2014.291	37 39		TK2 TK2
STF1338AB	09219+3811	310.5 308.2 309.9 306.7 309	1 1.07 1.1 1.06 1.05	2014.226 2014.231 2014.283 2014.291 2014.338	27 43 11 41 44		TK2 TK2 TK2 TK2 TK2
STF1424AB	10200+1950	127.1 125.8 126.1	4.8 4.79 4.72	2014.223 2014.239 2014.242	30 35 78	γ Leo	TK1,4 TK1,4 TK1,4
STF1487	10556+2445	112.3	6.62	2014.25	45	54 Leo	TK1,4
STFA 19	11279+0251	181.7	88.49	2014.3	16	τ Leo	f
STF1523AB	11182+3132	179.3 179.3	1.69 1.68	2014.365 2014.376	82 38	ξ Uma	TK2 TK2
STF1670AB	12417-0127	8.6 7.5 6.7	2.08 2.07 2.07	2014.338 2014.365 2014.373	36 47 62	γ Vir	TK2 TK2 TK2
STT 261	13120+3205	337.8 337.6	2.56 2.53	2014.382 2014.393	36 33		TK2 TK2
STF1768AB	13375+3618	95.2 95.6 95.2	1.7 1.67 1.67	2014.379 2014.382 2014.393	46 42 53	25 CVn	TK2 TK2 TK2
STF1864AB	14407+1625	111.2 111.1	5.31 5.34	2014.412 2014.417	37 43	π Boo	TK2 TK2
STF1877AB	14450+2704	343.1 343.4	2.76 2.9	2014.42 2014.428	57 28	ε Boo	TK2 TK2
STF1888AB	14514+1906	303.1 303.7	5.59 5.58	2014.395 2014.412	43 43	ξ Boo	TK2 TK2
STT 288	14534+1542	159.1 159.7	1 0.98	2014.412 2014.417	36 43		TK2 TK2
STF1909	15038+4739	65.7 66.2 65.4 64.9	1.04 1.01 1.03 1.11	2014.393 2014.395 2014.412 2014.42	84 60 32 77	44 Boo	TK2 TK2 TK2 TK2
STF1919	15127+1917	10.5	23.22	2014.445	41		f
STF1932AB	15183+2650	264.1 264	1.59 1.56	2014.431 2014.437	26 25		TK2 TK2
STF1938BC	15245+3723	4.4 3.9	2.18 2.17	2014.42 2014.428	44 45	μ Boo	TK2 TK2
STF2032AB	16147+3352	238.1 238.3	6.98 6.96	2014.431 2014.437	34 36	σ CrB	TK2 TK2
STF2054AB	16238+6142	350.7 350.1	0.92 1.01	2014.448 2014.456	80 92		TK2
STF2118AB	16564+6502	64.6 66.5	0.94 0.91	2014.475 2014.478	24 81	20 Dra	TK2
STF2130AB	17053+5428	5.7 3.8 4.1 3.8	2.41 2.43 2.44 2.42	2014.475 2014.478 2014.483 2014.486	65 60 28 69	μ Dra	TK2
STF2140	17146+1423	103.6 103.2	4.64 4.61	2014.500 2014.505	44 38	α Her	TK2
STF2161AB	17237+3709	320.4 320.2	3.95 3.94	2014.500 2014.505	44 32	ρ Her	TK2

Table 1 concludes on the next page.

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Table 1 (conclusion). Double star observations in 2014

Designation	WDS ident	θ	ρ	Date	No	Name	Notes
STFA 34AB	17346+0935	190.2	41.23	2014.546	42	53 Oph	f
STF2194AB	17411+2431	6.8	16.26	2014.546	36		f
STF2272AB	18055+0230	126.4 126.4	6.04 6.09	2014.535 2014.541	72 73	70 Oph	TK2
STF2276AB	18057+1200	265.7	6.94	2014.56	39		TK1, 4
STF2289	18101+1629	224.2 223.6	1.19 1.2	2014.500 2014.505	43 52		TK2
STT 358AB	18359+1659	149.1 148.9	1.6 1.59	2014.541 2014.543	61 29		TK2
STF2382AB	18443+3940	347.5 346.8	2.25 2.21	2014.464 2014.483	38 41	ϵ Lyr	TK2
STF2383CD	18443+3940	76.2 77	2.35 2.33	2014.464 2014.483	37 41	5 Lyr	TK2
STFA 39AB	18501+3332	148.3 148.3	45.8 45.72	2014.543 2014.557	36 26	β Lyr	f
STF2404	18508+1059	181.9	3.56	2014.56	46		TK1, 4
STTA178	19153+1505	266.9	89.84	2014.565	37		f
STTA182AB	19268+5009	297	73.22	2014.557	37		f
STT 384AB	19438+3819	193.5 195.5 198	1 0.94 1.07	2014.568 2014.582 2014.601	33 30 35		TK2 TK2 TK2
STF2579AB	19450+4508	220 217.9 217.5	2.6 2.64 2.63	2014.568 2014.582 2014.601	57 67 65	δ Cyg	TK2 TK2 TK2
STF2583AB	1948+1149	101.5 101.3	1.3 1.37	2014.535 2014.543	39 39	π Aql	TK2
STF2628	20078+0924	338.4	2.96	2014.565	44		TK1, 4
STFA 50AC	20136+4644	172.7 172.7	106.86 106.81	2014.557 2014.587	40 33	31 Cyg	f
STF2758AB	21069+3845	152.1 152.2	31.58 31.58	2014.587 2014.645	44 44	61 Cyg	f
STF2822AB	21441+2845	317.4 317.9	1.61 1.58	2014.645 2014.647	36 42	μ Cyg	TK2
STF2822AD	21441+2845	43.4	197.09	2014.647	22	μ Cyg	f
S 799AB	21434+3817	59.8	149.52	2014.645	40	79 Cyg	f
STF2840	21520+5548	196.1	17.72	2014.688	40		f
STF2873	21582+8252	65.7	13.88	2014.688	33		f
STF2872AB	22086+5917	315.6	21.61	2014.697	29		f
STF2893	22129+7318	346.7	28.79	2014.697	38		f
STFA 58AC	22292+5825	191.2	40.65	2014.688	44	δ Cep	f
STF2947AB	22490+6834	55.5 55.3	4.51 4.52	2014.71 2014.727	29 27		TK2
STTA238AB	22527+6759	280.3 280.2	66.74 66.73	2014.71 2014.727	37 23		TK2 TK2
STF2950AB	22514+6142	274.7 276.1 275.3	1.18 1.25 1.23	2014.71 2014.727 2014.748	44 20 30		TK2 TK2 TK2
STF2909	22288-0001	164.5 164.5	2.23 2.05	2014.822 2014.825	98 49	ζ Aqr	TK2
STF2978	23075+3250	144.7	8.04	2014.748	36		TK2
STF3042	23519+3753	86.9	5.47	2014.861	19		TK2
STF3049AB	23590+5545	325.9 326.2	3.17 3.07	2014.751 2014.757	46 35	σ Cas	TK2; NC TK2
STF3050AB	23595+3343	338.4 338.8	2.28 2.31	2014.836 2014.861	37 33		TK2 TK2

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Table 2. Residuals for double stars in 2014

Designation	WDS	Name	Date	θ	ρ	$\Delta\theta$	$\Delta\rho$	Ref.; Notes
STF 60 AB	00491+5749	η Cas	2014.8	324.2	12.95	0.6	-0.39	Str1969a
STF 73 AB	00550+2338	36 And	2014.9	327.8	1.03	-1.3	-0.09	Mut2010b; 1
STF 262 AB	02291+6724	ι Cas	2014.8	229.1	2.68	1	0.06	Hei1996b
STF 742	05364+2200		2014.1	273.4	4.1	-2	-0.04	Hop1973b; 2
STF 958 AB	06482+5542		2014.2	256.6	4.55	-0.4 0.1	0.01 0.08	Kis2009 Kis2009
STF 982 AB	06546+1311	38 Gem	2014.1	143.3	7.36	2	0.14	Hop1952; 3
STF 1110 AB	07346+3153	α Gem	2014.1	55.1	5.02	-0.2 0.3	0.03 0.07	Hei1988a Doc1985c
STF 1196 AB	08122+1739	ζ Cnc	2014.2	24.2	1.07	1.4	-0.04	WSI2006b; 4
STF 1338	09219+3811		2014.2	308.5	1.05	-3.2	0.04	Sca2002b; 5
STF 1424 AB	10200+1950	γ Leo	2014.2	126.2	4.75	0.1	0.29	Rab1958
STF 1523 AB	11182+3132	ξ Uma	2014.4	179.3	1.69	-1.3	-0.05	Msn1995
STF 1670 AB	12417-0127	γ Vir	2014.4	7.4	2.07	0	-0.11	Sca2007c
STT 261	13120+3205		2014.4	337.7	2.55	-0.8	-0.03	Kis2012
STF 1768 AB	13375+3618	25 CVn	2014.4	95.3	1.68	0	-0.02	Sod1999
STF 1888 AB	14514+1906	ξ Boo	2014.4	303.4	5.59	-0.2	-0.1	Sod1999
STT 288	14534+1542		2014.4	159.4	0.99	0.4	-0.03	Hei1998
STF 1909	15038+4739	44 Boo	2014.4	65.5	1.05	0 0.2	0.05 -0.07	Sod1999 Zirm 2010
STF 1932 AB	15183+2650		2014.4	264.1	1.58	-1.1 -0.9	0.06 -0.04	Hei1965c Sca2013b
STF 1938 BC	15245+3723	μ Boo	2014.4	4.2	2.17	0.2 0.4	-0.05 -0.07	Sca2013a Sod1999
STF 2032 AB	16147+3352	σ CrB	2014.4	238.2	6.97	0.1 0.1	-0.21 -0.3	Rag2009 Sca1979
STF 2118 AB	16564+6502	20 Dra	2014.5	66.1	0.92	-0.8	-0.23	Sca2002d
STF 2130 AB	17053+5428	μ Dra	2014.5	4.4	2.42	0.9	-0.07	Pru2012
STF 2140 AB	17146+1423	α Her	2014.5	103.4	4.63	0.3	-0.01	Baz1978
STF 2272 AB	18055+0230	70 Oph	2014.5	126.4	6.07	0.5	-0.19	Pxb2000b
STF 2289	18101+1629		2014.5	223.9	1.2	8	-0.04	Hop1964b; 6
STT 358AB	18359+1659		2014.5	149	1.6	2.2	0.09	Hei1995; 7
STF 2382 AB	18443+3940	ε Lyr	2014.5	347.1	2.23	0.9 0.9	-0.05 -0.12	Nov 2006e WSI2004b
STF 2383 CD	18443+3940	5 Lyr	2014.5	76.6	2.34	0.2	-0.04	Doc1984b
STF 2579 AB	19450+4508	δ Cyg	2014.6	218.4	2.62	0.8	-0.1	Sca2012c
STF 2758 AB	21069+3845	61 Cyg	2014.6	152.2	31.58	-0.6 -0.2	0.05 -0.02	Pko2006b Kis1997
STF 2822 AB	21441+2845	μ Cyg	2014.6	317.7	1.59	-3.0	0.03	Hei1995; 8
STF 2909	22288-0001	ζ Aqr	2014.8	164.5	2.17	-1.5 -0.7	-0.19 -0.07	Hei 1984c; 9 Sca 2010c
STF 3050AB	23595+3343		2014.8	338.6	2.29	-0.8	-0.07	Hrt2011a

Table Notes.

1. The large variations in $\Delta\theta$ show the difficulties in measuring θ for small separations. See Table 3.
2. Residuals for 2009.186 (Courtot, 2010, p.7): $\Delta\theta$ -0.8 and $\Delta\rho$ - 0.12 and for 2008.08 (Alzner, 2008, p. 12): $\Delta\theta$ -0.7 and $\Delta\rho$ - 0.09.
3. Argyle (2013, p. 3) $\Delta\theta$ + 4.3 and $\Delta\rho$ + 0.03 for 2012.216; Argyle (2008, p. 5) $\Delta\theta$ + 3.1 and $\Delta\rho$ + 0.01 for 2006.244; Courtot (2010, p. 7) $\Delta\theta$ + 1.6 and $\Delta\rho$ + 0.04 for 2009.21.
4. Measurements from 2010 to 2012 were published in Maiwald (2013) and for 2013 in Maiwald (2014). The great variation in $\Delta\theta$ shows that the separation of the star is rather small for my telescope and location. See Table 4.
5. Residuals for my own measurements from 2010.3 to 2013.2 ($\Delta\theta$ all negative) can be found in (Maiwald, 2014, p. 191). (Argyle, 2014, p. 4): $\Delta\theta$ - 3.0 and $\Delta\rho$ + 0.09 for 2013.345.
6. In (Maiwald, 2014, p.190f.) $\Delta\theta$ 6.3 for 2013.5 was reported.
7. Data for 2012 from Maiwald (2013, p. 193), for 2013 from Maiwald (2014, p. 190). Argyle (2013, p. 4): $\Delta\theta$ + 4.4 and $\Delta\rho$ + 0.07 for 2012.683. See Table 5.
8. Star is known for deviations from ephemeris. Residuals from 2010.6 to 2013.8 in Maiwald (2014, p. 191). Argyle (2014): $\Delta\theta$ - 3.4 and $\Delta\rho$ + 0.18 for 2013.538.
9. Residuals from 2010.8 to 2013.8 in Maiwald (2014, p. 191). Argyle (2014, p. 4): $\Delta\theta$ - 2.4 and $\Delta\rho$ + 0.26 for 2013.864 for the newer orbit.

Double Star Observations with a 150mm Refractor in 2014*Table 3: Residuals for STF 73 from 2012.9 to 2014.9*

Designation	WDS	Nights	Date	θ	ρ	$\Delta\theta$	$\Delta\rho$	Ref.
STF 73 AB	00550+2338	4	2012.9	326.5	1.13	-0.3	0.04	Mut2010b
		4	2013.9	328.4	1.01	0.5	-0.09	
		3	2014.9	327.8	1.03	-1.3	-0.09	

Table 4: Residuals for STF 1196 from 2010.2 to 2014.2

Designation	WDS	Nights	Date	θ	ρ	$\Delta\theta$	$\Delta\rho$	Ref.
STF 1196 AB	08122+1739	4	2010.2	38.3	1	1.3	-0.06	WSI2006b
		2	2011.2	37.3	0.99	4	-0.09	
		1	2012.2	32.4	1.04	2.6	-0.05	
		2	2013.2	26.9	1.04	0.6	-0.06	
		4	2014.2	24.2	1.07	1.4	-0.04	

Table 5: Residuals for STT 358 AB from 2012.6 to 2013.5

Designation	WDS	Nights	Date	θ	ρ	$\Delta\theta$	$\Delta\rho$	Ref.
STT 358 AB	18359+1659	4	2012.6	150.2	1.63	2.3	0.11	Hei1995
		2	2013.5	149.1	1.6	1.7	0.08	
		2	2014.5	149	1.6	2.2	0.09	

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Courtot, Jean – Francois, "Micrometer measures of double stars in 2009," The Webb Society Double Star Section Circular No 18, 2010, 5 – 7.

Hartkopf, William I., Mason, Brian D., Sixth Catalog of Orbits of Visual Binary Stars.
<http://ad.usno.navy.mil/wds/orb6.html>

Maiwald, Marc Oliver, "Double Star Measurements Using a Small Refractor," *Journal of Double Star Observations*, **9**, 189 – 194, 2013.

Maiwald, Marc Oliver, "Double Star Observations with a 150mm Refractor in 2013", *JDSO*, **10**, 185 – 192, 2014.

Napier – Munn, Tim, Jenkinson, Graeme, "Analysis of Errors in the Measurement of Double Stars Using Imaging and the Reduc Software," *JDSO*, **10**, 193 – 198, 2104.

Workman, Brian, 2013, Binary Star Calculator,
http://www.saguaroastro.org/content/db/binaries_6th_Excel97.zip