The Webb Deep-Sky Society

Double Star Section Circular No 25

Contents

This circular has been edited and arranged by R.W.Argyle, Director of the Webb Society Double Star Section.
E-mail: rwa@ast.cam.ac.uk

On-line copies of Double Star Section Circulars Nos 1 to 24 are available on the following website:
http://www.webbdeepsky.com/
In case of difficulty, contact the Webb Society Webmaster, James Whinfrey at: jkwhinfrey@ratfox.net

For further information about the Webb Society contact:

In the USA and Canada: J. E. Isles, 10575 Darrel Drive, Hanover, Michigan 49241, U.S.A.
E-mail: j_isles@yahoo.com

In the UK: D. J. Miles, 10 Rosewood Gardens, Clanfield, Waterlooville, Hampshire, PO8 0LT, England.
E-mail: donjmiles@googlemail.com

or see the Society web site http://www.webbdeepsky.com

Editorial

The number of measures included in these Circulars is now 54846.

Observer	WDS code	Pairs	Measures	Method/source
R. W. Argyle	ARY	114	332	RETEL micrometer
R. W. Argyle	ARY	359	589	Repsold micrometer
J.-F. Courtot	CTT	45	160	RETEL & Meca-Precis micrometers
A. Debackére	DBR	47	47	CCD imaging
W. Knapp	KPP	164	164	Data mining
B. A. Skiff	SKF	238	1040	Data mining
N. Webster	WST	62	62	Graticule eyepiece
K. Wierzchos	WRS	2	17	Data mining
TOTALS		1031	2411	

Bob Argyle,
2017 May

Useful sites

The following websites also contain a considerable amount of interesting material for the serious double star observer and no claim is made for the completeness of the list. If anyone knows of any others please contact me:

The Washington Double Star catalogue - the complete reference for visual double stars - updated nightly. The site also contains the Sixth Catalogue of Visual Binary Star Orbits and much more at `http://ad.usno.navy.mil/wds`

Journal for Double Star Observations (`www.jdso.org`)

Observations et Travaux (in French). A journal published by the Société Astronomique de France which often contains double star observations. The SAF Double Star Commission has a website at `http://saf.etoilesdoubles.free.fr`

El Observador de Estrellas Dobles (in Spanish)
(`www.elobservadordeestrellasdobles.wordpress.com`)

Observatori Astronòmic del Garraf (`www.oagarraf.net`)

Il Bollettino delle Stelle Doppie (in Italian)
(`https://sites.google.com/site/ilbollettinodellestelledoppie/`)

The Double Star Section of the Astronomical Society of Southern Africa
(`http://assa.ac.za/sections/deep-sky/doublestars/`)

In addition the Stelle Doppie Double Star Database run by Giuseppe Sordiglioni allows the WDS catalogue to be quizzed with various search parameters. You can get a user name and password at `stelledoppie.goaction.it`

Acknowledgements

Much of the work presented here has made use of the Washington Double Star Catalogue maintained at the U.S. Naval Observatory (see above).

MICROMETER MEASURES OF DOUBLE STARS IN 2016

Bob Argyle, Lyndhurst, Ely Road, Waterbeach, Cambridge, CB25 9NW, UK

E-mail: rwa@ast.cam.ac.uk

Introduction

In this publication, the author presents his micrometric measurements which were mostly made between 2015.0 and 2016.0. A small number of pairs have mean epochs outside this range either due to delay in getting a sufficient number of observations to form a mean, or which were inadvertently left out of earlier papers. The 8-inch f/14 Cooke refractor at the Observatories of the University of Cambridge has again been used for this work. It is equipped with a RETEL micrometer at a power of x450. Using a Barlow lens, the screw constant is 12″.45 per revolution which allows an equivalent reading accuracy of ±0″.025. The scale and orientation of the micrometer is derived at the beginning and end of each observing session using a number of fixed, wide pairs with astrometry from the Hipparcos satellite.

Measurements are arranged as usual (see Courtot & Argyle, 2004 for more details). Table 1 gives the name of the pairs using the WDS nomenclature[2] with the following codes and contains 331 measurements of 114 systems:

FRK	Franks, W. S.	SHJ	South & Herschel	FYM	Fay, M.
H	Herschel, W.	STF	Struve, F. G. W.	STT	Struve, O.
STTA	Struve, O. Appendix	KNT	Knott, G.	STFA	Struve, W. Appendix
S	South, J.				

The protocols followed here for measuring are very similar to earlier publications and consist basically of multiple double measures of separation (usually 4 or 5) and repeated measures of position angle (usually 4 to 6) taken on several different evenings taken together to get the final mean values of position angle and angular distance.

Table 3 gives the residuals from known orbits. The orbital elements come from the online version of the 6th USNO Catalogue of Orbits of Visual Binary Stars (Hartkopf, Mason & Worley, 2014)

Acknowledgements

The author is grateful to Mr. T. Dobner, consulting engineer, for his work and support in keeping the telescope and dome operational. Much of the work presented here has made use of the Washington Double Star Catalogue maintained at the U.S. Naval Observatory.

References

Courtot, J.-F. & Argyle, R. W., *Webb Society Double Star Section Circular*, **12**, 1, 2004

Hartkopf, W. I., Mason, B. D. & Worley C. E.: Sixth Catalog of Orbits of Visual Binary Stars. Astrometry Department, U.S. Naval Observatory. http://ad.usno.navy.mil/ad/wds/hmw5.html

Mason, B. D., Wycoff, G. L. & Hartkopf, W. I. : Washington Double Star Catalogue (References and discovery codes) http://as.usno.navy.mil/ad/wds/wdsnewref.txt

Table 1: Measures of double stars

Pair	Comp	RA	Dec	V_a	V_b	PA (°)	Sep (″)	Epoch	N	Obs.
STTA255		00054	+1620	8.69	8.86	336.7	88.20	2016.840	2	ARY
STF3062		00063	+5826	6.42	7.32	0.5	1.62	2016.419	3	ARY
STF28	AB	00239	+2930	8.32	8.55	223.6	33.15	2016.997	2	ARY
FYM12	AC	00239	+2930	8.32	8.92	136.7	145.90	2016.997	3	ARY
H 5 17	AB	00369	+3347	4.36	7.08	173.7	35.56	2016.997	2	ARY
STF98	AB	01295	+3205	7.02	8.14	248.8	19.63	2016.997	2	ARY
STF180	AB	01535	+1918	4.52	4.58	1.4	7.50	2016.023	3	ARY
FRK2		01564	+3026	7.95	9.12	306.6	53.41	2016.997	2	ARY
H 5 12	AB	01579	+2326	4.80	6.65	47.8	37.09	2016.980	3	ARY
STF202	AB	02020	+0246	4.10	5.17	265.1	1.82	2016.023	3	ARY
STF227		02124	+3018	5.26	6.67	69.1	3.73	2016.981	3	ARY
STF239		02174	+2845	7.09	7.83	211.3	13.56	2016.997	2	ARY
STF331		03009	+5221	5.21	6.17	85.5	11.92	2016.112	3	ARY
STF346	AB	03054	+2515	6.21	6.19	264.6	0.44	2015.382	3	ARY
STF448		03479	+3336	6.68	9.36	8.0	4.00	2011.100	2	ARY
STTA44		04173	+4613	7.12	7.99	322.6	57.99	2016.112	2	ARY
SHJ 40	AB	04204	+2721	5.08	7.51	258.3	48.76	2015.809	3	ARY
S445	AB	04210	+5015	7.31	8.19	327.9	70.80	2016.101	2	ARY
S445	AC	04210	+5015	7.31	9.30	262.8	150.27	2016.101	2	ARY
STF550	AB	04320	+5355	5.78	6.82	309.9	10.27	2013.299	2	ARY
STF618	AB	05036	+6305	7.68	7.98	212.4	32.28	2016.318	2	ARY
STF617	DE	05036	+6305	9.24	9.82	124.3	13.58	2016.318	2	ARY
S459		05034	+6027	4.12	7.44	210.4	83.51	2016.323	2	ARY
STF634	AB	05226	+7914	5.14	9.14	141.9	31.10	2016.313	3	ARY
STF638		05143	+6949	7.52	9.06	226.1	4.85	2016.313	3	ARY
STF653	AB	05154	+3241	5.03	10.9	224.8	14.45	2016.143	3	ARY
STF718	AB	05323	+4924	7.47	7.54	73.2	7.72	2015.516	3	ARY
STF728		05308	+0557	4.44	5.75	43.4	1.19	2015.630	4	ARY
STF866	AB	06183	+6212	8.89	10.12	169.9	17.71	2016.299	2	ARY
STF866	AC	06183	+6212	8.89	9.58	269.2	79.99	2016.299	2	ARY
STF872	AB	06156	+3609	6.89	7.38	216.4	11.50	2016.208	3	ARY
STT147	AB	06343	+3805	6.77	8.69	74.4	42.74	2016.220	2	ARY
STT147	A,CD	06343	+3805	6.77	9.85	118.8	44.54	2016.220	2	ARY
STF948	AB	06462	+5927	5.44	6.00	67.9	1.95	2016.282	3	ARY
STF948	AC	06462	+5927	5.44	7.05	310.3	8.70	2016.282	3	ARY
STF953		06412	+0859	7.10	7.66	150.8	7.26	2015.488	3	ARY
STTA72	AC	06247	+5940	7.58	7.58	322.5	132.97	2007.275	3	ARY
STF974	AB	06530	+3852	6.14	10.20	224.5	22.04	2014.756	2	ARY
STF997	AB	06561	−1403	5.27	7.14	345.5	3.05	2015.121	2	ARY
SHJ77	AC	07041	+2034	4.05	7.66	347.4	100.22	2015.558	3	ARY
STF1037	AB	07128	+2713	7.24	7.27	307.1	1.03	2016.237	3	ARY
STF1050	AB	07199	+5455	8.08	8.80	200.7	19.61	2013.620	3	ARY
STF1066		07201	+2159	3.55	8.18	229.5	5.49	2016.222	3	ARY
STF1110	AB	07346	+3153	1.93	2.97	55.1	5.20	2016.226	9	ARY
STF1116		07345	+1218	7.81	8.50	96.6	1.83	2015.590	3	ARY

STF1121	AB	07366	−1429	6.92	7.30	306.3	7.19	2015.149	3	ARY
STF1126	AB	07401	+0514	6.55	6.96	177.3	1.00	2016.459	4	ARY
KNT4	AB	07478	−1601	6.60	6.54	312.6	128.10	2016.159	2	ARY
STF1177		08056	+2732	6.69	7.41	351.8	3.63	2016.299	2	ARY
STF1196	AB	08122	+1739	5.30	6.25	18.8	1.17	2016.192	5	ARY
STF1196	AB,C	08122	+1739	4.92	5.85	67.0	5.87	2016.192	5	ARY
STF1245	AB	08358	+0637	5.98	7.16	25.3	10.10	2016.602	3	ARY
STF1245	AE	08358	+0637	6.52	7.61	207.2	113.04	2014.985	4	ARY
STF1254	AC	08404	+1940	6.52	7.61	342.9	63.75	2014.126	2	ARY
STF1254	AD	08404	+1940	6.52	9.20	44.1	82.55	2014.126	2	ARY
STF1273	AB,C	08468	+0625	3.49	6.66	307.6	2.83	2016.014	5	ARY
STF1315		09128	+6141	7.33	7.65	207.3	25.04	2015.938	2	ARY
STF1356		09285	+0903	5.69	7.28	112.3	0.91	2016.200	3	ARY
STT215		10163	+1744	7.25	7.46	176.8	1.74	2016.298	2	ARY
STF1495		10598	+5854	7.25	8.84	36.8	34.53	2016.456	2	ARY
STF1523	AB	11182	+3132	4.33	4.80	169.7	1.92	2016.425	5	ARY
STF1669	AB	12413	−1301	5.88	5.89	314.6	5.13	2016.382	3	ARY
STF1669	AC	12413	−1301	5.88	10.3	228.2	45.87	2016.356	2	ARY
STF1670	AB	12417	−0127	3.48	3.53	2.5	2.50	2016.348	5	ARY
STF1695		12563	+5406	6.04	7.75	282.0	3.67	2015.531	2	ARY
SHJ162	AB	13149	−1122	7.11	8.18	44.3	112.55	2016.356	2	ARY
STF1755		13324	+3649	7.34	8.10	131.3	4.07	2014.492	3	ARY
STF1768	AB	13375	+3618	4.98	6.95	99.8	1.80	2016.490	2	ARY
STF1785		13491	+2659	7.36	8.15	189.0	3.15	2016.507	5	ARY
STFA26	AB	14162	+5122	4.76	7.39	33.1	38.82	2016.544	2	ARY
STT288		14534	+1542	6.89	7.55	161.2	1.11	2016.533	4	ARY
STF1884		14484	+2422	6.58	7.48	58.1	2.09	2015.767	4	ARY
STF1888	AB	14514	+1906	4.76	6.95	301.8	5.49	2016.516	7	ARY
STF1909		15038	+4739	5.20	6.10	72.1	0.91	2016.537	1	ARY
STF1919		15127	+1917	6.71	7.38	10.6	23.18	2016.544	2	ARY
STF1938	BaBb	15245	+3723	7.09	7.63	3.7	2.31	2016.526	5	ARY
ANON∗		15234	+1045	8.48	8.80	183.1	93.07	2013.864	3	ARY
STF1954	AB	15348	+1032	4.17	5.16	172.4	4.43	2016.521	3	ARY
STF1964	AB-CD	15382	+3615	8.07	8.06	86.3	14.98	2014.870	3	ARY
STF1964	CD	15382	+3615	8.06	9.02	22.5	1.73	2016.538	3	ARY
STF1965		15394	+3638	4.96	5.91	307.4	6.24	2016.517	3	ARY
STF2055	AB	16309	+0159	4.15	5.15	43.9	1.76	2016.497	3	ARY
STF2084		16413	+3136	2.95	5.40	126.4	1.49	2016.570	2	ARY
H 5 127		16436	+0637	7.81	9.04	293.5	53.39	2016.576	2	ARY
SHJ239	AB	16458	+0835	5.33	9.29	228.8	84.06	2016.576	2	ARY
STF2118	AB	16564	+6502	7.07	7.30	65.9	1.04	2015.661	3	ARY
STF2130	AB	17053	+5428	5.66	5.69	1.7	2.30	2016.885	4	ARY
STF2173	AB	17304	−0104	6.06	6.17	147.5	0.88	2015.645	2	ARY
STF2194	AB	17411	+2431	6.51	9.28	7.3	15.84	2013.272	2	ARY
STF2204		17464	−1318	8.06	8.13	24.3	14.46	2011.063	2	ARY
STF2272	AB	18055	+0230	4.22	6.17	126.5	6.36	2016.530	6	ARY
ANON		19090	-1841	6.96	9.5	180.6	26.82	2016.676	1	ARY
STF2525	AB	19266	+2719	8.19	8.39	291.3	2.38	2016.473	3	ARY
STF2579	AB	19450	+4508	2,89	6.27	218.1	2.84	2016.326	5	ARY
STF2727	AB	20467	+1607	4.36	5.03	265.9	8.99	2016.885	4	ARY

STT413	AB	20474	+3629	4.73	6.26	3.6	1.05	2016.886	4	ARY
STF2758	AB	21069	+3845	5.20	6.05	152.2	31.43	2016.854	3	ARY
STF2777	AB,C	21145	+1000	4.54	10.17	5.8	76.50	2016.369	2	ARY
STF2822	AB	21441	+2845	4.75	6.18	320.8	1.81	2016.886	3	ARY
STF2848		21580	+0556	7.21	7.73	57.2	10.85	2015.922	2	ARY
S802	AB	22024	−1658	7.22	7.15	249.3	4.37	2014.203	3	ARY
SHJ345	AB	22266	−1645	6.29	6.39	78.0	1.34	2016.886	3	ARY
STF2909	AB	22288	−0001	4.34	4.49	162.4	2.39	2016.876	5	ARY
STF2920	AB	22345	+0413	7.55	8.85	144.3	13.54	2012.834	3	ARY
STT480		22461	+5804	7.65	8.64	116.6	30.36	2016.006	2	ARY
STF2950	AB	22514	+6142	6.03	7.08	278.0	1.07	2016.037	2	ARY
STF3009	AB	23243	+0343	6.87	8.76	230.2	6.96	2015.882	2	ARY
STF3019		23307	+0515	7.77	8.37	184.7	10.69	2016.361	4	ARY
STF3031		23412	+0616	7.80	8.58	311.1	13.89	2016.862	2	ARY
STF3033		23439	+0715	9.07	9.40	185.5	3.52	2016.862	2	ARY
H 2 24		23460	−1841	5.65	6.46	135.5	7.25	2012.855	2	ARY
STF3044		23530	+1155	7.27	7.91	103.0	19.03	2016.854	3	ARY
STF3049	AB	23590	+5545	4.99	7.24	328.3	3.35	2016.112	3	ARY
STF3050		23595	+3343	6.46	6.72	341.7	2.45	2016.983	3	ARY

*ANON - A: HD 107030, B = +11° 2198

Table 2: Residuals from known orbits

Pair	ADS	Residual(O−C) PA(°)	Sep (″)	Orbit	Period(yrs)	Date	Grade
STF3062	61	+1.9	+0.07	Söderhjelm	106.7	1999	2
STF202	1615	+2.5	−0.01	Scardia	3267.49	2015	4
STF346	2336	+6.8	−0.05	Heintz	227	1981	3
STF728		−1.0	−0.13	USNO	613.39	1999	4
STF948AB	5400	+1.6	+0.05	WSI	907.6	2006	4
STF1037	5871	+1.9	+0.11	Scardia	118.35	2015	4
STF1066	5983	+1.1	0.00	Hopmann	1200	1960	4
STF1110	6175	+1.1	+0.07	Docobo	459.8	2014	3
STF1126	6263	+0.3	+0.17	Zirm	752	2015	4
STF1196AB−C	6650	+1.3	−0.06	Heintz	1115	1996	4
STF1196AB	6650	+2.7	+0.05	WSI	59.582	2006	1
STF1273	6993	0.0	+0.01	Drummond	589	2014	4
STF1356	7390	+1.7	+0.08	Muterspaugh	117.97	2010	2
STT215	7704	−1.4	+0.18	Zaera	670.27	1984	4
STF1670	8630	−0.7	+0.04	Scardia	169.014	2007	2
STF1523	8119	+0.8	+0.04	Mason	59.878	1995	1
STF1768	8974	+5.9	+0.11	Söderhjelm	228	1999	3
STF1785	9031	+1.8	+0.27	Heintz	155.75	1988	2
STT288	9425	+3.4	+0.12	Heintz	313	1998	4
STF1909	9494	+0.2	+0.15	Zirm	209.8	2011	2
STF1888	9413	+0.7	+0.03	Söderhjelm	151.6	1999	2
STF1938	9626	0.0	+0.06	Kiyaeva	265	2014	2
STF1954	9701	+0.5	+0.46	WSI	1038	2004	4

STF2055	10087	+1.5	+0.34	Heintz	129	1993	2
STF2118	10279	−0.9	−0.10	Scardia	422.22	2002	3
STF2084	10157	−0.6	+0.22	Söderhjelm	34.45	1999	1
STF2130	10345	+0.5	−0.23	Prieur	812	2012	4
STF2173	10598	+2.5	+0.17	Heintz	46.4	1994	1
STF2272	11046	+1.7	−0.04	Eggenberger	88.379	2008	1
STF2579	12880	+1.2	+0.10	Scardia	918.1	2012	4
STF2525	12447	+1.9	+0.20	Scardia	882.9	2015	4
STF2727	14279	+1.0	+0.05	Hale	3249	1994	4
STT413	14296	+4.2	+0.13	Rabe	391.3	1948	4
STF2758	14636	0.0	−0.23	Pulkovo	678	2006	4
SHJ345	15934	+9.8	+0.05	Hale	3500	1994	4
STF2822	15270	−2.2	+0.29	Heintz	789	1995	4
STF2909	15971	−0.2	+0.10	Scardia	486.7	2010	3
STF3050	17149	+1.7	+0.04	Hartkopf	717	2011	4

MICROMETER MEASURES OF SOUTHERN DOUBLE STARS IN 2016

Bob Argyle, Lyndhurst, Ely Road, Waterbeach, Cambridge, CB25 9NW, UK

E-mail: rwa@ast.cam.ac.uk

Introduction

Between 2016 Aug 21 and Sep 16 the author had the use of the 26.5-inch (67-cm) Grubb refractor in Johannesburg. Known as the Innes telescope, it is located at the former site of the Republic Observatory and was erected on that site in February 1925. The telescope was built for the discovery and observation of close double stars and it is still available for that use today.

The telescope has a focal length of 10.92 metres giving a focal ratio of f/16.2 for the objective. The micrometer, which was made by Repsold in 1910, has a screw value of 9.089 arc seconds per revolution, according to van den Bos (1928). By measuring a number of fixed reference pairs (principally β^1 Sgr, and κ Lup), the screw value was found to be $9''.09$. Most measures were made with powers of x420 and x810. The programme of observation was similar to that carried out in 2013 (Argyle 2014) and included close visual binaries and wider pairs in the John Herschel catalogue which had not been measured for some time.

'ANON', for 'Anonymous', is used for pairs which are not in the current WDS catalogue.

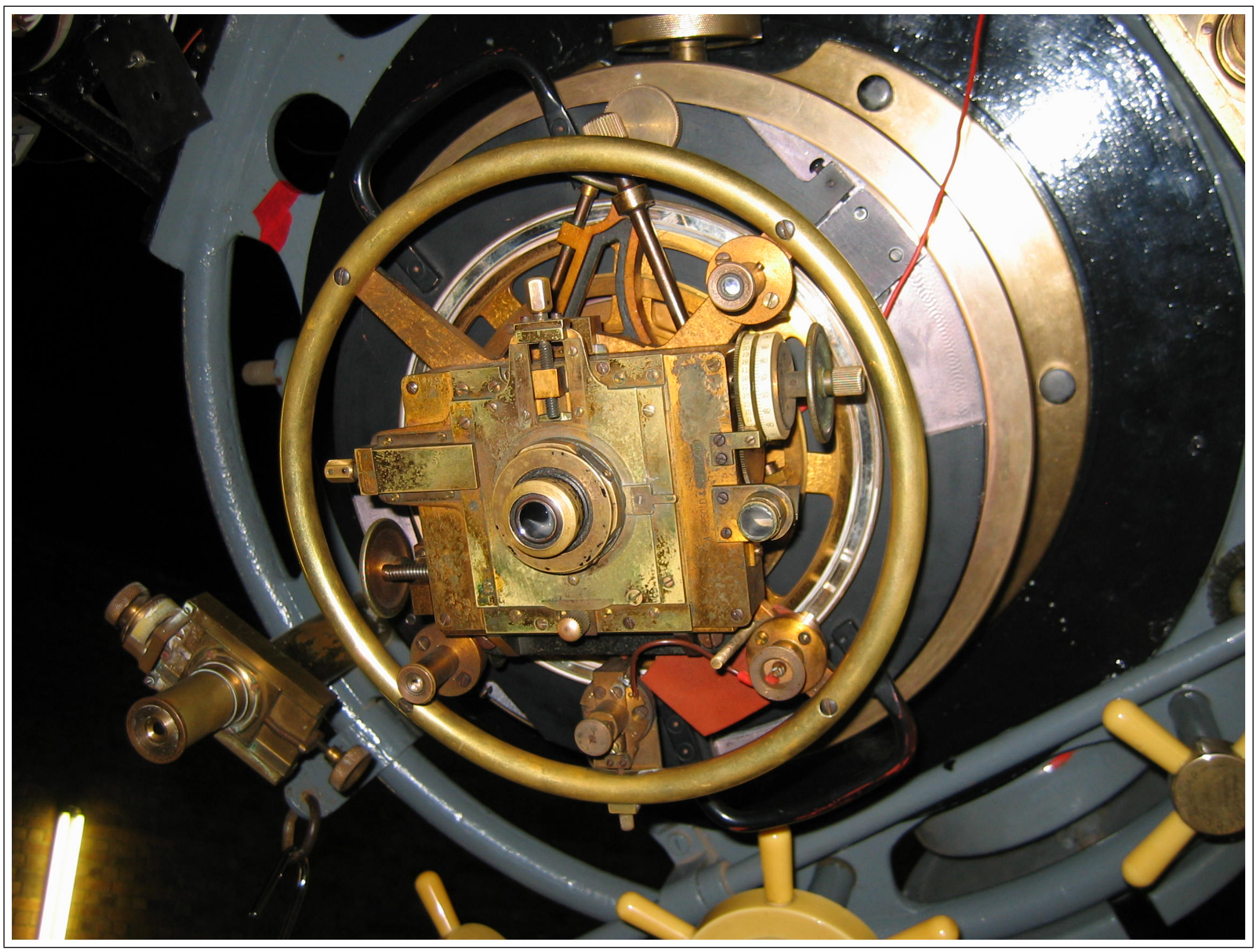

Figure 1. The Repsold micrometer (1910) on the Innes refractor

Table 1: Micrometric measurements of wide southern double stars

Pair	Comp	RA	Dec	V_a	V_b	PA	Sep	Epoch	N	Obs.
LCL 119	AC	00315	−6257	4.28	4.51	168.4	27.27	0.698	1	ARY
I 45	AB	00335	−5520	7.65	8.59	203.8	0.82	0.682	1	ARY
HJ 3376	AB,C	00335	−5520	7.65	9.86	242.0	7.00	0.682	1	ARY
MLO 1		00420	−5547	8.03	8.96	161.7	6.55	0.682	1	ARY
COO 3		00445	−6230	6.31	8.01	73.0	2.38	0.698	1	ARY
SLR 1	AB	01061	−4643	4.10	4.19	83.8	0.70	0.686	2	ARY
RMK 2	AB,C	01084	−5515	4.00	8.23	239.4	6.76	0.679	2	ARY
SLR 2	AB	01086	−4640	7.14	8.67	179.8	1.31	0.686	2	ARY
HJ 3423	AB	01158	−6853	5.00	7.74	315.6	4.77	0.682	1	ARY
I 27	CD	01158	−6853	7.84	8.44	345.4	1.21	0.682	1	ARY
HJ 3430	AB	01205	−5720	7.18	9.48	224.3	3.16	0.690	2	ARY
HJ 3435		01253	−5930	7.11	9.37	1.0	25.14	0.694	2	ARY
DUN 4		01388	−5327	7.15	8.49	105.1	10.31	0.694	2	ARY
DUN 5		01398	−5612	5.78	5.90	186.2	11.45	0.699	3	ARY
HJ 3475		01553	−6019	7.18	7.23	80.2	2.89	0.698	1	ARY
DAW 1	AB	02280	−5808	8.04	8.45	211.0	1.34	0.694	2	ARY
HJ 3503	AC	02280	−5808	8.05	9.61	298.9	17.64	0.690	1	ARY
DUN 7	A,BC	02397	−5934	7.67	7.69	97.4	36.67	0.694	2	ARY
DUN 252	AB	12266	−6306	1.25	1.55	112.0	4.20	0.653	4	ARY
R 207	AB	12463	−6806	3.52	3.98	52.7	1.12	0.664	4	ARY
HJ 4550		12483	−6708	7.63	8.74	97.0	13.59	0.668	1	ARY
GLI 185		12490	−6536	7.31	9.67	7.0	9.05	0.668	1	ARY
CPO 13		13003	−4836	7.21	9.20	69.6	5.05	0.676	1	ARY
R 213		13074	−5952	6.59	7.04	21.1	0.76	0.671	2	ARY
RMK 16	AB	13081	−6518	5.65	7.55	189.0	5.50	0.668	1	ARY
COO 152	AB	13129	−5949	6.26	9.42	145.9	25.32	0.674	1	ARY
HJ 4576		13161	−5704	7.06	9.99	116.0	9.00?	0.657	1	ARY
DUN 133	AB,C	13226	−6059	4.49	6.15	345.9	60.44	0.674	1	ARY
SLR 18	AB	13229	−4757	6.73	7.18	240.7	0.87	0.676	1	ARY
DUN 141		13417	−5434	5.20	6.53	162.8	5.63	0.666	2	ARY
HWE 94		13489	−3542	6.62	10.21	359.5	11.94	0.670	2	ARY
CPO 61	AB	13515	−4818	7.37	7.43	130.6	30.59	0.671	1	ARY
HJ 4619		13520	−4752	7.02	8.42	198.3	23.24	0.671	1	ARY
RMK 18		13521	−5249	5.24	7.50	288.5	18.46	0.671	1	ARY
HWE 28	AB	13535	−3540	6.27	6.38	316.7	1.11	0.685	2	ARY
HJ 4624		13540	−4708	5.87	10.45	349.8	21.01	0.666	2	ARY
BSO 9		13546	−5041	8.12	8.30	75.9	17.54	0.671	1	ARY
R 227	AB	13563	−5408	6.52	7.45	15.1	1.99	0.666	2	ARY
WFC 145	AB	14060	−4111	4.31	8.49	78.0	85.21	0.652	2	ARY
COO 167		14150	−6142	6.88	8.66	158.6	2.83	0.671	1	ARY
ANON 1		14151	−6139	8.57	10.6	18.5	22.30	0.671	1	ARY
BSO 10	AH	14165	−5718	7.27	10.02	113.7	30.24	0.671	1	ARY
POL 9	AB,CD	14208	−4225	7.20	8.88	211.5	78.49	0.663	2	ARY
COO 168	CD	14208	−4225	8.88	8.97	198.9	1.69	0.663	2	ARY
DUN 159	AB	14226	−5828	5.03	7.59	157.1	9.13	0.671	1	ARY
DUN 159	AC	14226	−5828	5.03	10.71	8.8	43.55	0.671	1	ARY

HJ 4690	AB	14373	−4608	5.55	7.65	23.7	19.59	0.693	1	ARY
RHD 1	AB	14396	−6050	-0.01	1.33	311.6	4.18	0.650	6	ARY
RHD 1	AB	14396	−6050	-0.01	1.33	312.3	4.19	0.667	6	ARY
RHD 1	AB	14396	−6050	-0.01	1.33	312.7	4.13	0.682	5	ARY
RHD 1	AB	14396	−6050	-0.01	1.33	312.9	4.11	0.699	5	ARY
NZO 52		14408	−6657	7.87	8.54	59.3	2.34	0.667	2	ARY
SKF1973		14410	−3608	5.64	9.36	147.9	82.66	0.709	1	ARY
DUN 166	AB	14425	−6459	3.18	8.47	224.2	15.70	0.656	2	ARY
H 3 97	AB	14460	−2527	5.12	7.25	20.0	13.94	0.685	1	ARY
HJ 4702	AB,C	14485	−3551	6.94	9.37	213.9	9.44	0.672	3	ARY
I 369	AB	14487	−6636	5.86	8.55	322.2	88.20	0.665	1	ARY
JRN 16	AD	14487	−6636	5.86	7.72	33.3	47.18	0.665	1	ARY
DON 680		14494	−6714	7.45	9.76	244.2	2.55	0.667	2	ARY
HJ 4706	AB	14513	−4724	7.74	8.99	219.9	7.03	0.673	3	ARY
HJ 4706	AC	14513	−4724	7.74		126.3	45.64	0.649	1	ARY
HJ 4707		14542	−6625	7.53	8.09	271.0	1.17	0.659	3	ARY
I 226	AB	14544	−3409	7.09	11.16	226.1	3.28	0.663	1	ARY
BU 347	AB	14546	−3318	6.00	11.0	318.5	13.33	0.709	1	ARY
BU 347	AC	14546	−3318	6.00	10.11	239.6	57.04	0.709	1	ARY
I 84	AB	14549	−3626	7.27	11.11	262.2	4.87	0.686	2	ARY
I 227	AB	14565	−3438	8.06	8.39	31.0	58.09	0.663	1	ARY
HJ 4715		14565	−4753	5.98	6.82	280.7	2.07	0.654	1	ARY
HJ 4718		14576	−3523	7.41	8.67	65.8	1.83	0.643	1	ARY
CPO 62	AB	14585	−4726	7.37	8.36	164.2	24.63	0.671	1	ARY
CPO 62	AC	14585	−4726	7.37				0.671	1	ARY
BU 239		14587	−2739	6.17	6.79	14.1	0.46	0.698	1	ARY
HJ 4723	AB	15019	−5155	7.57	9.99	167.3	5.31	0.657	1	ARY
HJ 4728		15051	−4703	4.56	4.60	64.5	1.82	0.661	5	ARY
HDO 242	AC?	15053	−4104	5.24	12.5	182.9	49.47	0.682	1	ARY
CPO 415	AB	15107	−4344	7.07	7.66	19.7	49.74	0.661	3	ARY
ANON 2	AC	15107	−4344	7.07		162.4	34.12	0.654	1	ARY
DUN 178	AC	15116	−4517	6.53	7.31	256.1	30.63	0.669	3	ARY
DUN 176		15123	−5206	3.50	6.74	248.7	71.64	0.663	2	ARY
HLD 121		15128	−5202	7.65	8.85	213.9	2.19	0.653	2	ARY
HJ 4735		15128	−6024	7.59	10.52	32.9	7.10	0.646	2	ARY
I 228		15140	−4348	7.98	8.24	13.1	1.24	0.679	2	ARY
I 329	AB	15140	−6121	6.72	7.68	345.7	1.03	0.704	1	ARY
I 329	AC	15140	−6121	6.72	9.61	297.6	44.89	0.704	1	ARY
DUN 179	AC	15145	−4323	7.32	8.53	45.4	10.54	0.667	2	ARY
HDO 244		15153	−4409	6.72	9.64	39.2	14.02	0.676	1	ARY
HJ 4753	AB	15185	−4753	4.93	4.99	299.0	0.83	0.659	4	ARY
DUN 180	AC					128.1	23.22	0.656	2	ARY
BU 227	AB	15192	−2416	7.53	8.64	163.2	1.99	0.688	2	ARY
HJ 4756		15197	−2416	7.90	8.27	246.7	0.58	0.690	1	ARY
LV 6		15206	−2701	7.87	10.0	28.2	16.73	0.690	1	ARY
I 332	AB	15207	−6729	6.42	8.23	108.1	1.25	0.665	1	ARY
I 332	AC	15207	−6729	6.42		71.9	55.23	0.665	1	ARY
HWE 76		15215	−3813	6.55	9.31	122.5	5.62	0.682	2	ARY
COO 186		15226	−5910	7.60	10.61	53.3	7.21	0.646	1	ARY
DUN 182	AC	15227	−4441	3.56	9.1	168.9	26.14	0.660	2	ARY

HJ 4757		15234	−5919	4.94	5.73	359.5	0.96	0.652	4	ARY
DUN 183	AB	15253	−3844	4.59	9.38	203.4	93.34	0.682	1	ARY
I 87	BC	15253	−3844	9.38	9.74	206.6	0.94	0.682	1	ARY
HJ 4774	AB,C	15290	−2852	6.98	9.63	10.7	9.66	0.698	1	ARY
CPO 16	AB	15295	−5821	7.03	7.98	34.0	2.58	0.652	2	ARY
CPO 16	AC	15295	−5821	7.03	10.2	194.8	67.02	0.652	2	ARY
B 2036	AB	15313	−3349	7.7	7.9	3.0	0.39	0.682	1	ARY
S 672		15317	−2010	6.31	8.94	279.3	11.47	0.685	1	ARY
LAL 123	AB	15332	−2429	6.94	7.00	301.8	9.27	0.685	1	ARY
HJ 4786	AB	15351	−4110	2.95	4.45	277.4	0.95	0.653	4	ARY
HJ 4788		15359	−4457	4.68	6.51	12.3	2.09	0.672	2	ARY
HRG 119	AC	15367	−4208	9.11	10.60	184.2	13.52	0.698	1	ARY
HDO 250		15381	−4234	4.33	11.16	30.0	11.82	0.698	1	ARY
DUN 189	AB	15388	−5222	5.42	10.72					ARY
BU 121		15396	−2739	8.41	8.46	283.6	2.02	0.694	2	ARY
BU 122		15399	−1946	7.65	7.67	226.9	1.74	0.685	1	ARY
I 89		15411	−3959	6.84	8.13	168.6	1.49	0.659	2	ARY
ARG 28	AB	15419	−3009	7.86	10.10	23.8	35.34	0.682	1	ARY
ARG 28	AC	15419	−3009	7.86	10.40	331.7	35.92	0.682	1	ARY
BU 35	AB	15428	−1601	7.27	8.69	112.4	2.35	0.685	1	ARY
BU 354		15432	−2525	7.31	9.30	290.7	5.89	0.687	1	ARY
HJ 4797		15442	−5013	6.86	10.62	257.8	21.07	0.687	1	ARY
HLD 124		15450	−5047	6.61	8.45	191.0	2.15	0,687	1	ARY
HJ 4795	AB	15450	−5907	7.58	10.43	230.4	7.84	0.657	1	ARY
HJ 4795	AC	15450	−5907	7.58	12.0	124.8	21.46	0.657	1	ARY
HJ 4795	DE	15450	−5907	10.2	11.4	234.3	7.89	0.657	1	ARY
DUN 191	AB,C	15453	−5841	7.75	8.09	295.9	32.62	0.657	1	ARY
BU 620	AB	15462	−2804	7.58	7.03	173.9	0.74	0.694	2	ARY
HJ 4803	AC	15462	−2804	7.58	8.97	212.5	50.48	0.698	1	ARY
BU 36		15536	−2520	4.69	6.98	268.4	2.36	0.700	2	ARY
DUN 195	AB	15548	−5020	6.81	7.46	9.4	12.11	0.687	1	ARY
DUN 194	AC	15549	−6045	6.35	9.97	47.3	44.10	0.704	1	ARY
DUN 194	AD	15549	−6045	6.35	9.02	356.9	48.43	0.704	1	ARY
HJ 4813		15555	−6011	5.91	8.36	102.7	4.81	0.704	1	ARY
PZ 4		15569	−3358	5.09	5.56	49.5	10.32	0.685	3	ARY
SPM 33		15571	−4810	6.34	11.52	313.7	33.90	0.687	1	ARY
SHJ 213		15591	−1956	8.11	8.50	317.9	17.84	0.677	2	ARY
RMK 21	AB	16001	−3824	3.37	7.50	18.7	14.97	0.646	1	ARY
BU 38		16029	−2501	7.17	9.45	344.5	4.53	0.685	1	ARY
ANON 3		16034	−6030	10.5	11	294.7	14.85	0.665	1	ARY
HJ 4825	AB,C	16035	−5747	4.64	8.02	242.1	11.33	0.704	1	ARY
RSS 29		16037	−6030	7.13	8.11	179.2	53.02	0.685	2	ARY
HWE 82		16038	−3304	7.71	7.86	345.9	2.33	0.674	2	ARY
H 3 7	AC	16054	−1948	2.59	4.52	20.0	13.94	0.685	1	ARY
DUN 199	AC	16086	−3906	6.62	7.13	183.8	44.30	0.649	1	ARY
ANON 4		16094	−3242	11.1	12.4	14.6	67.08	0.663	1	ARY
BSO 11	AB	16095	−3239	6.70	7.23	85.1	7.87	0.674	2	ARY
BSO 11	AC	16095	−3239	6.70		90.6	56.13	0.663	1	ARY
BU 40	AB	16118	−2733	8.07	9.86	350.5	4.91	0.704	2	ARY
BU 120	AB	16120	−1928	4.35	5.31	1.8	1.55	0.698	1	ARY

MTL 2	CD	16120	−1928	6.60	7.23	56.2	2.48	0.698	1	ARY
HJ 4839	AB	16123	−2825	5.80	8.13	69.0	3.75	0.692	2	ARY
SEE 268		16147	−3908	8.38	8.53	190.0	1.76	0.653	2	ARY
SKF1313		16149	−2529	6.06	9.87	36.1	46.18	0.666	2	ARY
SEE 271		16193	−4240	5.83	6.86	112.9	0.38	0.657	1	ARY
BLM 4	Aa,A	16212	−2536	3.06	5.24	225	0.5	0.682	2	ARY
H 4 121	AB	16212	−2536	2.89	8.42	272.5	20.27	0.668	4	ARY
HJ 4843		16214	−3318	7.42	11.50	268.9	12.77	0.685	1	ARY
BU 624		16229	−2307	7.81	9.30	325.0	1.44	0.676	1	ARY
HJ 4845		16238	−4115	8.10	8.47	124.5	1.77	0.657	1	ARY
HJ 4848	AB	16239	−3312	6.93	7.29	152.7	6.20	0.685	1	ARY
H N 39		16247	−2942	5.89	6.60	0.5	4.21	0.682	1	ARY
COO 197	AB	16253	−4909	8.11	8.23	93.2	2.53	0.665	4	ARY
H 2 19	AB	16256	−2327	5.07	5.74	337.6	3.18	0.661	2	ARY
HJ 4853		16272	−4733	4.51	6.12	333.9	22.86	0.660	1	ARY
GNT 1		16294	−2626	0.96	5.4	276.0	3.16	0.673	4	ARY
HDS2335		16315	−3901	7.39	10.48					ARY
HJ 4866		16397	−5700	7.23	7.79	122.8	3.65	0.665	1	ARY
SLR 12	AB	16399	−4747	8.00	8.07	156.3	1.42	0.666	2	ARY
HJ 4871	AC	16399	−4747	8.00	10.8	41.3	35.39	0.660	1	ARY
B 1818		16408	−6027	6.29	9.09	34.9	1.32	0.665	1	ARY
SLR 21		16411	−4745	7.39	9.41	316.9	1.90	0.666	2	ARY
DUN 206	AC	16413	−4846	5.71	6.76	264.5	10.20	0.652	2	ARY
HJ 4876	AD	16413	−4846	5.71	10.5	161.2	13.30	0.660	1	ARY
R 283		16425	−3705	6.98	7.83	244.7	0.91	0.662	2	ARY
BU 1116	AB	16443	−2727	6.58	10.15	19.9	2.42	0.698	1	ARY
DUN 209	AB	16482	−3653	7.51	8.37	138.0	14.91	0.679	2	ARY
HJ 4889		16510	−3731	6.23	7.77	4.7	6.70	0.669	3	ARY
WFC 181	AC	16519	−3803	2.97	9.41	256.6	80.60	0.679	2	ARY
HJ 4890		16540	−4655	7.92	8.14	319.7	30.41	0.643	1	ARY
HJ 4893	AB	16544	−4150	7.44	9.6	53.2	7.03	0.655	2	ARY
ANON 5		16548	−4150	10	10	192.9	5.45	0.657	1	ARY
ANON 6		16548	−4150	10.5	11.5	312.7	3.66	0.657	1	ARY
COO 289	AC	16569	−4031	7.27	9.48	252.7	7.94	0.651	2	ARY
COO 289	AD	16569	−4031	7.27	9.61	236.8	15.24	0.651	2	ARY
COO 289	AE	16569	−4031	7.27		339.4	38.19	0.649	1	ARY
SEE 316		17004	−4839	6.34	7.69	173.1	0.99	0.665	3	ARY
HLD 131		17011	−5633	6.37	9.86	134.2	2.21	0.672	2	ARY
HJ 4901		17011	−5851	8.26	8.47	130.5	2.78	0.679	1	ARY
COO 206	AB	17029	−5010	7.29	8.14	233.1	8.03	0.665	1	ARY
SIN 99	AC	17029	−5010	7.29	8.14	129.1	57.80	0.665	1	ARY
SEE 318		17062	−3838	8.36	8.65	356.8	1.36	0.660	2	ARY
HDO 266	AB	17063	−3714	5.69	10.0	78.7	5.77	0.660	2	ARY
HDO 266	AC	17063	−3714	5.69	12.5	31.8	53.83	0.649	1	ARY
COO 208		17074	−4427	7.11	9.2	137.1	4.99	0.667	2	ARY
DUN 213		17103	−4644	6.96	8.26	167.9	8.25	0.655	3	ARY
HJ 4920		17130	−5836	7.03	9.20	322.0	2.92	0.679	1	ARY
DUN 214	AB	17133	−6712	5.99	8.78	16.0	39.05	0.641	1	ARY
BAU 48	AB	17133	−6712	5.99	12.02	168.8	53.16	0.641	1	ARY
HWE 86		17139	−3818	6.91	8.96	149.6	2.57	0.660	2	ARY

SHJ 243	AB	17153	−2636	5.12	5.12	142.7	5.36	0.665	4	ARY
I 408		17163	−4220	6.96	8.88	177.9	1.72	0.682	1	ARY
H 1 35		17177	−2638	6.94	9.09	336.5	5.81	0.676	2	ARY
MLO 4	AB	17190	−3459	6.37	7.38	124.0	0.86	0.658	4	ARY
BSO 13	AB	17191	−4638	5.61	8.88	258.3	10.78	0.669	4	ARY
HJ 4931		17206	−5926	7.76	7.78	256.0	0.88	0.679	1	ARY
COO 213	AB	17228	−5828	6.87	9.34	284.6	9.20	0.679	1	ARY
HJ 4942	AB	17254	−5623	3.32	10.21	326.1	18.42	0.704	1	ARY
HJ 4942	AC	17254	−5623	3.32	12.16	64.4	41.23	0.704	1	ARY
BU 128		17268	−2620	7.49	9.86	325.7	4.56	0.698	1	ARY
HJ 4949	AB	17269	−4551	5.63	6.46	251.1	2.12	0.709	1	ARY
DUN 216	AC	17269	−4551	5.63	7.12	311.6	102.54	0.709	1	ARY
SEE 328	AB	17272	−5038	5.91	10.91	159.2	75.51	0.704	1	ARY
DUN 217		17290	−4358	6.29	8.52	168.6	13.32	0.696	2	ARY
B 342		17294	−3831	6.82	7.57	115.4	0.41	0.673	2	ARY
HWE 39	AB	17301	−3343	6.74	9.53	322.3	4.29	0.698	1	ARY
HO 646	AC	17301	−3343	6.74	11.3	313.9	14.09	0.698	1	ARY
HO 646	AD	17301	−3343	6.74	9.41	28.2	59.02	0.698	1	ARY
HJ 4951	AE	17311	−6041	3.64	10.96	323.5	50.41	0.692	2	ARY
HWE 87		17313	−3901	7.44	9.01	232.6	3.16	0.647	2	ARY
HLD 136	AB	17317	−4102	7.81	8.06	106.0?	1.08	0.649	2	ARY
ARY 114	AC	17317	−4102	7.81	8.5	250.5	64.92	0.649	2	ARY
I 40		17318	−4602	6.03	10.5	209.7	20.54	0.709	1	ARY
HJ 4955		17318	−4953	2.79	11.13	346.6?	48.71	0.704	1	ARY
ANON 7	AB	17319	−3908	11	11	168.4	9.12	0.651	1	ARY
ANON 7	AC	17319	−3908	11	12	166.0	43.9	0.651	1	ARY
DUN 218	AC	17336	−3706	1.60	9.17	329.5	94.38	0.659	2	ARY
I 106		17373	−4915	7.27	8.26	35.0	1.22	0.663	2	ARY
POL 4	AB	17415	−5328	7.79	10.37	296.3	10.78	0.665	1	ARY
POL 4	AC	17415	−5328	7.79		23.6	44.95	0.665	1	ARY
ANON 8		17424	−4618	7.46		293.2	93.14	0.709	1	ARY
ANON 9		17423	−4621	8.46		350.2	55.74	0.709	1	ARY
R 303		17451	−5408	7.94	9.0	108.2	3.57	0.679	4	ARY
CPO 17		17456	−5047	8.07	8.12	172.1	1.17	0.663	2	ARY
HJ 4982		17505	−4817	7.02	9.31	57.4	40.59	0.663	2	ARY
HJ 4978		17505	−5337	5.69	9.22	267.7	12.26	0.691	2	ARY
HJ 4979		17521	−6024	7.49	10.02	236.9	10.03	0.679	1	ARY
SEE 342		17534	−3454	5.85	7.89	203.3	0.50	0.673	2	ARY
COO 222	AB	17568	−3956	7.87	8.41	124.2	3.61	0.659	4	ARY
COO 222	AC	17568	−3956	7.87		27.2	73.32	0.649	1	ARY
RMK 22		17572	−5523	7.02	7.93	96.7	2.38	0.679	1	ARY
R 306	AB	17579	−3600	6.83	9.49	17.6	3.41	0.660	3	ARY
I 1013		17580	−3908	6.46	8.19	132.5	1.17	0.674	1	ARY
DUN 219	AB	17589	−3652	5.84	7.75	253.3	54.21	0.663	3	ARY
DUN 219	AC	17589	−3652	5.84	11.3	173.8	40.69	0.663	3	ARY
PZ 6	AB	17591	−3015	5.39	6.96	104.4	5.90	0.664	2	ARY
PZ 6	AC	17591	−3015	5.39	13.2	239.5	26.11	0.652	1	ARY
HJ 5000	AB	17592	−3656	7.10	8.96	103.1	7.67	0.663	3	ARY
HWE 88	A,BC	18057	−3635	7.89	8.85	4.5	3.13	0.674	3	ARY
HWE 88	AC	18057	−3635	7.89	11	196.2	81.63	0.649	1	ARY

HWE 88	AD	18057	−3635	7.89	12	223.8	41.66	0.649	1	ARY
ANON 10		18057	−3635	9	9	237.7	12.15	0.649	1	ARY
HJ 5011		18064	−4145	7.58	8.48	344.1	28.34	0.689	2	ARY
HJ 5014		18068	−4325	5.65	5.68	2.7	1.81	0.674	4	ARY
RSS 472		18069	−2905	7.80	11.6					ARY
HJ 5015		18085	−4546	6.15	9.55	258.2	4.33	0.683	2	ARY
BU 244		18086	−2752	7.61	9.06	269.9	2.45	0.672	2	ARY
WNO 21		18089	−2528	6.78	8.76	64.0	13.57	0.690	1	ARY
BU 245		18101	−3044	5.77	7.99	345.3	4.14	0.665	2	ARY
HJ 5023		18108	−4026	8.34	8.59	275.5	9.12	0.675	2	ARY
BU 132	AB	18112	−1951	7.01	7.13	187.9	1.53	0.683	2	ARY
HJ 5030		18117	−2342	5.08	11.51	286.0	43.31	0.683	2	ARY
BU 759	AB	18122	−3921	8.79	9.17	124.4	2.02	0.675	2	ARY
HJ 5028	AC	18122	−3921	8.79	9.42	148.1	14.89	0.675	2	ARY
ANON 11	AB	18137	−4102	7.00	11	354.1	25.88	0.668	1	ARY
ANON 12	AC	18137	−4102	7.00	11	76.4	27.90	0.668	1	ARY
HJ 5029		18151	−5751	8.28	8.55	81.6	1.84	0.679	1	ARY
HJ 5034		18162	−4601	7.52	8.59	100.0	2.37	0.709	1	ARY
I 1020		18164	−4028	8.20	7.97	273.0	0.48	0.682	1	ARY
BU 760	AB	18176	−3646	3.30	8.0	110.3	3.46	0.655	3	ARY
I 249		18197	−6353	6.25	10.8	349.7	7.99	0.679	1	ARY
DUN 220		18222	−5534	8.07	8.45	177.1	31.17	0.692	2	ARY
GLE 2		18232	−6130	4.54	8.1	158.6	3.71	0.679	1	ARY
BU 133		18277	−2638	6.59	8.48	233.2	0.77	0.666	2	ARY
ANON 13	AC	18281	−2645	6.27	8.67	134.9	54.43	0.690	1	ARY
H N 125		18289	−2503	8.21	8.48	107.9	2.68	0.666	2	ARY
WNO 6		18290	−2635	6.67	7.99	182.0	41.83	0.666	2	ARY
HWE 43	AB	18311	−3259	5.41	9.78	185.1	3.40	0.641	1	ARY
DUN 222		18334	−3844	5.58	6.16	358.4	21.46	0.663	1	ARY
STN 62		18345	−3449	7.57	7.77	134.9	2.42	0.653	2	ARY
COO 227	AB	18438	−3819	5.12	10.01	213.2	29.46	0.652	2	ARY
KUI 88		18488	−1836	6.87	8.14	158.0	0.65	0.671	1	ARY
HJ 5070		18513	−2201	9.04	9.26	50.5	9.68	0.671	1	ARY
I 112	AB	18540	−4716	7.11	9.05	192.9	2.11	0.709	1	ARY
DUN 224	AC	18540	−4716	7.11	7.28	61.8	87.20	0.709	1	ARY
HJ 5074		18592	−3932	6.49	11.8	245.6	16.11	0.698	1	ARY
BSO 14	AB	19011	−3704	6.33	6.58	280.5	13.36	0.645	2	ARY
B 957	AC	19016	−3653	7.34	9.57	22.7	57.64	0.641	1	ARY
HDO 150	AB	19026	−2953	3.27	3.48	251.8	0.63	0.657	5	ARY
HJ 5082	AB	19031	−1915	6.15	9.00	89.1	7.65	0.661	2	ARY
HJ 5082	AC	19031	−1915	6.15	10.8	112.4	20.17	0.661	2	ARY
R 317	AB	19031	−4543	7.95	8.83	286.7	1.72	0.645	2	ARY
HJ 5078	AC	19031	−4543	7.95	8.83	211.7	18.62	0.649	1	ARY
HJ 5078	AC	19031	−4543	7.95	8.83	211.2	19.24	0.641	1	ARY
H N 129		19042	−2254	6.90	9.16	309.1	8.25	0.663	3	ARY
H N 126		19043	−2132	7.87	8.06	185.6	1.41	0.668	4	ARY
HJ 5084		19064	−3704	4.53	6.42	343.2	1.56	0.653	4	ARY
S 710		19069	−1614	6.10	8.42	0.4	6.40	0.676	1	ARY
S 711	AB	19081	−2650	7.27	8.65	123.6	45.33	0.663	3	ARY
COO 233	AB	19087	−3348	8.15	9.04	255.5	12.03	0.660	2	ARY

ANON 14	AC	19087	−3348	8.15	11	332.8	11.24	0.649	1	ARY
DUN 225	AB	19124	−5148	7.24	8.36	250.0	70.18	0.671	2	ARY
HU 1654	AC	19124	−5148	7.24	11.0	261.3	28.23	0.663	1	ARY
HJ 5094	AB	19127	−3351	7.34	7.78	182.3	31.27	0.666	2	ARY
HJ 5092		19139	−4722	8.06	8.35	350.7	17.96	0.680	3	ARY
GLE 3		19172	−6640	6.12	6.42	351.1	0.55	0.679	1	ARY
S 715		19177	−1558	7.07	7.90	17.3	8.40	0.676	1	ARY
H 5 77		19182	−1852	6.97	10.37	159.4	36.35	0.676	1	ARY
I 116	AB	19240	−4557	8.57	9.43	24.0	2.67	0.671	1	ARY
I 116	AC	19240	−4557	8.58	8.62	190.3	15.91	0.674	2	ARY
SEE 375		19267	−2619	7.77	12.0	167.8	12.65	0.654	2	ARY
H N 119		19299	−2659	5.61	8.82	143.9	7.46	0.652	3	ARY
S 722	AB	19392	−1654	7.17	7.45	236.2	10.30	0.676	1	ARY
HJ 599	AC	19407	−1618	5.42	7.65	41.0	45.54	0.676	1	ARY
COO 238		19423	−5257	7.70	9.30	45.6	3.47	0.679	1	ARY
I 119		19426	−5901	7.93	8.95	151.2	2.54	0.652	1	ARY
HJ 5132		19440	−6618	7.61	9.74	308.7	21.53	0.694	2	ARY
BU 467		19465	−2131	7.68	9.91	137.4	3.72	0.690	2	ARY
HJ 5140		19498	−6454	8.19	8.33	253.9	1.47	0.694	2	ARY
I 122		19507	−4152	7.77	10.09	336.4	5.30	0.709	1	ARY
DUN 229		19583	−5154	7.65	8.23	242.1	80.87	0.679	1	ARY
HDO 294		20012	−3835	8.08	9.11	34.6	1.25	0.665	1	ARY
HJ 5163		20051	−6304	7.73	8.44	248.7	1.32	0.709	1	ARY
HJ 5168	AB	20074	−2943	6.85	10.30	79.2	18.75	0.654	1	ARY
HJ 5168	AC	20074	−2943	6.85		100.6	72.62	0.654	1	ARY
HDO 295		20111	−5731	6.76	7.68	283.2	0.45	0.641	1	ARY
HJ 5171	AB	20146	−6426	6.94	9.75	305.8	17.00	0.694	2	ARY
HJ 5171	AC	20146	−6426	6.94	9.96	335.0	34.57	0.694	2	ARY
H 5 87		20194	−1907	5.43	9.43	178.5	55.88	0.654	1	ARY
SEE 415		20209	−4533	7.39	12.0	96.8	11.03	0.657	1	ARY
BU 763	AB	20239	−4225	5.67	7.25	351.6	0.43	0.664	3	ARY
R 321		20269	−3724	6.58	8.09	128.2	1.69	0.666	3	ARY
BU 60	AB	20273	−1813	5.13	8.53	149.3	3.63	0.656	2	ARY
RSS 36		20280	−4237	8.22	8.77	266.9	35.68	0.659	2	ARY
SHJ 323	AB	20289	−1749	4.97	6.88	193.7	1.54	0.656	2	ARY
SHJ 324		20299	−1835	5.91	6.68	238.0	21.83	0.656	2	ARY
HJ 5194		20303	−6904	7.12	11.22	257.3	3.83	0.668	1	ARY
GLI 259	AB	20319	−4054	8.44	8.44	158.9	4.08	0.663	2	ARY
HJ 2973	AB	20322	−2209	7.77	8.10	129.3	39.58	0.674	1	ARY
HJ 2975		20335	−2214	7.54	11.56	20.5	10.26	0.674	1	ARY
JC 18	AB	20338	−4033	7.78	8.54	224.3	4.61	0.663	2	ARY
I 41		20365	−4533	7.74	8.53	356.2	2.26	0.664	2	ARY
HJ 5211	AB	20409	−4224	6.26	10.10	298.9	19.96	0.651	2	ARY
BU 674	AB	20448	−2054	7.95	9.63	99.1	1.95	0.674	1	ARY
BU 153		20473	−2625	7.43	9.02	250.6	1.93	0.663	2	ARY
STN 53		20479	−2745	7.70	10.73	174.9	18.12	0.674	1	ARY
S 763	AB	20484	−1812	7.24	7.79	292.9	15.78	0.654	1	ARY
HJ 5226		20501	−2722	7.25	8.79	67.4	18.80	0.663	2	ARY
RMK 26		20516	−6226	6.23	6.58	81.7	2.69	0.689	2	ARY
HJ 5228		20517	−4054	7.37	9.33	104.1	32.49	0.665	1	ARY

HJ 3003		20530	−2347	6.57	8.57	197.9	1.43	0.663	2	ARY
SKF1168		20531	−4637	7.60	11.6	231.2	16.85	0.665	1	ARY
I 1429		20548	−4636	7.80	8.82	146.8	1.12	0.665	1	ARY
DUN 236		21022	−4300	6.68	6.95	72.6	57.45	0.663	2	ARY
SKF1173		21237	−3947	7.51	8.98	153.1	93.96	0.665	1	ARY
COO 250		22130	−4903	7.74	10.42	352.4	5.47	0.676	1	ARY
I 20		22180	−6249	7.36	8.42	187.5	0.65	0.663	1	ARY
HJ 5334	AB	22273	−6458	4.49	8.73	279.4	6.77	0.663	1	ARY
COO 252	AB	22426	−4713	6.00	11.10	125.1	7.14	0.641	1	ARY
COO 252	AC	22426	−4713	6.06	9.50	210.6	45.31	0.641	1	ARY
DUN 245		23086	−5944	7.45	9.44	289.7	13.61	0.709	1	ARY
DUN 247		23180	−6100	6.87	8.17	294.4	51.80	0.686	2	ARY
DUN 249		23239	−5349	6.14	7.07	211.4	26.35	0.709	1	ARY

Table 2: Residuals from known orbits

Pair	Residual(O−C) PA(°)	Sep (″)	Orbit	Period(yrs)	Date	Grade
I 45	+2°.0	+0″.13	Zirm	665.1	2013	5
SLR 1	+0°.4	+0″.11	Argyle	170.7	2015	3
I 27 CD	−1°.1	+0″.11	Söderhjelm	85.2	1999	3
HJ 3423 A-CD	−0°.9	−0″.19	Scardia	857	2005	5
DUN 5	−0°.5	−0″.17	Scardia	475.2	2015	4
R 207	−8°.6	+0″.26	Rica	194.276	2012	5
HWE 28	+1°.4	+0″.10	Docobo	373	2015	4
RHD 1	+1°.3	+0″.09	Pourbaix	79.91	2016	2
RHD 1	+1°.8	+0″.10	Pourbaix	79.91	2016	2
RHD 1	+2°.0	+0″.04	Pourbaix	79.91	2016	2
RHD 1	+2°.0	+0″.02	Pourbaix	79.91	2016	2
DON 680	+2°.2	+0″.23	Zirm	261.4	2014	5
HJ 4707	+2°.8	−0″.04	Mason	346	1999	4
BU 239	−2°.1	0″.00	Ling	429.19	1998	4
HJ 4757	+4°.6	+0″.13	Hartkopf	258	2010	4
B 2036	+2°.0	−0″.01	Hartkopf	227.78	2011	4
HJ 4786	+1°.1	+0″.12	Heintz	190	1990	3
COO 197	+0°.7	+0″.21	Argyle	1132	2015	5
H 2 19	+0°.5	+0″.31	Novacevic	2398	2007	5
GNT 1	−1°.2	+0″.58	Pavlovic	1217.536	2005	5
R 283	−0°.1	+0″.07	Argyle	691	2015	4
SEE 318	+0°.1	+0″.44	Zulevic	285.08	1987	5
BSO 13	+0°.3	+0″.25	Scardia	953	2013	5
MLO 4	+1°.9	+0″.01	Soderhjelm	42.15	1999	2
SEE342	−1°.3	+0″.08	Alzner	700	2009	5
HJ 5000	+0°.8	+0″.25	Zasche	1219.7	2009	5
HJ 5014	+3°.5	+0″.07	Argyle	450	2001	4
BU 132	+1°.0	+0″.13	Hartkopf	3021.1001	2011	5
KUI 88	+3°.4	+0″.14	Hartkopf	909.7	2013	4
HJ 5084	+1°.1	+0″.13	Heintz	121.76	1986	2

HDO 150	$+1^\circ.8$	$+0''.04$	De Rosa	21.0	2012	1
H N 126	$+2^\circ.2$	$+0''.16$	Heintz	500	1998	4
GLE 3	$-0^\circ.6$	$+0''.02$	Docobo	156.8	2007	3
HDO 294	$-0^\circ.3$	$-0''.10$	Dommanget	4484.5	1978	5
SHJ 323	$+5^\circ.4$	$-0''.26$	Heintz	278	1986	5
I 20	$+1^\circ.5$	$-0''.02$	Ling	982.79	2004	5

Notes

Pair	Notes
ANON 1	14151-6139 A = HD 124327 B = TYC 9005-3946-1.
ANON 2	15107-4344 = CPO 415 AC.
ANON 3	16034-6030. In NGC6025.
ANON 4	16094-3242. In field with BSO 11. A = TYC 7334-933-1. B = TYC 7334-225-1.
ANON 5	16548-4150. In NGC 6231.
ANON 6	16548-4150. In NGC 6231.
ANON 7	17319-3908. Close and wide triple 100″ NW of HD 158530.
ANON 8	17424-4618. A = V867 Ara.
ANON 9	18057-3635. A = HD 160465. In same field as HWE 88. TYC 7403-6685-1 + TYC 7403-6525-1.
ANON 10	18137-4102. A = HD 166701.
ANON 11	18281-2645. A = HD 169938.
ANON 12	19087-3348 = COO 233 AC.
ANON 13	18281-2645. AB = HDS 2615. A = HD 169938. C = HD 169969.
ANON 14	19087-3348. A = HD 178341.

References

Argyle, R. W., *Webb Society Double Star Section Circulars*, **22**, 4, 2014

Acknowledgements

Permission to use the telescope was granted by the South African Association for Science Technology Advancement, specifically Dr. Shadrack Mkansi. Vital technical support was provided by the Johannesburg Centre of the Astronomical Society of Southern Africa especially by Jerome Jooste. This paper has benefitted from the use of the WDS, maintained by the United States Naval Observatory. The Cartes du Ciel software was used in collaboration with this work and proved extremely useful. Dr. Rainer Anton kindly provided some recent astrometry on β^1 Sgr.

MICROMETRIC MEASURES OF DOUBLE STARS IN 2016

Jean-François Courtot, Chaumont, France

E-mail: jeff6bwo@yahoo.fr

Introduction

The measurements presented here have been made during 2016 using a homemade 205 mm Newtonian and either a Retel filar micrometer (F) at a power of x508 or a Lyot double-image micrometer (L) at x 464. The procedures have been outlined in previous circular DSSC 23 (1). Further indications on some observed peculiarities with double-image micrometers can be found also in DSSC 24 (2). As a complement, a short description follows about the determination of East-West direction with the Lyot double-image micrometer.

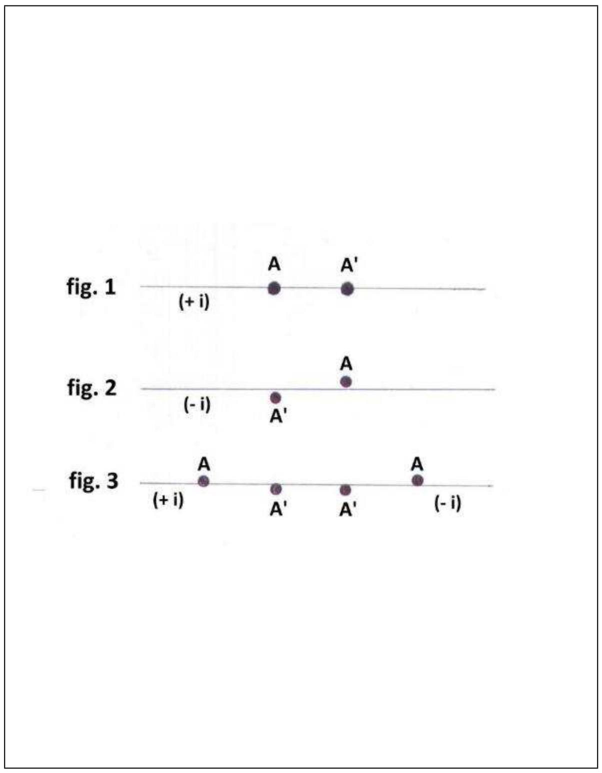

Figure 1,2,3 Position angle setting configurations in the Lyot micrometer - see text

Although not necessary for current position angle measurements with a double-image micrometer, a threaded, or reticle-eyepiece, and field illumination is needed to determine the East-West direction. After a sufficiently bright single star near the meridian has been brought in the field, the spath blade is inclined from an angle i_{max} for maximum separation of ordinary and extraordinary images. Two images A and A$'$ of the same star are now observed in the field. The box of the micrometer is then rotated so that the two star images are nearly along the horizontal direction, parallel to the line of the observer's eyes whose head is normally vertical without any stress. Then, the box of the micrometer staying in position, the reticle-eyepiece only is rotated in its holder so that the thread appears exactly parallel to the direction defined by A and A$'$ (Fig. 1). This done, the spath blade is set at $-i_{max}$ or so to check if the two star images still stay exactly parallel to the thread after the spath blade inclination has been reversed. Depending on atmospheric conditions it may not be exactly the case since both ordinary and extraordinary images are differently polarized (2). Fig. 2 shows, exaggerated, what may be observed at $-i_{max}$. The difference can amount to 1° or so. If this is observed, an intermediate setting has to be found so that both images at i_{max}

and $-i_{max}$ appear successively in symmetrical positions as shown in Fig. 3.

The micrometer box is then rotated from 90° so that the thread and images appear in a vertical direction. Parallelism is checked in this position as well, both at i_{max} and $-i_{max}$. It has been observed that, possibly for some psycho-physiological or optical reason, parallelism or perpendicularity are more easily and accurately checked along a horizontal or vertical direction than along any other intermediate setting.

At this point, the spath blade inclination is set at zero. The eyepiece secured in its holder, the process of finding E–W direction is completed as usual, rotating the micrometer box only until the star runs exactly along the thread when the driving clock is stopped. Eventually, the E–W angle reading is averaged with the W–E direction (± 180°) to compensate for the error of eccentricity.

Measurements have been arranged as usual in Table 1. Table 2 gives a short comment on each measured pair whilst residuals O–C with recently computed orbits are to be found in Table 3.

Table 1 - Measures

Pair	Comp	RA	Dec	V_a	V_b	PA (°)	Sep ('')	Epoch	N	Obs.	Method
STF205	A-BC	02039	+4220	2.3	5.0	63.0	9.80	2016.084	3	CTT	F
KUI15	AB	03520	+0632	6.3	6.6	209.9	0.85	2016.079	1	CTT	F
STF550	AB	04320	+5355	5.8	6.8	308.6	10.13	2016.071	1	CTT	F
STF948	AB	06462	+5927	5.4	6.0	68.2	1.96	2016.198	3	CTT	F
STF948	AC	06462	+5927	5.4	7.3	309.4	9.00	2016.198	3	CTT	F
STF1126	AB	07401	+0514	6.6	7.0	175.7	0.88	2016.214	3	CTT	L
STF1196	AB	08122	+1739	5.3	6.3	17.6	1.12	2016.243	2	CTT	L
STF1196	AC	08122	+1739	5.3	5.9	62.0	6.22	2016.274	1	CTT	F
STF1333		09184	+3522	6.6	6.7	49.0	2.00	2016.303	2	CTT	F
STF1334	AB	09188	+3648	3.9	6.1	222.1	2.61	2016.297	2	CTT	F
STF1424	AB	10200	+1950	2.4	3.6	125.7	4.67	2016.318	4	CTT	F
STF1487		10556	+2445	4.5	6.3	112.0	6.56	2016.343	4	CTT	F
STF1523	AB	11182	+3132	4.3	4.8	169.1	1.88	2016.311	3	CTT	F
STF1536	AB	11239	+1032	4.1	6.7	95.7	2.15	2016.338	4	CTT	F
STF1555	AB	11363	+2747	6.4	6.8	148.2	0.76	2016.349	4	CTT	F+L
HJ503	AC	11363	+2747	6.4	11.2	156.2	22.45	2016.347	2	CTT	F
STF1639	AB	12244	+2535	6.7	7.8	324.7	1.88	2016.392	2	CTT	L
STF1768	AB	13375	+3618	5.0	7.0	96.6	1.73	2016.420	3	CTT	L
STF1835	A-BC	14234	+0827	5.0	6.8	194.8	6.03	2016.467	4	CTT	L
STF1909		15038	+4739	5.2	6.1	76.7	0.84	2016.503	5	CTT	L
STF2055	AB	16309	+0159	4.2	5.2	43.5	1.40	2016.517	4	CTT	L
STF2130	AB	17053	+5428	5.7	5.7	2.6	2.59	2016.536	4	CTT	L
STF2142	AB	17117	+4945	6.2	9.4	110.5	4.80	2016.574	4	CTT	F
STF2140	AB	17146	+1423	3.5	5.4	103.8	4.82	2016.562	8	CTT	F+L
STF2161	AB	17237	+3709	4.5	5.4	320.3	4.05	2016.626	4	CTT	F
STF2272	AB	18055	+0230	4.2	6.2	124.3	6.55	2016.648	4	CTT	F
STF2276	AB	18057	+1200	7.1	7.4	256.2	6.93	2016.583	4	CTT	F
STF2276	AC	18057	+1200	7.1	11.0	305.5	63.76	2016.584	4	CTT	F
STF2382	AB	18443	+3940	5.2	6.1	347.5	2.26	2016.623	4	CTT	F
STF2383	CD	18443	+3940	5.3	5.4	76.1	2.40	2016.618	4	CTT	F
STF2375	AB	18455	+0530	6.3	6.7	121.1	2.42	2016.659	4	CTT	F
STF2486	AB	19121	+4951	6.5	6.7	204.0	7.23	2016.662	4	CTT	F
STF2579	AB	19450	+4508	2.9	6.3	215.4	2.70	2016.673	4	CTT	F

STF2583	AB	19487	+1149	6.3	6.8	105.8	1.48	2016.688	4	CTT	F
STT388	AB	19524	+2551	8.3	8.5	137.4	3.76	2016.734	4	CTT	F
STT388	AC	19524	+2551	8.3	8.3	128.6	31.60	2016.734	4	CTT	F
STF2727	AB	20467	+1607	4.4	5.0	265.7	9.04	2016.698	4	CTT	F
STF2741	AB	20585	+5028	5.9	6.8	25.2	2.00	2016.791	4	CTT	L
STF2751		21021	+5640	6.2	6.9	355.2	1.63	2016.710	4	CTT	F
STF2780	AB	21118	+5959	6.1	6.8	214.4	1.09	2016.759	6	CTT	L
STF2863	AB	22038	+6438	4.5	6.4	274.4	8.19	2016.742	4	CTT	F
SHJ345	AB	22266	−1645	6.4	6.6	73.6	1.23	2016.760	5	CTT	F+L
STF2909	AB	22288	−0001	4.3	4.5	162.8	2.36	2016.800	4	CTT	L
STF2935	AB	22431	−0819	6.8	7.9	307.0	2.42	2016.859	3	CTT	L
STT489	AB	23079	+7523	4.6	6.8	4.1	1.12	2016.831	4	CTT	L

Table 2 – Notes

Pair	ADS	Notes
STF205A-BC	1630	γ^{1-2} And. Nearly fixed since W. Struve (1830).
KUI15AB		Slow retrograde relative motion (6° since 1937), getting wider: $+0''.5$.
STF550AB	3274	1 Cam. Fixed since W. Struve (1830).
STF948AB	5400	12 Lyn. Long period orbital pair. Slow retrograde relative motion: 88° in 185 years. Getting slightly wider: $+0''.4$.
STF948AC	5400	Nearly fixed since W. Struve (1831).
STF1126AB	6263	Slow direct relative motion: 43° in 187 years. Getting closer: $-0''.6$.
STF1196AB	6650	ζ Cnc. Fourth revolution since W. Struve (1826).
STF1196AC	6650	Long period orbital system. Retrograde relative motion: 94° in 190 years. Barycentre's position of (AB) determined using mass-luminosity relation before computing residuals with Heintz's orbit. Position angle and separation of C from barycentre: 65°.3 and $5''.89$.
STF1333	7286	Very slow direct relative motion: 9° in 188 years, getting slightly wider: $+0''.6$.
STF1334AB	7292	38 Lyn. Very slow retrograde relative motion: 19° in 187 years, separation without any noticeable change.
STF1424AB	7724	γ Leo. Very slow direct relative motion: 26° in 196 years, getting wider: $+1''$.
STF1487	7979	54 Leo. Very slow direct relative motion: 9° in 186 years.
STF1523AB	8119	ξ UMa. Orbital pair. Retrograde relative motion. Over 3 complete revolutions since W. Struve.
STF1536AB	8148	ι Leo. Orbital pair. Near the end of its first revolution since W. Struve (1832).
STF1555AB	8231	Very long period orbital pair. Direct relative motion: 168° in 187 years.
HJ503AC	8231	HJ503AC = STF1555AC. Direct relative motion: 8° in 172 years, getting wider: $+3''$.
STF1639AB	8539	Orbital pair. Direct relative motion: 32° in 180 years, getting wider.
STF1768AB	8974	25 CVn. Orbital pair. Retrograde relative motion: 339° in 185 years.
STF1835A-BC	9247	Very slow direct relative motion: 9° in 184 years. Separation without any noticeable change. Measurement with the double image micrometer in half distance configuration.
STF1909	9494	44 Boo. Orbital pair. Direct relative motion: 204° in 184 years. Getting closer.
STF2055AB	10087	λ Oph. Orbital pair. Direct relative motion. Second revolution since W. Struve (1825).
STF2130AB	10345	μ Dra. Long period orbital pair. Retrograde relative motion: 204° in 188 years. Getting wider.
STF2142AB	10397	Very slow retrograde relative motion: 4° or so since 1830. Getting closer: $-0''.5$. Nearly common proper motions according to WDS. $\pi_A = 10.54$ mas according to Simbad Catalogue. No parallax information found for B.
STF2140AB	10418	α Her. Very long period orbital pair. Retrograde relative motion: 14° in 187 years. Visual magnitudes and component spectral types sensibly different (M5 Ib / G5 III).

		Two sets of measurements using both micrometers for a possible chromatic differential effect. No significant difference observed. Internal relative errors better with the Lyot micrometer. 1. Lyot: 2016.554: 104°.1 ± 0.6 , 4″.83 ± 0″.02 (4n) x 464 2. Filar: 2016.569: 103°.5 ± 1.0 , 4″.81 ± 0″.07 (4n) x 508. Values in Table 1 are average values.
STF2161AB	10526	ρ Her. Slow direct relative motion: 14° in 186 years, getting slightly wider.
STF2272AB	11046	70 Oph. Nearby orbital pair ($\pi = 0''.2$). Third revolution since W. Struve (1825).
STF2276AB	11056	Nearly fixed since W. Struve (1830). PA 266° published in WDS Catalogue for 2014 in error of +10° . True value probably: 256° .
STF2276AC	11056	Nearly fixed since 1905.
STF2382AB	11635	ϵ^1 Lyr. Long period orbital pair. Retrograde relative motion: 39° in 185 years.
STF2383CD	11635	ϵ^2 Lyr. Long period orbital pair. Retrograde relative motion: 78° in 185 years.
STF2375AB	11640	Very slow direct relative motion: 14° in 187 years. Getting slightly wider: +0″.2.
STF2486AB	12169	Very slow retrograde relative motion: 20° in 184 years. Getting closer: −3″ .
STF2579AB	12880	δ Cyg. Orbital pair. Retrograde relative motion: 181° in 186 years.
STF2583AB	12962	Very slow retrograde relative motion: 14° in 187 years. Separation without any noticeable change.
STT388AB	13050	Nearly fixed since O. Struve (1848).
STT388AC	13050	Very slow retrograde relative motion: 7° in 109 years. Separation without any noticeable change.
STF2727AB	14279	γ Del. Physical pair. Very slow retrograde relative motion: 7° in 186 years. Getting closer: -2″.9.
STF2741AB	14504	Slow retrograde relative motion: 17° in 233 years.
STF2751	14575	Very slow direct relative motion: 11° in 184 years. Possibly getting closer: −0″.2.
STF2780AB	14749	Very slow retrograde motion: 13° in 185 years. Separation without any noticeable change.
STF2863AB	15600	ξ Cep. Very slow retrograde motion: 13° in 185 years. Getting wider: +2″.6.
SHJ345AB	15934	53 Aqr. Long period orbital pair. Near periastron. Direct relative motion: 131° in 193 years.
STF2909AB	15971	ζ Aqr. Long period orbital pair. Retrograde relative motion: 215° in 235 years.
STF2935AB	16208	Very slow retrograde relative motion: 6° in 185 years. Possibly getting slightly closer: −0.″15. Neptune in the same finder field.
STT489AB	16538	Orbital pair. Direct relative motion. Second revolution since 1846.

Table 3 - Residuals

Pair	ADS	Residual(O−C) PA(°)	Sep (″)	Orbit	Period(yrs)	Date	Grade
STF948AB	5400	+5°.9	+0″.26	Popovic	706	1996	4
		+1°.9	+0″.06	W.S.I.	908	2006	4
STF1196AB	6650	+1°.6	0″.00	W.S.I.	59.6	2006	1
STF1196AC	6650	−0°.0	−0″.04	Heintz	1115	1996	4
STF1523AB	8119	−0°.4	+0″.01	Mason	59.9	1995	1
STF1536AB	8148	+0°.9	+0″.01	Söderjhelm	186	1999	2
STF1555AB	8231	−2°.3	+0″.10	Docobo	916	2007	4
STF1639AB	8539	+1°.7	+0″.04	Olevic	575	2000	4
STF1768AB	8974	+1°.9	+0″.04	Söderhjelm	228	2000	3
STF1909	9494	+4°.9	+0″.08	Zirm	210	2012	2
STF2055AB	10087	+1°.1	−0″.02	Heintz	129	1993	2
STF2130AB	10345	+1°.1	+0″.06	Prieur	812	2012	4
STF2140AB	10418	+0°.9	+0″.18	Baize	3600	1978	4
STF2272AB	11046	−0°.2	+0″.09	Heintz	88	1973	1
		−0°.6	+0″.11	Pourbaix	88	2000	1

STF2272AB	11046	$-0^\circ.3$	$+0''.14$	Eggenberger	88	2008	1
STF2382AB	11635	$+2^\circ.0$	$-0''.07$	W.S.I.	1725	2004	4
		$+2^\circ.0$	$+0''.01$	Novakovic	1804	2006	4
STF2383CD	11635	$+0^\circ.6$	$+0''.01$	Docobo	724	1984	4
STF2579AB	12880	$-1^\circ.3$	$-0.''04$	Scardia	918	2012	4
STF2727AB	14279	$+0^\circ.8$	$+0''.10$	Hale	3249	1994	4
SHJ345AB	15934	$+5^\circ.4$	$-0''.05$	Hale	3500	1994	4
STF2909AB	15971	$-1^\circ.1$	$-0''.06$	Heintz	760	1984	4
		$+0^\circ.1$	$+0''.07$	Scardia	487	2010	3
STT489AB	16538	$+3^\circ.1$	$0''.00$	Scardia	163	2009	3

References

1) Courtot, J.-F., 2015, *Webb Society Double Star Circulars*, **23**, 6 sq.
2) Courtot, J.-F., 2016, *Webb Society Double Star Circulars*, **24**, 6-7.

Acknowledgements

Sincere thanks to Bob Argyle for arranging and editing this Circular and to our colleagues at the USNO Naval Observatory for maintaining the *Washington Double Star Catalogue*.

SOME 2016 MEASUREMENTS OF WIDE AND FAINT DOUBLE STARS

Wilfried R.A. Knapp, Vienna, Austria

E-mail: wilfried.knapp@gmail.com

Abstract: The number of my 2016 visual double star observation sessions remained modest due to ongoing cloudy weather conditions. Yet the number of objects with questionable WDS data (mostly suspect magnitudes for the secondary) found in these sessions or during session planning is rather high. Additionally several objects were suggested in private communications to be WDS listed with suspect data or to be of interest for other reasons. Images of these objects were taken with remote telescopes and then used for astrometry and photometry measurements to counter-check such impressions. This report presents the results of these measurements confirming in most cases the need for updating the current WDS catalog data but demonstrate in some cases also simply that visual impressions can be very misleading

Report:

1 Constellation Aql

Several observation sessions in this constellation gave for some objects the impression of wrong WDS magnitudes and one questionable object was suggested in a private email communication by Robert Korn. The WDS data per August 2016 are given in Table 1.1. The measurement results for these objects are given in Table 1.2 with the Notes column providing additional information about the used images and references to visual observation.

WDS-ID	Name		RA	Dec	Sep	PA	V_1	V_2
19364+1554	H5104	AB	19:36:22.98	+15:53:31.9	39.0	139	7.24	9.70
19213+0156	BAL1517	AB	19:21:17.96	+01:56:13.0	8.7	138	9.73	12.10
19260+0145	BU1468	AB	19:26:00.78	+01:45:19.4	29.4	332	8.74	11.18
19146+0251	BAL1989	AB	19:26:21.60	+02:15:48.6	10.8	54	11.70	12.50
19264+0218	BAL1990	AB	19:26:27.71	+02:18:12.6	2.7	184	11.16	11.80
19248+0254	BAL1985	AB	19:24:50.73	+02:53:16.8	16.0	302	10.72	12.70
19255+0307	BUP190	AB	19:25:29.75	+03:06:52.5	133.6	267	3.36	12.75
18465-0058	STF2379	AC	18:46:28.58	-00:57:41.9	25.0	148	5.88	10.90
18484-0115	BAL584	AB	18:48:20.64	-01:14:46.3	12.1	217	12.00	12.00
18488-0120	BAL585	AB	18:48:47.94	-01:20:41.5	4.6	148	9.80	10.10
19008-0027	HJ874	AB	19:00:45.40	-00:27:18.2	9.3	8	8.85	13.90
19008-0027	HJ874	AC	19:00:45.40	-00:27:18.2	24.8	299	8.85	12.00
19037-0024	J476	AB	19:03:45.79	-00:25:40.0	4.8	295	11.30	11.50

19025-0209	HJ875	AB	19:02:31.57	-02:09:19.2	14.9	90	11.24	12.50
19012-1009	B9036	AC	19:01:13.11	-10:09:00.9	13.5	125	10.56	12.20
19009-0829	J2248	AB	19:00:24.67	-08:30:11.4	9.7	195	12.20	13.00
19010-0827	J2249	AB	19:00:28.09	-08:28:30.4	7.8	227	11.80	12.30
19009-0722	J2934	AB	19:00:49.71	-07:22:49.9	6.8	81	9.40	12.00
19053-0610	BU974	AC	19:05:19.09	-06:10:23.8	19.6	119	9.96	12.70
19075-0514	RST4617	AB	19:07:32.35	-05:14:23.2	2.3	211	8.90	10.70
20377+0152	J3255	AB	20:37:29.82	+01:53:11.3	3.7	324	10.87	12.80
20377+0153	J1776	AB	20:37:29.84	+01:53:11.4	4.0	300	10.60	13.80

Table 1.1 WDS data per August 2016 for the selected Aql objects

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	$\rho('')$	$\epsilon_\rho('')$	θ	ϵ_θ	Mag	ϵ_{mag}	SNR	ΔV	Date	N
H 5104	A	19 36 23.060	15 53 33.37	0.06	0.07	39.271	0.092	139.608	0.135	7.117	0.060	498.70	0.06	2016.661	2
	B	19 36 24.824	15 53 03.46							11.812	0.061	87.10			
iT24 0.61m stack 2x3s. A too bright for reliable photometry. Indication that B might be far fainter than WDS listed by Robert Korn – confirmed by measurement															
BAL 1517	A	19 21 17.984	01 56 13.02	0.06	0.06	8.563	0.085	138.163	0.568	9.586	0.070	207.87	0.07	2016.661	5
	B	19 21 18.365	01 56 06.64							12.901	0.074	47.00			
iT24 0.61m stack 5x3s. B seemed fainter than WDS listed – confirmed by measurement															
BU 1468	A	19 26 00.789	01 45 19.42	0.05	0.06	29.660	0.078	331.036	0.151	8.543	0.060	310.32	0.06	2016.661	5
	B	19 25 59.831	01 45 45.37							11.222	0.061	104.22			
iT24 0.61m stack 5x3s. A too bright for reliable photometry. B seemed brighter than listed – measurement confirms WDS															
BAL 1989	A	19 26 21.603	02 15 48.54	0.07	0.07	10.826	0.099	54.088	0.524	12.104	0.091	71.82	0.09	2016.661	5
	B	19 26 22.188	02 15 54.89							12.562	0.092	57.36			
iT24 0.61m stack 5x3s															
BAL 1990	A	19 26 27.718	02 18 12.37	0,07	0,07	2,435	0,099	188,140	2,329	10,925	0,090	117,48	0.07	2016.661	5
	B	19 26 27.695	02 18 09.96							11,733	0,091	74,43			
iT24 0.61m stack 5x3s															
BAL 1985	A	19 24 50.741	02 53 16.78	0.06	0.07	15.955	0.092	302.021	0.331	10.769	0.080	136.33	0.08	2016.661	5
	B	19 24 49.838	02 53 25.24							12.694	0.082	55.79			
iT24 0.61m stack 5x3s															
BUP 190	A	19 25 30.196	03 06 54.05	0.07	0.07	136.966	0.099	266.249	0.041	6.180	0.072	64.25	0.07	2016.661	5
	B	19 25 21.071	03 06 45.09							12.771	0.073	56.17			
iT24 0.61m stack 5x3s. A too bright for reliable photometry. B seemed much fainter than listed – confirmed by measurement															
STF 2379	A	18 46 28.627	-00 57 42.43	0.06	0.06	23.418	0.085	147.498	0.208	6.315	0.060	493.70	0.06	2016.661	5
	C	18 46 29.466	-00 58 02.18							11.291	0.061	109.06			

iT24 0.61m stack 5x3s. A too bright for reliable photometry. C seemed fainter than listed – confirmed by measurement															
BAL 584	A	18 48 20.637	-01 14 46.30	0.06	0.07	12.216	0.092	217.511	0.432	12.034	0.052	76.83	0.05	2016.661	5
	B	18 48 20.141	-01 14 55.99							12.888	0.055	49.29			
iT24 0.61m stack 5x3s. B seemed fainter than listed – confirmed by measurement															
BAL 585	A	18 48 47.876	-01 20 40.11	0.06	0.07	4.622	0.106	148.724	1.143	11.092	0.051	113.36	0.05	2016.661	5
	B	18 48 48.036	-01 20 44.06							11.456	0.052	86.11			
iT24 0.61m stack 5x3s. Both components seemed fainter than listed – confirmed by measurement															
HJ 874	A	19 00 45.435	-00 27 18.23	0.07	0.08	10.517	0.106	345.462	0.579	7.145	0.080	531.87	0.08	2016.661	5
	B	19 00 45.259	-00 27 08.05							13.199	0.084	41.87			
iT24 0.61m stack 5x3s. A too bright for reliable photometry. There is some proper motion for A resulting in change of Sep and PA over time															
HJ 874	A	19 00 45.435	-00 27 18.23	0.07	0.08	25.344	0.078	299.266	0.240	7.145	0.080	531.87	0.08	2016.661	5
	C	19 00 43.961	-00 27 05.84							12.156	0.081	72.61			
iT24 0.61m stack 5x3s. A too bright for reliable photometry. C seemed tad fainter than listed – confirmed by measurement															
J 476	A	19 03 45.810	-00 25 40.17	0.06	0.06	4.775	0.085	294.365	1.018	11.613	0.071	86.85	0.07	2016.661	5
	B	19 03 45.520	-00 25 38.20							12.283	0.072	63.42			
iT24 0.61m stack 5x3s. Both components seemed fainter than listed – confirmed by measurement															
HJ 875	A	19 02 31.572	-02 09 19.37	0.06	0.06	14.885	0.085	90.462	0.327	11.347	0.071	106.89	0.07	2016.661	5
	B	19 02 32.565	-02 09 19.49							12.217	0.072	71.51			
iT24 0.61m stack 5x3s. B seemed much brighter than listed – measurement suggests only a tad brighter															
B 9036	A	19 01 13.107	-10 09 00.50	0.07	0.07	13.403	0.099	125.064	0.423	9.904	0.060	178.82	0.06	2016.661	5
	C	19 01 13.850	-10 09 08.20							12.291	0.062	64.37			
iT24 0.61m stack 5x3s															
J 2248	A	19 00 24.681	-08 30 11.54	0.06	0.06	9.440	0.085	195.870	0.515	12.210	0.072	64.07	0.07	2016.661	5
	B	19 00 24.507	-08 30 20.62							13.154	0.075	40.73			
iT24 0.61m stack 5x3s															
J 2249	A	19 00 28.098	-08 28 30.65	0.05	0.06	7.674	0.078	227.443	0.583	11.778	0.081	81.27	0.08	2016.661	5
	B	19 00 27.717	-08 28 35.84							12.334	0.082	63.09			
iT24 0.61m stack 5x3s															
J 2934	A	19 00 49.734	-07 22 49.99	0.05	0.06	6.864	0.078	81.201	0.652	11.136	0.081	111.38	0.08	2016.661	5
	B	19 00 50.190	-07 22 48.94							12.784	0.083	49.08			
iT24 0.61m stack 5x3s. Both components seemed fainter than listed – confirmed by measurement															
BU 974	A	19 05 19.173	-06 10 23.12	0.06	0.07	19.986	0.092	119.626	0.264	9.418	0.080	208.19	0.08	2016.661	5
	C	19 05 20.338	-06 10 33.00							12.758	0.083	50.23			
iT24 0.61m stack 5x3s. Mag A is for combined A+B. C seemed brighter than listed – not confirmed by measurement															
RST 4617	A	19 07 32.349	-05 14 23.23	0.07	0.08	2.343	0.106	214.120	2.597	9.165	0.050	187.91	0.05	2016.661	5
	B	19 07 32.261	-05 14 25.17							10.916	0.051	107.21			
iT24 0.61m stack 5x3s. Overlapping star disks. Both components seemed a bit fainter than listed – not at all confirmed by measurement															
J 3255	A	20 37 29.829	01 53 11.42	0.06	0.07	3.652	0.092	326.629	1.446	10.874	0.095	35.25	0.09	2016.734	5
	B	20 37 29.695	01 53 14.47							12.791	0.132	10.76			
iT18 0.31m stack 5x3s. SNR B <20															
J 1776	A	20 37 29.829	01 53 11.42	0.06	0.07	3.652	0.092	326.629	1.446	10.874	0.095	35.25	0.09	2016.734	5

B	20 37 29.695	01 53 14.47			12.791	0.132	10.76

iT18 0.31m stack 5x3s. SNR B <20. J 1776 is ident with J 3255

Table 1.2 below gives photometry and astrometry results for the given objects based on images taken with V-filter. RA and Dec are the coordinates based on plate solving with URAT1 (if available, else UCAC4) reference stars in the 8.5 to 18.5mag range. Sep is separation calculated as SQRT$(((\alpha_1-\alpha_2)$*$\cos(\delta_1))^2+(\delta_2-\delta_1)^2)$ in radians. ϵ_ρ is calculated as SQRT$(\Delta\alpha^2+\Delta\rho^2)$ with $\Delta\alpha$ and $\Delta\delta$ as average RA and Dec plate solving errors. PA is calculated as arctan $((\alpha_2-\alpha_1)$*$\cos(\delta_1))/(\delta_2-\delta_1))$ in radians depending on quadrant and ϵ_θ is the error estimation for PA calculated as $\arctan(\epsilon_\rho/\rho)$ in degrees assuming the worst case that ϵ_ρ points in the right angle to the direction of the separation means perpendicular to the separation vector. Mag is the photometry Vmag result based on UCAC4 reference stars with V mags between 8.5 and 18.5 mag. Results for stars significant brighter than 8.5 mag are for this reason not reliable. ϵ_{mag} is calculated as square root of $(\Delta V^2 +$ (2.5*Log10$(1+1/SNR))^2)$ with ΔV as the average V mag error over all used reference stars and SNR is the signal to noise ratio for the given star. Date is the Bessel epoch and N is the number of images used for the reported values. iT in the Notes column indicates the telescope used with aperture, number of images and exposure time given. WDS observation method code is in all cases "C".

2 Constellation Aqr

This constellation is too low in altitude for me for visual observations but one questionable object was suggested in a private email communication by Robert Korn and I selected additionally several Jonckheere objects in Aqr for a WDS data counter-check. The WDS data per August 2016 are given in Table 2.1. The measurement results for these objects are given in Table 2.2 with the Notes column providing additional information about the used images. Several J-objects were also checked for common proper motion with the results in Table 2.3. In the tables below DR1 refers to the Gaia DR1 catalogue release

WDS ID	Name		α	δ	ρ''	$\theta°$	V_1	V_2
23525-0638	J1427	AB	23:52:29.95	-06:37:19.7	6.9	144	9.88	11.50
23549-0438	J1430	AB	23:55:01.99	-04:37:25.6	9.7	16	11.20	13.80
20469-0417	J1709	AB	20:46:42.44	-04:15:23.1	8.1	215	9.60	10.60
20510-0038	J1711	AB	20:51:06.35	-00:36:20.6	8.5	222	9.60	9.60
22104-0108	J1727	AB	22:10:26.82	-01:05:54.4	4.7	154	11.00	11.10
22497-0225	J1729	AB	22:49:46.81	-02:24:43.3	6.0	155	10.70	11.80
20567-0600	J2330	AB	20:56:35.36	-05:59:50.2	6.4	114	12.20	12.60
22180-1108	J2367	AB	22:18:01.66	-11:08:54.9	7.5	34	12.70	12.67
22180-1106	J2368	AB	22:18:01.92	-11:06:59.5	12.9	126	11.60	12.60
22180-1106	J2368	AC	22:18:01.92	-11:06:59.5	18.2	71	9.80	11.80
22477-1403	STF2943	AB	22:47:42.77	-14:03:23.1	21.0	126	5.68	9.57

Table 2.1: WDS data per August 2016 for the selected Aqr objects

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ	ϵ_ρ	θ	$\Delta\theta$	Mag	ΔMag	SNR	ΔVmag	Date	N
J 1427	A	23 52 29.932	-06 37 19.78	0.10	0.08	6.879	0.128	144.210	1.067	9.821	0.111	64.14	0.11	2016.734	5
	B	23 52 30.202	-06 37 25.36							11.527	0.117	26.46			
iT18 0.31m stack 5x3s															
J 1430	A	23 55 02.050	-04 37 26.08	0.13	0.11	9.888	0.170	16.515	0.987	11.692	0.107	27.03	0.10	2016.734	5
	B	23 55 02.238	-04 37 16.60							14.083	0.201	5.73			
iT18 0.31m stack 5x3s. SNR B <10															
J 1709	A	20 46 42.466	-04 15 23.40	0.07	0.06	8.270	0.092	216.006	0.639	11.777	0.105	19.49	0.09	2016.734	5
	B	20 46 42.141	-04 15 30.09							13.148	0.154	8.19			
iT18 0.31m stack 5x3s. SNR B <10															
J 1711	A	20 51 06.550	-00 36 16.76	0.07	0.08	8.486	0.106	221.248	0.718	11.845	0.109	24.68	0.10	2016.734	5
	B	20 51 06.177	-00 36 23.14							11.985	0.111	22.50			
iT18 0.31m stack 5x3s															
J 1727	A	22 10 26.755	-01 05 52.62	0.07	0.07	4.676	0.099	153.932	1.213	12.145	0.079	20.49	0.06	2016.734	5
	B	22 10 26.892	-01 05 56.82							12.420	0.084	17.91			
iT18 0.31m stack 5x3s. SNR B <20															
J 1729	A	22 49 46.678	-02 24 42.52	0.10	0.07	6.136	0.122	152.036	1.140	12.424	0.110	13.99	0.08	2016.734	3
	B	22 49 46.870	-02 24 47.94							13.665	0.206	5.23			
iT18 0.31m stack 3x3s. SNR A <20 and B <10															
J 2330	A	20 56 35.362	-05 59 50.33	0.05	0.05	6.366	0.071	114.600	0.636	12.215	0.115	14.67	0.09	2016.734	5
	B	20 56 35.750	-05 59 52.98							12.602	0.124	12.22			
iT18 0.31m stack 5x3s. SNR A and B <20															
J 2367	A	22 18 01.543	-11 08 57.72	0.09	0.14	7.643	0.166	34.748	1.247	11.931	0.130	21.73	0.12	2016.734	5
	B	22 18 01.839	-11 08 51.44							12.061	0.130	20.69			
iT18 0.31m stack 5x3s															
J 2368	A	22 18 01.354	-11 06 58.63	0.05	0.12	12.774	0.130	125.900	0.583	11.667	0.117	26.88	0.11	2016.734	5
	B	22 18 02.057	-11 07 06.12							12.648	0.126	17.40			
iT18 0.31m stack 5x3s. SNR C <20															
J 2368	A	22 18 01.354	-11 06 58.63	0.05	0.12	17.919	0.130	70.132	0.416	11.667	0.117	26.88	0.11	2016.734	5
	C	22 18 02.499	-11 06 52.54							12.868	0.133	14.06			
iT18 0.31m stack 5x3s. SNR B <20															
STF 2943	A	22 47 42.816	-14 03 22.85	0.11	0.12	21.051	0.163	126.495	0.443	5.668	0.090	498.06	0.09	2016.736	5
	B	22 47 43.979	-14 03 35.37							9.739	0.090	216.49			
iT27 0.7m stack 5x3s V. Robert Korn suggested B much fainter - not confirmed, also no color issue found															
STF 2943	A	22 47 42.786	-14 03 23.22	0.10	0.19	20.981	0.215	126.705	0.586	6.151	0.100	977.56	0.10	2016.738	5
	B	22 47 43.942	-14 03 35.76							9.489	0.100	282.15			
iT27 0.7m stack 5x3s I. Spc A <B5 and B = A9															

Table 2.2: Photometry and astrometry results for the given objects. Columns content ident with Table 1.2

Name	δ	δ	ρ''	$\theta°$	μ_{α_1}	μ_{δ_1}	ϵ_{μ_1}		μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
J 1430	358.7585372	-4.623877408	9.719	15.676	62.48	-33.29	7.40	62.88	-33.02	7.40	0.96	Hg	2015	AACB	Gaia DR1
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather high, but Sep/PM<1000yrs - means a good CPM candidate															
J 1711	312.77728746	-0.6046973	8.434	222.347	12.48	32.00	6.53	14.86	34.32	6.53	0.96	Hg	2015	ABCB	Gaia DR1.
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather high, but Sep/PM<1000yrs - means a good CPM candidate. Difference in PM vector length could be seen as indication of an orbit															
J 1729	342.44454896	-2.4117936	5.979	154.021	-32.13	-34.52	5.68	-32.98	-34.98	5.68	0.96	Hg	2015	AACB	Gaia DR1.
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather high, but Sep/PM<1000yrs - means a good CPM candidate															
J 2368 AB	334.50567819	-11.1163464	12.697	125.360	-21.76	-25.42	9.95	-23.88	-23.42	9.95	0.96	Hg	2015	BACB	Gaia DR1.
PM data calculated from position comparison with 2MASS. Might be a good CPM candidate, pm error is a bit large															
J 2368 AC	334.50567819	-11.1163464	18.069	70.265	-21.76	-25.42	9.95	14.60	-16.13	9.95	0.96	Hg	2015	CCCB	Gaia DR1.
PM data calculated from position comparison with 2MASS - component C is optical															

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 2.3: CPM Check for Aqr objects

3 Constellation Aur

The WDS data for some Aur objects with suspect WDS data per August 2016 are given in Table 3.1. The measurement results for these objects are given in Table 3.2 with the column providing additional information about the used images and references to visual observation.

WDS ID	Name		α	δ	ρ''	$\theta°$	V_1	V_2
05228+3325	BU887	AB	05:22:46.53	+33:25:11.2	1.0	195	9.82	13.10
05228+3325	BU887	AC	05:22:46.53	+33:25:11.2	9.7	115	9.82	14.30
05228+3325	BU887	AD	05:22:46.53	+33:25:11.2	10.5	333	9.82	12.90
05228+3325	BU887	AE	05:22:46.53	+33:25:11.2	14.7	203	9.82	14.30
05228+3325	BU887	AF	05:22:46.53	+33:25:11.2	33.4	353	9.82	13.20
05228+3325	BU887	FU	05:22:46.19	+33:25:44.3	1.8	12	13.30	14.30
05039+3223	ES412	AB	05:03:54.44	+32:22:53.2	5.1	274	8.38	11.90

04577+3320 HU1220	AB	04:57:42.75	+33:19:52.7	4.4	13	9.80	12.10
05027+3507 J240	AB	05:02:46.08	+35:07:55.3	1.3	211	10.70	10.90
05022+3724 SEI55	AB	05:02:13.04	+37:24:01.3	7.1	104	9.60	11.10

Table 3.1: WDS data per August 2016 for the selected Aur objects

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ	ϵ_ρ	θ	$\Delta\theta$	Mag	Δ Mag	SNR	ΔVmag	Date	N
BU 887	A	05 22 46.536	33 25 11.23	0.07	0.08					9.367	0.101	104.02	0.10	2016.096	1
	B														
iT18 0.31m 1x3s. No resolution of B. Measured combined magnitude confirms the original Burnham 10.6 mag for B. Current WDS mag for B seems a erroneously update of the WDS data base after reporting 13.1mag for BU887C in Knapp 2015															
BU 887	A	05 22 46.536	33 25 11.23	0.07	0.08	9.883	0.106	113.305	0.616	9.367	0.101	104.02	0.10	2016.096	1
	C	05 22 47.261	33 25 07.32							13.103	0.125	13.85			
iT18 0.31m 1x3s. SNR C <20. Session planning suggested magnitude issue															
BU 887	A	05 22 46.536	33 25 11.23	0.07	0.08	10.689	0.106	333.795	0.570	9.367	0.101	104.02	0.10	2016.096	1
	D	05 22 46.159	33 25 20.82							12.396	0.113	20.50			
iT18 0.31m 1x3s. Session planning suggested magnitude issue															
BU 887	A	05 22 46.536	33 25 11.23	0.07	0.08	13.591	0.106	204.780	0.448	9.367	0.101	104.02	0.10	2016.096	1
	E	05 22 46.081	33 24 58.89							13.394	0.136	11.21			
iT18 0.31m 1x3s. SNR E <20. Session planning suggested magnitude issue															
BU 887	A	05 22 46.536	33 25 11.23	0.07	0.08	32.872	0.106	353.043	0.185	9.367	0.101	104.02	0.10	2016.096	1
	F	05 22 46.218	33 25 43.86							13.773	0.187	6.37			
iT18 0.31m 1x3s. SNR F <10. Session planning suggested magnitude issue															
BU 887	F	05 22 46.218	33 25 43.86	0.07	0.08	3.111	0.106	355.153	1.957	13.773	0.158	6.37	0.10	2016.096	1
	U	05 22 46.197	33 25 46.96							13.441	0.156	8.54			
iT18 0.31m 1x3s. SNR F and U <10. Session planning suggested magnitude issue															
ES 412	A	05 03 54.444	32 22 53.02	0.06	0.05	5.344	0.078	273.648	0.837	8.345	0.080	169.03	0.08	2016.096	1
	B	05 03 54.023	32 22 53.36							13.090	0.159	7.42			
iT18 0.31m 1x3s. SNR B <10. Visual observation suggests B fainter than listed - confirmed															
HU 1220	A	04 57 42.738	33 19 52.58	0.12	0.11	4.126	0.163	11.032	2.259	9.769	0.081	86.37	0.08	2016.096	1
	B	04 57 42.801	33 19 56.63							12.152	0.096	19.77			
iT18 0.31m 1x3s. Visual observation suggests B fainter than listed – not confirmed															
J 240	A	05 02 46.091	35 07 55.73	0.08	0.06		0.100			10.585	0.102	58.88	0.10	2016.096	1
	B														
iT18 0.31m 1x3s. No resolution of B. With 0.2mag delta_m according to WDS the combined mag of 10.6 would give ~11.2/11.4mag for A/B. Visual observation suggests both components fainter than listed - confirmed															
SEI55	A	05 02 13.051	37 24 01.03	0.08	0.07	7.092	0.106	103.786	0.859	9.745	0.091	84.76	0.09	2016.096	1
	B	05 02 13.629	37 23 59.34							11,768	0,097	28,76			
iT18 0.31m 1x3s. Visual observation suggests B fainter than listed - confirmed															

Table 3.2: Photometry and astrometry results for the given objects. Columns content identical with Table 1.2

4 Constellations Cnc, Gem, Leo, Com and CVn

The WDS data per August 2016 for some objects with assumed suspect data in these constellations are given in table 4.1. The measurement results for these objects are given in Table 4.2 with the column providing additional information about the used images and references to visual observation.

WDS ID	Name		α	δ	ρ	θ	V_1	V_2	Con
07307+3343	A2125	AB	07:30:43.10	+33:42:38.9	4.0	108	9.31	12.00	Gem
11411+1536	BRT1274	AB	11:41:04.94	+15:36:07.9	2.8	328	10.60	11.00	Leo
07332+3252	BU22	AB	07:33:14.80	+32:51:42.6	6.3	151	8.36	10.50	Gem
08160+1842	HO524	AB	08:15:58.45	+18:41:38.2	4.3	342	7.70	10.51	Cnc
07240+3427	POP74	AB	07:24:09.84	+34:27:29.6	9.6	148	9.70	11.30	Gem
07475+3325	STF1135	AB	07:47:30.34	+33:24:57.8	19.2	214	5.14	11.40	Gem
07475+3325	STF1135	AC	07:47:30.34	+33:24:57.8	92.8	344	5.32	11.18	Gem
12280+2158	COU53	AB	12:27:58.02	+21:58:11.9	2.5	213	10.00	10.80	Com
12175+2856	STT245	AB	12:17:30.60	+28:56:13.6	8.4	282	5.70	10.70	Com
13004+3856	COU1131	AB	13:00:22.49	+38:55:59.6	3.4	244	10.98	11.60	CVn
13164+4202	HJ1230	AB	13:16:23.98	+42:01:56.7	16.5	169	10.50	11.00	CVn
13042+3805	KZA37	AB	13:04:10.60	+38:04:52.4	24.4	66	12.56	13.55	CVn

Table 4.1: WDS data per August 2016 for the selected objects in Cnc, Gem, Leo, Com and CVn

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ''	ϵ_ρ''	θ	$\epsilon_\theta{}^\circ$	Mag	ϵ_{mag}	SNR	ΔV	Date	N
A 2125	A	07 30 43.101	33 42 38.91	0.06	0.06	4.047	0.085	109.339	1.201	9.246	0.050	181.30	0.05	2016.340	5
	B	07 30 43.407	33 42 37.57							11.774	0.052	71.53			
iT24 0.61m stack 5x3s. Visual observation: No resolution of B															
BRT 1274	A	11 41 04.905	15 36 07.22	0.07	0.08	2.524	0.106	329.750	2.412	10.747	0.033	75.27	0.03	2016.412	5
	B	11 41 04.817	15 36 09.40							11.010	0.035	61.09			
iT24 0.61m stack 5x3s. Touching star disks. Visual observation: Harder to resolve than expected															
BU 22	A	07 33 14.775	32 51 42.65	0.08	0.08	6.359	0.113	150.961	1.019	8.179	0.070	236.46	0.07	2016.340	5
	B	07 33 15.020	32 51 37.09							10.924	0.072	66.80			
iT24 0.61m stack 5x3s. Visual observation: B seemed fainter than listed - confirmed															
HO 524	A	08 15 58.428	18 41 37.56	0.07	0.09	4.414	0.114	345.840	1.480	7.569	0.080	267.21	0.08	2016.340	4

	B	08 15 58.352	18 41 41.84							11.204	0.084	43.71			
iT24 0.61m stack 4x3s. Touching star disks															
POP 74	A	07 24 09.850	34 27 29.51	0.08	0.07	9.507	0.106	147.411	0.641	10.986	0.080	157.26	0.08	2016.340	1
	B	07 24 10.264	34 27 21.50							12.149	0.081	90.94			
iT24 0.61m 1x3s. Visual observation: Brighter than listed? Not confirmed															
STF 1135	A	07 47 30.307	33 24 56.52	0.08	0.07	19.566	0.106	214.006	0.311	5.628	0.080	181.13	0.08	2016.340	4
	B	07 47 29.433	33 24 40.30							10.978	0.081	89.33			
iT24 0.61m stack 4x3s. A too bright for reliable photometry															
STF 1135	A	07 47 30.307	33 24 56.52	0.08	0.07	91.571	0.106	343.412	0.067	5.628	0.080	181.13	0.08	2016.340	4
	C	07 47 28.219	33 26 24.28							11.074	0.081	82.41			
iT24 0.61m stack 4x3s. A too bright for reliable photometry															
COU 53	A	12 27 57.949	21 58 13.12	0.13	0.21	2.234	0.247	214.088	6.309	12.082	0.083	23.82	0.07	2016.438	5
	B	12 27 57.859	21 58 11.27							12.666	0.094	16.90			
iT18 0.31m stack 5x3s. SNR B<20. Visual observation: Both components fainter than listed - confirmed															
STT 245	A	12 17 30.526	28 56 14.60	0.25	0.08	8.389	0.262	282.041	1.792	5.741	0.090	421.69	0.09	2016.438	5
	B	12 17 29.901	28 56 16.35							11.162	0.095	34.72			
iT18 0.31m stack 5x3s. A too bright for reliable photometry. Visual observation: B seems fainter than listed - confirmed															
COU 1131	A	13 00 22.457	38 55 58.91	0.02	0.02	3.378	0.028	243.451	0.480	12.397	0.033	81.36	0.03	2016.480	4
	B	13 00 22.198	38 55 57.40							13.347	0.038	46.60			
iT24 0.61m stack 4x3s. Visual observation: Both components fainter than listed – confirmed															
HJ 1230	A	13 16 24.009	42 01 56.68	0.08	0.06	16.418	0.100	169.837	0.349	12.452	0.081	80.87	0.08	2016.480	3
	B	13 16 24.269	42 01 40.52							12.886	0.082	68.50			
iT24 0.61m stack 3x3s. Visual observation: Both components fainter than listed – confirmed															
KZA 37	A	13 04 10.639	38 04 53.10	0.06	0.06	24.715	0.085	65.981	0.197	12.594	0.071	78.63	0.07	2016.480	5
	B	13 04 12.551	38 05 03.16							13.542	0.073	49.25			
iT24 0.61m stack 5x3s. Visual observation: No resolution															

Table 4.2: Photometry and astrometry results for the given objects. Columns content ident with table 1.2

5 Constellation Cyg

61 Cyg/STF 2758 is visually, besides the orange colour of both components, a rather unspectacular wide pair but is famous for its large proper motion (WDS has even to use a code "P" as workaround for the given proper motion values meaning that the values have to be understood as /100 instead of /1000 arcseconds as usual because this WDS column is limited to 3 digits) and infamous for its large number of components not sharing the same proper motion making it difficult to identify them – reason enough to have a closer look. The WDS data per August 2016 are given in Table 5.1. The measurement results for these objects are given in Table 5.2 with the Notes column providing additional information about the used images. CPM checks are given in Table 5.3.

WDS ID	Name		α	δ	ρ''	$\theta°$	V_1	V_2
21069+3845	STF2758	AB	21:06:53.95	+38:44:57.9	31.4	153	5.20	6.05
21069+3845	STF2758	AC	21:06:53.95	+38:44:57.9	748.1	218	5.35	10.23
21069+3845	STF2758	AD	21:06:53.95	+38:44:57.9	658.7	252	5.35	10.45
21069+3845	STF2758	AE	21:06:53.95	+38:44:57.9	336.5	268	5.35	9.63
21069+3845	STF2758	AE	21:06:53.95	+38:44:57.9	336.5	268	5.35	9.63
21069+3845	STF2758	AF	21:06:53.95	+38:44:57.9	360.7	240	5.35	11.30
21069+3845	STF2758	AG	21:06:53.95	+38:44:57.9	250.2	236	5.35	11.30
21069+3845	STF2758	AH	21:06:53.95	+38:44:57.9	108.0	271	5.35	9.97
21069+3845	SMR1	AI	21:06:53.95	+38:44:57.9	12.1	247	5.35	10.74
21069+3845	HZE4	AJ	21:06:53.95	+38:44:57.9	17.4	243	2.25	12.43
21069+3845	HZE4	AK	21:06:53.95	+38:44:57.9	7.8	83	2.25	13.05
21069+3845	SMR40	AO	21:06:53.95	+38:44:57.9	151.4	284	5.35	12.65
21069+3845	SMR40	AP	21:06:53.95	+38:44:57.9	146.2	294	5.35	12.84
21069+3845	SMR40	AQ	21:06:53.95	+38:44:57.9	68.0	324	5.35	13.19
21069+3845	STF2758	BC	21:06:55.26	+38:44:31.4	737.3	220	6.05	10.03
21069+3845	HZE4	BL	21:06:55.26	+38:44:31.4	9.9	145	2.74	14.04
21069+3845	FYM106	BM	21:06:55.26	+38:44:31.4	81.9	239	6.05	14.30
21069+3845	FYM106	BN	21:06:55.26	+38:44:31.4	48.5	129	6.05	14.40
21069+3845	TNN15	BR	21:06:55.26	+38:44:31.4	11.5	77	2.54	14.80
21070+3839	ES2059	AB	21:07:02.12	+38:39:31.7	7.0	267	10.11	12.60
21072+3841	MLB1018	AB	21:07:17.04	+38:41:10.9	4.6	251	12.10	13.50

Table 5.1: WDS data for 61 Cyg (plus two other objects nearby) per August 2016

Name		RA	Dec	$\Delta\alpha$	$\Delta\delta$	ρ''	ϵ_ρ''	θ	ϵ_θ	Mag	ϵ_{mag}	SNR	ΔV	Date	N
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	31.789	0.113	153.022	0.204	5.515	0.090	1.093.08	0.09	2016.360	5
	B	21 07 01.027	38 45 23.16							6.095	0.090	946.08			
iT24 5x1s V. Both components too bright for reliable photometry.															
STF 2758	A	21 06 59.949	38 45 52.91	0.06	0.06	31.807	0.085	153.722	0.153	4.572	0.150	1.595.62	0.15	2016.819	5
	B	21 07 01.153	38 45 24.39							4.852	0.150	1.391.90			
iT24 5x1s I. Both components too bright for reliable photometry. Spectral class based on $V-I$ color index: A = K2 and B = K5 not identical to, but at least near, the K5 and K7 given in the WDS catalog															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	839.804	0.113	219.371	0.008	5.515	0.090	1.093.08	0.09	2016.360	5
	C	21 06 14.246	38 35 02.28							10.106	0.090	124.99			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	747.956	0.113	249.845	0.009	5.515	0.090	1.093.08	0.09	2016.360	5

	D	21 05 59.760	38 41 33.77							10.398	0.091	110.53			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	340.848	0.113	266.730	0.019	5.515	0.090	1.093.08	0.09	2016.360	5
	E	21 06 30.699	38 45 32.05							9.533	0.090	150.24			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	371.228	0.113	240.168	0.017	5.515	0.090	1.093.08	0.09	2016.360	5
	F	21 06 32.260	38 42 46.82							11.595	0.091	66.70			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	260.398	0.113	235.988	0.025	5.515	0.090	1.093.08	0.09	2016.360	5
	G	21 06 41.339	38 43 25.83							11.277	0.091	76.49			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	A	21 06 59.794	38 45 51.49	0.08	0.08	111.252	0.113	270.005	0.058	5.515	0.090	1.093.08	0.09	2016.360	5
	H	21 06 50.282	38 45 51.50							10.948	0.091	89.79			
iT24 5x1s V. A too bright for reliable photometry															
SMR 1	A	21 06 59.794	38 45 51.49	0.08	0.08	21.501	0.113	240.309	0.301	5.515	0.090	1.093.08	0.09	2016.360	5
	I	21 06 58.197	38 45 40.84							11.655	0.092	64.07			
iT24 5x1s V. A too bright for reliable photometry															
HZE 4	A	21 06 59.794	38 45 51.49	0.08	0.08		0.113			5.515	0.090	1.093.08	0.09	2016.360	5
	J														
iT24 5x1s V. A too bright for reliable photometry. No resolution of J also not in the I-filter image with faintest stars up to R=15															
HZE 4	A	21 06 59.794	38 45 51.49	0.08	0.08		0.113			5.515	0.090	1.093.08	0.09	2016.360	5
	K														
iT24 5x1s V. A too bright for reliable photometry. No resolution of K also not in the I-filter image with faintest stars up to R=15															
SMR 40	A	21 06 59.794	38 45 51.49	0.08	0.08	157.804	0.113	282.008	0.041	5.515	0.090	1.093.08	0.09	2016.360	5
	O	21 06 46.597	38 46 24.32							12.668	0.094	39.10			
iT24 5x1s V. A too bright for reliable photometry															
SMR 40	A	21 06 59.794	38 45 51.49	0.08	0.08	151.045	0.113	291.472	0.043	5.515	0.090	1.093.08	0.09	2016.360	5
	P	21 06 47.776	38 46 46.78							12.878	0.095	36.19			
iT24 5x1s V. A too bright for reliable photometry															
SMR 40	A	21 06 59.794	38 45 51.49	0.08	0.08	68.057	0.113	316.357	0.095	5.515	0.090	1.093.08	0.09	2016.360	5
	Q	21 06 55.778	38 46 40.74							13.226	0.097	29.57			
iT24 5x1s V. A too bright for reliable photometry															
STF 2758	B	21 07 01.027	38 45 23.16	0.08	0.08	827.604	0.113	221.391	0.008	6.095	0.001	946.08	0.09	2016.360	5
	C	21 06 14.246	38 35 02.28							10.106	0.090	124.99			
iT24 5x1s V. B too bright for reliable photometry															
HZE 4	B	21 07 01.027	38 45 23.16	0.08	0.08		0.113			6.095	0.001	946.08	0.09	2016.360	5
	L														
iT24 5x1s V. B too bright for reliable photometry. No resolution of L also not in the I-filter image with faintest stars up to I=15															
FYM 106	B	21 07 01.027	38 45 23.16	0.08	0.08	100.722	0.113	237.708	0.064	6.095	0.001	946.08	0.09	2016.360	5
	M	21 06 53.748	38 44 29.35							14.125	0.107	18.24			
iT24 5x1s V. B too bright for reliable photometry. SNR M <20															

FYM 106	B	21 07 01.027	38 45 23.16	0.08	0.08	48.306	0.113	152.326	0.134	6.095	0.001	946.08	0.09	2016.360	5	
	N	21 07 02.945	38 44 40.38							14.665	0.119	13.52				
iT24 5x1s V. B too bright for reliable photometry. SNR N <20																
TNN 15	B	21 07 01.027	38 45 23.16	0.08	0.08		0.113			6.095	0.001	946.08	0.09	2016.360	5	
	R															
iT24 5x1s V. B too bright for reliable photometry. No resolution of R																
ES 2059	A	21 07 02.124	38 39 31.61	0.08	0.08	6.844	0.113	268.158	0.947	10.103	0.090	120.40	0.09	2016.360	5	
	B	21 07 01.540	38 39 31.39							12.717	0.096	31.71				
iT24 5x1s V																
MLB 1018	A	21 07 17.034	38 41 10.81	0.08	0.08	4.610	0.113	249.162	1.406	12.318	0.093	46.11	0.09	2016.360	5	iT24 5x1s V
	B	21 07 16.666	38 41 09.17							13.667	0.102	21.91				

Table 5.2: Photometry and astrometry results for 61 Cyg and two other objects by chance in the same image. Columns content ident with Table 1.2 with the exception of indicating "V" for V-filter and "I" for I-filter images (giving I-magnitudes instead of V mags for the latter – used only for components A and B to check the spectral class listed in the WDS catalog). Photometry for I-filter images was done with AAVSO VPhot with USNO B1 reference stars with I mag given.

α	δ	$\rho('')$	$\theta°$	V_1	V_2	μ_{α_1}	μ_{δ_1}	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	ST1	ST2	Ap	Me	Date	CPM Rat
21:06:53.951	+38:44:57.9	31.400	153.000	5.200	6.050	4170.00	3260.00		4120.00	3130.00		K5	K7			2015	
WDS21069+3845 data per August 2016. Date is the given year of last measurement																	
316.6527917	38.70613889	29.657	138.465											1.20	Pp	1951.515	
POSS I.O estimates																	
316.70945833	38.7405278	30.800	148.639			4171.21	3243.81		4076.48	3136.38				1.20	Pp	1989.680	
POSS II.J estimates. PM values estimated from POSS I.O to POSS II.J - common proper motion is obvious																	
316.72256700	38.7480550	30.627	149.630	5.517										1.30	E2	1998.468	
2MASS. M1 and M2 estimated from J- and K-band																	
316.74914167	38.7643028	31.789	153.022	5.515	6.095	4170.09	3269.11	22.92	4111.28	3162.58	22.92			0.61	C	2016.360	BCAA
iT24 5x1s V-filter. PM values calculated from 2MASS to iT24 image plate solved with URAT1 reference stars. CPM rating not this convincing - but this might be explained by the assumed orbit																	
316.74978750	38.7646972	31.807	153.722	4.572	4.852							K2	K5	0.61	C	2016.819	
iT24 5x1s I-filter. Spectral class based on $V-I$ color index																	

Table 5.3: CPM Check for 61 Cyg AB

The comparison of POSS I.O and POSS II.J images shows clearly that there is no other proper motion component nearby and that only the 61 Cyg AB is moving fast against the background stars – with the potential exception of components hidden in the glare of the A/B-components.

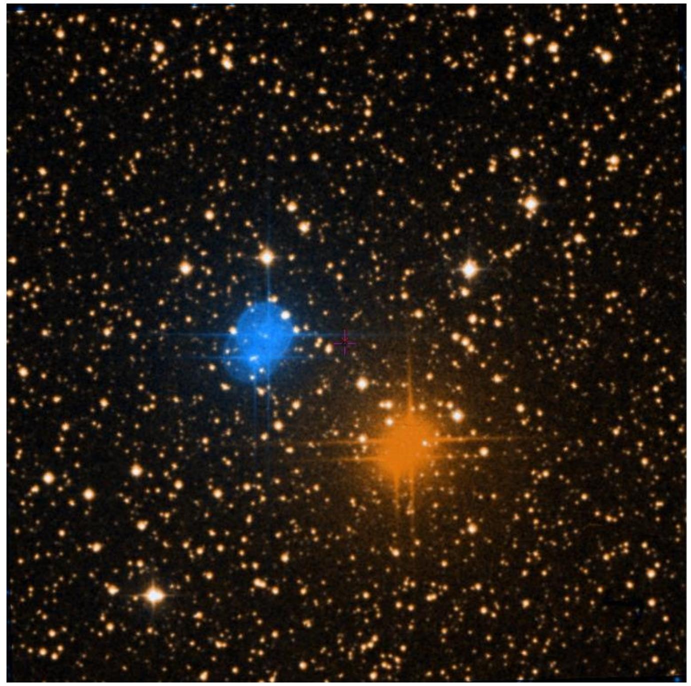

Figure 1: Red/Blue composite of POSS I.O und POSS II.J images

The first observation date given in the WDS catalog for the STF 2758 A-H components suggests that all these components were measured at very different times and certainly not necessarily by F. Struve – the spread is from 1753 (the year this double star discovered by Bradley, according to Aitken) to 1921. Friedrich Struve did his main double star work between 1824 and 1837 and died in 1864. The most probable epoch for Struve's first STF 2758 measurements seems to be about 1822 done for his first double star catalog (Tenn 2013). Lewis (1906) delivers even more precise data listing 3 observations in 1820 and one in 1822 but also earlier 30 measurements by 6 other observers. Struve did as it seems accordingly to his self-imposed separation limit only measurements for AB - but even if all other components were measured by other observers it is somewhat difficult to understand why these stars with such ridiculous large separations were considered as part of a 61 Cyg multiple especially with the background that Struve himself considered anything with separation larger than 32″ not a double. Curiously even more that more recent versions of the Struve catalogue (for example the version available via AstroPlanner) contains no G and H components and instead of F a component called for whatever reason "Aa".

This riddle is partly solved with a look at the WDS data file for 61 Cyg – according to this catalogue F. Struve is not only not the discoverer of STF 2758 as already mentioned but, as suspected, also never measured any other components besides the AB pair (after the earlier observations several times again in 1832 and 1837 according to Struve 1837). So it has to be considered as questionable homage to F. Struve to give 61 Cyg not only the “discoverer” ID STF 2758 and to credit him with the other listed components he himself would have never considered part of 61 Cyg.

The fact that 61 Cyg AB is a fast moving pair is known about 30 years before Friedrich Struve made his measurements (noticed 1792 by Piazzi with first calculated pm numbers published in 1803). 61 Cyg was the first object with a measured parallax giving a distance of ∼11 light years (by Bessel in 1838). The amazement about the other components listed besides AB with such huge separations is not only present for the current distribution of components but also for the situation given for example for the point of time given for the measurement of BC in 1879 (Ball 1884) as is shown with the star maps below with the 2016 map based on the measurements in this reports and the 1879 map is based on the proper motion data combined with the calculated orbit for this point of time:

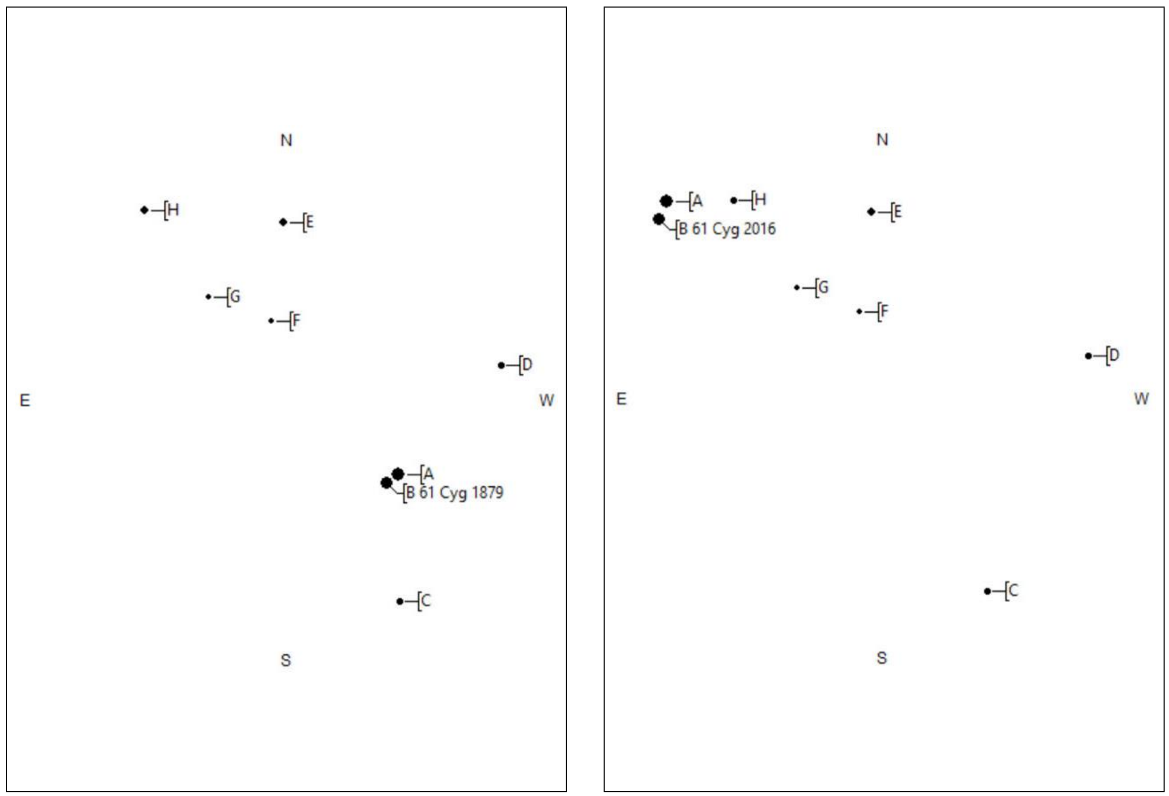

Figure 2: 61 Cyg A-H star maps comparing 1879(left) with 2016(right)

The basis for the inclusion of all these components as members of 61 Cyg cannot be the 1911 report of Benjamin Boss declaring 61 Cyg as member of a co-moving group of stars as this has obviously nothing to do with the stars visually near 61 Cyg but are stars visually far away like 14 Tau, 68 Vir, Beta Col, Pi Men ...

So the motivation to declare distant stars as members of a multiple against the optical impression and against the physical evidence (Comstock/Washburn observatory in 1908 for AC, Steenwijk/Monthly Notes of the Royal Astronomical Society 1919 for AD to AF and so on) remains after all rather unclear.

But the confusion does not end here – SMR 40 (Urban et al. 1998) and FYM 106 (according to WDS "measured" in the 2MASS Catalog 2003) continue with another 5 objects of similar curiosity with a first measurement date 1998. Some additional components measured for the first time 2005/6 in the red range (HZE 4 in Heinze et al. 2010 and TNN 15 in Tanner et al. 2010) might share the proper motion of 61 Cyg AB but could be hidden in the glare of the bright A/B components - but the number of observations is scarce and so far no PM data was measured here so caution is reasonable. Also curious is the fact that in the I filter image of 61 Cyg I took at least the component J given with $R = 12.43$ should be visible as stars up to at least Rmag 15 are resolved and the separation of $17''.4$ is large enough to be outside the star disk of A – yet also this one is not visible what suggests being this one a bogus even if a second observation is recorded. Interesting is here also the fact that none of these publications with exception of Tanner et al. 2010 had double stars as topics, so again the reason, why these measurements were included in the WDS are completely unclear. And even in case of Tanner et al. 2010 it was explicitly stated, that the measured star (WDS listed as component "R") does not share the common proper motion of 61 Cyg.

The current WDS data confusion for the 61 Cyg components finally suggests that all components of double/multiple stars should be given with precise positions and not only by separation and position angle in relation to the primary – this way the currently shaky position data given for doubles with fast proper motion components could be improved.

6 Constellation Del

Chris Thuemen (Yahoo Double Star Imaging Group) made me aware of STF2750 D (SLE518) being questionable. Other Del objects posed questions during session planning or visual observation. The WDS data per August 2016 are given in Table 6.1. The measurement results for these objects are given in Table 6.2 with the Notes column providing additional information about the used images and references to visual observation. The images for most objects are taken twice with V and I filter to be able to determine also the spectral class based on $V - I$ color index – this information is also given in the Notes column. Finally 2 pairs are also checked for common proper motion with the results given in Table 6.3.

WDS ID	Name		α	δ	ρ	θ	V_1	V_2
20536+1935	HO597	AB	20:53:38.45	+19:35:30.1	10.3	235	8.18	11.90
21050+1243	STF2750	A,BC	21:05:02.23	+12:43:20.5	16.0	281	8.96	10.49
21050+1243	SLE518	AD	21:05:02.23	+12:43:20.5	4.6	119	8.96	11.40
20415+1611	J2319	AB	20:41:16.63	+16:12:45.0	7.0	188	12.00	13.70
20385+1848	J3102	AB	20:38:44.03	+18:49:32.1	6.2	97	11.70	12.80

20378+1936	J3099	AB	20:37:26.87	+19:38:08.9	5.5	147	13.00	13.60
20244+1935	STF2679	AB	20:24:22.59	+19:34:30.0	24.4	78	7.88	9.69
20244+1935	STF2679	AC	20:24:22.59	+19:34:30.0	39.2	150	7.88	11.56
20170+1538	CHE269	AB	20:17:02.07	+15:38:03.8	26.6	285	8.97	9.92
20178+1520	CHE281	AB	20:17:46.51	+15:19:35.0	17.4	317	8.89	10.18
20181+1555	J553	AB	20:18:06.69	+15:54:09.5	3.6	21	10.60	11.90

Table 6.1: WDS data per August 2016 for the selected objects in Del

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	Sep	ϵ_ρ	PA	ϵ_θ	Mag	ϵ_{mag}	SNR	ΔV	Date	N
HO 597	A	20 53 37.854	19 35 23.86	0.03	0.03	10.328	0.042	56.437	0.235	8.142	0.050	284.81	0.05	2016.672	5
	B	20 53 38.463	19 35 29.57							13.425	0.057	40.40			
iT24 0.61m stack 5x3s V. Visual observation: B seemed far fainter															
STF 2750	A	21 05 02.291	12 43 20.48	0.04	0.05	16.008	0.064	279.820	0.229	8.796	0.050	273.34	0.05	2016.663	5
	BC	21 05 01.213	12 43 23.21							10.294	0.050	153.71			
iT24 0.61m stack 5x3s V															
STF 2750	A	21 05 02.289	12 43 20.47	0.04	0.04	16.008	0.057	279.820	0.202	8.829	0.050	278.20	0.05	2016.663	5
	BC	21 05 01.211	12 43 23.20							10.554	0.051	148.06			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = A0 and B = B3.5															
SLE 518	A	21 05 02.291	12 43 20.48	0.04	0.05		0.064			8.796	0.050	273.34	0.05	2016.663	5
	D														
iT24 0.61m stack 5x3s V. No resolution of D. Same with 60s exposure image with I-filter. Suggested as suspect by Chris Thuemen. Results suggests bogus															
J 2319	A	20 41 16.625	16 12 44.86	0.03	0.04	7.479	0.050	191.442	0.383	11.838	0.061	80.76	0.06	2016.688	5
	B	20 41 16.522	16 12 37.53							13.318	0.066	40.48			
iT24 0.61m stack 5x3s V. Visual Observation: B a tad brighter than listed - confirmed															
J 2319	A	20 41 16.625	16 12 44.86	0.04	0.04	7.484	0.057	191.658	0.433	11.826	0.151	79.87	0.15	2016.688	5
	B	20 41 16.520	16 12 37.53							13.294	0.153	37.71			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = A2 and B = A3															
J 3102	A	20 38 44.036	18 49 31.96	0.04	0.04	6.407	0.057	95.733	0.506	11.577	0.051	92.60	0.05	2016.688	5
	B	20 38 44.485	18 49 31.32							12.708	0.054	53.54			
iT24 0.61m stack 5x3s V															
J 3102	A	20 38 44.038	18 49 31.97	0.04	0.04	6.378	0.057	95.669	0.508	11.083	0.160	113.66	0.16	2016.688	5
	B	20 38 44.485	18 49 31.34							12.696	0.161	50.13			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = F5 and B = A2															
J 3099	A	20 37 26.875	19 38 08.98	0.03	0.04	5.485	0.050	144.582	0.522	13.088	0.056	44.36	0.05	2016.688	5
	B	20 37 27.100	19 38 04.51							13.486	0.059	35.23			

iT24 0.61m stack 5x3s V															
J 3099	A	20 37 26.872	19 38 09.01	0.04	0.05	5.461	0.064	145.126	0.672	13.178	0.162	40.79	0.16	2016.688	5
	B	20 37 27.093	19 38 04.53							13.713	0.164	30.33			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = B9 and B = B5															
STF 2679	A	20 24 22.575	19 34 29.66	0.03	0.04	24.371	0.050	77.271	0.118	7.866	0.050	336.12	0.05	2016.688	5
	B	20 24 24.257	19 34 35.03							9.794	0.050	200.48			
iT24 0.61m stack 5x3s V. A too bright for reliable photometry															
STF 2679	A	20 24 22.574	19 34 29.64	0.04	0.05	24.385	0.064	77.278	0.150	8.697	0.180	267.42	0.18	2016.688	5
	B	20 24 24.257	19 34 35.01							10.253	0.180	167.24			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A < B0 and B < B0															
STF 2679	A	20 24 22.575	19 34 29.66	0.03	0.04	38.673	0.050	149.907	0.074	7.866	0.050	336.12	0.05	2016.688	5
	C	20 24 23.947	19 33 56.20							11.589	0.051	92.70			
iT24 0.61m stack 5x3s V. A too bright for reliable photometry. Visual observation: B seemed fainter than listed – not confirmed															
STF 2679	A	20 24 22.574	19 34 29.64	0.04	0.05	38.687	0.064	149.871	0.095	8.697	0.180	267.42	0.18	2016.688	5
	C	20 24 23.948	19 33 56.18							11.507	0.180	94.24			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A < B0 and B = A4															
CHE 269	A	20 17 02.045	15 38 03.03	0.09	0.09	26.929	0.127	285.088	0.271	9.433	0.070	158.35	0.07	2016.727	5
	B	20 17 00.245	15 38 10.04							11.246	0.071	87.73			
iT24 0.61m stack 5x3s V. Visual observation: Both components fainter than listed - confirmed															
CHE 269	A	20 17 02.043	15 38 02.98	0.06	0.07	26.872	0.092	285.342	0.197	9.233	0.120	180.71	0.12	2016.721	5
	B	20 17 00.249	15 38 10.09							10.638	0.120	103.70			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = A7 and B = G3															
CHE 281	A	20 17 46.516	15 19 35.04	0.07	0.08	17.599	0.106	316.003	0.346	11.298	0.081	99.13	0.08	2016.721	5
	B	20 17 45.671	15 19 47.70							12.688	0.083	51.84			
iT24 0.61m stack 5x3s V. Visual observation: Both components fainter than listed - confirmed															
CHE 281	A	20 17 46.522	15 19 34.97	0.07	0.09	17.671	0.114	316.228	0.370	11.192	0.121	77.33	0.12	2016.721	5
	B	20 17 45.677	15 19 47.73							12.448	0.123	40.44			
iT24 0.61m stack 5x3s I. Spc according to V-I color index: A = A5 and B = A8															
J 553	A	20 18 06.719	15 54 09.58	0.06	0.07	3.695	0.092	19.621	1.429	10.589	0.051	100.58	0.05	2016.727	5
	B	20 18 06.805	15 54 13.06							11.863	0.054	54.82			
iT24 0.61m stack 5x3s V. Visual observation: Both components seemed brighter than listed – not confirmed. Reason color issue: Both stars blue-white															
J 553	A	20 18 06.721	15 54 09.66	0.06	0.06	3.544	0.085	20.490	1.371	10.879	0.121	62.62	0.12	2016.723	5
iT24 0.61m stack 5x3s I. Image quality questionable. Spc according to V-I color index: A = B2 and B = A2															
	B	20 18 06.807	15 54 12.98							11.852	0.123	40.60			
J 553	A	20 18 06.716	15 54 09.61	0.00	0.00	3.625	0.001	20.743	0.022					2015	
	B	20 18 06.805	15 54 13.00												
GAIA DR1 counter-check. Me = Hg and Ap = 0.96															

Table 6.2: Photometry and astrometry results for the given objects. Columns content ident with table 1.2 with exception of the columns "Mag" containing in this case also magnitudes in the near infrared range if the images were taken with *I* filter and "ΔVmag" accordingly

Name	α	δ	ρ''	$\theta°$	μ_{α_1}	μ_{α_2}	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
STF 2750 A,BC	316.2595189	12.72234501	16.086	279.975	40.54	-2.43	6.14	42.38	-5.30	6.14	0.96	Hg	2015	BBCB	GAIA DR1
PM data calculated from position comparison with 2MASS – despite WDS V-code not such a good CPM candidate, rather questionable															
CHE 269	304.25851871	15.6341835	26.901	285.091	-34.78	-55.39	6.14	-3.03	-2.20	6.14	0.96	Hg	2015	CCCB	GAIA DR1
PM data calculated from position comparison with 2MASS. Optical pair															

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 6.3: CPM Check for Del objects

7 Constellations Equ, Hya, Ori, Tau, Peg and UMa

I was made aware of issues with HJ3023/BU1504 and HU227 by a discussion in the Yahoo Double Star Imaging Group (Chris Thuemen). Especially curious seemed the WDS PA switch from 189° to 9° for BU1504 about mid 2016. The other objects posed questions during visual observations or session planning. The WDS data per August 2016 for the selected objects are given in table 7.1. The measurement results for these objects are given in Table 7.2 with the column providing additional information about the used images and references to visual observation. Table 7.3 contains a CPM check for SKF991.

WDS ID	Name		α	Δ	ρ	θ	V_1	V_2	Con
21229+0649	HJ3023	AB	21:22:53.61	+06:48:40.1	40.6	259	5.16	14.00	Equ
21229+0649	HJ3023	AC	21:22:53.61	+06:48:40.1	74.0	302	5.16	12.60	Equ
21229+0649	HJ3023	AE	21:22:53.61	+06:48:40.1	95.9	273	5.16	12.19	Equ
21229+0649	BU1504	CD	21:22:49.46	+06:49:19.2	5.1	9	12.60	13.20	Equ
21229+0644	ALD76	AB	21:22:52.26	+06:43:56.6	3.0	63	11.40	11.40	Equ
09090-1411	HU227	AB	09:09:01.29	−14:11:02.7	2.3	216	7.74	10.28	Hya
09090-1411	HU227	AC	09:09:01.29	−14:11:02.7	26.2	324	7.74	11.00	Hya
05355+0723	J676	AB	05:35:31.75	+07:23:18.7	1.6	286	10.19	10.32	Ori
05386+0654	J2730	AB	05:38:36.78	+06:53:06.7	5.0	209	11.43	13.20	Ori
05386+0654	BKO21	AC	05:38:36.78	+06:53:06.7	22.4	88	11.43	13.99	Ori
05119+0204	BAL1286	AB	05:11:49.05	+02:04:18.7	19.4	175	10.58	12.57	Ori
05134+0132	BAL1287	AB	05:13:23.95	+01:31:47.5	10.7	110	9.60	11.00	Ori
05463+2542	BRT138	AB	05:46:16.41	+25:42:06.0	6.0	119	8.38	11.20	Tau
23023+1522	HU992	AB	23:02:17.45	+15:22:13.0	5.4	126	10.05	14.10	Peg
23000+1526	SKF991	AB	23:00:02.35	+15:25:59.6	10.3	320	11.50	12.80	Peg

10588+6143	STF1491	AB	10:58:50.42	+61:42:56.4	14.1	33	8.39	11.33	UMa
11098+6123	ES1906	AB	11:09:48.42	+61:24:14.6	4.5	275	10.00	10.50	UMa
11158+6051	STI723	AB	11:15:47.58	+60:51:04.6	5.9	3	9.60	12.50	UMa

Table 7.1: WDS data per August 2016

Name		RA	Dec	Δ_α	Δ_δ	ρ''	ϵ_ρ	θ	ϵ_θ	Mag	Δ_{mag}	SNR	dV	Date	N
HJ 3023	A	21 22 53.702	06 48 40.50	0.09	0.07	40.896	0.114	256.870	0.160	5.962	0.070	771.47	0.07	2016.835	3
	B	21 22 51.028	06 48 31.21							14.216	0.078	31.93			
iT18 0.31m 3x60s. A too bright for reliable photometry															
HJ 3023	A	21 22 53.702	06 48 40.50	0.09	0.07	74.125	0.114	301.355	0.088	5.962	0.070	771.47	0.07	2016.835	3
	C	21 22 49.452	06 49 19.07							12.760	0.072	65.16			
iT18 0.31m 3x60s. A too bright for reliable photometry															
HJ 3023	A	21 22 53.702	06 48 40.50	0.09	0.07	95.990	0.114	273.159	0.068	5.962	0.070	771.47	0.07	2016.835	3
	E	21 22 47.267	06 48 45.79							12.287	0.071	88.89			
iT18 0.31m 3x60s. A too bright for reliable photometry															
BU 1504	C	21 22 49.452	06 49 19.07	0.09	0.07	5.199	0.114	7.903	1.256	12.760	0.072	65.16	0.07	2016.835	3
	D	21 22 49.500	06 49 24.22							13.468	0.074	44.72			
iT18 0.31m 3x60s. A too bright for reliable photometry															
	F	21 22 49.957	06 49 23.08	0.09	0.07	6.633	0.114	156.441	0.985	15.617	0.112	11.88	0.07	2016.835	3
	G	21 22 50.135	06 49 17.00							15.682	0.169	6.57			
iT18 0.31m 3x60s. Twin pair to BU1504CD. SNR F <20 and G <10															
ALD 76	A	21 22 52.277	06 43 56.98	0.09	0.07	2.979	0.114	66.241	2.192	11.382	0.071	92.01	0.07	2016.835	3
	B	21 22 52.460	06 43 58.18							11.497	0.071	89.88			
iT18 0.31m 3x60s															
HU 227	A	09 09 01.242	-14 11 02.38	0.17	0.22	2.548	0.278	222.783	6.228	7.700	0.110	242.97	0.11	2016.196	1
	B	09 09 01.123	-14 11 04.25							9.878	0.111	81.55			
iT27 0.7m 1x1s. A too bright for reliable photometry. Heavily overlapping star disks, measurement results rather unreliable															
HU 227	A	09 09 01.242	-14 11 02.38	0.17	0.22	26.898	0.278	324.617	0.592	7.700	0.110	242.97	0.11	2016.196	1
	C	09 09 00.171	-14 10 40.45							12.855	0.120	22.39			
iT27 0.7m 1x1s. A too bright for reliable photometry															
J 676	A	05 35 31.781	07 23 18.70	0.08	0.07	1.430	0.106	272.806	4.252	9.769	0.102	54.42	0.10	2016.235	1
	B	05 35 31.685	07 23 18.77							9.781	0.103	46.20			
iT18 0.31m 1x3s. Overlapping star disks - photometry unreliable. Visual observation suggested both components being brighter than listed - confirmed. Counter-check GAIA DR1: $1''.654$ $285^\circ.368$															
J 2730	A	05 38 36.794	06 53 06.43	0.12	0.09	4.965	0.150	210.456	1.730	11.451	0.095	36.19	0.09	2016.246	1

	B	05 38 36.625	06 53 02.15							13.306	0.149	8.62			
iT18 0.31m 1x3s. SNR B <10. Visual observation: B seemed brighter than listed – not confirmed															
J 2730 (BKO 21)	A	05 38 36.794	06 53 06.43	0.12	0.09	22.813	0.150	85.903	0.377	11.451	0.095	36.19	0.09	2016.246	1
	C	05 38 38.322	06 53 08.06							14.281	0.245	4.28			
iT18 0.31m 1x3s. SNR C <10. Visual observation: C fainter than listed - confirmed															
BAL 1286	A	05 11 49.059	02 04 18.78	0.09	0.06	19.674	0.108	174.710	0.315	10.428	0.072	58.49	0.07	2016.246	1
	B	05 11 49.180	02 03 59.19							12.626	0.097	15.85			
iT18 0.31m 1x3s. SNR B <10. Visual observation: B brighter than listed – not confirmed															
BAL 1287	A	05 13 23.972	01 31 47.31	0.08	0.08	10.623	0.113	109.695	0.610	10.083	0.072	65.83	0.07	2016.246	1
	B	05 13 24.639	01 31 43.73							11.542	0.077	33.01			
iT18 0.31m 1x3s. Visual observation: B seemed a bit fainter than listed - confirmed															
BRT 138	A	05 46 16.414	25 42 05.89	0.08	0.08	5.952	0.113	119.047	1.089	8.248	0.080	166.12	0.08	2016.246	1
	B	05 46 16.799	25 42 03.00							11.684	0.091	24.85			
iT18 0.31m 1x3s. Single digit precision suggested mag B questionable - confirmed															
HU 992	A	23 02 17.432	15 22 12.67	0.11	0.11	5.922	0.156	119.879	1.505	10.038	0.101	102.20	0.10	2016.735	5
	B	23 02 17.787	15 22 09.72							12.632	0.108	25.69			
iT24 0.61m stack 5x3s V. Image quality a bit questionable. Visual observation suggested B being brighter than listed - confirmed															
HU 992	A	23 02 17.444	15 22 12.39	0.23	0.15	5.987	0.275	122.534	2.626	9.129	0.111	75.30	0.11	2016.735	4
	B	23 02 17.793	15 22 09.17							12.027	0.125	18.12			
iT24 0.61m stack 4x3s I. Image quality a bit questionable. Spc according to V-I color index: A = K2 and B = G3															
SKF 991	A	23 00 02.357	15 25 59.36	0.15	0.08	10.285	0.170	318.643	0.947	11.387	0.111	61.18	0.11	2016.735	4
	B	23 00 01.887	15 26 07.08							12.138	0.113	45.14			
iT24 0.61m stack 4x3s V. Image quality a bit questionable. Visual observation suggested B being brighter than listed - confirmed															
SKF 991	A	23 00 02.347	15 25 59.03	0.14	0.08	10.331	0.161	320.135	0.894	11.315	0.093	47.38	0.09	2016.743	5
	B	23 00 01.889	15 26 06.96							11.946	0.097	30.62			
iT24 0.61m stack 5x3s I. Image quality a bit questionable. Spc according to V-I color index: A = A4 and B = A7															
STF 1491	A	10 58 50.381	61 42 56.34	0.07	0.06	14.024	0.092	33.084	0.377	8.286	0.060	248.37	0.06	2016.491	4
	B	10 58 51.458	61 43 08.09							11.619	0.061	101.78			
iT24 0.61m stack 4x3s. Visual observation: B seemed a bit fainter than listed - confirmed															
ES 1906	A	11 09 48.441	61 24 14.40	0.08	0.06	4.535	0.100	276.966	1.263	11.943	0.062	68.30	0.06	2016.491	5
	B	11 09 47.814	61 24 14.95							13.579	0.071	28.37			
iT24 0.61m stack 5x3s. Visual observation: Both components seemed fainter than listed – confirmed, but fainter than assumed															
STI 723	A	11 15 47.402	60 51 04.48	0.07	0.04	5.791	0.081	1.012	0.798	9.451	0.090	216.08	0.09	2016.491	5
	B	11 15 47.416	60 51 10.27							12.456	0.092	56.02			
iT24 0.61m stack 5x3s. Visual observation suggested B fainter than listed – not confirmed															

Table 7.2: Photometry and astrometry results for the given objects. Columns content ident with table 1.2

Name	α	δ	ρ''	θ°	μ_α	μ_δ	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
SKF 991	345.0097608	15.43317446	10.260	320.022	-7.07	-11.78	4.91	1.06	-9.32	4.91	0.96	Hg	2015	CCCB	GAIA DR1

PM data calculated from position comparison with 2MASS. Certainly not a CPM candidate despite the WDS V-code

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 7.3.1: CPM Check for SKF 991 based on comparison 2MASS to GAIA DR1

Brian Skiff commented on this result with *"Meanwhile even the modest proper motion has shifted the two stars by about 1″.7 on the sky between AC2000 and GAIA1. The fact that the relative position is fixed over ∼110 years, despite that motion, means the pair really is a physical one. Also I note matching spectral types. The motion you derived from the 2MASS positions seems to have some rather small but significant error involved"*. The comparison between AC2000 and GAIA DR1 positions gives indeed a completely different result:

Name	α	δ	Sep(″)	PA(°)	μ_{α_1}	μ_{δ_1}	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
SKF 991	345.0097608	15.43317446	10.260	320.022	-4.86	-12.34	2.39	-5.63	-12.68	2.92	0.96	Hg	2015	AACB	GAIA DR1

PM data calculated from position comparison with AC2000. Solid CPM candidate despite an in relation to the PM vector length rather large AC2000 position error

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 7.3.2: CPM Check for SKF 991 based on comparison AC2000 to GAIA DR1

This example shows quite well that we have always the question which data source we might rely on as no star catalog is completely free of errors – basically I tend to rely on 2MASS but this might be very well a very instructive example of a small but relevant position error in the 2MASS catalog. In terms of position comparison AC2000 seems very attractive because more than 100 years span to GAIA DR1 make even the large AC2000 position errors insignificant – on the other hand the heavy data processing involved in creating the AC2000 catalog gives room for some caveats. Counter-check with the new UCAC5 catalogue results again in a negative CPM assessment for SKF 991.

8 Constellation Ari

All of the listed objects posed questions during session planning but visual observation sessions failed due to ongoing bad seeing conditions. The WDS data per August 2016 for the selected objects are given in Table 3.1. The measurement results for these objects are given in Table 3.2 with the Notes column providing additional information about the used images and references to visual observation.

WDS ID	Name	α	δ	ρ	θ	V_1	V_2

01529+2152	J671	AB	01:52:58.180	+21:52:13.1	2.9	154	9.50	9.7
01537+1822	J2718	AB	01:53:38.580	+18:22:00.1	4.9	50	11.70	11.7
01566+1228	J316	AB	01:56:35.310	+12:28:05.4	3.0	242	11.10	12.5
02085+2227	BRT2307	AB	02:08:29.220	+22:26:58.4	3.0	241	11.00	12.1
02112+2604	BRT3260	AB	02:11:10.590	+26:03:34.3	4.1	175	11.64	13.1
02154+1205	HJ22	AB	02:15:24.310	+12:04:30.4	8.8	256	11.00	12.5
02162+2455	POU168	AB	02:16:11.370	+24:54:38.1	4.2	355	12.90	13.3
02175+2732	BRT128	AB	02:17:31.800	+27:31:19.9	5.5	116	11.22	11.9
02190+2309	BRT2308	AB	02:18:56.610	+23:08:21.0	3.3	119	11.30	11.7
02200+2632	COU355	AB	02:20:01.590	+26:32:17.3	3.8	346	9.67	12.2
02203+2415	J1120	AB	02:20:12.760	+24:14:03.3	3.5	287	10.00	12.0
02204+2456	POU175	AB	02:20:22.530	+24:55:34.7	12.3	48	10.59	12.4
02228+1142	BRT1169	AB	02:22:43.450	+11:42:06.0	3.6	86	11.30	11.3
02252+1217	BRT1170	AB	02:25:09.970	+11:17:43.3	4.6	232	10.80	10.9
02289+2514	POU197	AB	02:28:54.100	+25:13:22.8	10.1	100	9.48	11.2
02320+1743	HJ2145	AB	02:32:01.840	+17:42:36.0	15.5	223	11.59	13.8
02320+1743	HJ2145	AC	02:32:01.840	+17:42:36.0	27.0	296	11.59	14.6
02382+2908	BRT7	BC	02:38:12.350	+29:07:27.5	4.7	197	10.00	10.4
02386+1944	HJ2152	AB	02:38:37.330	+19:43:39.7	43.5	59	7.35	13.2
03068+1717	BRT1174	AB	03:06:47.300	+17:17:14.3	4.2	152	10.30	10.6
03083+3101	HJ331	AB	03:08:32.110	+31:00:43.9	18.2	309	11.40	12.2
03120+1538	BRT1175	AB	03:11:59.110	+15:37:26.6	2.9	136	11.50	11.5
03124+1855	HJ3244	AB	03:12:24.360	+18:53:47.5	8.5	97	10.64	12.6

Table 8.1: WDS data per August 2016

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ	ϵ_ρ	θ	ϵ_θ	Mag	ΔMag	SNR	dVmag	Date	N
J 671	A	01 52 58.224	21 52 12.95	0.10	0.09	2.721	0.135	153.247	2.830	11.580	0.07	54.50	0.07	2016.929	5
	B	01 52 58.312	21 52 10.52							11.801	0.07	46.75			
iT24 5x3s. Touching star disks. Visual observation suggests both stars much fainter than WDS listed. Confirmed															
J 2718	A	01 53 38.521	18 21 58.06	0.07	0.09	4.561	0.114	46.661	1.432	13.675	0.10	34.37	0.09	2016.929	5
	B	01 53 38.754	18 22 01.19							13.804	0.10	33.75			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
J 316	A	01 56 35.415	12 28 02.47	0.09	0.08	2.535	0.120	239.412	2.720	10.840	0.09	33.35	0.08	2016.929	5
	B	01 56 35.266	12 28 01.18							11.944	0.10	19.93			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - confirmed															

BRT 2307	A	02 08 29.271	22 26 58.24	0.10	0.09	2.854	0.135	243.353	2.699	11.178	0.06	111.12	0.06	2016.929	5
	B	02 08 29.087	22 26 56.96							12.228	0.06	54.78			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - rather not confirmed															
BRT 3260	A	02 11 10.593	26 03 34.22	0.08	0.08	3.909	0.113	176.047	1.658	12.049	0.07	42.53	0.07	2016.929	5
	B	02 11 10.613	26 03 30.32							13.054	0.09	21.91			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - to some degree confirmed															
HJ 22	A	02 15 23.722	12 04 27.87	0.06	0.07	8.722	0.092	74.506	0.606	12.713	0.07	67.28	0.07	2016.929	5
	B	02 15 24.295	12 04 30.20							13.572	0.07	44.85			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
POU 168	A	02 16 11.364	24 54 37.88	0.09	0.08	4.154	0.120	355.304	1.660	12.602	0.06	70.21	0.06	2016.929	5
	B	02 16 11.339	24 54 42.02							13.118	0.06	53.53			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
BRT 128	A	02 17 31.806	27 31 19.82	0.06	0.06	5.497	0.085	118.824	0.884	11.148	0.06	96.59	0.06	2016.929	5
	B	02 17 32.168	27 31 17.17							12.230	0.06	67.92			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
BRT 2308	A	02 18 56.612	23 08 21.05	0.08	0.09	3.775	0.120	124.713	1.827	12.466	0.08	32.86	0.07	2016.929	5
	C	02 18 56.837	23 08 18.90							12.881	0.08	31.17			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
COU 355	A	02 20 01.615	26 32 16.70	0.09	0.08	4.480	0.120	344.181	1.540	9.734	0.07	87.21	0.07	2016.929	5
	B	02 20 01.524	26 32 21.01							12.518	0.08	28.23			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - rather not confirmed															
J 1120	A	02 20 12.788	24 14 03.17	0.09	0.08	3.310	0.120	288.129	2.083	12.189	0.07	35.35	0.06	2016.929	5
	B	02 20 12.558	24 14 04.20							13.099	0.08	21.36			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - confirmed															
POU 175	A	02 20 22.557	24 55 34.63	0.09	0.08	12.018	0.120	45.119	0.574	10.539	0.05	142.72	0.05	2016.929	5
	B	02 20 23.183	24 55 43.11							12.427	0.05	72.06			
iT24 5x3s. Session Planning suggested some magnitudes issue - not confirmed															
BRT 1169	A	02 22 43.436	11 42 05.85	0.08	0.09	3.637	0.120	85.901	1.896	12.994	0.09	24.73	0.08	2016.929	5
	B	02 22 43.683	11 42 06.11							12.818	0.09	32.43			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - confirmed															
BRT 1170	A	02 25 09.966	11 17 43.39	0.12	0.14	4.873	0.184	230.337	2.167	10.545	0.08	60.13	0.08	2016.929	5
	B	02 25 09.711	11 17 40.28							10.841	0.09	33.74			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - rather not confirmed															
POU 197	A	02 28 54.097	25 13 22.54	0.08	0.08	10.172	0.113	99.164	0.637	9.340	0.07	252.70	0.07	2016.929	5
	B	02 28 54.837	25 13 20.92							12.394	0.07	78.94			
iT24 5x3s. Session Planning suggested some magnitudes issue - confirmed															
HJ 2145	A	02 32 01.833	17 42 35.91	0.10	0.07	15.390	0.122	223.032	0.454	11.369	0.08	119.84	0.08	2016.929	10
	B	02 32 01.098	17 42 24.66							13.802	0.08	41.60			
iT24 10x3s. Session Planning suggested some magnitudes issue - not confirmed															
HJ 2145	A	02 32 01.833	17 42 35.91	0.10	0.07	26.441	0.122	296.360	0.265	11.369	0.08	119.84	0.08	2016.929	10
	C	02 32 00.175	17 42 47.65							14.495	0.10	19.50			

iT24 10x3s. Session Planning suggested some magnitudes issue - not confirmed														
HEI 9007	A	02 38 14.316	29 06 21.67	0.07	0.06	70.578	0.092	339.044	0.075	9.787	0.08	343.71	0.08	2016.929	5
	BC	02 38 12.390	29 07 27.58							12.016	0.08	107.83			
iT24 5x3s. Session Planning suggested some magnitudes issue - fully confirmed															
BRT 7	B	02 38 12.438	29 07 29.57	0.09	0.08	4.756	0.120	200.314	1.450	12.599	0.08	70.20	0.08	2016.929	5
	C	02 38 12.312	29 07 25.11							12.557	0.08	66.09			
iT24 5x3s. Main component to BRT7 not included in the session plan. Obviously also with some magnitude issue. Combined magnitude from BRT7 would be 11.825															
HJ 2152	A	02 38 37.330	19 43 39.19	0.10	0.08	43.952	0.128	58.109	0.167	7.221	0.05	433.84	0.05	2016.929	5
	B	02 38 39.973	19 44 02.41							14.365	0.06	35.00			
iT24 5x3s. Session Planning suggested some magnitudes issue - fully confirmed															
BRT 1174	A	03 06 47.306	17 17 13.74	0.10	0.07	4.206	0.122	152.190	1.662	11.062	0.06	100.15	0.06	2016.929	5
	B	03 06 47.443	17 17 10.02							11.402	0.06	77.80			
iT24 5x3s. Session Planning suggested some magnitudes issue - fully confirmed															
HJ 331	A	03 08 32.099	31 00 43.46	0.09	0.07	18.164	0.114	309.322	0.360	11.197	0.07	141.16	0.07	2016.929	5
	B	03 08 31.006	31 00 54.97							12.393	0.07	84.16			
iT24 5x3s. Session Planning suggested some magnitudes issue - rather not confirmed															
BRT 1175	A	03 11 59.081	15 37 27.73	0.09	0.08	2.353	0.120	143.447	2.930	12.073	0.09	50.42	0.09	2016.929	5
	B	03 11 59.178	15 37 25.84							12.287	0.09	37.59			
iT24 5x3s. Touching star disks. Session Planning suggested some magnitudes issue - fully confirmed															
HJ 3244	A	03 12 24.389	18 53 47.41	0.08	0.09	8.636	0.120	96.984	0.799	10.444	0.06	175.97	0.06	2016.929	5
	B	03 12 24.993	18 53 46.36							11.592	0.06	110.14			
iT24 5x3s. Session Planning suggested some magnitudes issue - fully confirmed															

Table 8.2: Photometry and astrometry results for the given objects. Columns content identical with Table 1.2

9 Discoverer Code BEM

Marco Prunotto suggested on the Cloudy Nights Double Star Observation forum to take images from all Bemporad double stars. As some of the BEM objects were listed with single digit precision magnitudes I decided to take images of these with V filter. While the images taken are of little aesthetical value they are of good use for astrometry and photometry measurements. BEM10 proved to be non-existent (already marked “Bogus” in WDS) and B16 selected as substitute proved to be a solid common proper motion pair without being V-coded in WDS so far (see Knapp 2016). The WDS data per August 2016 are given in Table 9.1. At first look the WDS data for the BEM objects seems of good quality but the measurement results given in Table 9.2 offer some surprises. I checked also besides BEM16 several other BEM objects for common proper motion – results for some good CPM candidates are given in Table 9.3.

WDS ID	Name	α	δ	ρ	θ	V_1	V_2	Con
12542+5250	BEM2	12:54:14.020	+52:51:23.2	5.0	271	12.00	11.40	UMa
14051+4913	BEM7	14:05:07.510	+49:13:37.2	4.7	85	11.80	11.98	UMa
14151+5048	BEM10	14:15:09.740	+50:48:11.8	13.5	274	11.62	11.10	Boo
14286+4932	BEM11	14:28:30.520	+49:32:10.2	14.6	16	12.00	12.20	Boo
14305+5013	BEM12	14:30:28.270	+50:13:02.9	8.7	186	12.00	11.60	Boo
15097+4942	BEM16	15:09:41.540	+49:41:47.5	25.1	66	11.58	12.31	Boo
15185+5159	BEM18	15:18:36.130	+51:58:58.3	8.6	15	10.51	11.40	Boo
17387+4923	BEM28	17:38:47.960	+49:22:32.7	3.2	0	12.00	12.40	Her
17494+4822	BEM29	17:49:24.140	+48:22:36.6	5.0	136	10.47	12.60	Her
14281+4602	BEM9003	14:28:04.820	+46:02:25.3	8.5	241	11.80	13.10	Boo
15517+4614	BEM9006	15:51:41.320	+46:13:53.2	5.1	256	11.10	11.30	Her
17516+4722	BEM9012	17:51:36.710	+47:21:36.5	4.5	143	12.30	12.30	Her
14407+4928	BEM9013	14:40:43.100	+49:27:33.3	5.3	332	10.80	11.50	Boo
14236+5205	BEM9019	14:23:34.070	+52:04:56.7	14.1	14	10.50	10.90	Boo
15092+5257	BEM9020	15:09:11.510	+52:56:39.6	13.3	4	11.70	12.20	Boo

Table 9.1: WDS data per August 2016

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ''	ϵ_ρ	θ°	ϵ_θ	Mag	ϵ_{mag}	SNR	ΔV	Date	N
BEM 2	A	12 54 14.033	52 51 23.31	0.01	0.01	5.028	0.014	271.140	0.161	12.026	0.033	78.91	0.03	2016.321	9
	B	12 54 13.478	52 51 23.41							13.016	0.038	45.99			
iT24 0.61m stack 9x3s															
BEM 7	A	14 05 07.492	49 13 37.09	0.06	0.04	4.822	0.072	82.492	0.857	11.878	0.071	84.28	0.07	2016.319	5
	B	14 05 07.980	49 13 37.72							11.956	0.071	85.57			
iT24 0.61m stack 5x6s															
BEM 10	A	14 15 09.705	50 48 11.80	0.12	0.19	-	0.225	-	-	11.694	0.095	36.03	0.09	2016.255	5
	B	-	-							-	-	-			
iT18 0.31m stack 5x3s. Number of reference stars rather small. No companion - bogus															
BEM 11	A	14 28 30.860	49 32 24.30	0.03	0.05	14.648	0.058	16.286	0.228	11.863	0.067	35.71	0.06	2016.271	5
	B	14 28 30.438	49 32 10.24							11.766	0.067	36.88			
iT18 0.31m stack 5x3s															
BEM 12	A	14 30 28.224	50 13 02.89	0.11	0.07	8.682	0.130	186.283	0.860	11.907	0.096	31.80	0.09	2016.255	5
	B	14 30 28.125	50 12 54.26							12.632	0.104	20.27			
iT18 0.31m stack 5x3s. Number of reference stars rather small. WDS catalog data rather confirmed, WDS mag B probably a typo with 11.6 instead of 12.6															
BEM 16	A	15 09 41.590	49 41 45.41	0.04	0.07	25.165	0.081	66.088	0.184	11.629	0.085	38.00	0.08	2016.271	5

	B	15 09 43.961	49 41 55.61							12.333	0.090	25.89			
iT18 0.31m stack 5x3s															
BEM 18	A	15 18 36.158	51 58 58.15	0.07	0.06	8.556	0.092	12.598	0.617	10.307	0.091	66.43	0.09	2016.255	4
	B	15 18 36.360	51 59 06.50							12.039	0.099	25.54			
iT18 0.31m stack 4x3s															
BEM 28	A	17 38 48.022	49 22 32.00	0.09	0.11	3.180	0.142	360.000	2.559	11.654	0.089	19.11	0.07	2016.288	4
	B	17 38 48.022	49 22 35.18							11.700	0.090	18.64			
iT18 0.31m stack 4x3s. SNR A and B <20															
BEM 29	A	17 49 24.145	48 22 36.89	0.07	0.06	4.946	0.092	137.559	1.068	10.444	0.104	39.88	0.10	2016.288	2
	B	17 49 24.480	48 22 33.24							12.565	0.142	10.35			
iT18 0.31m stack 2x3s. SNR B <20															
BEM 9003	A	14 28 04.817	46 02 25.39	0.05	0.08	8.536	0.094	240.141	0.633	13.175	0.094	16.89	0.07	2016.271	5
	B	14 28 04.106	46 02 21.14							13.389	0.100	14.67			
iT18 0.31m stack 5x3s. SNR A and B <20															
BEM 9006	A	15 51 41.347	46 13 53.09	0.04	0.04	5.182	0.057	257.179	0.625	11.906	0.078	30.28	0.07	2016.280	4
	B	15 51 40.860	46 13 51.94							12.237	0.081	25.55			
iT18 0.31m stack 4x3s															
BEM 9012	A	17 51 36.688	47 21 36.77	0.07	0.05	4.535	0.086	140.316	1.087	12.297	0.135	13.49	0.11	2016.288	3
	B	17 51 36.973	47 21 33.28							12.623	0.152	9.82			
iT18 0.31m stack 3x3s. SNR A <20 and B <10															
BEM 9013	A	14 40 43.080	49 27 33.90	0.12	0.14	5.193	0.184	331.883	2.034	10.822	0.102	50.87	0.10	2016.255	5
	B	14 40 42.829	49 27 38.48							12.041	0.112	21.39			
iT18 0.31m stack 5x3s															
BEM 9019	A	14 23 34.035	52 04 56.82	0.05	0.07	14.054	0.086	14.433	0.351	10.343	0.082	67.97	0.08	2016.255	5
	B	14 23 34.415	52 05 10.43							10.840	0.083	52.96			
iT18 0.31m stack 5x3s															
BEM 9020	A	15 09 11.514	52 56 39.82	0.12	0.06	13.333	0.134	4.588	0.577	12.168	0.093	22.66	0.08	2016.255	5
	B	15 09 11.632	52 56 53.11							12.383	0.094	21.85			
iT18 0.31m stack 5x3s															

Table 9.2: Photometry and astrometry results for the selected objects. Columns content ident with table 1.2

Name	α	δ	ρ''	θ°	μ_{α_1}	μ_{δ_1}	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
BEM 11	217.1268609	49.53617053	14.646	16.271	-49.25	-2.65	5.91	-49.33	-3.02	5.91	0.96	Hg	2015	AACB	GAIA DR1

PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather large but Sep/PM<1000yrs - looks like a good CPM candidate

BEM 12	217.61759729	50.2174897	8.748	185.907	-29.18	3.16	8.20	-28.41	3.58	8.20	0.96	Hg	2015	AACB	GAIA DR1
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather large but Sep/PM<1000yrs - looks like a good CPM candidate															
BEM 16	227.42332690	49.6960137	25.118	65.961	40.03	-121.94	6.77	34.67	-122.87	6.77	0.96	Hg	2015	AABB	GAIA DR1
PM data calculated from position comparison with 2MASS. Solid CPM candidate															
BEM 9012	267.90292660	47.3602392	4.527	142.553	-4.92	20.26	5.12	-5.82	20.60	5.12	0.96	Hg	2015	AACB	GAIA DR1
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather large but Sep/PM<1000yrs - looks like a good CPM candidate															
BEM 9013	220.17947093	49.4594295	5.233	331.358	-21.94	35.94	9.48	-20.87	37.93	9.48	0.96	Hg	2015	AACB	GAIA DR1
PM data calculated from position comparison with 2MASS. PM error in relation to the PM vector length rather large but Sep/PM<1000yrs - looks like a good CPM candidate															

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 9.3: CPM Check for some BEM objects with fast proper motions

10 Backlog 2015

Chris Thuemen (Yahoo Double Star Imaging Group) made me 2015 aware of some doubles in his Peg images suggesting suspect WDS data. I took then images for a planned joint report on these objects but this project somehow never realized – so I am listing the results of these measurements as appendix to the 2016 report. Besides the expected magnitude issues we find here also one bogus object and an A component being a double star itself. Besides one of the selected objects qualifies quite solid as common proper motion pair.

WDS ID	Name		α	δ	ρ	θ	M_1	M_2
23144+3147	HJ983	AB	23:14:24.088	+31:46:40.6	16.8	158	9.20	10.30
23144+3147	HJ983	AC	23:14:24.088	+31:46:40.6	25.7	298	9.20	14.40
22068+3435	ES386	AB	22:06:48.602	+34:35:12.2	7.0	76	9.35	13.50
22071+3431	HO612	AB	22:07:03.262	+34:31:16.7	10.0	77	6.98	12.00
23215+2457	STF3005	AB	23:21:32.171	+24:56:44.8	20.5	23	8.70	12.91
23237+3217	ES398	AB	23:24:41.829	+32:19:38.8	6.1	266	9.10	11.00
22336+1619	HJ297	AB	22:33:08.457	+16:19:06.5	12.9	165	9.50	10.00
22337+2506	HJ1781	AB	22:33:42.000	+25:06:14.0	25.0	286	8.53	11.80

Table 10.1: WDS data per August 2016 for the selected Peg objects

Name		α	δ	$\Delta\alpha$	$\Delta\delta$	ρ''	ϵ_ρ	$\theta°$	ϵ_θ	Mag	ϵ_{mag}	SNR	ΔV	Date	N
HJ 983	A	23 14 24.176	31 46 40.93	0.06	0.06	16.855	0.085	157.305	0.288	9.217	0.070	243.78	0.07	2015.678	5
	B	23 14 24.686	31 46 25.38							10.522	0.070	139.46			
iT24 0.61m 5x3s															
HJ 983	A	23 14 24.176	31 46 40.93	0.06	0.06	25.735	0.085	297.693	0.189	9.217	0.070	243.78	0.07	2015.678	5
	C	23 14 22.389	31 46 52.89							14.520	0.088	19.62			
iT24 0.61m 5x3s															
ES 386	A	22 06 48.652	34 35 12.10	0.09	0.08		0.120			9.279	0.090	212.93	0.09	2015.678	5
	B														
iT24 0.61m 5x3s. No resolution of B. As stars fainter than 14.5mag are very well resolved in this image: Bogus assumed															
HO 612	A	22 07 03.504	34 31 18.21	0.09	0.08	9.652	0.120	79.131	0.715	7.216	0.090	347.63	0.09	2015.678	5
	B	22 07 04.271	34 31 20.03							13.284	0.096	32.66			
iT24 0.61m 5x3s. A too bright for reliable photometry															
STF 3005	A	23 21 32.167	24 56 44.64	0.05	0.07	20.491	0.086	22.725	0.241	8.656	0.090	284.27	0.09	2015.678	5
	B	23 21 32.749	24 57 03.54							11.680	0.091	83.14			
iT24 0.61m 5x3s															
ES 398	A	23 24 41.839	32 19 38.78	0.07	0.05	6.400	0.086	264.980	0.770	10.005	0.080	171.60	0.08	2015.678	5
	B	23 24 41.336	32 19 38.22							12.960	0.084	43.45			
iT24 0.61m 5x3s															
HJ 297	Aa	22 33 08.455	16 19 05.54	0.09	0.09	3.030	0.127	359.456	2.405	12.644	0.092	63.93	0.09	2015.672	5
	Ab	22 33 08.453	16 19 08.57							13.120	0.093	48.46			
iT24 0.61m 5x6s. HJ297 A is a double itself. Components Aa and Ab are also given in catalogs like UCAC4 and GAIA DR1															
HJ 297	Aa	22 33 08.455	16 19 05.54	0.09	0.09	12.355	0.127	165.285	0.590	12.644	0.092	63.93	0.09	2015.672	5
	B	22 33 08.673	16 18 53.59							12.400	0.091	81.75			
iT24 0.61m 5x6s															
HJ 1781	A	22 33 42.051	25 06 13.83	0.08	0.07	25.102	0.106	286.050	0.243	8.407	0.090	269.57	0.09	2015.678	4
	B	22 33 40.275	25 06 20.77							13.056	0.095	37.07			
iT24 0.61m 4x3s															

Table 10.2: Photometry and astrometry results for the selected objects. Columns content identical with Table 1.2

Name	α	δ	ρ''	$\theta°$	μ_{α_1}	μ_{δ_1}	ϵ_{μ_1}	μ_{α_2}	μ_{δ_2}	ϵ_{μ_2}	Ap	Me	Date	CPM Rat	Source
HJ 983 AB	348,6007338	31,77803353	16,876	157,288	68,81	18,10	1,03	67,77	18,32	1,13	0,96	Hg	2015	AAAB	GAIA DR1
PM data directly from GAIA DR1 (e_pm calculated as RMS over e_pm RA and Dec). AB solid CPM candidate while C is only optical															
HO 612	331,76455483	34,5217191	9,782	78,067	127,98	60,95	6,56	-2,23	-6,38	6,56	0,96	Hg	2015	CCCB	GAIA DR1
PM data calculated from position comparison with 2MASS. Optical pair with fast proper motion for A															

CPM Rating according to Knapp/Nanson 2016 plus fourth criterion Sep/PM (A <100yrs, B <1000yrs, C >1000yrs)

Table 10.3: CPM Check for HJ983 and HO612

References

Ball, R.S., 1884, Observations in search of stars with annual parallax, Dunsink Observatory Publications, **5**, 1-157

Bessel, F. W.,1839, "Bestimmung der Entfernung des 61sten Sterns des Schwans. Von Herrn Geheimen Rath und Ritter Bessel", *Astronomische Nachrichten* **16**, (5-6), 65-96

Buchheim, Robert, 2008, CCD Double-Star Measurements at Altimira Observatory in 2007, *Journal of Double Star Observations*, **4**, No. 1, 28

Heinze, A.N., Hinz, P.M., Sivanandam, S., Kenworthy, M., Meyer, M., & Miller, D. – 2010, Constraints on Long Period Planets, *Astrophysical Journal*, **714**, 1551-1569

Knapp, Wilfried R.A. and Nanson, John, 2017, A new concept for counter-checking of assumed CPM pairs, *Journal of Double Star Observations*, bf n No. n Page nn

Knapp, Wilfried R.A., 2015, Photometry on Some Wide and Faint Double Stars, *Journal of Double Star Observations*, **11** No. 4, 384-386

Knapp, Wilfried R.A., 2016, Measurement of some VizieR I/330 Objects, *Journal of Double Star Observations*, **12**, No. 6, 589-594

Lewis, Thomas, 1906, *Measures Of The Double Stars Contained In The Mensurae Micrometricae Of F. G. W. Struve*, Andesite Press (August 13, 2015)

Piazzi, Giuseppe, 1803, Praecipuarum stellarum inerrantium positiones mediae ineunte seculo XIX: ex observationibus habitis in specula Panormitana ab anno 1792 ad annum 1802. Typis regiis., 111.

Struve, Friedrich G.W., 1837, *Stellarum duplicium et multiplicium mensurae micrometricae*, St. Petersburg

Tanner, A. M., Gelino, C. R., & Law, N. M., 2010, A high-contrast imaging survey of SIM lite planet search targets., *Publications of the Astronomical Society of the Pacific*, **122**, Issue 896, 1195-1206

Tenn, Joseph S. – 2013, Keepers of the Double Stars, *Journal of Astronomical History and Heritage* **16**, 81 - 93

Urban, S.E., Corbin, T.E., Wycoff, G.L., Martin, J.C., Jackson, E.S., Zacharias, M.I., & Hall, D.M.,1998, The AC 2000, *Astronomical Journal*, **115**, 1212 - 1223

Acknowledgements

The following tools and resources have been used for this research:

1. Washington Double Star Catalog

2. iTelescope:

1. iT24 0,61m: 610mm CDK with 3962mm focal length. CCD: FLI-PL09000. Resolution 0.62 arcsec/pixel. V-filter. No transformation coefficients available. Located in Auberry, California. Elevation 1405m

2. iT18 0.31m: 318mm CDK with 2541mm focal length. CCD: SBIG-STXL-6303E. Resolution 0.73 arcsec/pixel. V-filter. Located in Nerpio, Spain. Elevation 1650m
3. iT27 0.7m: 700mm CDK with 4531mm focal length. CCD: FLI PL09000. Resolution 0.53 arcsec/pixel. V-filter. Located in Siding Spring, Australia. Elevation 1122m
4. 2MASS All Sky Catalog
5. URAT1 Catalog
6. UCAC4 Catalog
7. GAIA DR1 Catalog
8. AAVSO VPhot
9. Aladin Sky Atlas v9.0
10. SIMBAD, VizieR
11. AstroPlanner v2.2
12. MaxIm DL6 v6.08
13. Astrometrica v4.10.0.427

DOUBLE STAR MEASUREMENTS WITH AN ASTROMETRIC EYE-PIECE IN 2016

Neil Webster, Bromley, Kent BR2 0SD

E-mail: nweb124@gmail.com

Introduction

The following measurements were made with a Meade 12-mm astrometric illuminated reticle eyepiece attached to a recently purchased Altair Astro 115-mm refractor (focal length 805mm, f7). The optical train also employed a 2.5x Powermate to give a total magnification of 167.5x. Calibration was achieved over two evenings using the timing/transit method as outlined in Teague[1]. Three separate stars were used and the results (reassuringly close) averaged to give a calibration of: $12''.49 \pm 0''.4$ per division on the measuring scale. Measures of 62 pairs were made totalling 1237 individual measurements.

Method

Earlier attempts with a smaller scope (SW 80-mm APO) had indicated the necessity of taking multiple readings to achieve a credible result. Unless stated, each system has 10 separation and 10 position angle measurements (N = 20) from which a final result and associated uncertainty were calculated. As expected the later results were, overall, found to be closer to WDS values especially in P.A. Early P.A. values were made by turning the motor off and allowing the primary to drift and cross the outer protractor scale. The scope was moved manually in R.A. to allow further measurements to be made. However, even with a relatively small system this was not easy and the following method was adopted:

With the motor on, the two stars were positioned parallel to the measurement-axis with the primary positioned to pass through the centre-point. The system was then steered to the outer scale using the R.A. control on the handset. The value that the primary passed through was noted and the appropriate conversion to the correct P.A. value made afterwards.

This has the advantage that repeated measurements can be easily made and the scope can be easily slewed to the next system afterwards. The PA results were seen to immediately improve using this method. It, of course, relies on precise polar alignment of the mount so movement in declination is at an absolute minimum.

Due to the small magnification of the system the limiting useful minimum separation measurement is about $14''$. The accuracy of PA for small separations is also harder to achieve especially if the secondary is very faint. The faintest magnitude used for measurement was 10.3 due partly to local light pollution but also due to the obscuring red light used to illuminate the measuring eyepiece.

As most of these systems are comparatively wide the orbits are generally very long (30,000 years+) and very few have accurate orbital calculations. Residuals (from the online version of 6th USNO Catalogue of Orbits of Visual Binary Stars) have been given for the few systems calculated.

Residuals from the Fourth Catalogue of Interferometric Measurements have provided a more extensive set of residuals.

References

(1) Teague, E. T. H. (2012) in Argyle, R. W. (ed.), Observing and Measuring Visual Double Stars, Springer

(2) The Cambridge Double Star Atlas, (Mullany J. Tirion W. pub. Cambridge)

(3) Washington Double Star Catalogue (Mason, B.D., Wycoff, G.L. & Hartkopf, W.I.):
(4) `http://ad.usno.navy.mil/proj/WDS`
(5) Sixth Catalogue of Orbits of Visual Binary Stars (Hartkopf, W.I., Mason, B.D. & Worley, C.E.):
`http://www.usno.navy.mil/USNO/astrometry/optical-IR-prod/wds/orb6/sixth-catalog-of-orbits-of-visual-binary-stars`
(6) Fourth Catalogue of Interferometric Measurements of Binary Stars:
`http://www.usno.navy.mil/USNO/astrometry/optical-IR-prod/wds/int4`

Table 1: Measures of Double Stars

Pair	Comp	RA	Dec	V_a	V_b	PA (°)	± (°)	Sep (″)	± (″)	Epoch (2016+)	N	Obs
STF 30	AB	00272	+4959	6.96	8.92	314.0	0.2	12.8	0.1	0.903	20	WST
STF 60	AB	00491	+5749	3.52	7.36	324.2	0.1	12.9	0.1	0.903	20	WST
STF 948	AC	06462	+5927	5.44	7.05	306.7	0.2	9.3	0.2	0.350	20	WST
STF1110	AC	07346	+3153	1.93	9.83	162.2	0.4	69.8	0.4	0.308	20	WST
STF1268	AB	08467	+0846	4.13	5.99	307.9	0.3	31.3	0.3	0.294	20	WST
STF1315		09128	+6141	7.33	7.65	27.3	0.3	24.6	0.2	0.350	20	WST
STF1321	AB	09144	+5241	7.79v	7.88v	97.4	0.2	17.2	0.3	0.369	20	WST
STF1415	AB	10178	+7104	6.65	7.27	167.7	0.1	16.9	0.2	0.635	20	WST
LDS2863	AB	10306	+5559	4.88	8.86	302.9	0.1	122.8	0.4	0.635	20	WST
STF1495		10598	+5854	7.25	8.84	36.0	0.1	34.2	0.2	0.643	20	WST
ENG 45	AB	11118	+4250	7.24	8.30	247.3	0.1	135.0	0.5	0.643	20	WST
STF1520	AB	11161	+5246	6.54	7.81	345.8	0.1	11.9	0.2	0.643	20	WST
STF1579	AB-D	11551	+4629	6.68	6.97	113.7	0.2	62.6	0.2	0.297	20	WST
STF1657	AB	12351	+1823	5.11	6.33	270.0	0.1	21.6	0.3	0.294	20	WST
STF1687	AC	12533	+2115	5.15	9.76	127.1	0.5	28.5	0.3	0.369	20	WST
STF1692	AB	12560	+3819	2.85	5.52	228.5	0.2	20.0	0.3	0.291	20	WST
STF1744	AB	13239	+5456	2.23	3.88	152.4	0.2	14.4	0.2	0.294	20	WST
STF1821	AB	14135	+5147	4.53	6.62	237.5	0.1	13.1	0.2	0.294	20	WST
STFA 28	AB	15245	+3723	4.33	7.09	171.0	0.3	109.0	0.4	0.294	20	WST
STF2010	AB	16081	+1703	5.10	6.21	13.0	0.4	26.5	0.3	0.342	20	WST
STF2078	AC	16362	+5255	5.38	5.50	193.3	0.2	89.3	0.4	0.311	20	WST
STFA 35		17322	+5511	4.87	4.90	310.0	0.1	62.5	0.1	0.294	20	WST
STF2241	AB	17419	+7209	4.60	5.59	15.1	0.3	30.7	0.3	0.342	20	WST
STF2308	AB	18002	+8000	5.70	6.00	231.4	0.2	20.0	0.3	0.326	20	WST
STFA 38	AD	18448	+3736	4.34	5.62	149.9	0.2	44.2	0.1	0.623	20	WST
STF2426	AB	19000	+1253	7.45	8.96	260.6	0.2	16.6	0.2	0.627	20	WST
SHJ 286		19050	−0402	5.52	6.98	208.9	0.3	39.1	0.3	0.553	19	WST
STTA178		19153	+1505	5.69	7.68	266.8	0.3	89.8	0.4	0.624	18	WST
STT 588	AB	19250	+1157	5.24	8.65	282.1	0.2	104.0	0.5	0.631	20	WST
STFA 43	AB	19307	+2758	3.19	4.68	53.8	0.2	34.6	0.3	0.621	20	WST
STFA 46	AB	19418	+5032	6.00	6.23	132.5	0.3	40.0	0.1	0.621	20	WST
STF2578	AB	19457	+3605	6.37	7.04	122.8	0.1	14.6	0.2	0.646	20	WST
WEB 9	AB	20007	+3635	6.69	8.97	202.0	0.1	71.6	0.3	0.646	20	WST
STFA 50	AC	20136	+4644	3.93	6.97	172.7	0.1	108.6	0.5	0.616	20	WST
STFA 50	AD	20136	+4644	3.93	4.83	322.3	0.1	336.7	1.1	0.616	20	WST
ENG 72	AB	20145	+3648	4.96	6.71	154.9	0.2	215.3	0.7	0.646	20	WST
HO 588	AB	20169	+3130	6.91	8.89	296.8	0.3	50.8	0.2	0.646	20	WST

STTA205		20197	+4108	7.19	8.91	320.4	0.3	46.2	0.3	0.646	20	WST
STF2758	AB	21069	+3845	5.20	6.05	154.9	0.2	33.3	0.3	0.616	20	WST
STF2806	AB	21287	+7034	3.17	8.63	251.4	0.2	13.5	0.2	0.662	20	WST
STFA 57	AB	21344	+6644	7.07	7.18	25.2	0.2	183.1	0.7	0.721	20	WST
STF2816	AC	21390	+5729	5.73	7.48	117.1	0.2	11.9	0.1	0.794	20	WST
STF2816	AD	21390	+5729	5.73	7.53	338.7	0.2	20.7	0.2	0.794	20	WST
STF2840	AB	21520	+5548	5.64	6.42	196.4	0.2	17.9	0.3	0.721	20	WST
S 800	AB	21538	+6237	7.07	7.91	145.1	0.1	62.5	0.1	0.721	20	WST
STF2873	AB	21582	+8252	7.00	7.47	66.1	0.2	13.4	0.2	0.739	20	WST
STT 461	AD	22039	+5949	6.66	7.84	72.0	0.1	184.0	0.6	0.794	20	WST
STT 461	AE	22039	+5949	6.66	6.96	36.9	0.1	237.1	0.8	0.794	20	WST
STT 461	AC	22039	+5949	6.66	10.03	39.7	0.1	89.2	0.4	0.794	20	WST
STF2872	A-BC	22086	+5917	7.14	7.98	314.6	0.1	22.0	0.2	0.739	20	WST
STF2883		22106	+7008	5.56	8.56	252.8	0.3	14.2	0.2	0.750	20	WST
STF2893		22129	+7318	6.19	7.91	347.0	0.2	28.9	0.2	0.750	20	WST
STF2894	AB	22189	+3746	6.21	8.85	193.9	0.1	16.1	0.2	0.903	20	WST
STFA 58	AC	22292	+5825	4.21	6.11	191.2	0.2	40.3	0.2	0.750	20	WST
HJ 1786	AB	22345	+4046	7.00	9.46	226.0	0.1	43.5	0.3	0.758	20	WST
STF2922	AB	22359	+3938	5.66	6.29	185.2	0.1	22.5	0.2	0.758	20	WST
A 1469	AD	22359	+3938	5.66	9.08	142.6	0.2	81.7	0.3	0.758	20	WST
A 1469	AE	22359	+3938	5.66	7.25	238.6	0.1	335.2	1.1	0.758	20	WST
S 813	AB	22393	+3903	4.84	10.3	47.2	0.2	62.6	0.2	0.834	20	WST
STT 480		22461	+5804	7.65	8.64	116.4	0.2	30.7	0.2	0.750	20	WST
STA 238	AB	22527	+6759	7.02	7.58	280.3	0.1	68.8	0.4	0.758	20	WST
STF2960	AC	22564	+4136	5.56	9.35	47.1	0.2	61.5	0.2	0.834	20	WST

Table 2: Residuals from known orbits

Pair	ADS	Residual(O−C) PA(°)	Sep (″)	Orbit	Period(yrs)	Date	Grade
STF 1110	6175	−4.1	−1.8	Kiyaeva	187200	2015	5
		−5.8	−0.1	Kiyaeva	134630	2015	5
		−4.9	+0.4	Kiyaeva	128170	2015	5
STF 1321	7251	−0.8	+0.3	Chang	975	1972	4
STF 1821	9173	+2.2	−0.7	Kiyaeva	61010	2006	5
STF1821	9173	+2.7	−1.1	Kiyaeva	66750	2006	5
STF 2241	10759	−1.7	+1.1	Kiselev	31000	2009	5
STF 2308	11061	0.0	+1.2	Kiselev	18000	1996	5
STFA 46	12815	−0.6	+0.2	Hauser, Marcy	135127	1999	4
STF 2758	14636	+2.9	+1.7	Polyakov	678	2006	4
STF 2873	15571	+0.3	−0.3	Polyakov	192400	2006	5

Table 3: Residuals from Fourth Catalogue of Interferometric Measurements

Pair	ADS	HIP (TYC)	Epoch (catalogue)	(O-C) PA(°)	(O-C) Sep(″)

STF 30 AB	361	2151	2003.809	+1.4	−1.0
STF 60	671	3821	2003.766	+5.5	+0.1
STF 948 AC	5400	32438	2008.885	−2.0	+0.6
STF 1110 AC	6175	36850	1991.25	−1.2	−1.2
STF 1268 AB	6988	43100	2003.283	+0.2	+1.1
STF 1315	7226	45206	1991.59	+0.4	−0.2
STF 1415	7705	50433	2003.251	+0.4	+0.4
LDS 2863 AB		51459	1991.70	−0.1	0.0
STF 1495	8001	53750	1991.64	−0.6	+0.1
ENG 45 AB		54692	1991.75	+0.1	+0.2
STF 1520 AB	8108	55044	2013.0556	+3.1	−0.2
STF 1579 AB-D	8347	58112	1991.73	−0.1	−0.4
STF 1657 AB	8600	61418	2003.284	−0.1	+1.7
STF 1692 AB	8706	63125	2003.284	−0.1	+0.9
STF 1744 AB	8891	65378	2012.190	+1.5	+0.8
STF 1821 AB	9173	69483	2008.278	+2.0	−0.5
STFA 28 AB	9626	75411	1991.62	0.0	+0.1
STF 2010	9933	79043	2003.418	0.0	−0.9
STF 2078 AC	10129	81292	1991.68	−0.9	−0.1
STFA 35	10628	85829	1999.40	−1.2	+0.3
STF 2241 AB	10759	86614	1991.70	−0.4	+0.5
STF 2308 AB	11061	88136	2012.7725	+1.4	+0.5
STFA 38 AD	11639	91971	2003.418	−0.4	+0.5
STF 2426 AB		93273	1991.82	−0.1	0.0
SHJ 286	12007	93717	2003.418	−0.7	−0.1
STTA 178		94624	1991.57	−0.2	0.0
STT 588 AB*		95447	2014.14	−0.8	−1.4
STFA 43 AB	12546	95947	2003.418	+0.5	+0.2
STFA 46 AB	12815	96895	2003.628	−1.2	+0.9
STF 2578 AB	12893	97228	2013.637	−1.6	−0.4
WEB 9 AB		98510	1991.47	0.0	+0.3
STFA 50 AC	13554	99675	1991.72	−0.3	+1.7
STFA 50 AD	13554	99675	1991.72	−0.5	+0.2
ENG 72 AB		99770	1991.61	+0.1	+0.2
HO 588 AB	13630	99967	2003.629	−0.2	+0.5
STTA 205		(3155 00153)	1991.65	+0.5	+0.6
STF 2806 AB	15032	106032	1991.50	+2.5	+0.1
STFA 57 AB		106515	1991.73	−0.2	+0.8
STF 2816 AC	15184	106886	2007.8672	−2.2	+0.1
STF 2816 AD	15184	106886	2003.620	0.0	+1.0
STF 2840 AB	15405	107930	2003.621	+0.7	+0.2
S 800 AB	15434	108073	1991.61	0.0	0.0
STF 2873 AB	15571	108456	2012.7705	−0.1	−0.3
STT 461 AD	15601	108925	1991.62	−2.1	−0.4
STT 461 AE	15601	108925	1991.61	−0.3	−0.3
STT 461 AC	15601	108925	1991.43	0.0	−0.9
STF 2872 AB	15670	(3981 01587)	1991.68	−1.3	+0.8
STF 2883	15719	109475	2003.621	+0.7	−0.2
STF 2893	15764	109659	2003.629	0.0	+0.1
STF 2894 AB	15828	110171	1991.48	+0.4	+0.3

STFA 58 AC	15987	110991	2003.629	+0.2	−0.2
STF 2922 AB	16095	111546	2003.625	0.0	+0.3
A 1469 AD	16095	111546	1991.47	−1.3	0.0
A 1469 AE	16095	111546	1991.65	0.0	−0.2
S 813 AB	16148	111841	1991.46	−1.9	+1.2
STT 480	16260	(3992 00747)	1991.64	0.0	−0.1
STTA 238 AB		112970	1991.72	0.0	−0.4
STF 2960 AC	16381	113281	1991.41	−1.2	−0.6
STT 486	16481	113853	2003.629	−0.4	+1.0

*STT 588 - significant proper motion - most recent WDS measure used. All Residuals: observed (NW) − latest catalogue measurement

TWO NEW VISUAL COMMON PROPER MOTION PAIRS

Kacper Wierzchos, University of South Florida, Department of Physics, 4202 East Fowler Ave, ISA 2019 Tampa, FL 33620-7100

E-mail: kwierzchos@mail.usf.edu

Abstract

The present paper presents two new common proper motion pairs in the constellations of Canis Major and Puppis that are not currently listed in the WDS catalogue. The proper motion of both pairs has been checked in different catalogues, and astrometry of the pairs is presented for different epochs. Both of the pairs present similar magnitudes and spectral types between components and may be physical. Both appear in the Cape Photographic Durchmusterung (CPD) catalogue, and one of them is also listed in the Bonner Durchmusterung (BD), therefpre the inclusion of the pairs in the WDS is proposed.

Method

Pair 1 (07203-2146)

A previously non-catalogued common proper motion (CPM) pair was found serendipitously on March 1 2017 when doing visual observations of the pair WDS 07193-2203 (LAL 53), which happened to be in a nearby field. The pair - whose suggested provisional name is WRS 1 - was visually detected with a 80mm f/7 APO refractor with a 7 mm orthoscopic eyepiece yielding a magnification of x80. After the visual observation, its presence was confirmed in ALADIN images[1] and the proper motion of the components was assessed with SIMBAD. This pair is formed by the stars 2MASS J07201728-2145373 and 2MASS J07201845−2145272 with coordinates (J2000) 07h 20m 17s.28 $-21° 45' 37''.3$ and 07h 20m 18s.45 $-21° 45' 27''.2$ respectively. An image of the pair is shown in Figure 1.

The proper motions of the components appear in SIMBAD as $\mu_\alpha = -4.9$ mas/yr, $\mu_\delta = 11.90$ mas/yr for the primary and $\mu_\alpha = -5.0$ mas/yr, $\mu_\delta = 15.0$ mas/yr for the secondary. The proper motions for this pair listed in the GAIA catalogue[2] are also consistent between components and are $\mu_\alpha = -1.3$ mas/yr, $\mu_\delta = 6.0$ mas/yr for the primary and $\mu_\alpha =$ -2.8 mas/yr, $\mu_\delta = 8.0$ mas/yr for the secondary. Based on the $B - V$ index, the spectral types of the stars are likely F5 and G5. This pair is listed in the BD and CD catalogues as BD $-21°$ 1883 and CPD $-21°$ 2040 + 2041.

Pair 2 (08097-2002)

This pair - whose suggested provisional name is WRS 2 - was found in 2MASS images. After checking that it is not currently listed in the WDS catalogue, the proper motion of the components was also assessed with SIMBAD. Based on the $B - V$ index the spectral types of the stars are likely K4 and K5. The pair is formed by the stars 2MASS J08094277−2001423 and 2MASS J08094217−2001588 with coordinates (J2000) 08h 09m 42s.77 $-20° 01' 42''.3$ and 08h 09m 42s.17 $-20° 01' 58''.8$ respectively. An image of the pair is shown in Figure 2.

The proper motions of the components appear in SIMBAD as $\mu_\alpha = -2.8$ mas/yr, $\mu_\delta = -31.4$ mas/yr for the primary and $\mu_\alpha = -4.4$ mas/yr, $\mu_\delta = -30.8$ mas/yr for the secondary. The proper motions for this pair listed in the GAIA catalogue[2] are also consistent between components and are $\mu_\alpha = -2.3$ mas/yr, $\mu_\delta = -30.9$ mas/yr for the primary and $\mu_\alpha = -6.8$ mas/yr, $\mu_\delta = -28.4$mas/yr for the secondary. This pair is listed in the CPD catalogue as CPD -19° 3161.

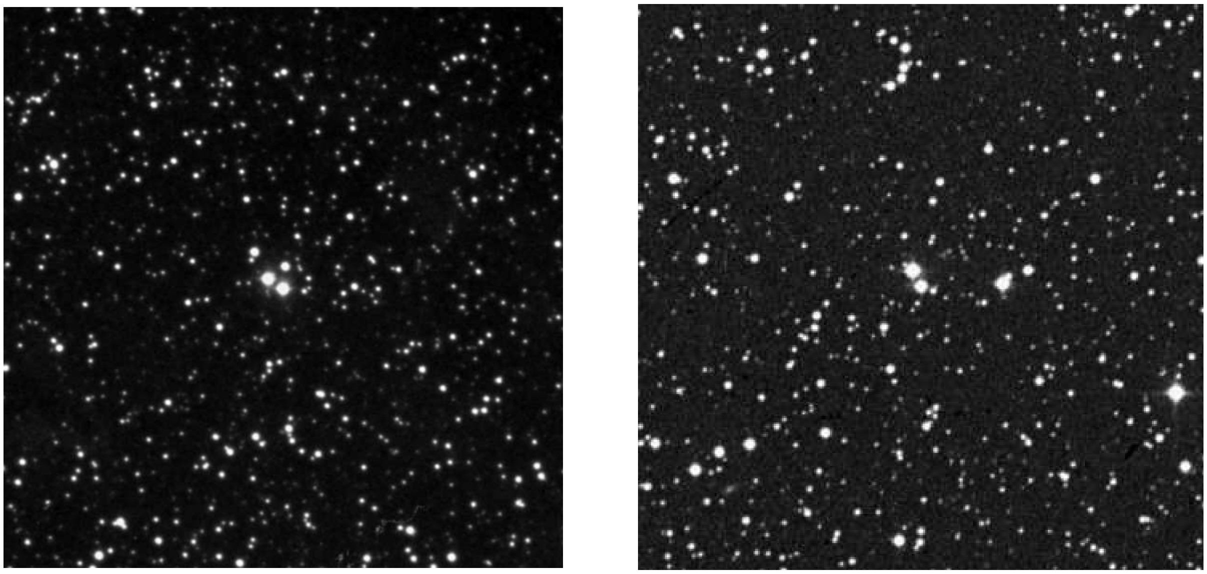

Figure 1: POSS images for Pair 1 (07203-2146) (left) and Pair 2 (08097-2002) (right). Field size is 10′x 10′

Astrometric history

For both pairs, Table 1 shows the provisional name, coordinates of the primary component, visual magnitudes V of both stars obtained from the TYCHO-2 catalogue[3], the proper motions as listed in SIMBAD, $(B - V)$ index and probable spectral type based on that index. The astrometric history of both pairs is shown in Table 2 and 3[4].

Prov. Desig.	α (2000)	δ (J2000)	V	μ_α, μ_δ	$(B - V)$	Spec. Type
WRS 1	07 20 17.28	−21 45 37.3	10.35, 10.77	−4.9 11.9	0.46	F5
				−5.0 15.0	0.70	G5
WRS 2	08 09 42.77	−20 01 42.3	10.49, 11.89	−2.8 −31.4	0.98	K4
				−4.4 −30.8	1.12	K5

Table 1. Coordinates, magnitudes, proper motions and $B - V$ index of the pairs

Epoch	$\theta°$	ρ''	source
1923.020	58.4	19.31	AC2000
1991.25	58.1	19.34	Tycho-2
1996.934	58.1	19.20	DENIS
1998.977	58.1	19.28	DENIS
1999.305	58.3	19.25	2MASS
2000.0	58.2	19.28	UCAC2
2004.805	58.1	19.27	CMC15
2010.5	58.1	19.29	WISE
2015.0	58.0	19.28	GAIA1

Table 2: Astrometric measurements of the pair WRS 1

Epoch	θ°	ρ''	source
1917.8	206.6	18.59	AC2000
1979.234	208.3	18.81	GSC-ACT
1999.277	207.9	18.87	DENIS
1999.299	207.7	18.93	2MASS
2000.0	208.1	18.92	UCAC2
2009.057	208.0	18.83	CMC15
2015.0	208.1	18.95	GAIA1

Table 3: Astrometric measurements of the pair WRS 2

Conclusion

In the present paper, two possibly physical common proper motion pairs are reported. Both pairs present similar magnitudes and spectral types between components, and little or no change in their position angle and separation has been observed throughout their astrometric history. Their inclusion in the WDS catalogue is suggested.

Acknowledgements

This publication makes use of data products from the Two Micron All Sky Survey (2MASS), which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. Also, this research has made use of the ALADIN sky atlas developed at CDS, Strasbourg Observatory, France.

The author gratefully acknowledges the help of Maria Womack and Brian Skiff. This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory. This work has made use of data from the European Space Agency (ESA) mission Gaia[5], processed by the Gaia Data Processing and Analysis Consortium (DPAC)[6]. Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement. The author also acknowledges support from NSF grant AST-1615917.

References

(1) Arenou, F., Luri, X., Babusiaux, C., Fabricius, C., Helmi, A., Robin, A. C., Vallenari, *et al.*, 2017, Astronomy & Astrophysics, Gaia Data Release 1. Catalogue validation, **599** A50, 35

(2) Bonnarel, F., Fernique, P., Bienaymé, O., Egret, D., Genova, F., Louys, M., Ochsenbein, F., Wenger, M., & Bartlett, J. G., 2000, Astronomy and Astrophysics Supplement, **143**, 33-40.

(3) Høg, E., Fabricius, C., Makarov, V.V., *et al.*, 2000, Astronomy and Astrophysics, **355**, 27-31

(4) Skiff, B., 2017, personal communication

(5) `https://www.cosmos.esa.int/gaia`

(6) `https://www.cosmos.esa.int/web/gaia/dpac/consortium`

MEASURES OF WIDE DOUBLE STARS USING A WEBCAM - II

Axel Tute, Küssaberg, Germany

Introduction

In this publication, the I present my measurements made with a webcam and a 100/1300 Maksutov-Cassegrain telescope (MCT). A detailed description of the setup was reported in DSSC21 (Tute 2011). These measurements were mostly made between 2013 and 2016. Several measurements were done in 2010 and 2011, but due to insufficient numbers of measurements, were left out of the first report. In contrast to the first report an astrometric tool programmed in Python by my son was used. The tool allows the position of the star in the picture to be measured, by calculating the "center of gravity".

The measurements are arranged as in the first report. The table gives the name of the pairs using the WDS nomenclature. The table also contains the residuals of the measurements calculated from the last measuremed result listed in the WDS.

Notes

When calculating the residuals I found three stars with a significant absolute difference. Interestingly, they all show the same behaviour: the current measurement listed in the WDS shows a significant change of the separation from previous measurements. However my measurement is very close to the older measurements in the WDS.

S 513AD:

1894	265″.8	25°	WDS
2007	264″.7	25°	WDS
2011	274″.7	24°	WDS
2015	265″.0	24°	New

STFA 4 AB:

1834	176″.2	302°	WDS
2001	200″.5	299°	WDS
2012	207″.1	298°	WDS
2013	202″.5	298°	New

STT 70:

1875	116″.5	178°	WDS
2006	114″.6	179°	WDS
2012	117″.0	178°	WDS
2013	114″.5	178°	New
2014	114″.4	178°	New

Acknowledgments

Much of the work presented here has made use of the Washington Double Star Catalogue maintained at the U.S. Naval Observatory.

References

Tute, A., *Webb Society Double Star Circulars*, **21**, 18, 2011

Pair		RA	Dec	Date	N	ρ ($''$)	±	θ (°)	±	Last Measure (WDS)			Residuals $\Delta\rho$(%)	$\Delta\theta$(°)
H 5 17	AD	00369	+3343	2013.832	33	35.7	0.3	174.1	0.3	2015	35.7	174	0.0	−0.1
				2014.731	33	35.7	0.3	173.9	0.4	2015	35.7	174	0.0	+0.1
STFA 4	AB	01562	+3715	2013.832	33	202.5	0.3	297.5	0.1	2012	207.1	298	−2.2	+0.5
				2014.73	33	202.5	0.3	297.5	0.1	2012	207.1	298	−2.2	+0.5
BUP 30	AC	02228	+4124	2013.832	33	305.8	0.2	8.6	0 1	2012	302.2	10	+1.2	+1.4
AG 304		02358	+3441	2013.832	33	142.4	0.2	16.4	0.1	2013	143.2	17	−0.6	+0.6
STTA 38	AB	03446	+2704	2013.172	33	135.5	0.2	51.8	0.1	2013	135.1	52	+0.3	+0.2
				2014.151	33	135.9	0.4	51.9	0.1	2013	135.1	52	+0.6	+0.1
STFA 8	AB	03475	+2406	2013.170	33	116.8	0.2	290	0.0	2011	117.3	290	+0.4	0.0
				2013.172	33	116.9	0.2	290.1	0.1	2011	117.3	290	−0.3	−0.1
STTA 40	AB	03494	+2423	2013.570	33	87.0	0.2	309.0	0.1	2015	86.9	309	+0.1	0.0
				2013.172	33	86.8	0.2	309.2	0.1	2015	86.9	309	−0.1	−0.2
STTA 70		06141	+2359	2013.172	33	114.5	0.1	178.4	0.1	2012	117	178	−2.1	−0.4
				2014.151	33	114.4	0.2	178.3	0.1	2012	117	178	−2.2	−0.3
S 513	AD	06212	+2108	2015.112	33	265.0	0.2	23.9	0.0	2011	274.7	24	−3.5	+0.1
				2015.115	33	264.9	0.2	23.9	0.1	2011	274.7	24	−3.6	+0.1
STTA 77		06290	+2013	2015.112	33	113.3	0.1	330.0	0.1	2015	112.8	330	+0.4	0.0
				2015.115	33	113.1	0.2	330.1	0.1	2015	112.8	330	+0.3	−0.1
S 524	AB	06341	+2207	2015.112	33	53.4	0.1	244.2	0.1	2011	53.3	244	+0.2	−0.2
				2015.115	33	53.4	0.1	244.0	0.1	2011	53.3	244	+0.2	0.0
SHJ 77	AC	07041	+2034	2013.285	33	101.3	0.2	347.1	0.1	2008	101.3	347	0.0	−0.1
				2014.151	33	101.6	0.2	347.1	0.1	2008	101.3	347	+0.3	−0.1
STF 1090	AB	07265	+1831	2013.285	33	60.5	0.2	98.1	0.1	2015	60.7	98	−0.3	−0.1
				2014.151	33	60.5	0.2	98.3	0.1	2015	60.7	98	−0.3	−0.3
STTA 89		07510	+3137	2015.115	33	76.6	0.1	83.6	0.1	2015	76.8	84	−0.3	+0.4
STTA 94		08362	+1347	2013.285	33	43.4	0.1	133.1	0.2	2013	43.1	133	+0.7	−0.1
S 605		09541	+0457	2013.285	33	53.5	0.2	287.0	0.2	2014	53.3	287	+0.4	0.0
STT 341	AB-G	18058	+2127	2013.580	33	133.2	0.1	238.4	0.1	2012	133.3	238	−0.1	−0.4
				2013.591	33	133.1	0.2	238.3	0.1	2012	133.3	238	−0.2	−0.3
GUI 21	AD	18267	+2627	2013.580	33	162.6	0.2	285.2	0.1	2012	162.9	285	−0.2	−0.2
				2013.591	33	162.7	0.2	285.4	0.1	2012	162.9	285	−0.1	−0.4
STFA 37	AB-CD	18443	+3940	2010.507	33	209.2	0.1	172.1	0.1	2015	208.7	172	+0.2	−0.1
				2016.646	33	209.5	0.2	171.9	0.1	2015	208.7	172	+0.4	+0.1
SHJ 282	AC	18549	+3358	2010.580	33	45.8	0.1	349.5	0.2	2014	45.3	349	+1.1	−0.5
				2011.580	33	45.5	0.1	349.1	0.2	2014	45.3	349	+0.4	−0.1
				2011.583	33	47.7	0.1	349.2	0.1	2014	45.3	349	+0.9	−0.2
ARN 18	AE	19020	+1907	2013.580	33	174 9	0.3	338.3	0.1	2013	173.8	339	+0.6	+0.7
				2013.591	33	175.1	0.3	338.2	0.1	2013	173.8	339	+0.7	+0.8

STTA 177	AC	19126	+1651	2013.580	33	98.4	0.1	276.3	0.1	2015	98.1	276	+0.3	−0.3
				2013.591	33	98.4	0.1	276.7	0.1	2015	98.1	276	+0.3	−0.7
STTA 181	AB	19201	+2639	2014.507	33	63.2	0.1	359.6	0.1	2013	62.5	359	+1.1	−0.6
				2016.517	33	63.3	0.1	359.5	0.1	2005	62.5	359	+1.3	−0.5
				2016.646	33	63.4	0.2	359.4	0.1	2005	62.5	359	+1.4	−0.4
STFA 41	AB	19244	+1656	2013.580	33	341.1	0.2	78.1	0.1	2013	340.9	78	+0.1	−0.1
				2013.591	33	342.0	0.1	78.2	0.1	2013	340.9	78	+0.3	−0.2
				2016.646	33	342.3	0.2	78.0	0.1	2013	340.9	78	+0.4	0.0
STFA 42		19287	+2440	2014.507	33	426.6	0.2	28.1	0.1	2012	426.6	28	0.0	−0.1
				2016.646	33	427.7	0.2	28.1	0.1	2012	426.6	28	+0.3	−0.1
H 6 26		19373	+1628	2013.580	33	87.5	0.2	81.7	0.1	2013	87.3	82	+0.2	+0.3
				2013.591	33	87.1	0.2	81.4	0.3	2002	87.3	82	−0.2	+0.6
STF 2560	AC	19437	+2343	2014.507	33	8.1	0.2	66.3	0.1	2012	117.7	66	+0.3	−0.3
STF 2822	AD	21441	+2845	2013.832	33	196.9	0.2	43.5	0.0	2012	196.7	43	+0.1	−0.5
				2014.731	33	196.9	0.2	43.5	0.1	2012	196.7	43	+0.1	−0.5

COMMON PROPER MOTION PAIRS AND OTHER DOUBLES FOUND IN SPECTRAL SURVEYS - 11. SURVEY WORK FOR 2016 PRIOR TO GAIA

Brian A. Skiff, Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, AZ 86001-4499, USA

e-mail: bas@lowell.edu

Introduction

This report presents about 1000 measures of both known and newly-identified doubles picked up while preparing various spectral surveys in machine-readable form. It collects work done through most of 2016 in all parts of the sky. Follow-up measures are given from astrometric catalogues of pairs reported by several observers, including contributors to this journal, who often gave only a single observation (including myself!). Due to the appearance of the first GAIA catalogue, this is probably my final contribution of this nature.

GAIA and its consequences

On 2016 Sep 13 the GAIA1 catalogue became available through the CDS-Strasbourg VizieR catalogue-query utility. The next day I submitted to Brian Mason at the U.S. Naval Observatory my final (?) collection of measurements for new and known double stars. It was immediately clear while beginning to peruse even this first tranche of the spacecraft results that there was no longer much point in identifying new common-motion binaries by trawling through catalogues such as this. There are likely to be *m*illions of such systems in the final product, which will be identified by much more sophisticated means of analysis than merely common motion, but including radial-velocity and the spectral types (luminosities) of the component stars. This is a dramatic change, and thus (in my opinion) the notion of 'discovery' of such pairs or extended systems has become moot. I would certainly like to hear discussion of why this might not be so!

Already papers have been submited or have appeared in the professional literature making first runs at this sort thing for specific purposes. An early example is by Semyeong Oh and several colleagues: `https://arxiv.org/abs/1612.02440` "Co-moving stars in Gaia DR1: An abundance of very wide separation co-moving pairs". This makes a search for co-moving pairs with extreme separations up to 10 parsecs. They found about 13,000 such pairs and higher-order systems using the preliminary dataset.

Ryan Oelkers and his colleagues at Vanderbilt University and at Fisk University, both in Nashville, Tenneesee, looked specifically for low-mass stars that were part of systems present in GAIA1: `https://arxiv.org/abs/1611.07883` "Gaia Assorted Mass Binaries Long Excluded from SLoWPoKES (GAMBLES): Identifying Wide Binary Pairs with Components of Diverse Mass"

Despite the contrived acronym, they found nearly 1900 pairs fitting their criteria, probably having significant overlap with Oh *et al*. Neither work made any use of the WDS(!), and it is certain that some fraction of the pairs identified will be already known.

At least for the two million brighter stars for which GAIA1 shows parallaxes and proper motions, the data are a factor of 100 better than what we have had available hitherto. Thus the relative offsets, the fundamental datum for pairs, are reliable to a couple digits in the third decimal, whereas previously this was the case only exceptionally and by exceptional methods, such as via long-baseline interferometry. The promise is that two more decimals of precision will be added to the final product. The GAIA1 motions are good in most cases to something under 1 milliarcsecond per year, compared to a few or several milliarcsec for the best cases from Tycho-2, UCAC, URAT1. The parallaxes appear already to be a factor of three or so better than the best revised Hipparcos-2 parallaxes. This means for pairs where both are given parallaxes and motions, one can see by inspection whether they are a physical or optical system. Several early reports suggest the errors shown in GAIA1 for both parallax and proper motion are somewhat overestimated, i.e., they did better than they thought.

In a desultory comparison of many pairs both bright and faint, I found that nearly all pairs wider than about 1″.5 are resolved by GAIA1. The errors on the relative offsets are something like 0".001, and will only get better with future data releases. This means there is no reason to measure pairs as wide or wider than this from the ground unless you think you can get precision higher than this. I did manage to find a few faint pairs of mine under an arcsecond where both components appear in GAIA. A few of these are added below in the main table.

Now what?!

Given this new state of affairs, is there anything left to do? Yes, but it will be more difficult! Clearly for close pairs, that is, well under 1″ separation, where there is significant orbital motion, continued observation will be required to complete orbital determination. The increased use of speckle interferometry by amateur observers will be the main method of obtaining the necessary at useful precision. Likewise there is still much work to be done characterizing systems by physical properties such as spectral type, stellar mass, orbits, apsidal motion, the existence of low-mass third stars, planetary companions, photometric variability, and so on.

But the simple task that I have been engaged in — identifying relatively wide common-motion doubles — is effectively finished. I will continue to flag pairs in my comprehensive spectral-classifications catalogue (item B/mk at VizieR) for future reference. But after nearly 3000 new pairs (under 'SKF' and other acronyms — more than Burnham, and about as many as Couteau), and contributing over 20,000 new measurements to the observation database (about as many as Wulff Heintz), it is time to move on.

As before, large tables, some 210 spaces wide, were prepared for submission to the WDS folks. This allows the WDS database to be populated directly with complete 'best' information gleaned from VizieR and SIMBAD. Here I show a much simplified table, stripped down to only the measures and astrometric sources. A large number of comments are added below, indicated by an asterisk following the WDS designation.

In the column of data sources, I adopt acronyms for common catalogues, but also show standard 19-digit 'bibcodes' for papers in the literature that contain astrometry. Only occasionally did the authors of these papers recognize the doubles involved or intend the data to be used in this way. Interestingly, when a specific paper is the first item in the astrometry list for new pairs, the WDS are assigning the discoverer acronym to them (not to me), so the authors are unsuspectingly getting double-star designations they don't know about. I should mention that the 'bibcode' and arXiv preprint character strings given in the main table and the notes should allow you to access the source papers through a simple Web browser search.

A few GAIA measures are included below in cases where previously there were only estimates available previously or the astrometric history was poor. These are merely illustrative. The USNO will eventually do the GAIA/WDS match-up on pairs having accurate coordinates in the WDS, so there is no need to do it now using the preliminary versions of GAIA.

Finally, I have added a list of recent corrections to WDS to show that the catalogue continues to need work in cleaning up the entries. For instance, I show that some pairs are not real (notably Tycho TDS and TDT pairs, at least half of which are spurious), and correct IDs and coordinates errors, and other inevitable bookkeeping slips. What I call 'ID errors' are cases where the WDS gives precise coordinates, but for the wrong star. Coordinates errors are where the WDS position is either simply wrong or approximate, on blank sky not centered exactly on the target. I apologize for the sometimes cryptic nature of these.

Table 1: Astrometry

WDS desig.	N	Alias	Epoch	θ	ρ	Source
00032+7619		MRI 7	1954.723	306.9	49.66	USNO-A2.0
			1983.847	306.5	49.20	GSC-ACT
			2010.5	306.5	49.18	WISE
			2013.520	306.6	49.18	URAT1
00103+7231	*	HJ 1941	1898.2	197.0	12.82	AC2000 mean epoch
			1983.872	195.9	12.09	GSC-ACT,n=2
			2010.5	197.1	12.23	WISE
			2013.494	197.1	12.25	URAT1
00138+7233	AB,G*	SKF 2748	1954.726	198. :	8.4 :	POSS-I blue estimate
			1993.714	194. :	8.4 :	POSS-II blue estimate
			2006.	199.7	8.36	GALEX
			2013.430	195.0	8.45	URAT1
			2015.0	194.7	8.66	GAIA1
00244+7909		SKF 2749	1897.696	122.3	4.43	AC2000
			1999.817	121.6	4.77	2MASS
			2000.0	122.6	4.71	UCAC4
			2013.592	122.2	4.68	URAT1
00272+5955		SKF 2750	2004.632	44.2	2.51	IPHAS DR2
			2015.0	41.7	2.59	GAIA1
00491-7334	*	Hei 614	2000.912	311.8	3.92	2MASS 6x
			2000.958	312.8	3.92	2MASS 6x
			2002.657	310.7	3.98	IRSF
			2005.7	311.0	4.01	Spitzer/SAGE
00547+0709		SKF 2666	2005.742	217.3	1.03	SDSS DR7
00592-2418	*	SKF 2751	1954.676	36. :	5.9 :	POSS-I estimates
			1996.863	35.3	5.97	GSC-2.3
			2015.0	35.4	5.99	GAIA1
01016+7617		SKF 2752	1899.237	159.8	53.84	AC2000
			1983.847	160.3	53.44	GSC-ACT
			1983.850	161.2	53.67	GSC-ACT
			1991.25	160.0	53.71	Tycho-2
			1999.820	160.1	53.65	2MASS
			2000.0	160.1	53.69	UCAC4
			2010.5	160.1	53.73	WISE
			2013.446	160.1	53.67	URAT1
01025-3113		SKF 2783	1955.936	194. :	12.7 :	POSS-I estimates
			1998.872	195.3	12.75	2MASS
			1999.667	195.6	12.76	DENIS
			2000.0	195.5	12.69	UCAC2
			2000.0	195.4	12.71	UCAC4
			2007.494	195.5	12.66	CMC15
			2010.5	195.4	12.73	WISE
01168+2023		SKF 2667	2004.707	128.2	1.27	SDSS DR7
01290+7412	*	HJ 2045	1983.850	82.3	26.98	GSC-ACT
			2000.322	81.6	27.08	2MASS mean epoch
			2010.5	81.9	27.12	WISE
			2013.549	81.8	27.20	URAT1
01310+5938		SKF 2812	1954.753	181.6	19.47	USNO-A2.0
			1999.790	182.5	19.49	2MASS
			2010.5	182.6	19.50	WISE
			2013.433	182.8	19.49	URAT1
01330+6911	*	SKF 2668	1954.	282. :	23.8 :	POSS-I red estimate
			1990.57	280.9	25.08	GSC-2.2 mean epoch
			1995.873	281. :	24.7 :	POSS-II far-red estimate

			2000.746	281.4	24.71	2MASS
			2010.5	281.7	25.05	WISE
			2013.433	280.9	24.91	URAT1
01357+7600		LDS 1533	1954.723	12.4	187.07	USNO-A2.0
			2010.5	12.3	186.77	WISE
			2013.489	12.3	186.79	URAT1
01380+7701	*	LEP 124	1954.723	191. :	33.4 :	POSS-I red estimate
			1993.678	190.1	32.95	GSC-2.3 mean epoch
			1999.878	190.8	32.82	2MASS
			2010.5	190.6	32.98	WISE
			2013.325	190.8	33.00	URAT1
01426+6610		SKF 2753	1999.812	120.9	6.63	2MASS
			2013.623	120.8	6.63	URAT1
01458+6027	*	SKF 2754	2005.994	145.2	1.97	SDSS DR7
			2005.994	147.0	2.10	SDSS DR9
			2006.759	147.9	1.87	IPHAS DR2
			2015.0	145.5	1.98	GAIA1
01535+2308		SKF 2669	2004.724	236.4	1.80	SDSS DR7
			2008.751	234.7	1.85	SDSS DR9
01583+7131		SKF 2670	1894.804	62.0	57.62	AC2000
			1929.9	61.9	57.42	AGK2
			1954.739	61.5	57.53	USNO-A2.0
			1983.847	61.7	57.76	GSC-ACT
			1983.850	61.6	57.69	GSC-ACT
			1991.25	61.8	57.71	Tycho-2
			2000.0	61.8	57.72	UCAC4
			2013.500	61.8	57.72	URAT1
02005+5939	*	UR 12	2000.033	277.3	5.84	2MASS
			2003.706	277.6	5.61	IPHAS DR2
			2013.177	278.3	5.73	URAT1
02020+6028		SKF 2784	1904.919	246.8	33.60	AC2000
			1983.845	247.0	33.78	GSC-ACT,n=2
			1991.25	246.9	33.79	Tycho-2
			2000.0	246.8	33.80	UCAC4
			2013.481	246.8	33.83	URAT1
02030+7814		SKF 2755	1954.723	272.4	28.32	USNO-A2.0
			1983.850	272.2	28.81	GSC-ACT
			2000.702	272.3	28.93	2MASS
			2000.0	272.2	28.92	UCAC4
			2010.5	272.2	28.97	WISE
			2013.550	272.3	28.98	URAT1
02184+2651		SKF 2813	1998.755	112.8	5.62	2MASS
			2000.0	114.3	5.69	UCAC4
			2001.673	113.9	5.53	CMC15
			2010.5	113.5	5.63	WISE
			2013.645	113.3	5.55	URAT1
02303+2624		SKF 2671	2005.844	304.8	1.15	SDSS DR7
02372+6009	*	SKF 2756	1952.706	234.5	18.39	SuperCOSMOS POSS-I red
			1989.968	233.8	18.03	GSC-2.3
			1989.968	234.8	17.95	SuperCOSMOS POSS-II red
			1994.825	233.7	18.06	SuperCOSMOS POSS-II far-red
			1999.006	233.2	18.00	2MASS
			2003.868	233.1	17.94	IPHAS DR2
			2010.5	232.6:	17.88:	WISE
			2013.681	233.5	18.10	URAT1
02381+5139		Aru 27	1955.9	322.9	31.01	USNO-A1.0
			1983.731	322.3	32.21	GSC-ACT,n=2
			2000.0	321.6	33.03	UCAC2
			2010.5	320.8	33.10	WISE
			2013.475	320.8	33.49	URAT1

02567+7639			SKF 2757	1954.736	243.3	16.17	USNO-A2.0
				1999.823	243.0	17.37	2MASS
				2013.558	243.2	17.46	URAT1
03026+7740			SKF 2758	1897.962	105.7	7.56	AC2000
				1991.25	104.6	7.54	Tycho-2
				1999.823	104.8	7.62	2MASS
				2000.0	104.9	7.56	UCAC4
				2013.611	104.9	7.60	URAT1
03201-2851		*	LDS 93	1880.65	358.1	253.44	Argentine General Catalogue
				1890.	359. :	252. :	CPD
				1933.80	358.1	252.76	Yale zone
				1955.955	358.1	253.04	USNO-A1.0
				1968.045	358.1	253.03	CPC2
				1976.80	358.0	253.00	Rousseau
				1981.687	358.0	253.09	GSC-ACT
				2010.5	358.1	253.01	WISE
03274+3912		*	SKF 2814	1928.992	282.4	18.25	AC2000
				1982.804	283.0	18.12	GSC-ACT
				1991.25	283.4	18.37	Tycho-2
				2000.0	283.5	18.27	UCAC2
				2013.516	283.7	18.26	URAT1
				2015.0	283.7	18.26	GAIA1
03385+6929		*	SKF 2672	1999.807	327.1	7.03	2MASS
				2013.507	327.2	7.13	URAT1
03541+7310		*	PRZ 5	1898.315	240.2	28.89	AC2000
				1930.1	239.8	29.36	AGK2
				1953.784	239.5	29.56	USNO-A2.0
				1983.850	238.8	30.06	GSC-ACT
				1991.25	238.5	30.18	Tycho-2
				2013.581	238.2	30.36	URAT1
04085+0909			SKF 2785	1999.945	358.5	7.58	2MASS
				2005.988	385.6	7.49	UKIDSS DR6
				2013.482	358.1	7.42	URAT1
04086+7806			SKF 2759	1955.	45. :	12.8 :	POSS-I estimates, epoch uncertain
				1983.850	46.4	12.59	GSC-ACT
				2000.705	45.1	12.87	2MASS
				2002.	46.9	12.77	UCAC4
				2010.559	47.6	12.26	AllWISE
				2013.624	45.6	12.94	URAT1
04104-1642		*	GWP 559	1955.952	70.8	23.72	USNO-A2.0
				1955.952	70.7	23.72	SuperCOSMOS POSS-I red
				1983.762	70.6	23.78	SuperCOSMOS UK Schmidt blue
				1986.938	70.8	23.86	SuperCOSMOS UK Schmidt far-red
				1990.729	71.0	23.83	GSC-2.3
				2000.776	70.9	23.90	DENIS
				2006.345	70.5	23.91	CMC15
04160+4036		*	SKF 2815	1895.911	147.5	29.73	AC2000
				1983.022	148.4	29.72	GSC-ACT
				1998.186	148.4	29.74	2MASS
				2000.0	148.3	29.77	UCAC2
				2013.565	148.4	29.76	URAT1
04228+4257	AB	*	TDS 136	2005.816	231.6	1.77	UKIDSS DR6
04228+4257	AC	*	SKF 1028	2005.816	37.5	5.42	UKIDSS DR6
04297+2633	AB	*	HAT 6	1950.942	305.8	14.96	USNO-A2.0
				1983.017	306.7	15.18	GSC-ACT
				1994.776	305.8	15.25	GSC-2.3
				1998.113	305.9	15.34	Camargo+ 2003A A&A 409..361C
				2000.0	306.0	15.27	UCAC2
				2002.999	306.0	15.25	SDSS DR9
				2004.287	306.1	15.30	CMC15

				2006.	305.8	15.39	Spitzer, epoch approximate
				2009.821	305.8	15.39	UKIDSS DR8, n=2
				2010.5	306.1	15.34	WISE
				2013.598	306.1	15.30	URAT1
04305+4041		*	SKF 2816	1896.144	113.6	24.27	AC2000
				1983.022	113.0	24.09	GSC-ACT
				1991.25	113.5	24.20	Tycho-2
				2000.0	113.7	24.14	UCAC2
				2003.191	113.7	24.14	CMC15
				2013.513	113.7	24.13	URAT1
04313+6954		*	SKF 2673	1953.784	183.8	40.01	USNO-A2.0
				1983.845	184.1	39.85	GSC-ACT
				1999.812	184.0	39.95	2MASS
				2010.5	184.0	40.00	WISE
				2013.586	184.1	39.98	URAT1
04329-3253		*	SKF 2786	1998.969	90. :	1.0 :	2MASS estimate
				2015.0	93.0	2.35	GAIA1
04337+7509	AB	*	SKF 2674	1898.978	287.1	8.34	AC2000
				1999.108	285.5	8.32	2MASS
				2000.0	285.2	8.44	UCAC4
				2013.538	285.4	8.39	URAT1
04337+7509	AC	*	SKF 2674	1898.978	115.7	100.15	AC2000
				1953.784	116.4	102.37	USNO-A2.0
				1983.845	115.5	103.59	GSC-ACT
				1983.850	115.2	103.36	GSC-ACT
				1991.25	115.6	101.12	Tycho-2
				1999.108	115.5	101.34	2MASS
				2000.0	115.5	101.28	UCAC4
				2010.5	115.5	101.90	WISE
				2013.520	115.5	101.52	URAT1
04348+2242	AC	*	SKF 2819	1898.570	290.9	182.12	AC2000
				1991.25	291.0	182.35	Tycho-2
				2013.955	291.0	182.23	URAT1
04437+0927			SKF 2787	1955.960	311.8	24.47	USNO-A2.0
				1999.947	311.2	24.62	2MASS
				2006.835	311.4	24.23	SDSS DR7
				2013.5	310.9	24.55	URAT1
05240+7000	AB,C	*	UR 8	1999.949	335.2	7.32	2MASS
				2013.484	335.5	7.39	URAT1
05297+7431		*	SKF 2675	1899.443	343.5	19.33	AC2000 mean epoch
				1983.845	344.3	19.18	GSC-ACT,n=2
				1991.25	344.1:	19.47:	Tycho-2
				2000.0	344.1	19.37	UCAC4
				2000.206	344.2	19.44	2MASS
				2010.5	343.9	19.44	WISE
				2013.553	344.3	19.45	URAT1
05336-0444		*	SKF 2346	2015.0	288.1	0.84	GAIA1
05336-0502		*	WLK 1	1895.153	139.8	10.00	Fresneau+ 2007A&A...469.1221F
				1955.878	140.6	10.05	USNO-A2.0
				2006.875	138.1	10.80	CMC15
				2014.041	137.9	10.89	URAT1
05352-0524	Aa,B	*	PRS 9	1999.11	337.8	1.19	Hillenbrand+ 2000ApJ...540..236H
				2002.	337.8	1.19	Lada+ 2004AJ....128.1254L
				2005.002	337.8	1.19	Da Rio+ 2009ApJS..183..261D
				2005.002	339.0	1.19	Robberto+ 2010AJ....139..950R
				2005.257	337.5	1.21	Robberto+ 2013ApJS..207...10R
				2005.273	336.2	1.15	Robberto+ 2013ApJS..207...10R
				2010.8	335.8	1.22	Broos+ 2013ApJS..209...32B, epoch approximate
				2010.9	331.5	1.25	Da Rio+ 2012ApJ...748...14D

05408+7613			SKF 2760	1992.836	54. :	10.6 :	POSS-II red estimate
				2000.034	54.1	10.82	2MASS
				2013.557	53.5	10.68	URAT1
05453+6915			SKF 2676	1898.079	85.3	27.75	AC2000
				1983.844	85.4	27.64	GSC-ACT, n=2
				1991.25	85.5	27.80	Tycho-2
				2000.0	85.6	27.76	UCAC4
				2000.702	85.6	27.72	2MASS
				2010.5	85.7	27.68	WISE
				2013.488	85.6	27.76	URAT1
06013+6532	AB	*	STF 812	1894.456	68.4	25.24	AC2000 mean epoch
				2010.5	57.8	28.17	WISE
				2013.472	57.5	28.14	URAT1
06013+6532	AC	*	SKF 2788	1999.036	209.7	8.38	2MASS
				2013.302	210.4	8.34	URAT1
06040+0634		*	LEP 125	1999.764	136.1	4.14	2MASS
				2015.0	135.3	4.22	GAIA1
06043+2210	AC	*	COU 161	1954.893	6.5	14.67	USNO-A2.0
				2006.765	9.8	14.45	CMC15
				2010.5	10.5	14.39	WISE
				2013.463	10.0	14.25	URAT1
06050+0911			SKF 2820	1908.654	240.7	42.42	AC2000
				1982.878	239.5	42.40	GSC-ACT
				1991.25	240.3	42.40	Tycho-2
				2000.0	240.4	42.39	UCAC2
				2013.806	240.4	42.38	URAT1
06053+1838		*	GWP 737	1955.895	333.4	47.69	USNO-A2.0
				2013.536	333.2	47.64	URAT1
				2015.0	333.2	47.63	GAIA1
06100+7426			SKF 2677	1999.103	284.6	6.95	2MASS
				2013.214	287.2	6.78	URAT1
06171+7715			SKF 2761	1954.764	59. :	14.0 :	POSS-I estimates
				1998.900	57.3	14.79	GSC-2.2
				2000.034	56.1	14.54	2MASS
				2013.450	56.3	14.49	URAT1
06226+7445			SKF 2678	2000.0	286.8	16.41	UCAC4
				2000.263	286.6	16.26	2MASS
				2010.5	286.3	16.26	WISE
				2013.529	286.6	16.40	URAT1
06288+7730		*	LDS 1629	1954.764	27.6	32.89	USNO-A2.0
				2010.5	25.8	29.06	WISE
				2013.560	25.7	28.84	URAT1
06309+7702			SKF 2762	2000.168	156.7	7.06	2MASS
				2013.733	156.0	6.85	URAT1
06362+7456		*	UR 9	1983.845	315.8	12.30	GSC-ACT
				1988.709	317.9	12.47	GSC-ACT
				1999.198	317.8	12.97	2MASS
				2000.0	315.7	12.78	UCAC4
				2010.5	317.1	13.08	WISE
				2013.569	317.5	13.01	URAT1
06463+7446			SKF 2679	1999.899	327.8	22.23	2MASS
				2000.0	327.1	22.00	UCAC4
				2010.5	327.9	22.23	WISE
				2013.565	327.8	22.21	URAT1
07040+7112		*	LDS 1643	1953.113	81.2	30.24	USNO-A2.0
				2013.345	80.3	30.07	URAT1
07041+7514	AC		LDS 1642	1956.	19.9	61.48	AGK3 minus USNO-A2.0
				2010.5	20.0	60.51	WISE
				2010.559	20.4	61.06	AllWISE
				2013.479	20.2	61.49	URAT1

07135-1235		*	SKF 2789	1999.7	270.5	2.54	UCAC4
				2008.803	270.6	2.59	UKIDSS DR6
07165-2216		*	SKF 2790	1860.	261. :	68. :	southern BD
				1889.2	261. :	67.8 :	CPD
				1921.908	258.1	67.99	AC2000
				1933.49	258.1	67.89	Yale zone
				1953.053	257.3	67.95	USNO-A1.0
				1976.91	257.9	67.98	Rousseau
				1980.209	257.9	67.94	GSC-ACT
				1980.212	257.8	68.03	GSC-ACT
				1991.25	258.0	67.88	Tycho-2
				2000.0	258.0	67.89	UCAC2
				2010.5	258.0	67.93	WISE
07208+7618			SKF 2763	1954.903	269.0	70.37	USNO-A2.0
				1983.845	269.2	69.72	GSC-ACT
				1999.122	269.3	70.16	2MASS
				2000.0	269.2	70.12	UCAC4
				2010.5	296.2	70.16	WISE
				2013.524	269.2	70.13	URAT1
07237+7629			SKF 2764	1954.903	38. :	10.3 :	POSS-I estimates
				1999.122	37.1	10.37	2MASS
				2013.652	37.2	10.36	URAT1
07297+0850			SKF 2765	1918.8	135.5	118.42	AC2000 mean epoch
				1955.221	135.8	118.23	USNO-A2.0
				1985.047	135.8	118.62	GSC-ACT
				1991.25	135.6	118.51	Tycho-2
				2000.0	135.5	118.55	UCAC2
				2003.203	135.5	118.65	CMC15
				2013.903	135.5	118.58	URAT1
07325+7609			SKF 2766	1999.122	161.7	18.37	2MASS
				2010.5	161.9	18.48	WISE
				2013.547	161.9	18.40	URAT1
07439+7753		*	ARU 26	1954.903	141.9	32.07	USNO-A2.0
				1983.845	143.7	31.72	GSC-ACT
				2013.740	145.4	31.53	URAT1
07458+7749	AB		STF 1100	1898.607	67.0	19.55	AC2000
				1954.903	66.1	17.44	USNO-A2.0
				1983.845	64.3	17.78	GSC-ACT
				2010.5	62.7	17.38	WISE
				2013.708	62.5	17.30	URAT1
07458+7749	AC		* DAM 15	1954.903	121.5	18.10	USNO-A2.0
				1983.845	121.3	17.99	GSC-ACT
				2010.5	121.5	17.34	WISE
				2013.714	121.5	17.36	URAT1
07458+7749	BC		* DAM 15	1954.903	181.8	16.53	USNO-A2.0
				1983.845	182.2	17.08	GSC-ACT
				1999.122	181.9	17.21	2MASS
				2000.0	182.2	17.10	UCAC4
				2010.5	182.2	17.03	WISE
				2013.717	181.8	17.06	URAT1
07514+3713			SKF 2680	2001.072	130.4	1.61	SDSS DR7
07546-2503		*	SKF 2791	1910.720	296.9	10.43	AC2000
				1991.25	293.8	10.13	Tycho-2
				1998.259	294.1	10.13	DENIS
				1999.108	294.2	10.11	2MASS
				2000.0	294.0	10.11	UCAC2
				2006.439	294.1	10.09	CMC15
				2010.5	293.8	10.04	WISE
07549-1900		*	SKF 2792	1916.288	224.6	17.73	AC2000
				1968.643	223.0	18.10	CPC2

				1991.25	222.5	18.01	Tycho-2
				2000.0	222.4	18.00	UCAC2
				2010.5	222.2	17.93	WISE
07594-1029	AB,D		ARU 28	1955.881	282.4	44.08	USNO-A1.0
				2000.0	282.2	44.16	UCAC2
				2010.5	282.2	44.19	WISE
				2014.172	282.2	44.14	URAT1
08080+2738			SKF 2681	2002.038	177.2	1.57	SDSS DR7
				2002.851	176.5	1.51	SDSS DR7
08100+0657		*	SKF 2767	1916.324	34.9	15.52	AC2000
				1929.1	33.9	15.61	AGK2
				1961.64	35.6	15.39	AGK3
				1982.881	35.0	15.33	GSC-ACT
				1991.25	34.8	15.54	Tycho-2
				2000.0	34.8	15.57	UCAC2
				2002.724	34.8	15.59	CMC15
				2013.895	34.8	15.58	URAT1
08227+0927			GRV 760	1951.985	90.4	32.56	USNO-A1.0
				2013.928	89.9	32.70	URAT1
08356+1438	AC	*	SKF 2793	1953.5	295.2	81.11	USNO-A2.0 mean epoch
				1989.5	295.4	81.37	GSC-2.2 mean epoch
				1997.855	295.3	81.37	2MASS
				2000.0	295.1	81.44	UCAC4
				2005.096	295.4	81.49	SDSS DR7
				2005.096	295.5	81.42	SDSS DR9
				2010.5	295.3	81.66	WISE
				2010.559	295.3	81.54	AllWISE
				2013.880	295.2	81.54	URAT1
08418+5114			SKF 2682	2000.258	281.7	1.06	SDSS DR7
08458+4853	AB	*	SDK 2	1953.121	83. :	20.4 :	POSS-I estimates
				2000.905	84.2	20.40	SDSS DR9
				2001.066	83.2	20.12	SDSS DR9
				2001.071	84.3	20.32	SDSS DR9
				2013.825	84.0	20.17	URAT1
08458+4853	AC	*	SKF 2821	2001.071	116.3	3.53	SDSS DR9
				2001.071	116.9	3.54	SDSS DR8 z-band estimate
08598+2154			SKF 2683	2004.946	210.4	1.09	SDSS DR7
				2015.0	214.8	1.03	GAIA1
09026+6913		*	SKF 2684	1955.068	251.3	48.48	USNO-A2.0
				1999.360	251.0	48.92	2MASS
				2010.5	251.1	48.95	WISE
				2013.761	251.1	48.94	URAT1
09305+1516	AC	*	SKF 2794	1950.216	87. :	16.6 :	POSS-I estimates
				1998.851	86.8	16.79	2MASS
				2000.0	87.5	16.63	UCAC4
				2002.133	87.3	16.60	CMC15
				2005.931	86.6	16.75	SDSS DR7
				2010.5	87.2	16.74	WISE
				2013.968	87.2	16.79	URAT1
09425+7318			SKF 2685	1955.068	241.5	13.73	APM-Cambridge POSS-I
				1955.068	243. :	14.0 :	POSS-I estimates
				1999.957	242.7	14.05	2MASS
				2013.801	242.5	14.15	URAT1
09434+1543			SKF 2686	2005.356	235.4	1.76	SDSS DR7
09514+0335			SKF 2687	2001.140	160.7	2.10	SDSS DR7
				2009.090	162.0	1.96	UKIDSS DR8
09578+7546			SKF 2768	1900.239	231.5	2.09	AC2000
				1999.204	227. :	2.5 :	2MASS estimate
				2000.0	222.9	2.38	UCAC4
				2015.0	223.1	2.64	GAIA1

10089+0720		*	SKF 2769	1955.224	154.0	12.90	USNO-A2.0
				2000.154	154.6	13.40	2MASS
				2002.120	153.8	13.03	SDSS DR7
				2002.120	153.8	13.12	SDSS DR9
				2002.194	153.2	13.76	SDSS DR7
				2002.194	154.1	13.61	SDSS DR9
				2005.991	154.7	13.33	UKIDSS DR8
				2006.051	154.7	13.30	UKIDSS DR8
				2014.175	154.9	13.30	URAT1
10089+0719		*	SKF 2770	2002.194	98.4	1.26	SDSS DR7
10089+3939			SKF 2688	2002.999	257.5	1.63	SDSS DR7
10225+0726		*	OCC 9060	1903.314	85.0	3.00	AC2000
				2000.0	89.8:	4.14 :	UCAC4, coords uncertain
				2000.157	90.0	4.10	2MASS
				2000.370	90.6:	3.89 :	CMC15
				2002.120	89.5	4.16	SDSS DR7
				2002.120	92.4	4.25	SDSS DR9
				2010.015	89.6	4.15	UKIDSS DR8
				2010.5	91.0:	4.20:	WISE
				2010.559	89.6	4.22	AllWISE
				2015.0	89.9	4.13	GAIA1
10259+0831			LDS 914	1951.092	286.2	45.65	USNO-A2.0
				1985.048	285.8	45.35	GSC-ACT
				2014.094	285.6	45.52	URAT1
10273+1451			SKF 2795	1950.216	219. :	14.5 :	POSS-I red estimate
				1997.929	217.7	14.46	2MASS
				2005.416	218.1	14.55	SDSS DR7
				2013.962	217.8	14.46	URAT1
10290+0822		*	GWP 1384	1951.092	354.7	103.59	APM-Cambridge POSS-I
				1951.093	355.0	104.11	SuperCOSMOS POSS-I red
				2013.900	356.1	102.13	URAT1
10305+1511			SKF 2796	1900.5	80.9	5.88	AC2000
				1997.929	82.3	6.40	2MASS
				2001.509	82.4	6.40	CMC15
				2006.085	81.6	6.50	SDSS DR7
				2013.933	82.1	6.45	URAT1
10322+3536			SKF 2689	2003.316	359.7	1.10	SDSS DR7
10385+1253			SKF 2690	2003.076	45.3	1.26	SDSS DR7
10520+0904	AC	*	SKF 2797	1911.383	150.2	44.91	AC2000
				1984.889	150.3	44.70	GSC-ACT
				1991.25	150.5	44.87	Tycho-2
				2000.162	150.6	44.74	2MASS
				2013.800	150.4	44.87	URAT1
10549-6818	AC		DAM 533	1894.119	73.8	16.53	AC2000
				1998.435	77.8	16.00	DENIS
11128-0038			SKF 2691	2007.300	49.3	0.94	SDSS DR7
11498+4024			SKF 2692	1953.283	27.3	77.73	USNO-A2.0
				1984.097	27.3	77.57	GSC-ACT
				1998.287	27.4	77.63	2MASS
				2004.130	27.4	77.41	SDSS DR7
				2005.054	27.3	77.60	CMC15
				2013.817	27.3	77.59	URAT1
11516+0749			SKF 2771	1952.297	33. :	15.5 :	POSS-I estimates
				2000.173	34.3:	15.82:	2MASS
				2000.348	34.1	15.86	CMC15
				2010.032	34.2	15.76	UKIDSS DR8
				2013.685	34.2	15.84	URAT1
11526+1413			SKF 2798	1952.081	302. :	17.4 :	POSS-I estimates
				1982.8	302.6	17.36	GSC-ACT, n=2
				1998.025	303.5	17.43	2MASS

		1998.1	303.3	17.41	Bordeaux meridian circle
		2000.0	303.2	17.39	UCAC4
		2003.076	303.6	17.43	SDSS DR7
		2010.010	302.9	17.29	UKIDSS DR8
		2010.5	302.2	17.22	WISE
		2013.856	303.1	17.32	URAT1
11527+3937	SKF 2693	1955.227	3.1	11.68	USNO-A2.0
		1984.097	3.7	12.16	GSC-ACT
		1984.097	4.1	12.27	GSC-ACT
		2000.217	3.9	12.44	2MASS
		2000.62	4.0	12.35	UCAC4
		2003.314	3.5	12.32	CMC15 mean epoch
		2004.130	3.5	12.48	SDSS DR7
		2010.5	4.3	12.31	WISE
		2013.833	3.8	12.46	URAT1
11530+4018	SKF 2694	1955.227	115.3	25.46	USNO-A2.0
		2000.0	115.4	25.63	UCAC2
		2000.217	115.5	25.53	2MASS
		2002.995	115.4	25.49	CMC15
		2013.830	115.5	25.52	URAT1
11541+3757	SKF 2695	1950.367	204. :	13.0 :	POSS-I red estimate
		1997.281	202. :	14.8 :	SuperCOSMOS POSS-II far-red estimate
		1997.423	201. :	15.0 :	SuperCOSMOS POSS-II red estimate
		1999.933	204.3	15.17	2MASS
		2004.083	203.5	14.95	SDSS DR7
		2004.083	203.4	15.02	SDSS DR9
		2013.926	203.5	15.09	URAT1
11552+1441	SKF 2799	1950.298	93.1	36.94	USNO-A2.0
		1982.299	93.2	36.84	GSC-ACT
		1985.048	93.5	37.02	GSC-ACT
		1998.333	93.6	36.96	2MASS
		1998.565	93.5	36.96	Bordeaux meridian circle
		2000.0	93.5	36.98	UCAC4
		2001.303	93.6	36.94	CMC15
		2013.891	93.5	36.96	URAT1
12003+4124	SKF 2696	1895.323	57.7	11.11	AC2000
		2000.0	60.4	11.16	UCAC2
		2000.102	60.5	11.11	2MASS
		2004.597	60.4	11.13	CMC15
		2010.5	60.5	11.13	WISE
		2013.831	60.4	11.14	URAT1
12020+7618	LDS 1745	1955.161	167.0	113.74	USNO-A2.0
		1955.161	167.0	113.60	APM-Cambridge POSS-I
		1955.161	167.0	113.63	SuperCOSMOS POSS-I red
		1997.111	166.9	113.54	GSC-2.3
		2000.273	167.0	113.51	SuperCOSMOS POSS-II far-red
		2010.5	166.9	113.52	WISE
		2013.602	166.9	113.54	URAT1
12021+2211	SKF 2697	2005.195	99.2	1.74	SDSS DR7
12033+0819	SKF 2772	1957.321	356.6	48.96	USNO-A2.0
		2000.200	356.4	48.95	2MASS
		2013.751	356.3	48.94	URAT1
12048+1102	SKF 2698	2002.5	244. :	1.1 :	SDSS DR8 estimate, epoch uncer
12062+4139	SKF 2699	1955.227	357.0	17.52	USNO-A2.0
		1998.271	357.2	17.30	2MASS
		2000.0	357.1	17.27	UCAC2
		2002.209	357.2	17.26	CMC15
		2003.248	356.9	17.32	SDSS DR7
		2013.846	357.1	17.30	URAT1

12091+4128			SKF 2700	1955.227	80. :	11.5 :	POSS-I estimates
				1998.271	80.1	11.79	2MASS
				2000.0	80.3	11.41	UCAC4
				2004.897	80.2	11.59	CMC15
				2013.868	80.4	11.64	URAT1
12120+3850			LDS 4188	1955.227	9.8	18.46	USNO-A2.0
				2013.741	9.4	18.54	URAT1
12139+0655		*	LEP 52	1957.321	225.8	34.31	USNO-A2.0
				2003.248	225.9	34.24	SDSS DR7
				2008.135	225.8	34.41	UKIDSS DR8
				2013.670	225.8	34.31	URAT1
12139+7708			SKF 2773	1999.332	137.2	5.73	2MASS
				2013.907	137.8	5.72	URAT1
12176+3428	AB	*	SKF 2701	1956.349	199. :	4.6 :	POSS-I estimates
				1987.3	199.7:	3.35:	GSC-2.2 mean epoch
				1998.191	189.0:	5.41:	2MASS
				2004.283	199.7:	3.95:	SDSS DR7
				2004.283	201.3:	3.94:	SDSS DR9
				2010.5	191.4:	4.21:	WISE
				2010.559	198.3:	4.20:	AllWISE
				2014.047	200.9:	3.80:	URAT1
				2015.0	200.5	3.85	GAIA1
12176+3428	AC	*	SKF 2701	1944.3	151.7	37.43	AC2000 mean epoch
				1956.349	151.5	37.39	USNO-A2.0
				1983.130	151.2	37.20	GSC-ACT
				1991.294	151.4	37.25	ERLCat
				1998.191	152.2:	37.48:	2MASS
				2000.0	152.5	37.70	UCAC2
				2000.0	152.5	37.67	UCAC4
				2004.283	152.7:	37.68:	SDSS DR7
				2004.283	153.2:	37.70:	SDSS DR9
				2010.5	152.0	37.56	WISE
				2010.559	152.3	37.71	AllWISE
				2013.847	152.6	37.63	URAT1
				2015.0	152.6	37.64	GAIA1
12194+3335		*	LDS 4202	1956.349	224.3	126.26	USNO-A2.0
				1983.130	224.3	126.15	GSC-ACT
				2010.5	224.3	126.25	WISE
				2013.805	224.3	126.26	URAT1
12195+4056		*	SKF 2703	1955.227	166.4	46.60	APM-Cambridge POSS-I red
				1998.281	165.8	47.09	2MASS
				2003.316	166.1	47.33	SDSS DR7
				2010.5	165.9	47.09	WISE
				2013.791	165.8	47.12	URAT1
12210+3400			SKF 2704	1956.349	330.4	127.93	USNO-A2.0
				1988.208	330.2	127.70	SuperCOSMOS POSS-II blue
				1998.191	330.4	127.59	2MASS
				2004.283	330.5	127.83	SDSS DR7
				2010.5	330.4	127.73	WISE
				2013.845	330.4	127.73	URAT1
12219+2833		*	LDS 1300	1955.292	100.3	62.21	USNO-A2.0
				2010.5	98.9	62.13	WISE
				2013.834	98.7	62.14	URAT1
12243+3644	AB	*	KZA 31	1956.349	320.2	44.04	USNO-A2.0
				1983.130	319.7	43.96	GSC-ACT
				2000.0	319.2	44.14	UCAC2
				2013.785	318.9	44.17	URAT1
12243+3644	AC	*	KZA 31	1956.349	97.7	46.84	USNO-A2.0
				1983.130	97.4	47.02	GSC-ACT
				2000.0	97.6	47.23	UCAC2

				2013.769	97.6	47.37	URAT1
12247+4116			SKF 2705	1950.371	235. :	11.5 :	POSS-I estimates
				1983.346	233.6	10.97	GSC-ACT
				1998.284	233.7	11.24	2MASS
				2000.0	233.7	11.14	UCAC2
				2003.248	233.7	11.23	SDSS DR7
				2013.766	233.7	11.23	URAT1
12273+3839			SKF 2706	1950.370	283.5	18.48	SuperCOSMOS POSS-I red
				1957.324	281.1	18.45	USNO-A2.0
				1998.287	282.1	18.58	2MASS
				1999.389	282.1	18.63	CMC15
				2004.207	282.3	18.58	SDSS DR7
				2004.207	282.2	18.58	SDSS DR9
				2010.5	282.1	18.64	WISE
				2013.753	282.2	18.58	URAT1
12309+3119	AB		SKF 2707	2004.362	95.5	1.74	SDSS DR7
				2006.428	95.6	1.80	UKIDSS DR8
12309+3119	AC		SKF 2707	1950.274	109.7	86.38	USNO-A2.0
				1990.081	109.6	86.61	GSC-2.3
				1990.226	109.7	86.84	SuperCOSMOS POSS-II blue
				1997.415	109.8	86.47	SuperCOSMOS POSS-II far-red
				1999.138	109.7	86.61	2MASS
				2002.378	109.9	86.34	CMC15
				2004.362	109.6	86.93	SDSS DR7
				2006.428	109.7	86.98	UKIDSS DR8
				2010.5	109.8	86.41	WISE
				2013.639	109.7	86.63	URAT1
12320+3406			SKF 2708	1946.708	113.7	25.03	AC2000
				1950.364	114.7	25.05	USNO-A2.0
				1983.130	114.6	24.99	GSC-ACT
				2000.0	114.5	24.97	UCAC2
				2013.685	114.5	24.97	URAT1
12365+3135			SKF 2709	1998.172	340.6	6.14	2MASS
				2004.316	340.3	5.94	SDSS DR7
				2006.354	340.9	6.17	UKIDSS DR8
				2008.802	340.9	5.88	UKIDSS DR9
				2013.818	340.2	6.15	URAT1
12372+3545			LEP 58	1950.364	4.6	273.09	USNO-A2.0
				1983.130	4.5	273.11	GSC-ACT
				2010.5	4.5	273.01	WISE
				2013.791	4.5	273.03	URAT1
12429-0116			SKF 2710	2000.116	247.5	1.49	SDSS DR7
				2006.331	244.1	1.20	SDSS DR7
				2006.331	244.9	1.28	SDSS DR9
13046+7426	AB	*	SKF 2711	1999.352	243.1	8.19	2MASS
				2013.747	243.2	8.17	URAT1
13046+7426	AC	*	SKF 2711	1897.381	114.2	13.59	AC2000
				1999.352	99.1	8.73	2MASS
				2013.695	95	8.1	URAT
13084+			SKF 2712	2002.	78 :	0.9 :	SDSS DR7 minus 2MASS
13088+6838			SKF 2713	1955.169	91. :	11.4 :	POSS-I estimates
				1999.373	95.7	10.75	2MASS
				2000.0	98.0	10.84	UCAC4
				2010.5	96.4:	11.14:	WISE
				2010.559	95.4:	10.99:	AllWISE
				2013.623	95.7	10.70	URAT1
13108+7739		*	SKF 2774	1895.980	191.9	25.21	AC2000
				1983.338	192.3	25.57	GSC-ACT
				1984.168	192.3	25.43	GSC-ACT
				1991.25	192.5	25.52	Tycho-2

				2000.0	192.4	25.58	UCAC4
				2013.706	192.4	25.57	URAT1
13338+1030			SKF 2714	2002.194	189.5	3.17	SDSS DR9
				2003.322	189.3	3.17	SDSS DR7
				2007.212	189.5	3.17	UKIDSS DR8
13354+1029			SKF 2715	2003.322	138.2	1.06	SDSS DR7
13395+6749			AZC 167	1955.377	323.7	13.15	USNO-A2.0
				2013.585	323.1	13.40	URAT1
13419+0028			SKF 2716	1999.218	124.7	1.16	SDSS DR7
				1999.218	125.8	1.17	SDSS DR9
				2006.396	141.7	1.07	SDSS DR7
				2006.396	136.7	1.17	SDSS DR9
13438+2103			SKF 2717	2005.189	79.4	2.38	SDSS DR7
13573+1513	AB	*	SKF 2800	1950.293	263. :	11.7 :	POSS-I red estimate
				1999.988	262.4	12.77	2MASS
				2001.057	261.6	12.61	CMC15
				2005.364	262.5	12.62	SDSS DR7
				2014.012	262.5	12.68	URAT1
13573+1513	AC	*	SKF 2800	1950.293	97. :	106.2 :	POSS-I estimates
				1982.299	97.3	106.38	GSC-ACT
				1998.0	97.6	105.96	Bordeaux meridian circle
				1999.988	97.7	105.89	2MASS
				2001.057	97.7	105.89	CMC15
				2005.364	97.7	105.91	SDSS DR7
				2010.5	97.7	105.96	WISE
				2013.914	97.7	105.94	URAT1
14176+7022		*	LDS 1785	1955.388	51.6	109.50	USNO-A2.0
				1983.291	52.5	109.00	GSC-ACT
				2010.5	53.2	108.74	WISE
				2013.612	53.3	108.72	URAT1
14431+6911			SKF 2718	1955.388	28.1	31.34	USNO-A2.0
				1991.431	28.1	31.22	GSC-2.2
				1999.327	27.8	31.21	2MASS
				2010.5	27.9	31.17	WISE
				2013.579	27.9	31.17	URAT1
14435+0558			SKF 2719	2003.322	263.3	1.07	SDSS DR7
14518+0343			SKF 2720	2000.357	57.0	1.26	SDSS DR7
14563+0853			LEP 71	1954.419	180.6	775.94	USNO-A2.0
				1982.300	181.3	776.32	GSC-ACT
				2013.868	181.3	776.34	URAT1
15054+6807			SKF 2721	1956.201	138. :	10.1 :	POSS-I estimates
				1999.382	135.4	10.80	2MASS
				2010.5	135.8	10.63	WISE
				2010.559	135.9	10.70	AllWISE
				2013.507	135.8	10.75	URAT1
15154+6713			SKF 2722	1999.398	15.2	5.26	2MASS
				2004.455	15.3	5.32	SDSS DR7
				2013.682	14.7	5.23	URAT1
15155+0830			SKF 2775	1912.002	136.6	7.99	AC2000
				2000.0	138.9	7.84	UCAC2
				2000.324	139.1	7.84	2MASS
				2013.844	139.2	7.85	URAT1
15173+0726			SKF 2723	2003.319	15.1	1.68	SDSS DR7
				2006.456	13.6	1.69	UKIDSS DR8
15242+1952			SKF 2724	2004.450	301.4	1.11	SDSS DR7
15284+1559			SKF 2725	2005.190	207.0	1.46	SDSS DR7
				2005.190	206.9	1.49	SDSS DR9
				2005.367	206.8	1.50	SDSS DR9
15574+6833			DAM 87	1893.912	149.1	17.69	AC2000
				2013.609	133.5	10.61	URAT1

16035+7237		*	SKF 2726	1900.325	147.1	4.74	AC2000
				1999.333	148.7	4.85	2MASS
				2010.5	150.8	4.85	WISE
				2010.559	150.4	4.73	AllWISE
				2014.006	149.1	4.86	URAT1
16065+7547	AB,C	*	LDS 1838	1955.380	167.8	60.88	USNO-A2.0
				1983.346	167.5	61.51	GSC-ACT
				2013.594	166.8	61.99	URAT1
16090+7234	AC	*	HJ 3345	1983.292	162.2	13.95	GSC-ACT
				2013.522	163.5	14.14	URAT1
16227+7708			SKF 2776	2000.449	284.0	4.88	2MASS
				2013.978	284.9	4.75	URAT1
16254-2710		*	LDS 4666	2007.329	38.6	2.55	UKIDSS DR8
				2015.0	44.1	2.96	GAIA1
16291+0949			SKF 2801	1914.334	119.3	19.83	AC2000
				1929.5	120.9	19.33	AGK2
				1982.300	120.7	19.52	GSC-ACT
				1991.25	121.1	19.49	Tycho-2
				2000.0	120.9	19.52	UCAC2
				2013.777	120.9	19.51	URAT1
16301+1540			SKF 2727	2000.	323. :	0.7 :	SDSS DR7 minus 2MASS
				2015.0	290.8	0.73	GAIA1
16318+2947			SKF 2728	2003.324	67.4	1.61	SDSS DR7
				2003.324	70.1	1.62	SDSS DR9
				2003.404	64.6	1.44	SDSS DR7
				2003.404	67.2	1.65	SDSS DR9
16375+3250		*	SKF 2729	1954.487	341.3	27.52	USNO-A2.0
				2002.353	340.7	27.63	SDSS DR7
				2003.180	340.7	27.65	SDSS DR7
				2013.490	341.0	27.65	URAT1
16536+7344			UR 10	1953.452	9.7	46.00	USNO-A2.0
				1999.399	9.5	46.42	2MASS
				2001.457	9.1	46.38	SDSS DR7
				2010.5	9.4	46.37	WISE
				2013.615	9.5	46.36	URAT1
16577+2358			SKF 2730	2003.325	51.9	1.13	SDSS DR7
17011+6929			SKF 2731	1953.452	155.9	18.35	USNO-A2.0
				1953.452	156. :	18.8 :	POSS-I estimates
				1993.625	155.9	19.07	GSC-2.2
				1999.379	156.1	19.26	2MASS
				2010.5	156.1	19.22	WISE
				2013.559	156.1	19.15	URAT1
17012+6829			SKF 2732	1954.4	286. :	15.1 :	POSS-I estimates, epoch uncertain
				1999.379	287.4	15.48	2MASS
				2010.5	286.9	15.47	WISE
				2013.541	286.8	15.46	URAT1
17033+4427			SKF 2733	2004.453	190.0	1.38	SDSS DR7
				2004.455	193.1	1.30	SDSS DR7
				2005.435	196.3	1.19	SDSS DR7
17055+7713			SKF 2777	1999.390	137.4	9.69	2MASS
				2000.0	137.1	9.65	UCAC4
				2010.5	137.9	9.52	WISE
				2010.559	138.2	9.77	AllWISE
				2013.731	137.1	9.71	URAT1
17159+7301			SKF 2734	1895.483	158.1	23.27	AC2000
				1991.25	158.0	23.50	Tycho-2
				2010.5	158.0	23.50	WISE
				2013.595	157.9	23.47	URAT1
17174+4221	AB	*	SKF 2735	1954.515	299.3	14.26	USNO-A2.0
				1992.555	299.0	14.22	GSC-2.3

				2000.174	299.0	14.15	2MASS
				2001.906	299.3	14.14	CMC15
				2013.609	299.1	14.16	URAT1
				2015.0	299.1	14.16	GAIA1
17174+4221	AC	*	SKF 2735	2005.424	138.5	2.74	SDSS DR9
				2015.0	133.7	2.42	GAIA1
17201+3541		*	SKF 2822	1855.	275. :	91. :	BD
				1930.4	276.4	89.36	AGK2
				1942.913	276.3	89.55	AC2000
				1954.509	276.3	89.44	USNO-A2.0
				1957.46	276.2	89.47	AGK3
				1982.387	276.4	89.42	GSC-ACT
				1991.25	276.4	89.39	Tycho-2
				2000.0	276.4	89.35	UCAC2
				2010.5	276.4	89.41	WISE
				2013.825	276.3	89.33	URAT1
17295+6953		*	UR 11	1999.380	2.8	5.42	2MASS
				2001.720	2.7	5.53	SDSS DR7
				2001.720	2.8	5.52	SDSS DR9
				2013.450	3.4	5.44	URAT1
17368+7603		*	SKF 2778	1999.391	1.2	61.07	2MASS
				2010.5	1.4	61.27	WISE
				2013.447	1.2	61.16	URAT1
17394+7059			SKF 2736	1953.671	257. :	15.3 :	POSS-I estimates
				1999.382	258.3	14.49	2MASS
				2013.573	259.6	14.01	URAT1
				2015.0	259.6	14.00	GAIA1
17524+0834	AB	*	AHD 7	2013.890	85.0	34.71	URAT1
17524+0834	AC	*	AHD 7	1999.849	247.9	6.37	CMC15
				2005.433	246.2	6.14	SDSS DR9
				2013.948	248.4	6.44	URAT1
17529+0744		*	SKF 2779	1898.51	62.3	67.72	Röser AC
				1917.19	62.3	67.94	Fresneau+ 1984AJ.....88.1378F
				1918.761	62.0	67.91	AC2000
				1919.55	62.2	67.99	Röser AC
				1929.0	61.9	68.02	AGK2
				1933.52	61.7	67.91	Röser AC
				1953.611	62.0	67.74	USNO-A2.0
				1961.45	61.8	67.75	AGK3
				1982.478	62.3	67.46	GSC-ACT
				1991.25	62.1	67.70	Tycho-2
				2000.0	62.1	67.70	UCAC2
				2013.8	62.1	67.65	URAT1
17590+7634		*	LDS 1881	1953.608	180.6	11.29	APM-Cambridge POSS-I red
				1953.608	179.7	11.35	SuperCOSMOS POSS-I red
				1993.631	179.8	11.47	GSC-2.3
				1993.631	179.5	11.34	SuperCOSMOS POSS-II red
				1996.432	177.0	11.66	SuperCOSMOS POSS-II far-red
				2010.5	177.2:	11.91:	WISE
				2010.559	177.4	11.70	AllWISE
				2013.336	178.9	11.27	URAT1
				2015.0	178.6	11.33	GAIA1
18006+6833			LDS 1460	1952.631	170.7	30.16	USNO-A2.0
				1983.368	171.0	30.65	GSC-ACT
				2013.571	171.2	30.61	URAT1
18045+7316		*	HDS 2544	1999.385	28.8	6.83	2MASS
				2013.549	29.0	6.86	URAT1
18186+7042			SKF 2737	1855.	268. :	29.8 :	BD
				1895.476	265.4	29.56	AC2000
				1930.5	264.5	29.53	AGK2

			1957.53	264.5	29.53	AGK3
			1983.371	264.7	29.56	GSC-ACT
			1991.25	264.7	29.67	Tycho-2
			2000.0	264.8	29.67	UCAC4
			2013.492	264.8	29.67	URAT1
18207-1138		SKF 2802	1919.471	342.1	6.21	AC2000
			1999.319	344.2	5.61	2MASS
			1999.516	343.9	5.54	DENIS
			2000.0	344.3	5.60	UCAC4
			2003.685	344.2	5.56	CMC15
			2006.456	344.0	5.62	UKIDSS DR6
			2007.2	342.4	5.56	GLIMPSE-3D
			2014.186	344.6	5.60	URAT1
18332+6929		SKF 2738	1953.671	333.2	14.42	USNO-A2.0
			1953.671	331. :	15.4 :	POSS-I estimates
			1992.2	332.9	14.99	GSC-2.2 mean epoch
			1999.401	332.6	15.12	2MASS
			2000.0	333.0	15.07	UCAC4
			2013.557	332.6	15.20	URAT1
18463+6909	*	SKF 2739	1896.981	230.0	6.17	AC2000
			1999.401	227.0	6.69	2MASS
			2000.0	227.4	6.74	UCAC4
			2010.5	228.3:	6.68:	WISE
			2013.576	227.4	6.74	URAT1
18488+6853	*	LDS 2421	1954.430	274. :	34.1	: POSS-I estimates
			1991.466	274. :	34.6 :	POSS-II red estimate
			1992.552	274. :	34.7 :	POSS-II far-red estimate
			1992.566	274. :	34.6 :	POSS-II blue estimate
			2013.393	274.3	34.60	URAT1
			2015.0	274.3	34.59	GAIA1
19067+6716		LDS 2760	1954.430	225.8	18.75	USNO-A2.0
			2013.382	220.5	23.36	URAT1
19340+6532		SKF 2803	1892.889	114.5	36.93	AC2000
			1956.71	114.5	37.09	AGK3
			1983.677	114.7	36.96	GSC-ACT
			1991.25	114.8	36.96	Tycho-2
			2000.0	114.8	36.96	UCAC4
			2013.701	114.8	36.96	URAT1
19381+4409		DEA 421	1893.772	187.9	22.46	AC2000
			1982.390	190.3	22.32	GSC-ACT
			1991.25	188.8	22.26	Tycho-2
			1998.448	188.9	22.16	2MASS
			2002.467	189.0	22.22	CMC15
			2010.5	189.0	22.17	WISE
			2013.747	188.9	22.21	URAT1
20066+7639		SKF 2804	1953.748	346. :	18.8 :	POSS-I red estimate
			1992.1	345.1	19.05	GSC-2.2 mean epoch
			1999.445	345.1	18.90	2MASS
			2003.740	344.5	18.90	SDSS DR7
			2003.7403	344.5	18.93	SDSS DR9
			2003.7404	344.8	19.00	SDSS DR9
			2010.5	345.2	19.00	WISE
			2013.458	344.8	18.99	URAT1
20095+7651		SKF 2805	1899.594	346.9	158.85	AC2000
			1953.748	346.8	158.88	USNO-A2.0
			1957.07	346.6	158.88	AGK3
			1984.659	346.7	159.22	GSC-ACT
			1991.25	346.6	158.77	Tycho-2
			2000.0	346.6	158.74	UCAC4
			2013.589	346.6	158.70	URAT1

20109+7616		*	LDS 1929	1953.748	13.3	15.18	USNO-A2.0
				1984.659	12.8	15.25	GSC-ACT
				2013.489	13.6	15.22	URAT1
20520+4346	BC	*	SKF 2740	1892.694	192.4	73.32	AC2000
				1991.25	192.1	73.31	Tycho-2
				2000.444	192.1	73.55	2MASS
				2000.0	192.2	73.44	UCAC4
				2013.653	192.2	73.45	URAT1
21044+6501			SKF 2806	1898.558	283.7	46.64	AC2000
				1952.628	284.0	46.66	USNO-A2.0
				1983.680	283.7	46.58	GSC-ACT
				1991.25	283.6	46.67	Tycho-2
				2013.670	283.7	46.67	URAT1
21080+0630			SKF 2741	2008.827	41.4	2.03	SDSS DR9
21255-8138			DEA 494	1995.669	124. :	217.2 :	UK Schmidt far-red estimate
				1998.604	124.1	217.29	DENIS
				1998.640	124.1	217.43	DENIS
				1999.694	124.2	217.56	DENIS
				2000.674	124.1	217.45	2MASS
				2010.5	124.2	217.44	WISE
				2010.559	124.2	217.47	AllWISE
21232+0409			SKF 2742	2005.742	108.4	1.42	SDSS DR7
				2005.742	103.4	1.42	SDSS DR9
				2008.825	111.6	1.40	SDSS DR9
21270+7339			ZUC 15	2003.740	146.9	5.76	SDSS DR9
				2003.741	143.6	5.99	SDSS DR9
21424-6410		*	SKF 2807	2000.797	45. :	2.5 :	2MASS estimate
				2015.0	38.5	2.93	GAIA1
21447-3632			SKF 2808	1999.507	112. :	2.8 :	2MASS estimate
				2000.	112.3:	2.86:	UCAC4, measures poor
21503+7410	AB	*	UC 4578	1953.524	187.0	73.22	USNO-A2.0
				1992.722	186.9	73.39	GSC-2.3
				2010.5	186.8	73.56	WISE
				2013.445	186.9	73.60	URAT1
21503+7410	AC	*	UC 4578	1953.524	119.5	50.86	USNO-A2.0
				1992.722	119.4	51.02	GSC-2.3
				2010.5	119.5	51.19	WISE
				2013.372	119.5	51.13	URAT1
21503+7410	BC	*	UC 4578	1953.524	48.2	71.42	USNO-A2.0
				1992.722	48.1	71.61	GSC-2.3
				2010.5	48.1	71.62	WISE
				2013.378	48.1	71.65	URAT1
21527+6724			SKF 2743	1895.223	122.0	19.20	AC2000
				1983.680	121.7	19.17	GSC-ACT
				1991.25	122.0	19.40	Tycho-2
				1999.743	122.1	19.26	2MASS
				2000.0	122.1	19.28	UCAC4
				2013.353	122.1	19.27	URAT1
21570+090	0		SKF 280	9 1953.622	303.1	103.83	USNO-A2.0
				1987.638	303.4	104.17	SuperCOSMOS POSS-II blue
				1990.710	303.2	104.34	SuperCOSMOS POSS-II red
				1994.510	303.3	104.25	SuperCOSMOS POSS-II far-red
				2000.513	303.2	104.33	2MASS
				2008.829	303.1	104.29	SDSS DR9, n=2
				2010.5	303.2	104.39	WISE
				2013.238	303.2	104.41	URAT1
21576+7621		*	SKF 2780	1900.584	344.7	22.68	AC2000
				1929.9	345.8	22.44	AGK2
				1956.65	346.2	22.60	AGK3
				1983.680	345.9	22.30	GSC-ACT

				1991.25	345.5	22.34	Tycho-2
				1999.776	345.5	22.36	2MASS
				2000.0	345.5	22.36	UCAC4
				2010.5	345.6	22.35	WISE
				2013.416	345.5	22.37	URAT1
22085-5825			SKF 2810	1929.685	5.4	111.69	Fresneau+ 2007A&A...469.1221F
				1980.592	5.5	111.20	SuperCOSMOS UK Schmidt blue
				1983.062	5.6	111.19	USNO-A2.0
				1985.530	5.7	111.19	SuperCOSMOS ESO Schmidt red
				1995.510	5.6	111.16	SuperCOSMOS UK Schmidt red
				1995.512	5.7	111.15	GSC-2.3 = UK Schmidt red
				1998.509	5.7	111.07	DENIS
				1999.666	5.7	111.08	SuperCOSMOS UK Schmidt far-red
				2000.0	5.7	111.11	UCAC4
				2000.543	5.7	111.07	2MASS
				2010.5	5.7	111.07	WISE
22115+7502			LDS 1972	1954.14	296.8	17.25	USNO-A2.0 mean epoch
				1983.680	297.6	17.89	GSC-ACT
				2010.5	299.3	18.04	WISE
				2013.355	299.1	17.99	URAT1
22150+5703	AC	*	STG 10	1999.704	218.2	104.23	2MASS
				2010.5	219.9	109.10	WISE
				2013.589	220.5	108.83	URAT1
22203+0204		*	SKF 2744	1951.687	103.1	5.35	USNO-A2.0
				1990.642	102.4	5.67	GSC-2.3
				2008.753	104.8	5.73	SDSS DR9
				2009.607	105.0	5.72	UKIDSS DR8
22344+6915			LDS 4979	1952.631	99.7	50.43	USNO-A2.0
				2013.448	100.2	50.34	URAT1
22365-1618		*	SKF 2823	1999.512	348.9	7.27	2MASS
				2000.0	348.0	6.98	UCAC4
				2010.5	305.4:	6.64:	WISE
22526-1437		*	SKF 2824	1999.512	251.4	6.41	2MASS
				2000.0	251.5	6.38	UCAC4
				2006.951	251.3	6.32	CMC15
22599+7016	AB	*	SKF 2745	1999.779	257.0	5.00	2MASS
				2000.0	257.6	4.91	UCAC4
				2013.400	258.2	4.88	URAT1
22599+7016	AC	*	SKF 2745	1895.327	183.4	14.74	AC2000
				1991.25	184.3	14.80	Tycho-2
				1999.779	184.2	14.87	2MASS
				2000.0	184.1	14.85	UCAC4
				2010.5	183.2	14.75	WISE
				2013.426	184.3	14.85	URAT1
23130+0934		*	SKF 2811	1916.319	276.3	23.53	AC2000
				1929.3	275.6	23.36	AGK2
				1958.73	275.8	23.53	AGK3
				1983.609	276.2	23.28	GSC-ACT
				1991.25	276.0	23.52	Tycho-2
				2000.0	276.3	23.44	UCAC2
				2002.141	276.4	23.43	CMC15
				2013.033	276.4	23.43	URAT1
23133+7439	AB	*	LDS 2029	1952.634	271.8	150.33	USNO-A2.0
				2010.5	272.7	149.86	WISE
				2013.550	272.8	149.87	URAT1
23133+7439	AC	*	LDS 2029	1952.634	51.3	38.10	USNO-A2.0
				2010.5	51.7	39.24	WISE
				2013.463	51.6	39.27	URAT1
23153+7458		*	LDS 2031	1952.634	105.9	28.84	USNO-A2.0
				2013.469	103.4	26.76	URAT1

23209+7436		SKF 2746	1898.459	333.9	32.12	AC2000
			1929.9	333.1	31.80	AGK2
			1956.70	334.2	32.11	AGK3
			1983.678	332.6	31.72	GSC-ACT
			1983.847	333.6	31.88	GSC-ACT
			1984.897	333.6	31.72	GSC-ACT
			1991.25	333.2	31.97	Tycho-2
			2000.0	333.3	31.97	UCAC4
			2013.581	333.3	31.99	URAT1
23261+6728	*	SKF 2747	1999.765	166.2	7.40	SDSS DR9
			2000.710	166.3	7.41	2MASS
			2013.459	166.3	7.30	URAT1
23296+0814		SKF 2781	1991.708	227.6	8.63	GSC-2.3
			2000.803	227.6	8.78	2MASS
			2005.698	227.7	8.79	SDSS DR7
			2005.698	227.8	8.77	SDSS DR9
			2007.838	227.9	8.78	UKIDSS DR8
			2008.819	227.8	8.69	SDSS DR9
			2012.869	227.9	8.75	URAT1
23456+6057		STI 1207	1999.786	243.3	4.16	2MASS
			2013.630	243.9	4.08	URAT1
23467+0727	*	LDS 5120	2005.698	217.2	1.68	SDSS DR9
			2008.773	217.5	1.68	SDSS DR9
23551+7645	*	SKF 2782	1896.852	128.4	8.22	AC2000
			2000.0	127.5	8.32	UCAC4
			2000.855	127.7	8.33	2MASS
			2010.5	128.6:	8.06:	WISE
			2013.553	128.5	8.17	URAT1

Table 2:

Pair	
00103+7231	The WDS 2011 measure is poor (PA certainly near 197° , not 185°).
00138+7233	This is a blue companion to an M giant binary.
00491-7334	There are RAVE4 radial velocities for the stars separately, yielding −10 and −5 km/sec, respectively.
00592-2418	These two stars were identified previously as Haro-Luyten blue stars PHL 925 and PHL 3190. A spectral type (sdO8) is available for the primary only, but both stars are blue. Common motion is clear from blinnking POSS-I and II, and the long-term fixedness is confirmed via the GAIA1 measure.
01290+7412	The 2012 measure by Riddle *et al.* using the Robo-AO system on the 1.5-m telescope at Palomar Mountain seems relatively poor; the paper, however, says large ρ measures like this one are less good.
01330+6911	The companion is not very red (2MASS $J-K$ =0.64), implying a cool white dwarf, but the photometry may be poor.
01380+7701	Previously identified by Lepine as LSPM J0137+7700 N + S.
01458+6027	The components are similar in relative brightness on the SDSS u, z, and 2MASS J images (i.e. similar color across the visible to the near-IR), suggesting both are B-type stars.

02005+5939	Already identified by Nicholson from URAT1.
02372+6009	IPHAS photometry suggests the secondary (at least) is an H-alpha emitter. The delta-mag implies this is a late-M type star $\tilde{M}$7.
02381+5139	Confirmed optical.
03201-2851	The astrometric history was previously spotty; Luyten's 1920 measure in the WDS is probably only approximate.
03274+3912	This is a matched pair of A-type stars. The GAIA1 parallax and proper motions indicate an optical pair, but the errors there are relatively large.
03385+6929	A third (blue) star involved is optical.
03541+7310	Przbyllok's 1922 measure is wrong or for another pair, and there are no candidates fitting the description within $10'$ radius. This is an optical pair nevertheless.
04104-1642	The stars are both white dwarfs per spectra reported by Kilkenny *et al.* 2015MNRAS.453.1879K. The present measures confirm their suspicion that the two stars are related — they considered them to be a new pair without checking the WDS.
04160+4036	Small proper motion, but matching LAMOST DR1 radial velcities: -7.5, -6.6 km/sec (LAMOST spectral types are F5V + F2V).
04228+4257	Wider separations for AC near $5''.9$ are likely to be for AB,C. The URAT1 proper motion for component C suggests common motion.
04297+2633	Comprises the variable T Tauri stars DI Tau and DH Tau. The V magnitudes average near 13.2 and 12.9 from my 2012 and 2015 lightcurve means with zero-points adjusted to within a few percent of the standard system. DI Tau is always the fainter star on average, though it is a more actively accreting star and has flares. DH Tau has a smoothly-varying and regular lightcurve just from rotation of the spotted star. This means accretion is essentially complete.
04305+4041	Small proper motion, but matching LAMOST DR1 radial velocities: -16.9, -14.4 km/sec, respectively.
04313+6954	Despite the relative fixity, the pair has an unphysical color mismatch, unless the primary is a K-giant and the companion a G-type subgiant.
04329-3253	I could get only a rough placeholder estimate originally, but GAIA1 has provided an excellent recent confirming measure.
04337+7509	Measures of AC are scattered due to crowding by B; the physical link of C is nevertheless uncertain. GAIA1 parallax and proper motion indicate that component C is optical.
04348+2242	This is an overlooked distant component to a known Struve pair; the GAIA1 parallax confirms the link. There is a lot more astrometry available from catalogues besides these bookend measures.
05240+7000	Component C was already identified by Nicholson from URAT1. The close TDSC pair is unconfirmed, but this easy one was missed previously.
05297+7431	The small motion gave suspicions that this is optical, but the spectral-type/color/delta-mag seemed consistent. GAIA1 astrometry now indicates an optical pair.
05336-0444	This is a demonstration of GAIA1 astrometry on a close faint pair, which confirms my previous single estimate from an image.
05336-0502	The WDS 1958 measure appears to be an estimate only.

05352-0524	This turns out to be the same pair as WDS 05352-0524 OP = GET 28, which had only the separation measured previously. Now merged in the WDS.
06013+6532	The older Struve component B is obviously optical; the new closer companion almost certainly has common motion.
06040+0634	Previously identified by Lepine as LSPM J0604+0633 N + S.
06043+2210	Component C is confirmed optical.
06053+1838	The companion is blue (APASS $B-V = 0.2$, IPHAS $r-i = 0.07$), and so must be intermediate-color white dwarf, newly identified as such here. The WDS 2014 separation is poor.
06288+7730	Optical.
06362+7456	Already identified by Nicholson from URAT1. Schmidt plate separations poor, but okay in PA.
07040+7112	The companion is a known cool white dwarf.
07135-1235	The HD and Houk spectral types both wrong: the stars are probably type A or F per DENIS $J-K$ color.
07165-2216	An overlooked relatively bright pair; not in the Oeltzen Argelander or AGC, but the original BD and Cape PD measures are adduced.
07439+7753	Optical.
07458+7749	An optical trio.
07546-2503	Possibly optical but a near-match in magnitiudes, colors, and spectral types.
07549-1900	Another near-match, but GAIA1 data suggests it is optical.
08100+0657	The motion is very small, but the near-equal magnitudes and early spectral types are relatively uncommon, so the link seems likely. GAIA1 parallax and proper motion now confirm the physical link.
08356+1438	This is a third distant M-dwarf companion to known Hussey pair.
08458+4853	The new and probably somewhat better estimate for AB from the POSS-I plate-scans gives higher confidence that the white dwarf component B has common motion. The new nearby M-dwarf companion (component C) was first identified but probably mis-reported by Holberg *et al.*, 2013MNRAS.435.2077H. They describe it incorrectly as $5''$ due west. The magnitude of component C is similar to the white dwarf component B, which is about right if it is an early-M dwarf, i.e. both stars about have $M_V \sim 10$ or so. See additional comments by Kuchner *et al.* in `http://arxiv.org/abs/1607.05713`.
09026+6913	The USNO-A2.0 measure is poor due to crowding of the primary.
09305+1516	Component C is a new third distant M-dwarf companion to the known Heintz pair.
10089+0720	There is also third very faint red companion about $3''$ SE (not WDS 10089+0719 = SKF 2770), but the link is uncertain.
10089+0719	Near but not related to BD+08 2324 = WDS 10089+0720.
10225+0726	Brian Loader *et al.* lunar occultation pair with a 'vector separation only' measure, which appeared in the JDSO 2016 Feb, vol 12, page 143. The star is TYC 0252-0231-1 in their Table 2B. It is also an overlooked Astrographic Catalogue pair (but n=1). Modern measures are somewhat

dodgy; it was poorly resolved in URAT1 (omitted here).

10290+0822 These measures and the URAT1 proper motion suggest this is optical but with similar motion.

10520+0904 A third distant, bright component to a known Aitken pair.

12048+1102 The photometric colors are such that this may be a multiple system. Morgan *et al.*, 2012AJ....144...93M, claims one component is close DA+DM binary.

12139+0655 The companion is very blue, and must be white dwarf, newly identified here.

12176+3428 The physical link for this trio is uncertain. The measures for AB are all poor from proximity (except GAIA1), and AC separations are scattered due to component B being variously resolved or not. However, there has been no obvious relative motion of trio despite $2''.5$ sky motion between 1944 and 2015.

12194+3335 The ID is certain; Luyten's 1960 separation is simply wrong.

12195+4056 The companion is a fairly late-M dwarf.

12219+2833 Optical.

12243+3644 The three stars are unrelated.

12309+3119 A new hierarchical triple. The AC separations are scattered due to component B being variously resolved or not. The larger separations from SDSS and UKIRT data are more strictly for the components AC rather than AB,C.

13046+7426 AB have common motion, but component C is optical, and shown here since it is closely involved with the motion pair.

13108+7739 The motion is near zero, but the spectral-type/colors are consistent with being physical. Faint A0V stars are uncommon at high galactic latitude. GAIA1 parallax and proper motions now confirm the physical link.

13573+1513 Another new common-motion triple.

14176+7022 The added measures with increased temporal baseline confirm the monotonic trend, and thus this is an optical pair.

15574+6833 Optical.

16035+7237 A surprisingly overlooked common-motion AGK binary.

16065+7547 Optical; the existing WDS measures are certainly for AB,C and not AC.

16090+7234 The measures for AC merely correct an evidently long-standing quadrant error. The WDS magnitude for component is also now corrected.

16254-2710 The fainter component is definitely in first quadrant on visible-light, 2MASS, and UKIDSS images; see the UKIDSS K-band image especially.

16375+3250 This is a newly-identified main-sequence + degenerate binary, though the pair were already known as having common motion from the LSPM.

16536+7344 Already identified by Nicholson from URAT1.

17174+4221 Components AB certainly have common motion, but the physical link with component C, the faint DB-type star, is uncertain.

17201+3541 GAIA1 parallax and proper motions confirms the physical link.

17295+6953 Already identified by Nicholson from URAT1. This lies near but is unrelated to WDS 17296+6953 = MLR 188.

17368+7603 A bright third star 7″ NE is optical.

17394+7059 The POSS-I/II blink looks okay, but perhaps the stars have slightly different motion?

17524+0834 Components AB are certainly optical due to the spectral-type mismatch - component B is a background M-giant.

17529+0744 The early data are somewhat scattered, but there seems to be little motion over the 120-year baseline.

17590+7634 A peculiar case. Luyten's proper motion is wrong, and is actually near zero. The northern star is relatively blue and the southern star is red. Their nature is uncertain, and are not necessarily white dwarf (candidates) as described by Luyten; the redder one might be a galaxy.

18045+7316 The Hipparcos component B is spurious, but this real companion seems to have common motion.

18463+6909 Another one that has been surprisingly overlooked.

18488+6853 The companion is a known white dwarf.

19067+6716 Optical from relative motion and also a color/spectral-type mismatch.

20109+7616 The WDS ID is confirmed here; this is also a confirmed common-motion M-dwarf pair.

20520+4346 This is a new fairly bright but distant common motion companion to component B of an optical Otto Struve pair.

21255-8138 The extremely faint brown dwarf companion was identified by Deacon *et al.*, arXiv:1601.06162. The primary has V mag 11.8; the companion is barely detected on the UK Schmidt far-red plate (measured here for the first time), and is thus about I mag 20, suggesting V mag perhaps 26 or 28. The low-mass brown dwarfs get faint fast!

21424-6410 Another close pair poorly resolved on available images, but having a nice measurement in GAIA1.

21503+7410 This UCAC4 trio is spurious due to bogus moderately-large proper motions in that catalogue. The motions are in fact quite small and equivocal — there is no reason to expect the stars to be related at all.

21576+7621 An overlooked AGK pair; GAIA1 confirms the physical link.

22150+5703 The Hartkopf *et al.* UCAC4 measure is for the wrong pair; component C has near-zero motion, and is thus unrelated to the primary (ϵ Cep).

22203+0204 The similarly-bright stars comprise a double-degenerate pair, newly-identified here.

22365-1618 First reported by Stelzer *et al.*, arXiv:1608.00772

22526-1437 Also first reported by Stelzer *et al.*, arXiv:1608.00772

22599+7016 All three stars are blue, but proper motions are very small and equivocal (including in GAIA1), so the physical link is uncertain.

23130+0934 Another overlooked AGK pair for which there is additional astrometry available. GAIA1 confirms the physical link.

23133+7439	These measures plus the URAT1 proper motion suggest the stars have similar motion but are optical.
23153+7458	Optical.
23261+6728	Common motion is clear from a POSS-I/II blink. The companion does nots seem especially red: perhaps a cool white dwarf? The system lies 60″ NE of WDS 23261+6727 = MLR 94, which is not related.
23456+6057	The early Stein/AC measure is poor due to disparate AC epochs.
23467+0727	The previous approximate coordinates in the WDS have been corrected. The Luyten 1960 measure is a (pretty good) quadrant estimate.
23551+7645	The primary is a W UMa-type eclipsing binary.

Table 2: Comments and corrections

WDS	Pair	
01581+5928	TDS 2069	not double; 2MASS images definitive
03093+6849	WFC 13	the primary is BD+68 219, spectral type F5
03253+3825	ES 2147	ID confirmed, omit note 'I'
04133+4022	MLB 920	ID error; correct coords: 4 13 17.72 +40 23 09.1 (J2000, 2MASS); combined V = 12.5 TASS MkIV and APASS DR9), so component mags should be 13.2+13.3
04218+4338	COU 2030	confirmed on the UKIDSS K-band image, but no measurements available
04290+4103	LDS 5563	not found: no co-moving pair in $12' \times 12'$ field from POSS-I/II red plate blink
04356+6931	HJ 1145	WDS ID error: merge with WDS 04344+6928 = TDS 2898 (not BD+69 262, omit spectral type)
07467+7707	TDS 5189	not double; 2MASS images definitive
07576-1618	HJ 771	WDS ID error: primary is BD -15 2152 = HD 65329 about 1′ south of current coords at: 7 57 37.82 -16 18 14.7 (J2000, Tycho-2); spectral type of primary is 'A' in HD, and colors suggest unreddened late-B; fainter star is a much redder optical companion
08142+0658	J 377	WDS/Jonckheere ID error; pair is TYC 0207-0950-1 at: 8 14 10.49 +06 59 43.1 (J2000, UCAC2); the pair is oval in the correct orientation on 2MASS images; they look nearly equal and the combined V mag is 11.7 per ASAS-3, APASS, and TASS MkIV.
09475+0924	TDS 554	not double; SDSS and UKIDSS images definitive
09580+0658	TDS 6928	this one is real! confirmed approximately on UKIDSS images; no measures
10329-6139	VOU 87	WDS ID error; the pair is HD 305336 at: 10 32 53.35 -61 38 21.8 (J2000, UCAC2);

		combined V = 12.6 (APASS); spectral type B8 (Loden+ 1976AAS... 23..283L), the HDE type (F2) is wrong; no resolved catalogue astrometry available, but cf 2MASS images. added: GAIA 1: 313°.4; 3".00
10433-6728	TDS 7434	not double; 2MASS images definitive
11443-6515	LDS 362	ID confirmed, omit note 'I'
11524+3904AB	HDS 1674	component B does not exist (Hip/Tyc entry spurious); Sloan and 2MASS images dispositive
11565-6448	TDS 8131	not double; 2MASS images definitive
12135-6102	TDS 8275	not double; 2MASS images definitive
17522-3454	TDT 548	not double; 2MASS images definitive
17531+7423	LDS 1880	WDS coords error: 17 53 08.99 +74 24 17.6 (J2000, 2MASS); Luyten evidently intended to describe this as a 2″.1 pair, which Lepine seems to have adopted (see LSPM), whereas the WDS has 21″ along with a year 2000 measure that does not belong. the pair is clearly elongated on various images, consistent with the 2″ separation in PA 60 - 70 ° , but not resolved in catalogues. added: GAIA1: 55°.3; 2″.63
18044-2421	TDT 662	not double; UKIDSS K-band image definitive
18091+0924	PRY 3	the BD name is correct, but spectral type G0 is for AG+09 2168, which lies 2′.5 due south; the primary here is an M giant
18132-1114	TDT 741	not double; UKIDSS images definitive
18371+7409	TDT 960	not double; 2MASS images definitive
19450+1551	HDS 2803	not double; UKIDSS K image definitive; the star 9″ NW perhaps caused the error
20226+3656	Es 2506	ID error; the correct coords are: 20 22 31.79 +36 56 49.8 (J2000, UCAC2); combined V = 11.5, delta-mag ˜1.0. not HD 229142, so omit spectral type 'A'
22450+0736	TDT 3688	confirmed approximately on UKIDSS images; no measures
23005+7053	TDT 3837	not double; 2MASS images definitive

MEASUREMENTS OF DOUBLE STARS WITH ROBOTIC TELESCOPES IN 2016

A. Debackère, Socièté Astronomique de France

e-mail : andre.debackere@free.fr

Abstract

These observations, measurements and discoveries were made with Gemini Telescope, Winer Observatory (Sonoita, AZ) University of Iowa and with LCOGT global telescope network.

Explanation of Table

Col.1	WDS designation (based on 2000 coordinates)
Col.2	Discoverer Number
Col.3	Components
Col.4	Mean date of observation
Col.5	Number of Observations
Col.6	Position Angle
Col.7	Separation (first measure)
Col.8	Magnitude of First Component
Col.9	Magnitude of Second Component
Col.10	Catalog identifier (UCAC4 otherwise USNO-B.1 or NOMAD, not identified when the object does not appear in any of the previous catalogs)
Col.11	Number of night and Observatory code
Col.12	Note
Col.13	2000 arcsecond coordinates

Table: Measures

WDS	Pair		Epoch	n	θ	ρ	V_1	V_2	Catalog	Obs	N	Precise coords
00523−6523	DAW 183		2016.422	1	92.9	5.68	12.1	12.7	124−000857	1K92		005226.85−652258.0
01071+3225	DBR 88	A	2016.818	2	317.6	13.76	16.7	18.2	1224−0019281	2FTN		010708.27+322440.0
		B							1224−001927			010707.536+322450.2
01071+3225	DBR 88	A	2016.818	2	74.8	6.24	16.7	19.3	1224−0019281	2FTN		010708.27+322440.0

		C							1224−0019284			010708.664+322441.2
01071+3225	DBR 88	A	2016.848	1	198.9	2.88	16.7	21.2	1224−0019281	1FTN		010708.27+322440.0
		D							non ident.			010708.18+322437.3
01337−6314	LDS 52		2016.422	1	86.6	8.25	12.8	12.9	134−001395	1K91		013342.50−631350.3
06144+2233	L 7		2016.028	1	83.1	2.54	10.7	11.1	563−026202	1FTS		061424.65+223314.7
06217+2645	DBR 15		2016.118	1	307.0	2.22	13.8	15.2	584−028228	1GEM		062143.04+264454.0
06217+2649	DBR 19		2016.118	1	313.4	4.18	12.5	15.3	585−028193	1GEM		062145.48+264837.9
06226+2647	DBR 16		2016.180	1	302.6	3.00	13.0	14.5	584−028468	1GEM		062238.73+264642.1
06266+3933	COU 2057		2016.054	1	334.1	1.69	10.4	11.5	648−039550	1FTN		062639.29+393316.8
06279+3715	MLB 1028		2016.062	5	297.7	7.89	10.5	14.8	637−035143	2GEM	1	062758.59+371444.2
										3FTN		
06285+3717	ALI 567		2016.118	1	59.8	15.04	11.1	12.2	637−035201	1GEM		062830.29+371735.9
06287+3723	STF 906	AB	2016.118	1	336.5	6.48	9.8	10.5	637−035224	1GEM		062844.84+372250.8
06287+3723	STF 906	AC	2016.118	1	141.4	156.42	9.8	11.2	637−035224	1GEM		062844.84+372250.8
07445−2803	ALD 114	AB	2016.030	2	110.4	3.62	9.3	11.2	310−030620	1FTS		074429.62−280316.3
										1FTN		
07445−2803	DAM 452	A	2016.030	2	55.4	8.04	9.3	16.5	310−030620	1FTS		074429.62−280316.3
		C							310−030623	1FTN		
08575−6254	FIN 12		2016.030	2	188.4	3.59	8.5	10.6	136−018030	2FTS	1	085729.58−625350.3
09570+1946	STF 1399		2016.334	1	175.3	30.55	7.4	8.2	549−048048	1K92		095701.94+194544.8
11268+0301	STF 1540	AB	2016.334	1	149.4	28.23	6.5	7.5	466−046383	1K92		112645.75+030045.6
11268+0301	STF 1540	AC	2016.33	1	191.1	205.20	6.5	11.2	466−046383	1K92		112645.75+030045.6
12095−1151	STF 1604	AB	2016.333	1	88.7	8.96	6.8	9.4	391−056520	1K92		120928.86−115128.0
12095−1151	STF 1604	AC	2016.333	1	5.0	10.43	6.8	8.5	391−056520	1K92		120928.86−115128.0
12095−1151	STF 1604	BC	2016.333	1	322.5	12.84	9.4	8.5	391−056522	1K92		120929.47−115127.7
19063−3129	PRO 220		2016.744	1	356.9	12.49	10.7	10.9	293−217022	1FTS	1	190621.89−312853.8
19134−3215	PRO 223		2016.722	1	*	*	10.5	11.4	289−201772	1FTS	1*	191323.62−321520.4
19560−3242	BRT 1804		2016.722	1	*	*	10.2	11.3	287−206745	1FTS	1*	195602.53−324246.5
19584−5725	DAW 25		2016.733	2	219.8	3.20	9.3	10.5	163−211118	2FTS	1	195823.29−572513.4
20327−8155	HJ 5175	AB	2016.744	1	300.9	10.02	10.9	11.7	041−016182	1FTS	1	203243.03−815523.5
20327−8155	HJ 5175	AC	2016.744	1	196.9	12.27	10.9	11.8	041−016182	1FTS	1	203243.03−815523.5
20452−7159	HEI 281		2016.733	2	88.7	2.56	9.9	12.2	091−073172	2FTS	1	204515.19−715856.1
23032+5120	DBR 1	AB	2016.886	2	285.3	11.19	10.5	11.4	707−109966	2FTN		230310.08+512020.6
23027+5121	DBR 13	AB	2016.888	1	129.1	4.34	13.6	14.6	707−109867	1FTN		230239.28+512120.0
23031+5117	DBR 33		2016.888	1	59.9	2.57	14.7	16.6	707−109950	1FTN		230304.54+511632.8
23033+5116	BKO 930		2016.888	1	18.2	6.24	13.5	15.6	707−109987	1FTN		230318.64+511548.1
23036+5116	DBR 14		2016.888	1	222.5	5.67	12.3	14.3	707−110055	1FTN		230339.10+511616.1
23046+5122	DBR 2		2016.903	2	94.4	12.25	11.2	12.9	707−110204	2FTN		230438.27+512229.5
23049+5119	DBR 3	AB	2016.903	2	30.6	23.29	11.1	13.3	707−110248	2FTN		230451.61+511923.6
23049+5119	DBR 3	AC	2016.903	2	48.7	13.23	11.1	15.8	707−110248	2FTN		230451.61+511923.6
23049+5120	ROE 94	AC	2016.903	2	25.1	23.90	10.7	13.2	707−110259	2FTN		230455.33+512122.7

23051+5118	HJ 1846	2016.903	2	142.3	9.26	11.3	12.0	707−110282	2FTN	230505.17+511844.9
23488+1349	HJ 1909	2016.829	1	115.8	8.98	12.4	12.9	520−146031	1FTN	234852.42+134847.1
23535+1412	HJ 1915	2016.829	1	275.2	9.81	13.6	13.7	522−145303	1FTN	235330.54+141224.8

Observatory codes

GEM: Gemini Telescope (T0.51m), MPC code 857, Winer Observatory, Sonoita, Arizona, USA, Iowa Robotic Telescope, University of Iowa
FTN: Faulkes Telescope North (T2m), MPC code F65, Haleakala, Hawaii, LCOGT
FTS: Faulkes Telescope South (T2m), MPC code E10, Siding Spring, Australia, LCOGT
MPC code K91: (T1m), Sutherland, South Africa, LCOGT
MPC code K92: (T1m), Sutherland, South Africa, LCOGT

Notes

1 Neglected couple
* seen as single star (WDS data: PRO 223, 1910, $3''.8$ and BRT 1804, 1911, $3''.3$)

A STUDY OF THE DOUBLE STAR DBR 89

A. Debackère, Sociètè Astronomique de France

e-mail : andre.debackere@free.fr

Abstract

This paper presents a work aiming at the determination of the nature, either physical or optical, of a double star called DBR 89, one of the components of which has a planet (exoplanet). The photometric distances of the two components are estimated and found to be very close. This result supports the hypothesis that this pair constitutes a physical binary. This hypothesis is confirmed by a statistical test and by the fact that the two stars have common proper motions, in agreement with the detailed study carried out by other authors.

Background

Reading the article[1] by Marie-Claude Paskoff, published in the journal *Observations et Travaux No 52 Spécial Étoiles Doubles* (pages 59 to 62) entitled "Les Lycéens dans les étoiles ... doubles", led me to take an interest in determination of the distance of observed stars. The objective of the method is to try to answer the following question: Is the observed couple of stars a physical pair or an optical pair? If the distances of the components to the observer are very different, the couple of stars is optical; otherwise it is probable that it is a physical pair whose components are linked by gravitation. I presented a first draft of this work at the meeting of the Double Stars Committee of the Société Astronomique de France which was held in Lille in September 2016. On the basis of the remarks made by the scientific advisers of the committee present at this meeting, I refined the method. Of course, this criterion of distance is not sufficient on its own to decide; it is necessary to supplement it with other elements when they are known - trigonometric parallax, proper motions, radial velocities - without forgetting the statistical aspect by determining the probability that an object is at the given angular separation of the observed star.

Choice of target

I chose the star EPIC-211089792 (=TYC ID 1818-1428-1), listed DBR 89 in the WDS[2] (The Washington Visual Double Star Catalog (Mason + 2001-2014)) and particularly well studied since the detection of a new exoplanet by the Super-WASP observatory then by the K2[3] space mission during its fourth campaign: a hot Jupiter EPIC-211089792b. A call for observations was launched by Alexandre Santerne in early January 2016. I participated in this work by providing images in the B, V and R bands of the target, obtained on 8 January 2016 with the Faulkes Telescope North[4] (FTN) located at the summit of Haleakala in Hawaii (3 B-frames, 3 V-frames and 3 R-frames, 20s each). In fact, there is a "contaminant" at $4''.3$ NE of the target, BVR images are used to estimate contamination by the presence of the second component which could not be resolved by the data recorded by the mission Kepler K2 The results are published in the article by Alexandre Santerne[5]: *EPIC211089792 B: an aligned and inflated hot Jupiter in a young visual binary* published in "The Astrophysical Journal, Volume 824, Number 1". I also made images in B and V on January 19, 2017 with the FTN and the FTS (Faulkes Telescope South[6]) as well as February 2 and 3, 2017 with the FTN.

Distance module method

1) Position measurements of components A and B of the DBR 89 pair on the images obtained on January 8, 2016 from FTN (ASTROMETRICA[7] and GAIA-DR1 catalog). See Figure 4 and Table 1.

2) Measurement of the angle of position θ and the angular separation ρ of the components of the DBR 89 pair (REDUC[8], calibration of the images with two pairs of reference stars giving the CCD orientation Δ and the sampling E ($''$ / pix) of images).

In our study the two pairs of stars chosen for the calibration are:

C1 = UCAC4 573-010526; RA = 04h 10m 32.57s DEC = + 24° 28′ 28″.0

C2 = UCAC4 573-010525; RA = 04h 10m 31.09s DEC = + 24° 28′ 16″.8

and

C′1 = UCAC4 573-010519; RA = 04h 10m 25.88s DEC = 24° 24′ 36″.4

C′2 = UCAC4 573-010520; RA = 04h 10m 26.37s DEC = 24° 24′ 38″.8

The coordinates of these stars are measured on an image of January 8, 2016 using the software ASTROMETRICA and the catalog GAIA-DR1 to calculate the polar coordinates of the two reference pairs. See Figure 4 and Table 1.

3) Photometric measurements of the components of the DBR 89 (SUBARU Image Processor 9: MAKALI'I with two reference stars).

The two reference stars used are:

R1 = UCAC4 573-010534; B = 13.564 ± 0.059; V = 12.729 ± 0.034; R = 12.408 ± 0.044

R2 = UCAC4 572-010342; B = 13.131 ± 0.044; V = 12.389 ± 0.043; R = 12.134 ± 0.048

The data come from the APASS catalog (AAVSO Photometric All Sky Survey DR9 (Henden +, 2016)) The magnitudes measurements of the components A and B of the DBR 89 pair are performed in 3-circle aperture photometry. See Figure 4 and Table 2.

4) Interstellar extinction correction

a) E$(B-V)$ = $(B-V)$ measured - $(B-V)$ corrected

The extinction depends on the wavelength λ, it is stronger in the blue, which means that the objects appear redder than they actually are.

$m_{corrected} = m_{real} - A$

Where A is the extinction measured in magnitude

$A_\lambda = R_\lambda \times$ E$(B-V)$ according to Les Cahiers Clairaut[10] Spring 2008 no. 121 page 4 the following values are commonly allowed:

- For blue $A_B = 4.315 \times$ E$(B-V)$
- For green $A_V = 3.315 \times$ E$(B-V)$
- For red $A_R = 2.673 \times$ E$(B-V)$

b) Determination of the absolute magnitude of each component of the DBR 89 pair

We use the tables established by Frédéric Arenou linking color index, spectral type, class of luminosity and absolute magnitude. The study by Alexandre Santerne[5] on page 4 gives information on the spectral type and the class of luminosity of the two components of the DBR 89 pair. See Table 2 - the values used are extracted from the table of Frédéric Arenou. In our case E$(B-V)$ = 0.19 (see the article by Alexandre Santerne[5] page 7: Reddening E$(B-V)$ [mag] 0.19 ± 0.02)

- $A_B = 0.81985$
- $A_V = 0.62985$
- $A_R = 0.50787$

The magnitudes measurements of the two components in the 3 previous bands B, V and R are thus corrected for extinction. See Table 3.

5) Corrected Color Index

After calculating the weighted averages of the magnitudes of the two components in B and V, we then calculate the corrected color index for each component of the studied pair, taking into account extinction in blue and green. See Table 3.

6) Distance calculations of the components A and B of the studied couple

Pogson's law makes it possible to calculate the distance of an object knowing its apparent magnitude and its absolute magnitude:

log d = (m_V - A_V - M_V + 5) / 5

d = 10 ((m_v - A_v - M_v + 5) / 5)

See table 4.

7) Error calculations

a) On the magnitudes of each component measured in V-band on the images obtained from the Faulkes Telescopes.

V_A = 12.520 ± 0.013; V_B 14.690 ± 0.031

b) On the absorption in V-band

A_v = 0.630 ± 0.066 (3.315 x 0.02 mag)

c) On the absolute magnitude M

The uncertainty on the absolute magnitude is estimated by Frédéric Arenou when establishing his tables at 0.3 mag for each component. We thus see that this latter uncertainty is significantly greater than the errors on the apparent magnitudes and on the absorption.

Finally, σ d / d = σ M x ln (10) / 5

This is an uncertainty of about 14% over the distance of each component. The difference of the distances of each component is less than the error on these distances, which makes it possible to suppose that the two stars can be at the same distance and thus constitute a physical pair. See Table 4

Component proper motions

1) My research with the latest catalog UCAC5 (Zacharias + 2017) gives me the proper movements in right ascension and declination of the two components:

Component A: Src ID Gaia 150054784248952576

pmAD (UCAC / Gaia proper motion in RA * cosδ) 15.2 mas / year ± 1.2 mas / year

pmDE (UCAC / Gaia proper motion in DE) -22.8 mas / year ± 1.2 mas / year

Component B: Src ID Gaia 150054784249943040

pmAD (UCAC / Gaia proper motion in RA * cosδ) 16.4 mas / year ± 2.0 mas / year

pmDE (UCAC / Gaia proper motion in DE) -25.5 mas / year ± 2.0 mas / year

The two components have common proper motions which confirm the physical binary nature of DBR 89.

2) Archive Images

- The CDS portal[11] gives us:

POSSI survey on 1949/12/21, sampling 1.6″ /pix

POSSII survey on 1993/12/11, sampling 1.0″ /pix

- On the other hand, my observations at the Faulkes Telescope North of the Las Cumbres Observatory network provide, for example, this image:

FTN V-band on 2016/01/08, sampling 0.3 ″ /pix

The images of 1949, 1993 and ours of 2016 show the two components moving together in the time thus presenting common proper motions which reinforces the physical reality of the couple.

Statistical Testing

I used the relationship given in the "wiki" 12 written by Frédéric Arenou. We can evaluate the probability of having an object at the angular separation ρ (in arc seconds) of a given star, its presence being due to chance alone.

Figure 1
1949 - $\theta \sim 35°$, $\rho \sim 3''$

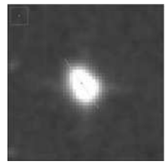

Figure 2
1993 - $\theta \sim 37°$, $\rho \sim 4''.5$

Figure 3
1949 - $\theta \sim 34°.15$, $\rho \sim 4''.32$

The probability of having at least one star of magnitude m in the surface element $\pi\ \rho^2$ around a given star is obtained with the Poisson law by:

P (ρ, m) = 1 - exp (-π ρ^2 D)

The field of the images obtained with the Faulkes Telescope 2 meters in diameter is approximately $10' \times 10'$ or an area of $600'' \times 600''$.

The use of ALADIN and the VizieR catalog service (choice of the NOMAD catalog) makes it possible to count the number of stars of the field whose magnitude in the V band is less than or equal to a given magnitude.

I counted 7 stars in magnitude brighter than 14.06 in a $10'$ x $10'$ field.

Let D = 7 / (600) x (600) = D / 360000

P (4.3; 14.06) = 1 - exp (-π x 4.32 x 7/360000) = 0.0011

So the chances of having at least one star within $4''.3$ of component A is 1 part in 886 or about 0.1%. This reinforces the option "physical couple"

Note: As an historical example, the notion of using separation to estimate the probability of physical connection has been used for a long time. For example, Robert Aitken[13] discusses it and gives a formula in the introduction to his ADS catalog of 1932 (ancestor of the WDS).

Conclusion

The difference between the distances of the components obtained here and the results of Alexandre Santerne can be explained by taking into account, in order to calculate the distance, all available magnitudes (from blue to thermal infrared). With this data, an energy spectral distribution (SED) model has been adjusted. The main parameters of this model are the distance and the extinction (assuming that the stellar properties, in particular the effective temperature T_{eff}) are known. The model provides a distance with a precision of 3pc by exploiting the information provided by several bands and not by a single band as is the case in this article. See Table 5.

The different methods used show that it is certainly a physical couple, which confirms Alexander Santerne's article. DBR 89 would therefore be a long-time orbital binary (several centuries) located between the Pleiades and the Hyades.

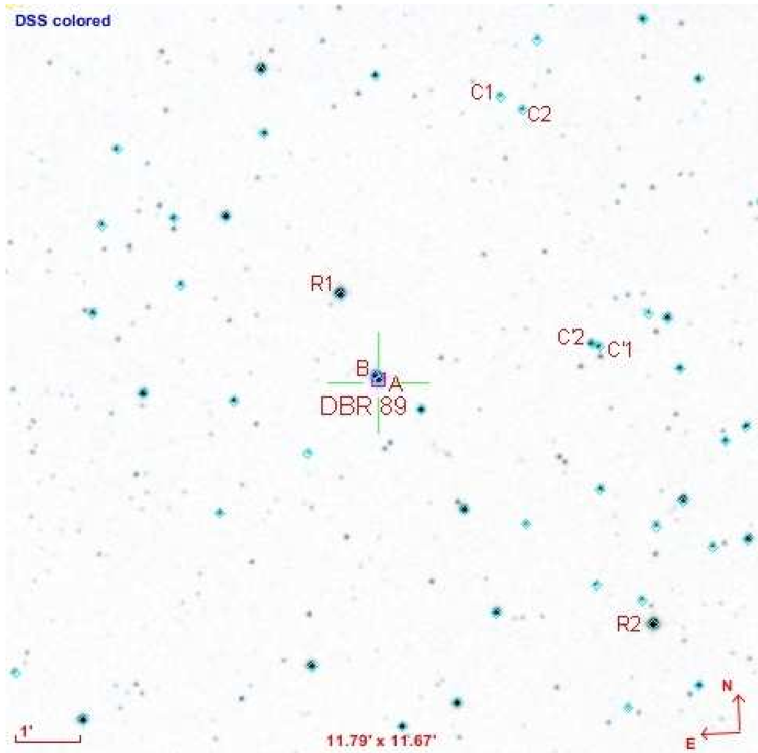

Figure 4: In ALADIN, field of DBR 89, calibration stars for astrometry and reference stars for photometry.

DBR 89 = EPIC 211089792 = UCAC4 573-010529		
Position (J2000)	α = 04h 10m 40.91s	$\delta = +24^\circ\ 24'\ 05''.9$
WDS id	04107+2424	
Couples for calibration	C_1C_2	$C'_1C'_2$
θ°	241.00049	70.27287
ρ''	23.101991	7.1102648
Dates	08/01/2016	19/01/2017
	2016.024	2017.053
Δ°	-0.065	0.400
S($''$ /pix)	0.304200	0.300365
Position angle (θ°)	34.1	34.2
Angular separation (ρ'')	4.33	4.31
Mean airmass	1.03	1.09

Table 1 - Data and observation journal of the stellar couple DBR 89

Component A				Component B			
Type	Class	$(B-V)$	M	Type	Class	$(B-V)$	M
G7	V	0.72	5.4	K5	V	1.15	7.4

Table 2 - Spectral types, luminosity classes, color index and absolute magnitudes.

date	site	Num. Obs			Component A			Component B		
		B	V	R	B_A	V_A	R_A	B_B	V_B	R_B
20160108	FTN	3	3	3	13.489	12.519	12.100	16.019	14.704	13.920
20170119	FTN	5	5		13.485	12.517		15.946	14.693	
20170131	FTN	10	10		13.479	12.513		15.990	14.706	
20170131	FTS	5	5		13.463	12.499		15.994	14.679	
20170202	FTN	15	14		13.482	12.521		15.987	14.702	
20170203	FTN	10	10		13.511	12.538		15.954	14.654	
Weighted averages		48	47	3	13.486 ±0.019	12.520 ±0.013	12.100 ±0.002	15.979 ±0.053	14.690 ±0.031	13.920 ±0.005
Extinction correction		$a_B =$ 0.820	$a_V =$ 0.630	$a_R=$ 0.508	B_A corr.	V_A corr.	R_A corr.	B_B corr.	V_B corr.	R_B corr.
Corrected magnitudes					12.666	11.890	11.592	15.159	14.060	13.412
Colour Index $(B-V_{corr.})$					0.776 ±0.023			1.099 ±0.061		

Table 3 - Apparent magnitudes of the two components of the DBR 89 pair and corrections due to extinction at different wavelengths.

Component A	Component B
M = 5.4 ± 0.3	M = 7.4 ± 0.3
m = 11.890 ± 0.067	m = 14.060 ± 0.099
d = 199 pc ± 28 pc	d = 215 pc ± 28 pc

Table 4 - Distance calculations

DBR 89	This paper	Data in A. Santerne's article
Position angle (θ)	34°.15	-
Angular separation (ρ)	4″.32	4″.3
V magnitudes	11.890/14.060	12.526/14.666
Spectral classes and types	-	G7V/K5V
Mean distance	200 pc	185 pc
Distance of components	864 AU	800 AU

Table 5 - Comparative Table

Acknowledgments

The author warmly thanks Alexandre Santerne of the Laboratory of Astrophysics of Marseille (France) for organizing this fruitful collaboration between professionals and amateurs as well as the LCOGT network team which allows me to access the Faulkes Telescope. He also thanked Frédéric Arenou of the Observatory of Paris (France), William Hartkopf of the US Naval Observatory (USA) for their advice and encouragement. Finally, he expresses his gratitude to Edgar Soulié and Daniel Bonneau, respectively president and scientific adviser of the of the Doubles Stars Committee of the Société Astronomique de France, for the rereading of this article.

This research has made use of the Washington Double Star Catalog maintained at the U.S.

Naval Observatory. the VizieR catalogue access tool, CDS, Strasbourg, France. The original description of the VizieR service was published in A&AS 143, 23,

References

1) http://articles.adsabs.harvard.edu/full/seri/O+T../0052/0000059.000.html
2) http://www.usno.navy.mil/USNO/astrometry/optical-IR-prod/wds/WDS
3) http://keplerscience.arc.nasa.gov/objectives.html
4) https://lco.global/observatory/2m/faulkes-telescope-north/
5) https://arxiv.org/pdf/1601.07680.pdf
6) https://lco.global/observatory/2m/faulkes-telescope-south/
7) http://www.astrometrica.at/
8) http://www.astrosurf.com/hfosaf/uk/tdownload.htm#reduc
9) https://makalii.mtk.nao.ac.jp/
10)http://acces.ens-lyon.fr/clea/archives/cahiers-clairaut/CLEA_CahiersClairaut_121_02.pdf
11)http://cdsweb.u-strasbg.fr
12)https://en.wikipedia.org/wiki/Double_star
13) Science, Volume 76, Issue 1961, pp. 103-104, " New General Catalogue of Double Stars within 120 degrees of the North Pole"

Index of previous Circulars

DSSC12: Micrometric measures of double stars from 2003.0 to 2004.0 (J.- F. Courtot & R. W. Argyle)
Measures of double stars made with an eyepiece micrometer (Magne Tollefsen)
Measures of double stars made with an eyepiece micrometer (Tim Leese)
CCD measures of double stars 2003 (Doug West)
Measures of double stars with a CCD camera and 35.5-cm reflector from 2002.953 to 2003.394 (Ernő Berkó, Tamás Ladányi, and György Vaskúti)
Data mining the Two Micron All Sky Survey 2MASS) for double stars (Martin Nicholson)
777 double stars in the Two Micron All Sky Survey (2MASS) (Martin Nicholson)
On double identities, recovered pairs, and optical imposters – investigations into some neglected double stars of the Washington Double Star Catalog (Richard Harshaw)
New measures for some neglected double stars of the Washington Double Star Catalog (Richard Harshaw)
Measures of some neglected southern double stars using the superCOSMOS database (Richard Jaworski)
Pp. 96, 2004

DSSC13: Micrometric measures of double stars from 2004.0 to 2005.0 (Bob Argyle)
Micrometer measurements from 2002.97 to 2004.94 (Andreas Alzner)
Measures of double stars with a CCD camera and 35.5-cm reflector from 2003.934 to 2003.942 (Ernő Berkó, Tamás Ladányi, and György Vaskúti)
Measures of neglected John Herschel southern double stars using on-line databases (Richard Jaworski)
Measures of selected John Herschel pairs between RA 0 h and 6 h using the SuperCOSMOS database (Richard Jaworski)
Suggested additional double stars to the WDS Catalog (Richard Jaworski)
The John Herschel multiple stars HJ 2116, HJ201 and HJ202 (Richard Jaworski)
Measures of neglected John Herschel southern double stars using the SuperCOSMOS database (Richard Jaworski)
Measures of 396 neglected southern double stars (Tòfol Tobal)
Possible anonymous southern visual double stars (Tòfol Tobal)
Measures of 622 neglected northern double star RA 00h - 12h 55m (Tòfol Tobal)
Measures of double stars made with an eyepiece micrometer (Magne Tollefsen)
Common proper motion pairs from the Sloan Digital Sky Survey (John Greaves)
HJ 327AC, HJ 2002 & HJ 9001 (Richard Jaworski and Bob Argyle)
Possible additional components to WDS double stars (Richard Jaworski)
A search for 'missing' Luyten double stars (Richard Jaworski)
Pp. 88, 2005

DSSC14: Micrometric measures of double stars from 2005.0 to 2006.0 (Bob Argyle)
Micrometer measures from 2004.94 to 2005.96 (Andreas Alzner)
Measures of double stars made with an eyepiece micrometer (Tim Leese)
2520 previously unreported double stars (Martin Nicholson & Hannah Varley)
Updated measures of neglected pairs in the Washington Double Star Catalog (Richard Harshaw)
BKO161 in place of STI 1445 (Gyorgy Vaskúti & Tamás Ladányi)
CCD measures of double stars at Palmer Divide Observatory - 2006.112 to 2006.238 (Brian D. Warner)
A modified industrial micrometer project - preliminary report (Morgan Spangle)
Some recent measures using a CCD camera (Morgan Spangle)
A search for 'missing' Luyten double stars - II (Richard Jaworski)
Measures of Luyten double stars using data from the 2MASS survey and SUPERCOSMOS image database (Richard Jaworski)
Measurement of the positions of Milburn (MLB) pairs from Sky Surveys (Richard Jaworski)
Measures of the neglected double star HJ2302 AB using the chronometric method (Ian Coster)
Pp. 68, 2006

DSSC15: Micrometric measures of double stars from 2006.0 to 2007.0 (Bob Argyle)
Measures of double stars with a CCD camera and 25-cm Cassgrain reflector in 2006 (Tamás Ladányi)
CCD observations of double stars at Waverley Observatory (Andrew Soon)
An analysis of errors in the measurement of visual double stars using the Celestron Micro-Guide with an SCT and Alt-Azimuth mount (Tim Napier-Munn)
Measures of 1027 neglected northern double stars RA 13h - 24h (Tòfol Tobal)
Measurement of the positions of Milburn (MLB) pairs from Sky Surveys - II (Richard Jaworski)
Some measures of double stars using the chronometric method, an eyepiece micrometer and the Aladin database (Ian Coster)
Candidate binary star systems in the Sloan Digital Sky Survey Data Release Five (Martin Nicholson)
Pp. 70, 2007

DSSC16: Micrometric measures of double stars in 2007 (Bob Argyle)
Micrometer measurements from 2006.21 to 2008.12 (Andreas Alzner)
Micrometric measures of double stars in 2007 (Jean - François Courtot)
Measures of double stars with a DSLR camera and 35.5-cm reflector from 2007.109 to 2007.194 (Ernő Berkó & György Vaskúti)
SDSS Data Release 6 proper motion information (John Greaves)
A trapezium in the field of Chevalier 138 (Thom Gandet)
Measurements of Selected Southern Double Stars - 1 (Richard Jaworski)
Measures of 1024 neglected visual double stars (Tòfol Tobal & Xavier Miret)
Pp. 84, 2008

DSSC17: Micrometric measures of double stars in 2008 (Bob Argyle)
Micrometer measures of the multiple system ES 1089 (Jean-François Courtot)
Measurement of some neglected southern multiple stars in Pavo (Tim Napier-Munn & Graham Jenkinson)
Measures of double stars with a DSLR camera and 35.5-cm reflector from 2008.781 to 2008.844 (Ernő Berkó)
A sequence of algorithms for the determination of binary star orbital elements and construction of the orbit relative to the apparent ellipse (Bill Oli18r)
Measurement of ten bright double stars using a Celestron Microguide eyepiece (Ian Coster)
Analysis of six neglected pairs in the WDS (Ian Coster)
A provisional orbit for STF 333 (WDS 02592+2120) (Ian Coster)
Measures of 36 anonymous and neglected southern visual double stars (Tófol Tobal & Xavier Miret)
OAG common proper motion wide pairs survey (Xavier Miret & Tófol Tobal)
Pp. 75, 2009

DSSC18: Micrometric measures of double stars in 2009 (Bob Argyle)
Micrometer measures of double stars in 2009 (Jean-François Courtot)
Measures of double stars with a DSLR camera and 35.5-cm reflector from 2008.852 to 2008.997 (Ernő Berkó)
Measures of double stars with a DSLR camera and 35.5-cm reflector from 2009.200 to 2009.835 (Ernő Berkó)
Measurement of some neglected southern multiple stars in Dorado and Pictor (Tim Napier-Munn & Graham Jenkinson)
Investigation of two anomalies in the WDSC (Tim Napier-Munn & Graham Jenkinson)
Five new visual double stars (Abdul Ahad)
Measures of 58 neglected southern visual double stars (Tòfol Tobal)
OAG Common proper motion wide pairs survey - Part II (OAG Supplement No. 24) (Xavier Miret & Tòfol Tobal)
Pp. 67, 2010

DSSC22 Micrometric measures of double stars in 2013 (Bob Argyle)
Micrometric measures of wide southern double stars in 2013 (Bob Argyle)
The system J 868 (WDS 00152+2722) – a new optical double star with orbital parameters (F. M. Rica)
A new visual binary system in Cetus (Abdul Ahad)
A new visual double star in Orion (Abdul Ahad)
Measurement of 24 southern multiple stars (Graeme Jenkinson and Tim Napier–Munn)
Common–motion pairs and other doubles found in spectral surveys: – 7. Miscellaneous new and known pairs (Brian Skiff)
Pp. 54, 2014

DSSC23 Micrometric measures of double stars in 2014 (Bob Argyle)
Micrometric measures of double stars in 2014 (J.–F. Courtot)
Orbital solution and astrophysical parameters for WDS 09005+3225 (= HU 718) and WDS 11137+2008 AB (= STF 1517 AB) (Francisco Rica)
A new double star near Gamma Hydrae (Abdul Ahad)
Two new common proper motion doubles in Virgo (Abdul Ahad)
Measurement of nine neglected southern multiple stars (Graeme Jenkinson)
Common–motion pairs and other doubles found in spectral surveys – 8. One hundred forty new pairs found in the Orion complex (Brian Skiff)
Common–motion pairs and other doubles found in spectral surveys – 9. Survey work for 2014 (Brian Skiff)
New astrometric catalogue available from USNO (Brian Skiff)
Pp. 100, 2015

DSSC24 Micrometric measures of double stars in 2015 (Bob Argyle)
Micrometric measures of double stars in 2015 (J.–F. Courtot)
Measures of double stars at the Winer Observatory and discovery of new pairs (Andrè Debackére)
Discoveries of new pairs with the LCOGT network telescopes (T2M Faulkes telescope North, Hawaii and T1M McDonald, Texas) (Andrè Debackére)
Five new common proper motion double stars (Abdul Ahad)
Measures of 17 southern multiple stars) (Graeme Jenkinson)
Measureent of neglected southern multiple stars – two listed pairs and a possible new pair (Graeme Jenkinson)
Measures of multiple stars in Norma (Graeme Jennkinson)
A new visual double star in Aquila (Ian Coster)
Common–motion pairs and other doubles found in spectral surveys: – 10. Survey work for 2015 (Brian Skiff)
Pp. 92, 2016