Near IR Measures II, 9-12 hr and Reference Stars

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Abstract: We list position angles, separations, and magnitude differences of our reference double stars and program double stars between 9^{hr} and 12^{hr} right ascension.

Introduction

The facilities and procedures used in our retirement hobby have remained virtually the same as noted in the reference (Gatewood and Gatewood 2012). After some testing we now use the magnitudes differences derived by ASTROSURF's REDUC. And we also installed MaxPoint for telescope control. This has improved our "on target" time significantly, usually placing the field well within our finder's small CCD field and occasionally within the much smaller field of our main camera. To reduce our systematic error we have expanded our reference system to include 36 selected wide double stars. The general character of that system can be determined from their annual means listed in Table 1.

Results

Even though we only observe a few good nights per year, we have obtain quite a bit of data. Much of it is better than we had thought possible from our north Georgia site. Table 1 lists the WDS number of each star followed by its discovery designation and the annual mean date of the observations. The position angles and separations with their standard errors are next followed by the average difference in the I band magnitude of the components and the number of nights observed in each listed year. Finally we list the total number of exposures in the mean. Unless given in the notes, the total number of delta I magnitude measurements is the same as the number of exposures. Where measured, V band and B band magnitudes and comments are given in the notes.

The standard errors listed in Table one are based upon the value given by the reduction program REDUC, the number of exposures, and our estimate of the standard errors of the reference system. The derivation of the field scale of the system included an analysis of the previous observations of 36 wide double stars provided to us by the US Naval Observatory. The correction to the main camera's rotation angle was based on the fit of the data to 152 star trails acquired regularly during the several observing periods. A more detailed description is beyond the scope of the present paper and will be provided later.

Most of the double stars with right ascensions between 9 and 12 hours are regular program pairs, the exceptions are S598AB, STF1424CD and STF1579AB-D. These double stars are part of our reference system. Double stars outside of those limits are generally reference stars or their companions. STTA177AC was originally part of that system but the third star in the system, BU139AB, seemed to be the cause of higher measurement errors. GAT3AB was included so that we could point out an interesting progression in its position angles and also those of STTA177AC.

Acknowledgements

Thanks to Brian Mason and William Hartkopf for for answering numerous data requests. This research made extensive use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

References

Gatewood, G.D. and Gatewood, C.V. 2012, **8**, 4, 335-339.

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Table 1. Measurements

WDS	NAME	DATE	PA	sePA	SEP	seSEP	Ia-b	N	exp
00097+5202	BU 484AC	2011.888	51.46	0.012	83.244	0.012	2.16	1	36
00097+5202	BU 484AC	2013.786	51.35	0.009	83.272	0.016	2.08	3	110
00097+5202	BU 484AC	2014.658	51.35	0.008	83.284	0.017	2.04	1	107
00097+5202	BU 484AC	2015.668	51.33	0.008	83.248	0.017	2.15	1	78
00097+5202	BU 484AB	2014.717	156.83	0.206	1.857	0.011	3.71	3	133
00097+5202	BU 484AB	2015.668	156.50	0.199	1.802	0.009	3.85	1	53
00464+3057	STFA 1AB	2013.776	46.47	0.021	47.338	0.024	0.15	3	92
00464+3057	STFA 1AB	2014.655	46.44	0.018	47.307	0.016	0.13	1	107
00464+3057	STFA 1AB	2015.718	46.41	0.010	47.311	0.012	0.12	1	90
01057+2128	STF 88AB	2011.923	159.24	0.036	29.711	0.017	0.41	1	23
01057+2128	STF 88AB	2013.805	159.24	0.024	29.731	0.018	0.28	3	123
01057+2128	STF 88AB	2014.655	159.27	0.021	29.729	0.013	0.25	1	118
01057+2128	STF 88AB	2015.956	159.27	0.023	29.748	0.017	0.19	1	53
01323+4559	BVD 18	2013.825	231.11	0.008	85.356	0.017	0.31	2	79
01323+4559	BVD 18	2014.658	231.08	0.008	85.354	0.016	0.30	1	127
01323+4559	BVD 18	2015.956	231.13	0.010	85.509	0.023	0.29	1	59
03092+0728	STFA 6	2013.860	163.22	0.009	80.892	0.018	0.20	1	67
03092+0728	STFA 6	2015.811	163.17	0.010	80.959	0.018	0.17	2	153
03494+2423	STTA 40AB	2011.978	309.12	0.012	86.925	0.020	0.81	2	43
03494+2423	STTA 40AB	2013.860	309.13	0.008	86.911	0.015	0.81	2	70
03494+2423	STTA 40AB	2015.668	309.09	0.008	86.872	0.014	0.83	1	86
04422+2257	S 455AB	2011.978	213.71	0.019	62.773	0.036	2.59	1	24
04422+2257	S 455AB	2013.863	213.67	0.010	62.806	0.015	2.68	1	74
04422+2257	S 455AB	2015.668	213.65	0.012	62.792	0.015	2.73	1	77
04590+1433	SHJ 49AB	2011.986	305.69	0.018	39.307	0.016	1.51	1	23
04590+1433	SHJ 49AB	2013.863	305.71	0.010	39.304	0.008	1.53	2	111
04590+1433	SHJ 49AB	2015.958	305.69	0.010	39.305	0.013	1.56	1	88
05308+3950	STTA 63	2011.926	276.74	0.018	76.063	0.024	1.12	1	44
05308+3950	STTA 63	2015.958	276.81	0.008	76.092	0.013	1.23	1	175
05479+2441	STTA 66	2012.082	166.27	0.026	93.877	0.059	0.75	1	13
05479+2441	STTA 66	2015.956	166.27	0.007	93.746	0.016	0.77	1	101
07006+1243	STF1007AD	2012.066	28.43	0.016	67.900	0.026	0.37	1	16
07006+1243	STF1007AD	2013.863	28.46	0.007	67.941	0.012	0.39	1	124
07006+1243	STF1007AD	2015.956	28.45	0.009	67.913	0.013	0.37	1	96
07510+3137	STTA 89	2012.071	83.60	0.018	76.753	0.024	0.85	1	27
07510+3137	STTA 89	2013.863	83.63	0.010	76.775	0.015	0.92	1	79
07510+3137	STTA 89	2015.956	83.64	0.007	76.792	0.012	0.93	1	211
08404+1940	STF1254AB	2013.863	54.55	0.013	20.524	0.005	4.35	2	89
08404+1940	STF1254AB	2014.264	54.54	0.025	20.531	0.009	4.22	2	182
08404+1940	STF1254AB	2015.956	54.49	0.010	20.517	0.004	4.32	2	369
08404+1940	STF1254AC	2013.863	342.81	0.007	63.370	0.011	2.03	2	89
08404+1940	STF1254AC	2014.263	342.80	0.008	63.377	0.013	2.06	2	217
08404+1940	STF1254AC	2015.956	342.78	0.007	63.358	0.010	2.02	2	371
08404+1940	STF1254AD	2013.863	44.01	0.007	82.636	0.014	3.44	2	89

Table 1 continues on next page.

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Table 1 (continued). Measurements

WDS	NAME	DATE	PA	sePA	SEP	seSEP	Ia-b	N	exp	nt
08404+1940	STF1254AD	2014.263	44.02	0.009	82.642	0.015	3.42	2	217	
08404+1940	STF1254AD	2015.956	43.99	0.007	82.600	0.012	3.43	2	371	
08404+1940	S 572CD	2013.863	90.83	0.007	76.152	0.013	1.41	2	89	
08404+1940	S 572CD	2014.264	90.84	0.009	76.170	0.013	1.35	2	212	
08404+1940	S 572CD	2015.956	90.82	0.007	76.131	0.011	1.41	2	371	
09078-0013	SCJ 12	2012.255	261.25	0.174	6.566	0.022	0.00	1	25	3
09136+4659	STF1318	2012.285	228.46	0.165	2.600	0.014	1.32	1	30	4
09184+3522	STF1333	2012.285	49.85	0.190	1.910	0.008	0.26	1	26	5
09210+3811	STF1338AB	2012.266	305.40	0.402	1.067	0.011	0.22	1	13	
09233+0921	HEI 487	2012.203	104.80	0.407	1.069	0.013	1.66	1	28	6
09245+0621	STF1438AB	2012.285	314.12	0.358	1.978	0.016	0.03	1	9	
09273+0614	STF1355	2012.285	353.44	0.768	1.752	0.015	0.17	1	13	
09287+4536	S 598AB	2013.862	160.79	0.008	70.590	0.015	2.77	1	74	
09287+4536	S 598AB	2014.274	160.80	0.011	70.598	0.017	2.85	1	55	
09541+0457	S 605	2012.287	286.59	0.078	53.525	0.044	2.31	1	8	
10016+5535	KUI 46	2012.268	48.65	0.322	2.881	0.023	3.33	1	37	
Hip 49544	Gat 4	2015.342	211.93	0.762	2.359	0.053	2.36	1	28	7
10200+1950	STF1424CD	2013.863	4.79	0.012	90.623	0.024	2.35	1	16	
10200+1950	STF1424CD	2014.274	5.13	0.008	90.530	0.119	2.47	1	31	
10200+1950	STF1424AB	2012.257	126.25	0.070	4.700	0.006	1.38	1	48	
10347+4639	ES 918	2012.255	189.18	0.362	3.372	0.024	0.13	1	32	8
10432+3849	MLB 933	2012.266	245.11	0.319	3.631	0.016	1.09	1	28	
10470+1302	STF1472	2014.339	37.09	0.016	43.364	0.027	0.91	1	17	9
10598+5854	STF1495	2013.862	36.32	0.014	33.982	0.015	1.98	1	52	
10598+5854	STF1495	2014.348	36.37	0.020	34.007	0.018	1.88	1	41	
11046+1240	SIN 62	2012.285	round		Rho<0.6			1		10
11065+1416	HU 885AB	2012.219	257.14	0.568	1.985	0.018	0.93	1	5	
11065+1416	HU 885AB	2014.339	255.03	0.635	2.052	0.021	0.93	1	7	
11111+3027	STT 231AB	2014.300	262.55	0.012	34.155	0.007	1.11	2	94	
11129+3130	HEI 12	2012.285	122.06	1.302	2.346	0.057	0.77	1	20	11
11129+3130	HEI 12	2014.339	122.40	1.731	2.409	0.038	0.68	1	11	
11252+1608	HEI 156AB	2015.339	159.58	0.903	1.620	0.020	0.71	1	14	
11252+1608	UC 2134AC	2012.255	45.05	0.057	24.880	0.017	1.39	1	30	12
11252+1608	UC 2134AC	2015.339	45.05	0.053	24.968	0.016	1.54	1	53	
11263+1610	HEI 157	2015.339	156.61	1.143	1.602	0.023	0.93	1	12	
11279+0251	STFA 19AB	2013.862	181.63	0.038	88.463	0.082	2.85	1	10	
11279+0251	STFA 19AB	2014.265	181.70	0.015	88.764	0.024	2.97	1	22	
11323+3323	ES 2284	2012.285	76.72	1.098	3.007	0.035	0.83	1	13	13
11323+3323	ES 2284	2014.348	74.79	0.921	3.096	0.044	0.73	1	13	
11390+4109	STT 237AB	2012.329	244.44	0.102	2.045	0.004	0.90	2	67	
11406+2102	STF1566	2012.329	349.35	0.090	2.382	0.004	1.74	1	59	14
11456+0354	HJ 1196AB	2014.348	204.57	0.037	46.062	0.019	0.53	1	11	
11456+0354	HJ 1196AB	2015.339	204.65	0.029	46.391	0.025	0.69	1	53	
11456+0354	GAT 5Aa,Ab	2014.348	161.09	2.588	0.798	0.043	0.13	1	8	15

Table 1 continues on next page.

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Table 1 (continued). Measurements

WDS	NAME	DATE	PA	sePA	SEP	seSEP	Ia-b	N	exp	nt
11456+0354	GAT 5Aa,Ab	2015.339	165.69	1.855	0.873	0.089	0.30	1	4	
11485+1633	HEI 158	2015.339	280.48	0.055	1.602	0.012	1.17	1	23	
11551+4629	STF1579A,D	2013.862	113.77	0.009	63.009	0.012	0.38	4	183	
11551+4629	STF1579A,D	2014.285	113.78	0.009	63.032	0.011	0.35	4	147	
11551+4629	STF1579A,C	2013.862	41.79	0.045	3.869	0.003	1.92	4	183	
11551+4629	STF1579A,C	2014.291	41.88	0.091	3.868	0.007	1.88	4	142	
13309+2414	H 570AC	2013.405	256.36	0.033	76.929	0.028	0.13	1	41	
13309+2414	H 570AC	2014.296	256.35	0.008	77.004	0.013	0.27	4	171	
13309+2414	H 570AC	2015.370	256.31	0.014	77.060	0.021	0.11	4	148	
13309+2414	STT 268AB	2013.776	75.95	0.018	19.023	0.009	4.19	2	70	
13309+2414	GAT 2Ba,Bb	2014.000	32.58	0.921	1.500	0.039	0.27	2	31	
13504+2117	S 656	2014.452	208.22	0.011	85.682	0.020	0.34	1	103	
13504+2117	S 656	2015.348	208.24	0.013	85.714	0.021	0.47	2	86	
14538-0024	STTA131AB	2013.447	215.50	0.018	83.137	0.031	0.47	1	67	
14538-0024	STTA131AB	2014.358	215.48	0.014	83.093	0.022	0.51	2	140	
14538-0024	STTA131AB	2015.370	215.52	0.018	83.071	0.026	0.48	1	49	
14596+5352	SHJ 191	2013.403	341.51	0.021	40.371	0.016	0.90	2	51	
14596+5352	SHJ 191	2014.274	341.43	0.021	40.365	0.019	0.80	1	31	
14596+5352	SHJ 191	2015.337	341.44	0.022	40.325	0.022	0.87	2	72	
16060+1319	STF2007AB	2013.474	322.07	0.032	38.316	0.028	1.30	3	106	16
16060+1319	STF2007AB	2014.424	322.00	0.015	38.363	0.012	1.30	4	199	
16060+1319	STF2007AB	2015.404	321.92	0.016	38.383	0.017	1.28	2	176	
16406+0413	STFA 31AB	2013.482	229.49	0.012	69.667	0.016	1.01	4	113	
16406+0413	STFA 31AB	2014.403	229.45	0.011	69.650	0.015	1.03	5	244	
16406+0413	STFA 31AB	2015.414	229.45	0.014	69.641	0.018	1.04	4	268	
18448+3736	STFA 38AD	2013.638	149.93	0.017	43.711	0.016	1.20	4	121	
18448+3736	STFA 38AD	2014.504	149.91	0.010	43.680	0.009	1.24	3	253	
18448+3736	STFA 38AD	2015.548	149.87	0.019	43.661	0.018	1.28	1	102	
18483+5752	STI2390AC	2012.459	98.70	0.294	5.012	0.203	2.14	1	22	17
18483+5752	STI2390AC	2013.572	99.05	0.135	5.063	0.015	2.57	1	30	
18483+5752	STI2390AC	2014.921	99.33	0.239	5.022	0.018	2.18	1	39	
18483+5752	GAT 3AB	2012.459	114.10	0.330	2.228	0.019	1.60	1	26	18
18483+5752	GAT 3AB	2013.572	115.48	0.273	2.341	0.010	1.88	1	30	
18483+5752	GAT 3AB	2014.858	117.15	0.229	2.251	0.026	1.66	1	33	
19126+1651	STTA177AC	2013.592	276.37	0.031	98.437	0.038	0.26	1	40	19
19126+1651	STTA177AC	2014.510	276.32	0.008	98.289	0.017	0.15	4	253	
19126+1651	STTA177AC	2015.588	276.20	0.009	98.135	0.018	0.14	3	282	
19126+1651	BU 139AB	2014.468	132.03	0.414	0.538	0.005	0.47	3	119	20
19126+1651	BU 139AB	2015.392	135.77	3.934	0.561	0.078	0.29	1	14	
19153+1505	STTA178	2015.458	267.05	0.010	89.790	0.018	3.00	1	106	
19307+2758	STFA 43AB	2013.636	54.10	0.028	34.606	0.030	3.26	2	63	
19307+2758	STFA 43AB	2014.657	54.01	0.013	34.581	0.009	3.29	3	237	

Table 1 concludes on next page.

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Table 1 (conclusion). Measurements

WDS	NAME	DATE	PA	sePA	SEP	seSEP	Ia-b	N	exp	nt
19428+3741	STTA188AB	2013.628	121.03	0.021	60.607	0.025	1.23	3	109	
19428+3741	STTA188AB	2014.490	120.98	0.009	60.649	0.012	1.26	3	254	
19428+3741	STTA188AB	2015.591	120.98	0.009	60.665	0.011	1.26	2	235	
20099+2055	STF2637AC	2013.652	221.55	0.018	90.972	0.032	0.25	2	36	
20099+2055	STF2637AC	2014.529	221.55	0.009	91.038	0.017	0.30	3	209	
20099+2055	STF2637AC	2015.455	221.55	0.009	91.155	0.017	0.29	1	94	
20099+2055	STF2637AB	2013.652	331.09	0.055	11.615	0.016	2.07	1	30	
20099+2055	STF2637AB	2015.455	331.17	0.031	11.616	0.008	2.06	1	95	
20229+4259	STTA207AC	2013.710	64.63	0.010	85.778	0.018	2.52	2	59	
20229+4259	STTA207AC	2015.707	64.63	0.009	85.639	0.017	2.61	2	180	21
20229+4259	HO 128AB	2013.710	357.97	0.336	1.283	0.017	2.70	1	13	
20229+4259	HO 128AB	2015.668	357.63	0.238	1.352	0.006	2.51	2	64	22
20302+1925	S 752AC	2013.677	288.00	0.010	106.258	0.023	0.47	1	43	
20302+1925	S 752AC	2014.433	287.93	0.008	106.234	0.017	0.44	3	87	
20302+1925	S 752AC	2015.567	287.98	0.008	106.320	0.018	0.41	3	251	
22093+4451	HJ 1735	2013.721	285.65	0.008	109.960	0.019	0.02	5	148	
22093+4451	HJ 1735	2015.458	285.60	0.011	110.160	0.024	0.23	1	60	
22237+2051	STF2900AC	2013.742	306.09	0.011	92.180	0.021	2.47	4	302	
22237+2051	STF2900AC	2014.658	305.99	0.011	92.386	0.022	2.42	1	93	
22237+2051	STF2900AC	2015.668	305.81	0.009	92.665	0.018	2.51	1	84	
22237+2051	STF2900AB	2013.759	178.37	0.202	0.659	0.020	1.65	1	23	23
22237+2051	STF2900AB	2015.668	179.93	0.225	0.749	0.022	2.01	1	13	
23300+5833	SHJ 355AC	2011.806	268.71	0.013	75.558	0.016	2.18	3	100	
23300+5833	SHJ 355AC	2013.770	268.64	0.011	75.601	0.017	2.30	6	268	
23300+5833	SHJ 355AC	2014.658	268.64	0.011	75.590	0.019	2.16	1	102	
23300+5833	SHJ 355AC	2015.557	268.61	0.010	75.651	0.017	2.35	2	190	
23300+5833	DA 2CD	2015.625	213.07	0.296	1.301	0.012	1.72	2	43	
23592+5032	ARY 33	2011.901	139.24	0.010	100.160	0.023	0.89	2	106	
23592+5032	ARY 33	2013.783	139.19	0.013	100.091	0.025	0.76	4	229	
23592+5032	ARY 33	2014.658	139.20	0.011	100.099	0.019	0.76	1	99	
23592+5032	ARY 33	2015.668	139.17	0.009	100.075	0.017	0.80	1	90	

Notes:

All observations were obtained using a F/6.63 16 inch Newtonian telescope and a Barlow lens yielding an effective focal length of 374 inches. A SBIG 402 CCD with standard B, V and I filters was used for all imaging.

1. dMv=0.032, 92i, 33v
2. dMv=1.01, 43i, 10v. No apparent occultation noted.
3. dMv=0.09, 18i, 7v, on about half of the I band exposures B has more counts than A.
4. dMv=1.41, 25i, 5v
5. dMv=0.09, 23i, 3v
6. dMv=1.88, 17i, 11v, significant change since 1988.
7. GAT 4, dMv=2.37, 23i, 5v, somewhat different than Paper 1.
8. dMv=0.18, 23i, 9v
9. dMv=0.97, 21i, 7v
10. SEP is less than 0.5 arc sec. The image is round on a set of very good exposures. We note that the star was only observed as double once and we suspect that was a mistake such as recording the wrong star number with the observation.
11. dMv=0.60, 13i, 7v
12. UC2134AC, dMv=1.38, 22i, 8v. HEI195 may be UC 2134AC.
13. dMv=0.57, 13i, 13v
14. dMv=1.44, 59i, 20v
15. GAT 5, significant motion in angle may be from relative proper motion.
16. dMv=1.12, dMb=1.28, 481i, 24v, 27b
17. STI2390AC, dMv= 2.63, 69i, 22v, motion in angle may be from relative proper motion.

18. GAT 3, dMv= 1.82, 84i, 5v, motion in angle may be from relative proper motion.
19. STTA177AC, 3rd close star makes this system difficult to measure. Space borne measurements will likely differ from ground based measurements. It was dropped from our Reference Star list.
20. BU139AB, this pair is close to the near-IR diffraction limit of our 16 inch. Although well resolved our measurements are likely to suffer from adjacency effects. But hey, since we made the mirror ….
21. STTA207AC, dMv=1.72, dMb=1.07, 180i, 85v, 63b, the C companion is relatively very blue.
22. HO128AB, dMv=2.44, dMb=2.09, 35i, 33v, 9b
23. STF2900AB, the magnitude difference and proximity make this a difficult pair. Our measurements are likely to suffer from adjacency effects.