The Webb Deep-Sky Society

Double Star Section Circular No 30

Contents

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Editorial

The number of measures included in these Circulars is now 86325.

Observer	WDS code	Pairs	Measures	Method/source
Astro. Assoc. Queensland	AAQ	9	54	CCD imaging
R. W. Argyle	ARY	3	3	Internet astrometry
J.- F. Courtot	CTT	40	151	RETEL, homemade filar, Lyot micrometer
A. Debackère	DBR	1	1	Internet astrometry
J. Greaves	GRV	1	1	Internet astrometry
W. Knapp	KPP	247	247	Internet astrometry
TOTALS		301	457	

Bob Argyle, 2022 September

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://www.astro.gsu.edu/wds`

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

Etoiles Doubles (in French)
A newly established on-line journal and freely available from `www.etoilesdoubles.org`

El Observador de Estrellas Dobles (in Spanish)
(`www.elobservadordeestrellasdobles.wordpress.com`)
(Unfortunately this publication has closed down. The website currently contains all 27 of the published bulletins.)

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.saao.ac.za/sections/double-and-variable-stars`)

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

MICROMETRIC MEASURES OF DOUBLE STARS IN 2021

Jean-François Courtot, Chaumont, France

Introduction

The measurements presented here have been made during 2021 using two different telescopes: a homemade 205-mm (8-inch) Newtonian and either a RETEL filar micrometer at a power of x508 or a Lyot double-image micrometer at x464, and a 279-mm (11-inch) Schmidt-Cassegrain telescope with powers from x430 to x640 with different homemade filar micrometers (Ref. 1) and a homemade double-image micrometer at x614.

The measurement procedures have been outlined in previous circular DSSC 23 (Ref. 2). Further indications on some observed peculiarities with double-image micrometers can also be found in DSSC 24-25 (Ref. 3-4). Measurements have been arranged as usual in Table 1. Epochs are in Julian years. In last column, 'T205' denotes the 205-mm Newtonian telescope, 'C11' the 11-inch Schmidt-Cassegrain, 'L' is for the Lyot double-image micrometers whilst 'F' indicates that a filar micrometer has been used. Table 2 gives a short comment on each measured pair.

As usual also, besides known orbital pairs, some other pairs have been measured. When available, Gaia DR2 proper motions, parallaxes, luminosity and radial velocities data have been used to investigate the true nature of the observed pairs using Dommanget's criteria (Ref. 5, 6). The followed procedure can be found in DSSC 28 circulars (Ref. 7). Of possible interest, the case of STF958AB, WDS 06482+5542AB with a large discrepancy between first and second Dommanget criteria (see Table 2, ADS 5436).

For known observed orbital pairs, residuals with recently computed orbits are to be found in Table 3. Of possible interest here for the observers and orbit calculators, the case of STF1338AB, WDS 09210+3811 with large O-C residuals (Table 3, ADS 7307).

Table 1 - Measures

Pair	Comp	RA	Dec	V_a	V_b	PA (°)	Sep (″)	Epoch (Julian)	N	Obs.	Method
STF470	AB	03543	−0257	4.8	5.9	348.9	6.89	2021.137	4	CTT	T205/F
DA5	AB	05245	−0224	3.6	4.9	79.0	1.80	2021.153	3	CTT	T205/L
STF728		05308	+0557	4.4	5.8	43.9	1.31	2021.168	4	CTT	T205/L
STF795		05480	+0627	6.0	6.0	219.8	1.02	2021.201	3	CTT	T205/L
STF958	AB	06482	+5542	6.3	6.3	76.7	4.46	2021.227	3	CTT	T205/L
STF1126	AB	07401	+0515	6.6	7.0	175.9	0.86	2021.246	4	CTT	T205/L + C11/L
STF1338	AB	09210	+3811	6.7	7.1	316.0	1.20	2021.245	4	CTT	T205/L + C11/F+L
STF1356		09285	+0903	5.7	7.3	115.6	1.00	2021.259	4	CTT	T205/L + C11/L
STF1365		09315	+0128	7.4	8.0	157.2	3.42	2021.294	3	CTT	T205/L+C11/F
A2142		10057	+4103	8.0	8.8	293.2	1.03	2021.310	3	CTT	C11/F
STT216		10227	+1521	7.4	10.3	227.6	2.48	2021.336	4	CTT	C11/F
STF1590		12016	+7051	7.4	10.1	232.2	5.27	2021.388	4	CTT	C11/F
STF1722		13084	+1529	8.4	9.3	336.7	2.66	2021.402	4	CTT	C11/F
STF1785		13491	+2659	7.4	8.2	192.6	2.72	2021.412	3	CTT	C11/F
STF1821	AB	14135	+5147	4.5	6.6	235.9	13.75	2021.420	4	CTT	T205/F+C11/F
STF1888	AB	14514	+1906	4.8	7.0	294.9	5.11	2021.444	4	CTT	T205/F+C11/F
STT287		14515	+4456	8.4	8.6	10.8	0.63	2021.459	3	CTT	C11/L
STT288		14534	+1542	6.9	7.6	153.5	1.01	2021.451	4	CTT	T205/F+L+C11/F+L
STT298	AB	15360	+3948	7.2	8.4	190.6	1.21	2021.491	4	CTT	T205/L
STF1965		15394	+3638	5.0	5.9	306.4	6.38	2021.540	4	CTT	T205/F+C11/F

STF2021	AB	16133	+1332	7.4	7.5	0.4	4.04	2021.549	4	CTT	T205/F+C11/F
STF2161	AB	17237	+3709	4.5	5.4	320.7	3.97	2021.558	4	CTT	T205/F+C11/F
STFA35		17322	+5511	4.9	4.9	310.6	62.32	2021.570	4	CTT	T205/F+C11/F
STF2272	AB	18055	+0230	4.2	6.2	120.7	6.86	2021.585	4	CTT	T205/F
STF2281	AB	18096	+0400	6.0	7.5	282.9	0.81	2021.614	4	CTT	C11/L
STT353	AB	18208	+7120	4.5	5.9	261.8	0.46	2021.629	4	CTT	C11/L
STT359		18355	+2336	6.4	6.6	5.2	0.79	2021.664	4	CTT	C11/L
STF2422		18571	+2606	7.9	8.3	70.6	0.78	2021.673	4	CTT	C11/L
HJ2850		19008	+2318	8.8	9.7	274.3	2.56	2021.683	4	CTT	C11/F
STF2645		20095	+5140	8.6	9.0	140.0	1.76	2021.692	4	CTT	C11/F
S738AB		20106	+3338	7.8	8.4	106.2	42.37	2021.711	4	CTT	C11/F
STT541	BC	20106	+3338	8.4	9.7	184.3	1.75	2021.713	4	CTT	C11/F
STF2671	AB	20184	+5524	6.0	7.5	337.1	3.75	2021.731	4	CTT	T205/F+C11/F
STF2751		21021	+5640	6.2	6.9	356.4	1.62	2021.758	4	CTT	T205/L
STF2742		21022	+0711	7.4	7.6	213.2	3.00	2021.783	4	CTT	T205/L
STF2799	AB	21289	+1105	7.4	7.4	258.9	1.93	2021.809	4	CTT	T205/L
SHJ345	AB	22266	−1645	6.3	6.4	97.8	1.26	2021.769	5	CTT	T205/L
STF2947	AB	22490	+6834	6.9	7.0	55.3	4.63	2021.848	4	CTT	T205/L
STF2950	AB	22514	+6142	6.0	7.1	272.4	1.14	2021.886	3	CTT	T205/L
STF3050	AB	23595	+3343	6.5	6.7	343.3	2.51	2021.983	2	CTT	T205/L

Table 2 – Notes

Pair	ADS	Notes
STF470AB	2850	Apparent displacement since W. Herschel (1781): 2″.6. First Dommanget criterion: 3″.8. Second criterion: 1″.2. Current measured separation: 6″.9. Likely not an orbital pair.
DA5AB	4002	Very slow retrograde relative motion: 9° in 173 years. Getting wider: +0″.9. Starting from Dawes' measurement in 1848 (86°.8/0″.94), the effect of Gaia DR2 proper motions gives for 2021: 82°.0/1″.64 (Observed: 79°.0/1″.80). First Dommanget criterion: 1″. No DR2 radial velocity data for B: second criterion undetermined. After first criterion, possibly not an orbital pair. More data needed however.
STF728	4115	32 Ori. Orbital pair. Retrograde relative motion: 161° in 191 yrs. Getting wider.
STF795	4390	52 Ori. Orbital pair. Direct relative motion: 19° in 190 yrs. Getting closer: -0″.7.
STF958	5436	Very slow retrograde motion: 2° in 191 yrs. Getting slightly closer: -0″.6. First Dommanget criterion: 279″. Second criterion: 0″.9. Unusually large discrepancy. The first Dommanget criterion (determined after apparent displacement) would be compatible with the second (determined after radial velocities difference) if the apparent displacement was 10″ instead of observed 0″.6 or if the radial velocity difference was 0.66 km/s instead of 11.42 km/s (Gaia DR2). Starting from Struve's measurement in 1830.91 (76°.7/5″.07), the effect of DR2 proper motions gives for 2021.227: 81°.8/6″.1 (measured: 76°.7/4″.5). Relative position from DR2 equatorial coordinates for 2015.5: 256°.8/4″.6 compatible (±180°) with current micrometric measurements.
STF1126AB	6263	Slow direct relative motion: 43° in 192 yrs. Getting closer: −0″.6. First Dommanget criterion: 0″.96, compatible with possible orbital motion (current measured separation: 0″.86).
STF1338AB	7307	Long period orbital pair. Direct relative motion: 194° in 192 yrs. Getting closer: -0″.6˙ Large O-C residuals with Scardia 2002 orbit.
STF1356	7390	ω Leo. Second revolution since W. Struve. Clearly split with gap using the T205 Newtonian.
STF1365	7412	Very slow retrograde motion: 6° in 191 yrs, getting slightly wider: +0″.3. First Dommanget criterion: 15″ : possibly an orbital pair (current measured separation: 3″.4).
A2142	7631	Slow retrograde relative motion: 16° in 111 yrs. Getting wider: +0″.4. First Dommanget criterion: 5″ (current measured separation: 1″), compatible with a possible orbital motion.
STT216	7744	Orbital pair, retrograde relative motion: 301° in 176 yrs.

STF1590	8395	Very slow retrograde relative motion: 4° in 189 yrs. Getting slightly wider. Relative displacement: 0″.4. First Dommanget criterion: 11″ , second criterion of the same order: 16″ . Current measured separation: 5″.3 so possibly an extremely long period orbital pair.
STF1722	8796	Slow retrograde relative motion: 7° in 192 yrs. Getting closer: −0″.9. First Dommanget criterion: 12″ . No Gaia DR2 radial velocity data for A component: second criterion undetermined. Current measured separation: 2″.7, so possibly an orbital pair.
STF1785	9031	Orbital pair, direct relative motion. Second revolution since W. Struve.
STF1821AB	9173	Very slow retrograde relative motion: 3° in 242 yrs. Getting wider: +1″.3. First Dommanget criterion: 78″ . Current measured separation 13″.8, so possibly an orbital pair. See Table 3 for O-C residuals with Izmailov orbital elements. Relative position deduced from Gaia DR2 equatorial coordinates for 2015.5: 236°.6 / 13″.16, not matching so well other observations from other sources (WSI: 2012.66: 235°.8/13″.49 for instance) . A and B both spectroscopic binaries.
STF1888AB	9413	ξ Boo. Orbital pair. Second revolution since W. Struve. Getting closer.
STT287	9418	Orbital pair. Direct relative motion: 274° in 176 yrs. Split with gap using the C11. Elongated image with the T205mm.
STT288	9425	Orbital pair. Retrograde relative motion: 74° in 176 yrs.
STT298AB	9716	Orbital pair. Fourth revolution since O. Struve (1846). Magnitudes more likely 7.2/7.4 than 7.2/8.4 mentioned in WDS. Relative position for 2015.5 from Gaia DR2 equatorial coordinates: 167.7° /1″.06. Soderhjelm grade 1 ephemeris for the same epoch: 184°.4 / 1″.20 (O-C: −16°.8, −0″.14 i.e. a distance discrepancy of 0″.36 hardly compatible with submillarcsecond precision claimed for DR2 position measurements).
STF1965	9737	Very slow direct relative motion: 6° in 192 yrs. First Dommanget criterion: 7″.9. Current measured separation: 6″.4. Possibly a very long period orbital pair. No Gaia DR2 velocity data however and second Dommanget criterion undetermined.
STF2021AB	9969	Orbital pair. Direct relative motion: 46° in 192 yrs.
STF2161AB	10526	Very slow direct relative motion: 15° in 191 yrs. Separation without any noticeable change. First Dommanget criterion: 10″ . Current measured separation: 4″ . So possibly an orbital pair. No Gaia DR2 radial velocity data. Second Dommanget criterion undetermined.
STFA35	10628	ν Dra. Starting from measurement mentioned in WDS for 1690 (314° /71″.4 ; apparent displacement: 9″ in 381 yrs), the effect of Gaia DR2 proper motions gives for 2021: 310° / 69″ (measured: 310°.6/62″.3). The same calculation starting from the measurement by W. Struve in 1833.85 (313°.0/61″.74 ; apparent displacement: 0″.9 in 188 yrs) gives: 310.8° /60″.3, not matching well the observations in both cases. Starting from 1690 measurement (probably inaccurate), first Dommanget criterion: 5″.5. Starting from Struve 1833 measurement: 3″.2. Likely an optical pair. No GAIA DR2 radial velocity data however and so second Dommanget criterion undetermined.
STF2272AB	11046	70 Oph. Orbital pair. Third revolution since W. Struve.
STF2281A	11111	73 Oph. Orbital pair. Retrograde relative motion: 336° in 190 yrs. Getting wider.
STT353AB	11311	ϕ Dra. Orbital pair. Retrograde relative motion: 159° in 165 yrs. Getting wider. Elongated diffraction image using the C11. No distinct gap. Difficult measurement due to magnitude contrast (Δm: 1.4).
STT359	11479	Orbital pair. Retrograde relative motion: 348° in 172 yrs. Near apastron.
STF2422	11869	Retrograde relative motion: 34° in 189 yrs. Separation without any noticeable change. No Gaia DR2 data for the secondary: Dommanget criteria undetermined.
HJ2850	11934	Nearly fixed since 1876 measurement by Dembowski (274.7° /2″.51). From Gaia DR2 equatorial coordinates, relative position for 2015.5: 275.5° /2″.70, coherent with micrometric measurements. Gaia DR2 luminosity and radial velocity data missing however for both components: Dommanget criteria undetermined. Similar DR2 parallaxes: 2.733 & 2.633 mas.
STF2645	13447	Very slow direct relative motion: 5° in 190 years. Getting slightly wider. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 137°.4/1″.61, consistent with current micrometric measurements. First Dommanget criterion: 4″.0. No Gaia DR2 radial velocity data for determination of the second criterion. Similar Gaia DR2 parallaxes, nearly common proper motions: possibly a very long period orbital pair.
S738AB	13463	Very slow retrograde relative motion: 5° in 197 yrs, getting slightly wider. No Gaia DR2 luminosity nor radial velocity data: Dommanget criteria undetermined. Starting from James South measurement in 1824, the effect of Gaia DR2 proper motions gives for 2021: 105°.9/43″.29 (observed 106°.2/42″.37). Relative position for 2015.5 from Gaia DR2 equatorial coordinates: 106°.4/42″.01. Different parallaxes: 4.1 & 1.9 mas. Likely an optical pair.

STT541BC	13463	Very slow retrograde relative motion: 6° in 181 yrs. Getting slightly wider. No Gaia DR2 luminosity nor radial velocity data for B: Dommanget criteria undetermined. Relative position for 2015.5 from Gaia DR2 equatorial coordinates: 183°.1/1″.78, consistent with current micrometric measurements.
STF2671AB	13692	Very slow retrograde relative motion: 3° in 190 yrs, getting slightly wider. No sufficient Gaia DR2 data for Dommanget criteria determination. Similar parallaxes and proper motions for both components. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 335°.6/3″.71, compatible with current micrometric measurements.
STF2751	14575	Very slow direct relative motion: 14° in 190 yrs. Getting slightly closer. No Gaia DR2 luminosity nor radial velocity data: Dommanget criteria undetermined. Similar parallaxes and proper motions. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 353°.2 / 1″.64: compatible with micrometric measurements.
STF2742	14556	Slow retrograde relative motion: 11° in 190 yrs. Getting wider: +0″.6. First Dommanget criterion: 15″ . Current measured separation: 3″ . Similar parallaxes (8.6/8.5 mas). Possibly a long period orbital pair. No Gaia DR2 radial velocity data: second Dommanget criterion undetermined. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 215°.9/2″.97, compatible with micrometric measurements.
STF2799AB	15007	Long period orbital pair. Retrograde relative motion: 73° in 190 yrs. Getting wider. First Dommanget criterion: 2″.6 compatible with an orbital motion (current measured separation: 1″.9). No Gaia DR2 radial velocity data: second Dommanget criterion undetermined. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 263°.8/1″.85 giving O-C residuals with Izmailov grade 4, 2019 orbital elements: +4°.4/+0″.03. According to Gaia DR2 magnitude and luminosity data, B component in fact slightly brighter than A.
SHJ345AB	15934	53 Aqr. Long period orbital pair. Direct relative motion: 155° in 198 yrs. Near periastron.
STF2947AB	16291	Slow retrograde motion: 20° in 189 yrs. Getting wider: +1″.7. Similar parallaxes and proper motions for both components. First Dommanget criterion: 84″ . Current measured separation: 4″.6, so possibly an orbital pair. No Gaia DR2 radial velocity data however: second Dommanget criterion undetermined. Relative position from Gaia DR2 equatorial coordinates for 2015.5: 56°.4/4″.57, compatible with micrometric measurements.
STF2950AB	16317	Long period orbital pair. Retrograde relative motion: 46° in 189 yrs. Getting closer: −0″.9.
STF3050AB	17149	Long period orbital pair. Direct relative motion: 151° in 189 yrs. Getting wider.

Table 3 - Residuals from known orbits

Pair	Comp	ADS	Residual(O-C) PA(°)	Sep (″)	Orbit	Date	Grade	Period (yrs)
STF728		4115	+0°.1	−0″.06	USNO	1999	4	614
STF795		4390	−0°.8	+0″.03	Izmailov	2019	4	1260
STF1126	AB	6263	−3°.0	+0″.05	Izmailov	2019	4	1252
STF1338	AB	7307	−8°.0	+0″.21	Scardia	2002	3	303
STF1356		7390	−0°.4	+0″.09	Van Dessel	1976	2	118
STF1356		7390	−0°.3	+0″.10	Muterspaugh	2010	2	118
STT216		7744	−0°.4	+0″.16	Scardia	2009	3	315
STF1785		9031	+0°.8	+0″"01	Izmailov	2019	2	156
STF1821	AB	9173	+0°.4	+0″.09	Izmailov	2019	5	10141
STF1888	AB	9413	+0°.4	+0″.03	Heintz	1999	2	152
STF1888	AB	9413	−0°.2	−0″.11	Izmailov	2019	2	153
STT287		9418	+5°.5	0″.00	Heintz	1997	4	340
STT288		9425	−1°.1	+0″.08	Heintz	1998	4	313
STT298	AB	9716	0°.0	+0″.02	Söderhjelm	1999	1	56
			−0°.4	+0″.05	Izmailov	1999	1	55
STF2021	AB	9969	+5°.8	+0″.58	Hopmann	1970	5	5228
			+1°.8	0″.00	Izmailov	2019	4	950

STF2272	AB	11046	+0°.1	+0″.16	Pourbaix	2000	1	88
			+0°.3	+0″.17	Izmailov	2019	1	88
STF2281	AB	11111	+3°.1	+0″.02	Söderhjelm	1999	3	294
STT353	AB	11311	−2°.8	−0″.10	Andrade	2005	3	308
STT359		11479	+1°.7	+0″.04	Scardia	2000	3	219
STF2799	AB	15007	+1°.0	+0″.04	Izmailov	2019	4	1108
SHJ345	AB	15934	+0°.5	+0″.01	Tokovinin	2020	4	2000
STF2950	AB	16317	+2°.0	+0″.14	Izmailov	2019	4	817
STF3050	AB	17149	+0°.1	0″.00	Izmailov	2019	3	573

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(1) Courtot, J.-F., 2017, *Webb Society Deep Sky Observer*, **177**, 16 sq.
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The Gaia mission website is `https://www.cosmos.esa.int/gaia`.
The Gaia archive website is `https://archives.esac.esa.int/gaia`

THREE FAINT, RED, COMMON PROPER MOTION SYSTEMS IN BOOTES AND HERCULES

R. W. Argyle, Waterbeach, England

Abstract

Whilst searching for current data on bright pairs in Hercules and Bootes, area searches around these objects have revealed three much fainter, but apparently physical, pairs.

Introduction

The Gaia DR3 catalogue is currently unparallelled in astrometric quality and magnitude range. Objects as faint as 21st magnitude and as bright as 3rd magnitude are included amongst the 1.47 billion other stars in the current manifestion of the catalogue which is readily available at the Gaia archive `https://archives.esac.esa.int/gaia`. The positional accuracy is dependent on magnitude and is lower at the bright and faint ends. Indeed some DR3 positions of bright stars have significantly worse formal errors that their DR2 catalogue entries. It is expected that attempts will be made to extract better data from the brightest stars although it is understood that this is not a priority for the Gaia project team.

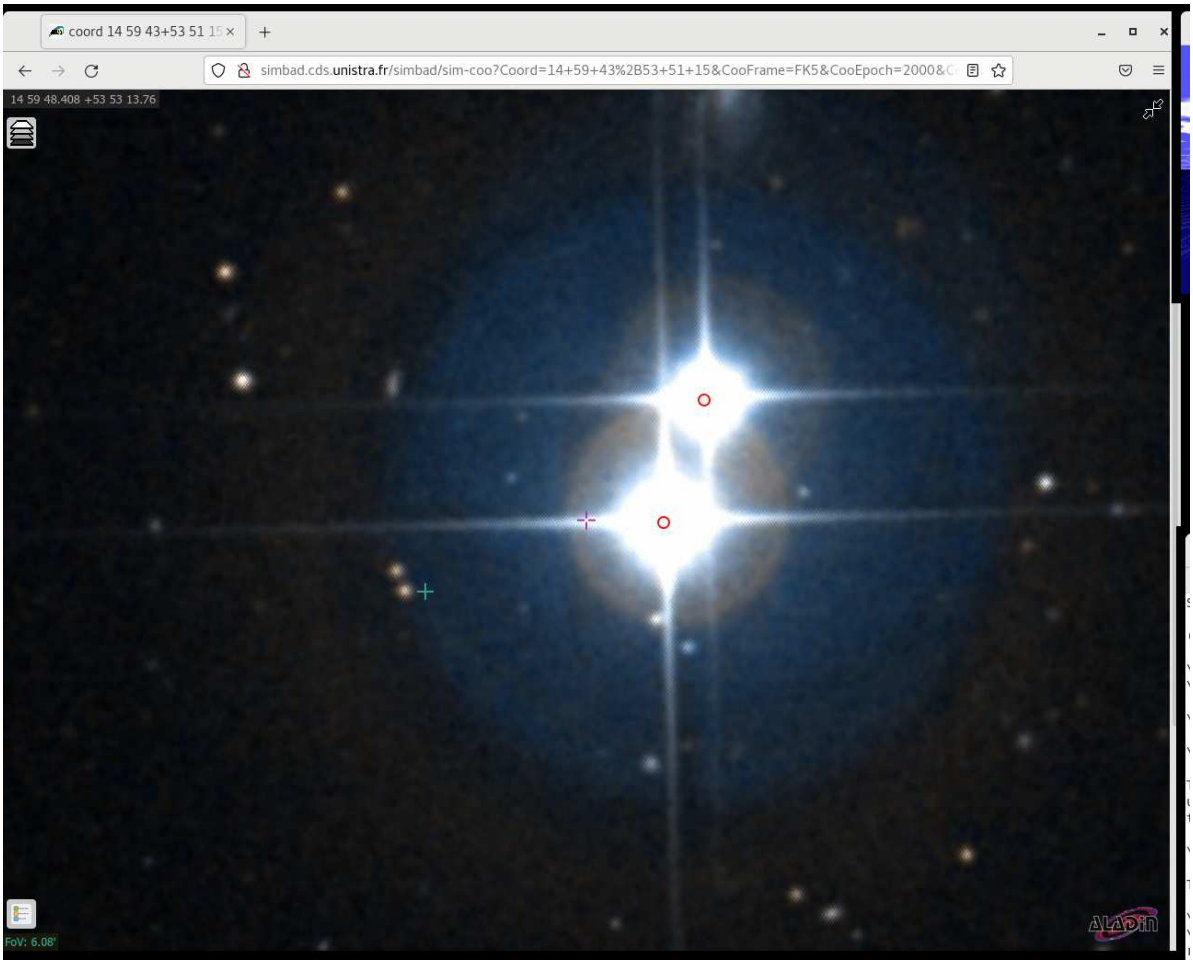

Figure 1: Field of SHJ 191. North is to the top, east to the left

Results

During the course of selecting pairs for the Double Star of the Month column on the Webb Society website, the areas around the bright pairs SHJ 191 and STF 2063 (H 4 62) were examined out to a radius of 100 arc seconds to ensure that both components of each pair were well within the search area, and to see if there were any common proper motion companions within that radius.

Nestling in the field of SHJ 191, about 1 arc minute east and slightly south of the A component is a pair of visibly red stars which appear to be almost equally bright. These are well seen by using the SIMBAD plotting tool to display the stars in the field of a given object (Fig. 1). In the field of STF 2063 (Fig. 2) is a pair of red images to the east of the brighter star and close to the end of the eastern spike. The pair which is resolved on the SIMBAD plot but which Gaia resolves with ease. The other pair in the field is just to the east of the northern spike.

Table 1 gives the Gaia DR3 positional data for the three pairs along with the observed G magnitude and the $G_{BP} - G_{RP}$ colour. The G magnitude is an instrumental value for the Gaia satellite which covers the wavelength range 350 - 1000 nm. The colour index is provided by $G_{BP} - G_{RP}$ where G_{BP} covers 350 - 680 nm and G_{RP} represents the wavelength range 640 - 1000 nm. For each of the three pairs being described here the value of $G_{BP} - G_{RP}$ is greater than 2 and suggests that the stars are of later spectral type. There are no radial velocity data for any of the stars discussed here.

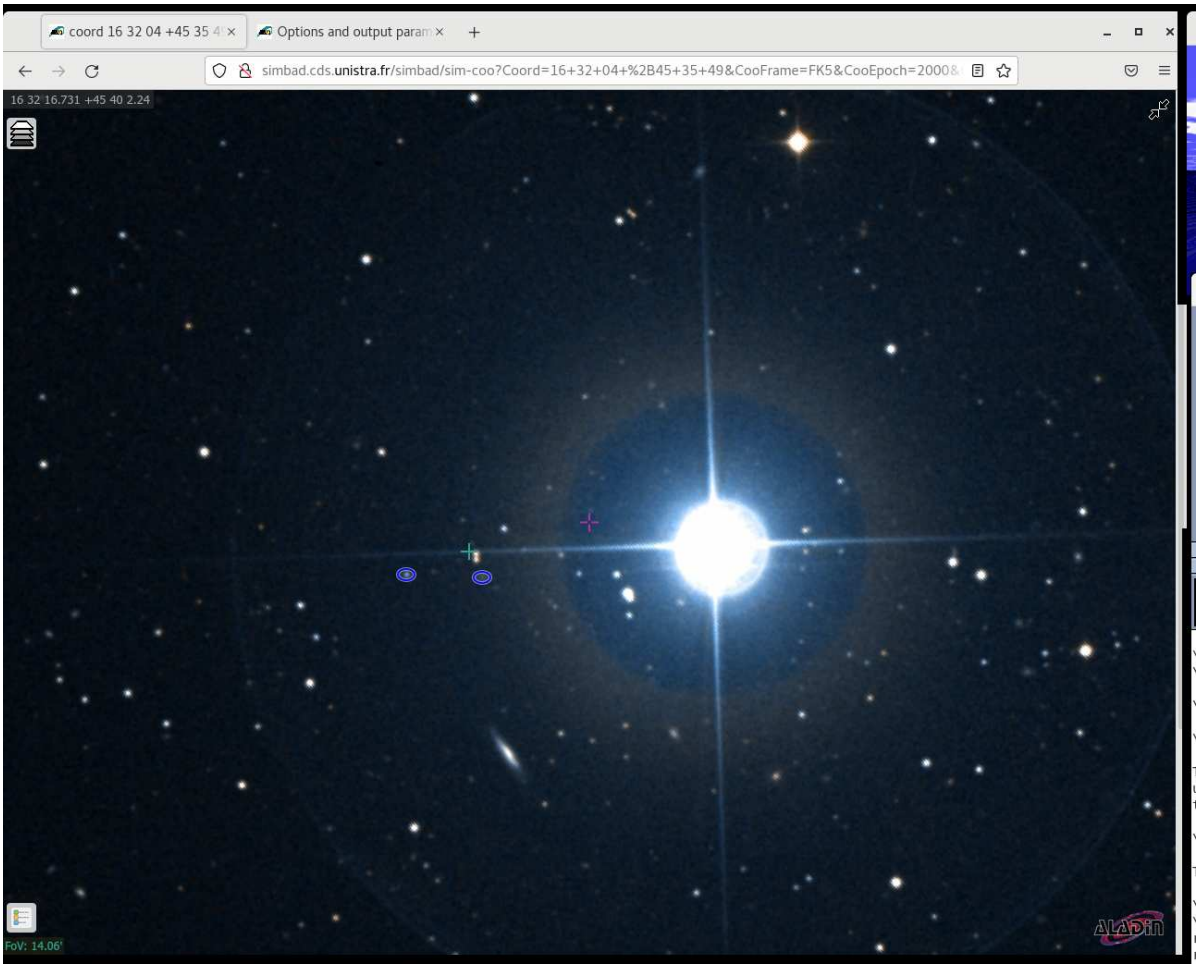

Figure 2: Field of STF 2063. North is to the top, east to the left

Table 1 - Gaia DR3 Astrometry and photometry of candidate pairs

Pair		RA(2000)	Dec(2000)	G	B_P-R_P	π (mas)	err (mas)	PM(α) (mas/yr^{-1})	PM(δ)	θ ($^\circ$)	Sep ($''$)	N
SHJ191	A	14 59 43.520	+53 51 14.82	16.75	2.56	5.315	0.042	-96.03	+1.88	202.61	6.87	1
(Pair)	B	14 59 43.819	+53 51 21.16	17.01	2.64	5.323	0.056	-96.54	+1.85			2
STF2063	A	16 32 03.467	+45 35 48.36	16.31	2.70	7.871	0.037	-32.82	+57.45	2.81	4.28	3
(Pair 1)	B	16 32 03.447	+45 35 44.09	16.47	2.76	7.876	0.044	-32.85	+57.18			4
STF2063	A	16 31 52.714	+45 39 51.70	17.56	2.43	2.789	0.087	-24.84	+21.49	37.50	4.04	5
(Pair 2)	B	16 31 53.010	+45 39 54.28	17.84	2.23	2.927	0.075	-24.98	+21.65			6

Table 2 - Gaia DR3 designations

N	DR3 catalogue number
1	1594247093832641152
2	1594247093833127936
3	1406712191575500544
4	1406712191575500288
5	1406725110837143552
6	1406725106543545472

Conclusion

The agreement between the parallaxes and proper motions between both components in each of the three faint pairs suggest that these are binary systems.

Acknowledgements

The Gaia DR3 catalogue presents results from the European Space Agency (ESA) space mission Gaia. Gaia data are being processed by the Gaia Data Processing and Analysis Consortium (DPAC). Funding for the DPAC is provided by national institutions, in particular the institutions participating in the Gaia MultiLateral Agreement (MLA).
The Gaia mission website is `https://www.cosmos.esa.int/gaia`.
The Gaia archive website is `https://archives.esac.esa.int/gaia`.

ASTRONOMICAL ASSOCIATION OF QUEENSLAND 2021 PROGRAMME: BLUE STAR OBSERVATORY MEASUREMENT OF NINE NEGLECTED SOUTHERN MULTIPLE STARS

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Abstract

This paper presents the final results of a 2021 programme of photographic measurements of nine southern multiple stars. All results were obtained using an Atik 460EX mono CCD camera used in conjunction with an equatorially mounted 400-mm F4.5 Newtonian reflector.

System	Last listed measure			New measure			Comment
	PA °	Sep.″	Epoch	PA°	Sep.″	Epoch∗	
POU635 nearby pair	n/a	n/a	n/a	136.753	3.365	2020.97	Possible new pair E of POU635
B2136	134	8.4	2000	130.008	8.669	2021.12	Clear change in PA.
RSS125	n/a	n/a	n/a	103.725	10.846	2021.12	Possible new A-C component.
BRT710	198	3.4	1899	321.721	4.610	2020.03	Possible incorrect original cataloguing.
B2716	214	4.6	2015	214.165	4.556	2021.30	Confirmation of 2015 measure.
DON703	218	3.1	1968	216.188	3.907	2021.50	Minor change in both axes.
FEN40 nearby pair	61	5.9	1916	7.474	8.939	2021.78	Possible new pair SE of FEN40
I 681	193	2.5	1998	191.421	2.462	2021.68	Small decrease in both axes.
BU279	89	5.5	2012	81.953	5.288	2021.78	Decreases in both axes.

∗ Epochs of new measures given in Besselian years as the average of the observations making up the measure.

The mean 95% confidence intervals for the new measures were ±1°.092 in PA and ±0″.170 in separation. The results are given below.

Introduction

These latest results are part of an ongoing programme commenced in 2008 by the Double Star Section of the Astronomical Association of Queensland. The target stars were selected from the Washington Double Star Catalogue (WDSC) and were observed in Queensland, Australia from a latitude of approximately 27° S.

Method

Nightly sets of one hundred images were obtained with the equipment described above, after which the images were stacked using Atik Dawn software and then analysed using the astrometric double star program REDUC (Losse, 2008). Approximately ten stacked images of each target were taken per night for seven nights and the results averaged to obtain measures of separation and position angle with sufficient confidence.

Full details of the method are given in Napier-Munn and Jenkinson (2009). Subsequent work on the errors inherent in the method is described in Napier-Munn and Jenkinson (2014). As proficiency has grown in the use of this equipment with the 400-mm reflector, close doubles with considerable magnitude difference between the components have been successfully measured. Fellow AAQ

member Des Janke provided invaluable assistance processing the original FITS image files into JPEG photographs.

Results

For all of the systems shown below the WDSC information is first reproduced, showing the epoch 2000 position, magnitudes, separation, PA, and the last recorded measurement. The new measurements are then given in tabular form, including the mean and standard deviation and 95% confidence limits. Any uncertainties between the images and the last recorded measurements are discussed. Finally a conclusion is given as to whether any movement of the component stars has occurred in PA or separation, based on the P-value for the t-test comparing the new mean values with the catalogued value ($P < 0.05$ is considered as evidence of change).

As detailed in the tabulated results below, we note:
i) A possible new pair to the east nearby POU635 in Taurus.
ii) A possible C component for RSS125.
iii) Possible incorrect catalogue details for BRT 710.
iv) A possible new pair nearby FEN40 in Aquarius.
Please note that all attached images are aligned with North to the bottom and East to the right.

POU635 Tau(nearby pair) RA. 05 17 43.3 DEC. +24 23 50 Last Measure MAG. 13.2 & 16.6 PA. n/a° SEP. n/a″

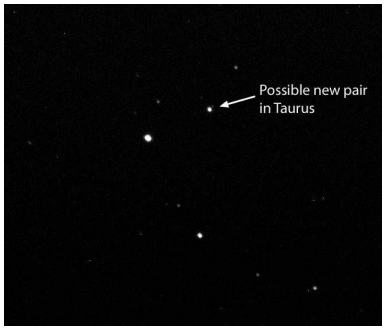

Figure 1: POU 635 (nearby pair) in Tau

Date	No. images	PA°	Sep″
20 November 2020	10	136.7	3.722
22 November 2020	10		
25 November 2020	10	136.5	3.315
19 December 2020	10	134.55	3.431
25 December 2020	10	138.67	3.411
13 January 2021	10	137.46	3.102
14 January 2021	10	137.42	3.209
Mean		136.753	3.365
Standard deviation		1.419	0.214
95% CI ±		1.489	0.225
P(t) movement		0.000	0.000

Table 2: Individual measures of POU 635

COMMENTS Possible new pair east of POU635. Poor quality images 22 November 2021 not used.

B2136 CMa RA. 07 09.7 DEC. -25 14 Last Measure 2000 MAG. 5.65 & 13.0 PA. 134° SEP. 8″.4

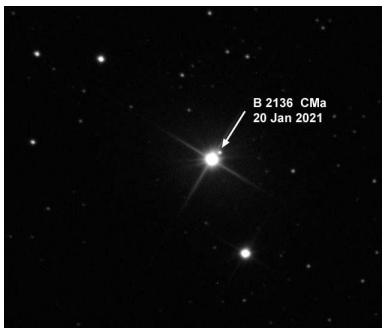

Figure 2: B 2136 in CMa

Date No. image	PA°	Sep″	
20 January 2021	10	130.12	8.851
21 January 2021	10	130.69	8.716
15 February 2021	10	129.91	8.613
17 February 2021	10	130.41	8.567
21 February 2021	10	128.60	8.211
12 March 2021	10	130.32	8.698
Mean		130.008	8.669
Standard deviation		0.739	0.110
95% CI ±		0.775	0.115
P(t) movement		0.000	0.002

Table 3: Individual measures of B 2136

COMMENTS Clear movement in PA over 21 years. Six nights imaging only due to inclement weather.

RSS125 CMa(new 'C' comp?) RA. 07 11.4 DEC. -27 44 Last Measure n/a MAG. 7.32 & n/a PA. n/a° SEP. n/a″

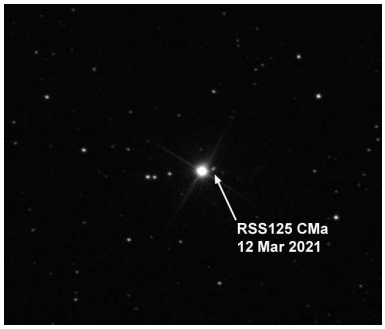

Figure 3: RSS 125 in CMa

Date	No. images	PA°	Sep″
20 January 2021	10	103.54	10.871
17 February 2021	10	103.94	10.877
22 February 2021	10	103.6	10.859
12 March 2021	10	103.82	10.777
Mean		103.725	10.846
Standard deviation		0.187	0.047
95% CI ±		0.298	0.074
P(t) movement		0.000	0.000

Table 4: Individual measures of RSS 125

COMMENTS Possible new A - C component of this pair. Four nights only imaging due to extended poor weather.

BRT710 Pup RA. 07 32 16.2 DEC. -41 49 13.2 Last Measure 1899 MAG. 13.7 & 15.7 PA. 198° SEP. 3″.4

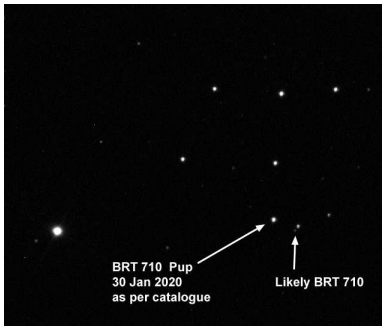

Figure 4: BRT 710 in Puppis

Date	No. images	PA°	Sep″
03 Jan 2020	10	321.42	4.656
04 Jan 2020	10	322.12	4.633
06 Jan 2020	10	322.18	4.721
07 Jan 2020	10	321.82	4.181
08 Jan 2020	10	321.17	4.715
30 Jan 2020	10	321.48	4.699
31 Jan 2020	10	321.86	4.664
Mean		321.721	4.610
Standard deviation		0.377	0.192
95% CI ±		0.348	0.177
P(t) movement		0.000	0.000

Table 5: Individual measures of BRT 710

COMMENTS Brighter star to NW possibly incorrectly catalogued as BRT710, but not resolved. The measured pair nearby as per above co-ordinates (not currently catalogued) probable original target. Large change to PA may be due to incorrect original N-S alignment.

B2716 Ant RA. 10 38.5 DEC. -31 40 54 Last Measure 2015 MAG. 11.07 & 11.1 PA. 214° SEP. 4″.6

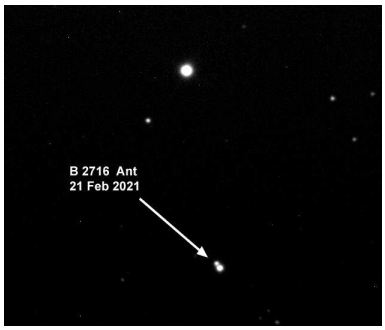

Figure 5: B 2716 in Antlia

Date	No. images	PA°	Sep″
21 February 2021	10	214.	4.545
22 February 2021	10	213.	4.499
12 March 2021	10	214.2	4.577
16 April 2021	10	214.08	4.587
18 April 2021	10	214.63	4.56
19 April 2021	10	213.91	4.567
Mean		214.165	4.556
Standard deviation		0.267	0.031
95% CI ±		0.280	0.033
P(t) movement		0.191	0.018

Table 6: Individual measures of B 2716

COMMENTS Six nights imaging only due to extended poor weather. No probable movement - confirmation of 2015 measure only.

DON703 TrA RA. 15 01.9 DEC. -68 35 Last Measure 1968 MAG. 9.66 & 14.8 PA. 218° SEP. 3″.1

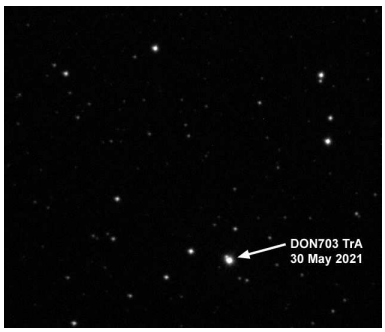

Figure 6: DON 703 in TrA

Date No	images	PA°	Sep″
25 May 2021	10	218.40	3.683
26 May 2021	10	219.89	4.004
30 May 2021	10	215.49	4.320
21 June 2021	10	213.51	3.717
19 July 2021	10	213.65	3.811
Mean		216.188	3.907
Standard deviation		2.859	0.262
95% CI ±		3.550	0.326
P(t) movement		0.229	0.002

Table 7: Individual measures of BRT 2075

COMMENTS Minor changes in both axes over 53 years. Five nights imaging only due to inclement weather.

FEN40 Aqr(nearby pair) RA. 22 38 05.015 DEC. -15 50 55.78 Last Measure 1916 MAG. 10.0 & 12.3 PA. 61° SEP. 5″.9

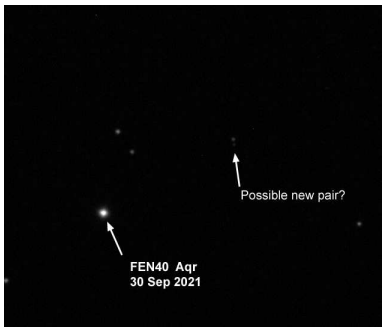

Figure 7: FEN 40 (nearby pait) in

Date	No. images	PA°	Sep″
13 September 2021)	10	7.78	8.982
17 September 2021	10	6.73	8.927
06 October 2021	10	8.01	8.775
08 October 2021	10	7.44	8.841
10 October 2021	10	7.41	9.168
Mean		7.474	8.939
Standard deviation		0.485	0.151
95% CI ±		0.602	0.187
P(t) movement		0.000	0.000

Table 8: Individual measures of Fen 40 (nearby pair)

COMMENTS Unable to resolve listed pair. Possible fainter new pair SE of FEN40. Extended poor weather prevented a full collection of the usual seven night's data.

I 681 Gru RA. 22 44.1 DEC. -42 29 Last Measure 1998 MAG. 10.21 & 11.16 PA. 193° SEP. 2″.5

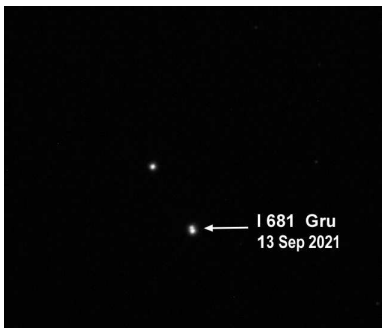

Figure 8: I 681 in Grus

Date	No. images	PA°	Sep″
18 August 2021	10	192.61	2.615
12 September 2021	10	190.63	2.332
13 September 2021	10	192.11	2.536
17 September 2021	10	192.15	2.538
19 September 2021	10	189.79	2.301
06 October 2021	10	189.78	2.349
08 October 2021	10	192.88	2.566
Mean		191.421	2.462
Standard deviation		1.325	0.130
95% CI ±		1.225	0.120
P(t) movement 0.020 0.473			

Table 9: Individual measures of I 681

COMMENTS Slight decrease in both axes over 23 years.
BU279 Aquarius RA. 23 42.7 DEC. -14 33 Last Measure 2012 MAG. 4.48 & 9.9 PA. 89° SEP. 5″.5

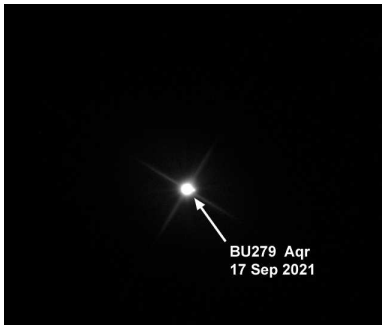

Figure 9: BU 279 in Aquarius

Date	No. images	PA°	Sep″
17 September 2021	10	82.37	5.262
19 September 2021	10	82.80	5.333
06 October 2021	10	–	–
08 October 2021	10	81.63	5.069
16 October 2021	10	81.01	5.489
Mean		81.953	5.288
Standard deviation		0.793	0.174
95% CI ±		1.261	0.277
P(t) movement		0.000	0.093

Table 10: Individual measures of BU 279

COMMENTS Decreases in both axes over nine years. Poor quality images of 06 Oct not used. Extended poor weather prevented a full collection of the usual seven nights' data.

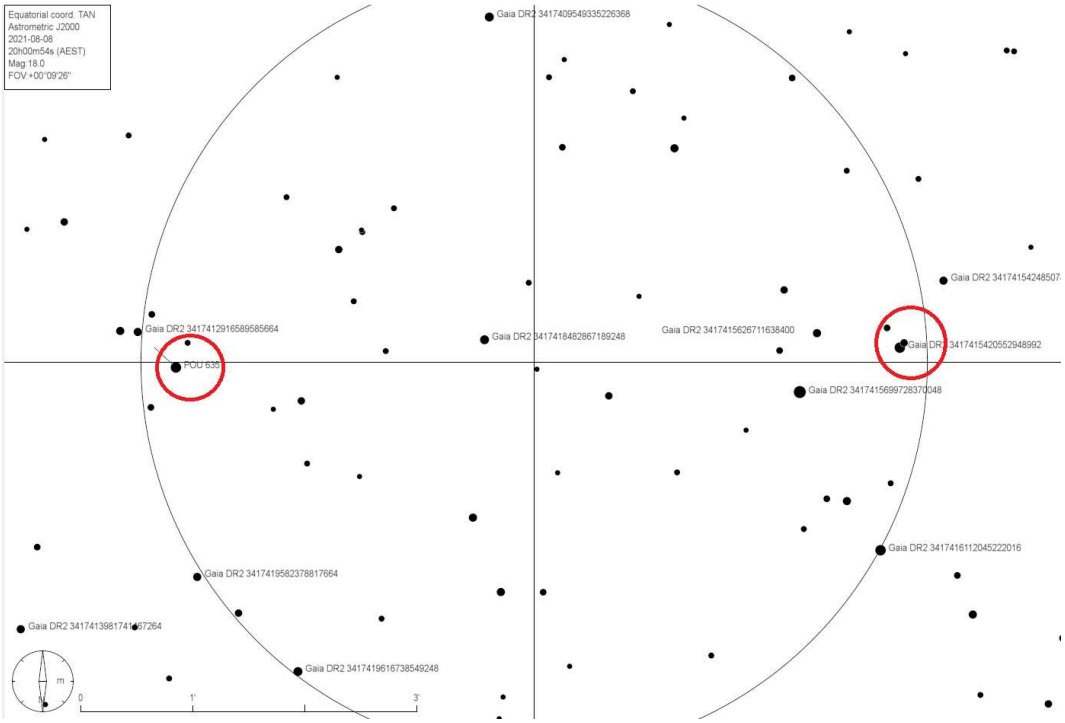

Figure 10: POU635 nearby pair location

Acknowledgements

This research has made use of the Washington Double Star Catalogue maintained at the U.S. Naval Observatory. The Edward Corbould Research Fund administered by the Astronomical Association of Queensland for granting of funds to upgrade imaging camera and observatory computer to suit.

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DOUBLE STAR MEASUREMENTS 2021

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Abstract

CCD images taken in 2021 with a remote telescope covering the southern skies are used to report photometric and astrometric measurements

Method

This article reports photometric and astrometric measurements obtained by processing CCD images captured 2021 with V-filter with the remote telescope iT32 in Siding Spring, New South Wales, Australia.

The main focus is the precise measurement of visual magnitudes. The WDS catalog contains currently (Jan 2022) about 154,000 objects. Approximately 50,000 of these are listed with single-digit magnitudes, which is indicative of estimates rather than accurate measurements, and over 16,000 objects are listed with magnitudes in the blue or red band (WDS codes $B/K/R/I$) and therefore require measurements in the V-band. After eliminating all objects not suited for resolution with iT32 with 20s exposure time (too close, too faint, too bright) about 10,000 objects in the southern skies remained as targets of interest for this project. The selection criterion for the objects for a specific imaging session is then at a given point of time simply the currently highest given altitude during nights without moon to eliminate atmospheric effects as far as possible - so this is then a more or less random selection out of the mentioned 10,000 objects. This report covers about 240 such objects, including several KPP objects also in need of photometry and some WDS objects that happened by chance in close visual proximity to the selected targets.

The intention was, to take four images in different nights for all selected objects, but unfavorable imaging conditions often reduced this to a single image. The images were plate solved with Astrometrica using the GAIA DR2 catalog (henceforth DR2) with reference stars in the magnitude range of 8.5 to 16.5 for RAqy/Dec coordinates and the UCAC4 catalog for photometry in the visual band. The objects were then located in the center of the image and astrometry/photometry was done by the rather comfortable Astrometrica procedure with point and click at the components delivering RA/Dec coordinates and V_{mag} measurements based on all reference stars used for plate solving. The error range of the reported visual magnitudes is calculated from the average plate solving V_{mag} error of the image and the signal to noise ratio of the components. Separation and position angle of the components are calculated from the given RA/Dec coordinates with an error range derived from the average plate solving RA/Dec position errors.

Results

Table 1: Results for measured WDS objects

WDS_ID	Comp	Date	PA	e_PA	Sep	e_Sep	M1	e_M1	M2	e_M2	N
01363−3338		2021.83732	124.076	0.495	9.81617	0.08485	11.420	0.070	14.681	0.076	1
01384−3119		2021.83732	96.586	0.118	35.13705	0.07211	13.919	0.063	15.302	0.079	1
01412−3654		2021.83728	257.057	0.297	13.66190	0.07071	11.050	0.070	13.879	0.072	1
01413−3404		2021.83730	205.853	0.215	15.04585	0.05657	13.784	0.062	14.915	0.066	1
01416−3348		2021.83729	280.901	0.190	20.25420	0.06734	14.248	0.064	14.396	0.064	2

01592−2332		2021.83726	170.346	0.349	16.40225	0.10000	12.723	0.091	12.826	0.091	1
02074−2527		2021.83731	285.553	0.403	14.06012	0.09899	13.618	0.082	15.385	0.108	1
02127−2501		2021.83731	210.912	0.502	8.91654	0.07810	12.400	0.061	14.803	0.068	1
02152−3038		2021.83725	292.890	0.358	13.57469	0.08485	12.245	0.060	12.430	0.060	1
02155−2925		2021.83727	228.035	1.164	4.92015	0.10000	9.305	0.080	13.539	0.104	1
02158−3252		2021.83723	41.804	0.370	19.82768	0.12806	10.162	0.100	10.965	0.100	1
02168−2643		2021.83731	65.345	0.174	21.09544	0.06403	12.867	0.071	13.484	0.071	1
02181−2906		2021.83727	46.537	0.392	11.41185	0.07810	12.282	0.061	13.707	0.062	1
02190−2334		2021.83724	137.732	0.722	8.97285	0.11314	11.690	0.080	11.759	0.080	1
02193−3602		2021.83726	34.006	0.217	20.60390	0.07810	11.784	0.060	12.723	0.061	1
02204−2538		2021.83724	145.617	0.370	12.09276	0.07810	10.954	0.070	11.411	0.070	1
02208−3726	AB	2021.83729	40.176	0.664	6.74023	0.07810	14.857	0.078	15.057	0.079	1
02208−3726	AC	2021.83729	132.394	0.043	104.05343	0.07810	14.857	0.078	15.887	0.098	1
02213−3718		2021.83729	328.517	1.119	3.99861	0.07810	11.368	0.071	11.697	0.071	1
02218−3108		2021.83724	197.053	0.433	10.33435	0.07810	12.213	0.060	13.016	0.061	1
02233−3214		2021.83725	90.297	0.840	5.78630	0.08485	11.087	0.060	14.667	0.073	1
02244−3515		2021.83723	221.089	0.470	8.61091	0.07071	10.692	0.060	11.363	0.060	1
02247−3529		2021.83723	189.825	0.422	9.59066	0.07071	15.691	0.076	17.135	0.153	1
02294−3420		2021.83727	335.527	0.120	37.37861	0.07810	12.220	0.060	13.670	0.062	1
02305+2514	AC	2022.07792	29.545	0.033	115.82432	0.06619	.	.	s12.695	0.034	3
02307+2527		2022.07792	49.899	0.283	13.39249	0.06619	13.452	0.034	14.869	0.036	3
02314+2523		2022.07792	112.900	0.513	7.39181	0.06619	14.449	0.035	14.882	0.036	3
02359−2830		2021.83723	54.689	0.809	6.08983	0.08602	10.930	0.060	11.130	0.060	1
02365−2613		2021.83728	98.017	0.717	6.23777	0.07810	11.986	0.070	13.687	0.073	1
04216−3229		2021.97138	311.024	1.106	5.37813	0.10387	11.810	0.088	12.453	0.088	3
04241−3157		2021.97139	81.946	0.356	12.15707	0.07564	13.346	0.062	14.642	0.069	3
04304−3052		2021.97139	237.110	0.387	12.58916	0.08505	14.239	0.066	14.272	0.067	3
04305−3142		2021.97140	23.922	0.234	17.40512	0.07118	13.747	0.066	14.795	0.070	3
04318−2617		2021.97140	98.786	0.262	16.53980	0.07564	13.848	0.072	14.814	0.077	3
04367−3233		2021.97141	272.803	0.327	14.47867	0.08259	13.940	0.062	14.279	0.064	3
04402−3455		2021.97141	93.368	0.211	19.17919	0.07071	14.048	0.066	15.435	0.081	3
04416−3030		2021.97141	228.255	0.447	10.60815	0.08280	11.776	0.067	13.997	0.069	3
04458−3436		2021.97142	230.178	1.438	6.65811	0.16797	12.462	0.064	12.561	0.064	3
04519−2414		2021.99468	238.376	0.351	12.67314	0.07778	11.469	0.065	15.134	0.073	2
04522−2512		2021.99468	83.721	1.044	5.62587	0.10267	11.888	0.086	12.528	0.086	2
04524−3140		2021.99332	87.762	0.807	5.54781	0.07810	10.162	0.065	15.640	0.127	2
04525−3631		2021.99469	348.875	0.975	4.36744	0.07441	13.040	0.066	13.510	0.068	2
04528−2521	AB	2021.99468	258.717	0.083	70.48074	0.10267	8.223	0.085	12.224	0.086	2
04528−2521	BC	2021.99468	139.109	1.461	4.02824	0.10267	12.224	0.086	13.237	0.088	2
04530−2758		2021.99469	224.608	0.673	8.47049	0.09944	11.141	0.085	11.647	0.085	2
04558−3100		2021.99470	45.240	0.197	22.72471	0.07810	15.866	0.083	16.226	0.097	2
04562−2657		2021.99471	77.951	0.375	12.45575	0.08148	11.652	0.060	12.022	0.060	2
04572−3756		2021.99471	298.346	0.542	9.36282	0.08852	13.123	0.061	14.152	0.063	2
04587−3236		2021.99471	343.922	1.046	4.49597	0.08215	11.469	0.060	11.989	0.060	2
05008−2804		2021.99472	49.395	0.828	5.37820	0.07778	12.416	0.061	12.519	0.061	2
05019−3103		2021.99472	73.274	0.541	9.37456	0.08852	14.115	0.063	14.648	0.065	2
05034−3024		2021.99472	109.128	0.834	7.53823	0.10971	14.899	0.091	15.188	0.092	2
05054−3002		2021.99473	251.823	0.358	11.37858	0.07107	13.605	0.057	14.789	0.061	2
05175−3536		2021.99473	324.337	0.656	6.81982	0.07810	9.572	0.070	11.696	0.071	2
05235−2859		2021.99473	297.559	0.343	12.41762	0.07444	12.438	0.060	15.689	0.075	2

08096−2916		2021.11440	338.918	0.337	13.27885	0.07810	11.719	0.061	13.817	0.073	1
08108−3342		2021.11439	33.482	0.083	53.94207	0.07810	11.355	0.061	13.238	0.065	1
08147−3051	AB	2021.11435	223.274	0.985	5.56974	0.09562	10.090	0.080	12.725	0.085	2
08151−2819		2021.11437	174.288	0.489	9.15545	0.07810	10.529	0.071	11.400	0.072	1
08152−2813	AB,C	2021.11437	51.851	0.147	30.41964	0.07810	9.050	0.070	9.809	0.070	1
08161−2815		2021.11437	339.909	0.902	4.96196	0.07810	11.032	0.072	11.635	0.074	1
08177−2941	AB	2021.11434	193.381	2.189	2.59032	0.09899	10.269	0.080	12.417	0.083	1
08177−2941	AD	2021.11434	40.376	1.021	5.55254	0.09899	10.269	0.080	14.675	0.113	1
08207−3012		2021.11444	76.512	0.295	13.72006	0.07071	13.004	0.072	13.981	0.076	1
08223−3408		2021.11433	251.950	0.911	6.22888	0.09899	9.775	0.080	10.249	0.080	1
08225−3024		2021.11437	124.188	0.587	7.61693	0.07810	10.830	0.070	11.204	0.071	1
08243−3329		2021.11434	203.309	1.094	5.56410	0.10630	10.048	0.090	10.809	0.091	1
08246−3240		2021.11440	172.133	1.759	2.66171	0.08148	12.436	0.068	12.779	0.070	2
08247−3255		2021.11441	119.468	0.038	128.23771	0.08485	7.683	0.070	11.250	0.071	1
08248−3240		2021.11439	49.371	0.273	16.37088	0.07810	12.063	0.063	12.434	0.064	1
08248−3240		2021.11440	49.448	0.286	16.33528	0.08148	12.045	0.067	12.438	0.068	2
08248−3240		2021.11441	49.526	0.298	16.29968	0.08485	12.027	0.071	12.441	0.072	1
08254−3249		2021.11441	177.884	0.431	11.26769	0.08485	12.748	0.072	11.779	0.071	1
08254−3546		2021.11436	143.671	0.764	5.30018	0.07071	11.075	0.063	11.117	0.063	1
08257−3302		2021.11441	297.868	0.458	10.61100	0.08485	11.026	0.071	11.705	0.071	1
08265−3249		2021.11441	129.533	1.339	3.62911	0.08485	11.817	0.072	11.606	0.072	1
08267−2658	AB	2021.11433	175.835	2.200	2.57681	0.09899	9.586	0.080	11.824	0.081	1
08267−2658	AC	2021.11433	102.600	0.595	9.53480	0.09899	9.586	0.080	16.183	0.128	1
08267−3531		2021.11436	218.088	0.239	16.96170	0.07071	8.994	0.060	9.898	0.061	1
08268−3242		2021.11441	118.057	0.788	6.16570	0.08485	10.861	0.070	12.601	0.072	1
08269−2658		2021.11433	76.804	1.639	3.46055	0.09899	12.042	0.081	13.837	0.087	1
08312−3233		2021.11438	328.756	0.483	9.26354	0.07810	11.557	0.071	10.908	0.071	1
08323−3234		2021.11438	89.636	0.568	7.87513	0.07810	9.327	0.070	13.632	0.084	1
08343−2900		2021.11442	235.770	1.372	5.61759	0.13454	10.668	0.120	12.399	0.121	1
08353−2923		2021.11443	356.011	0.647	7.51821	0.08485	11.478	0.060	12.029	0.061	1
08378−3228		2021.11435	235.003	0.664	7.32295	0.08485	10.114	0.070	12.631	0.076	1
08392−3413		2021.11436	130.631	0.765	6.35763	0.08485	10.283	0.070	12.425	0.077	1
08395−2852		2021.11438	131.407	0.532	8.40635	0.07810	11.452	0.061	11.971	0.061	1
08403−3210		2021.11437	205.262	0.989	4.52252	0.07810	8.073	0.060	9.256	0.061	1
08408−3226		2021.11437	153.772	0.506	8.85131	0.07810	10.858	0.061	12.136	0.063	1
08432−2826		2021.11442	31.269	0.506	9.60528	0.08485	11.934	0.071	13.029	0.074	1
08435−2815		2021.11442	353.650	0.301	16.12895	0.08485	10.259	0.070	11.667	0.071	1
08478−3329	AC	2021.11441	265.274	0.142	45.51035	0.11314	9.043	0.080	13.471	0.085	1
08478−3329	CD	2021.11441	46.868	0.903	7.18169	0.11314	13.471	0.085	13.754	0.085	1
13031−2947		2021.36920	8.245	0.385	11.62011	0.07810	11.308	0.060	16.973	0.134	1
13058−3412		2021.36103	88.573	0.660	6.81959	0.07848	11.546	0.070	13.860	0.072	2
13069−3224		2021.36921	56.851	0.314	14.26430	0.07810	10.846	0.060	15.511	0.070	1
13092−3147		2021.36105	359.199	0.381	9.62604	0.06403	13.926	0.062	16.089	0.087	2
13101−4213		2021.48636	240.451	0.555	13.13940	0.12728	8.808	0.081	13.806	0.089	1
13122−3337		2021.36103	239.383	0.834	5.34078	0.07778	12.484	0.060	13.492	0.061	2
13142−2743		2021.36104	274.124	0.565	7.55972	0.07460	11.517	0.065	16.420	0.138	4
13147−2752	AB	2021.36104	65.261	0.344	12.40768	0.07460	9.010	0.065	9.939	0.065	4
13147−2752	BC	2021.36104	170.855	0.083	51.27168	0.07460	9.939	0.065	15.148	0.074	4
13147−2752	BD	2021.36104	348.681	0.547	7.82922	0.07460	9.939	0.065	15.501	0.117	4
13160−3030		2021.37473	87.399	0.204	20.27433	0.07211	12.288	0.062	15.591	0.199	1
13169−2709		2021.36922	125.639	0.293	15.27420	0.07810	14.416	0.064	16.006	0.085	1

13190−2637		2021.37472	20.675	0.242	17.09066	0.07211	9.911	0.060	10.121	0.060	1
13227−2738		2021.36104	329.985	0.466	8.70235	0.07071	9.421	0.031	15.896	0.112	2
13292−2829		2021.37198	115.510	0.301	14.16363	0.07444	11.308	0.515	12.647	0.515	2
13303−3510		2021.37473	5.851	0.631	7.09698	0.07810	9.263	0.070	11.270	0.071	1
13308−3057		2021.37199	317.631	0.325	14.37475	0.08148	12.408	0.066	13.667	0.067	2
13317−3518		2021.37473	32.897	0.232	19.31780	0.07810	9.322	0.070	14.018	0.074	1
13324−3517	AB,C	2021.37473	297.573	0.401	11.14782	0.07810	9.691	0.070	12.818	0.073	1
13354−2656		2021.37197	240.643	0.451	10.35545	0.08148	10.817	0.061	12.160	0.062	2
13371−3517		2021.36106	284.046	0.442	10.11552	0.07810	10.830	0.065	12.121	0.065	2
13376−2910		2021.37474	59.986	0.200	26.34929	0.09220	11.322	0.060	15.335	0.117	1
13406−3027		2021.36920	226.446	0.308	11.90063	0.06403	15.855	0.079	16.768	0.131	1
13470−3006		2021.36105	119.377	0.331	12.24137	0.07071	14.498	0.073	16.370	0.102	2
13470−3009		2021.36105	299.100	0.413	9.79776	0.07071	14.442	0.073	15.495	0.080	2
14239−2931		2021.42929	69.245	0.528	9.19957	0.08485	11.729	0.070	12.699	0.071	1
14252−3112		2021.42929	71.315	0.247	18.13587	0.07810	11.248	0.060	12.223	0.060	1
14258−3408		2021.42928	254.718	0.395	12.29291	0.08485	12.139	0.071	12.347	0.071	1
14261−3409		2021.42928	243.891	0.148	32.78930	0.08485	13.264	0.071	16.473	0.120	1
14272−3251		2021.42930	146.325	0.645	6.91177	0.07778	12.578	0.071	13.090	0.071	2
14278−3231		2021.42930	156.230	0.355	12.57143	0.07778	12.992	0.071	12.974	0.071	2
14278−3238		2021.42930	267.541	0.193	23.08047	0.07778	9.189	0.070	13.913	0.072	2
14283−2907		2021.42931	254.340	0.663	7.33528	0.08485	14.465	0.063	16.971	0.157	1
14325−3102		2021.42935	83.419	0.367	13.26258	0.08485	15.784	0.086	16.604	0.128	1
14357−3307		2021.42933	115.156	0.869	8.86890	0.13454	9.764	0.100	12.968	0.101	1
14401−3216		2021.42936	43.602	0.033	136.87318	0.07810	13.383	0.062	13.244	0.062	1
14409−3220		2021.42936	72.933	0.307	14.56571	0.07810	7.945	0.060	9.932	0.060	2
14411−2747		2021.42933	304.423	0.226	21.51101	0.08485	15.773	0.080	16.360	0.088	1
14421−3219		2021.42936	101.841	0.566	7.16379	0.07071	12.159	0.061	12.577	0.061	1
14449−3506		2021.42933	45.774	0.236	20.60277	0.08485	14.100	0.063	15.120	0.067	1
14475−3030		2021.42936	191.000	1.538	5.01209	0.13454	11.534	0.112	12.565	0.113	1
14479−3325		2021.42935	64.272	0.543	14.19017	0.13454	10.150	0.102	10.622	0.101	1
14529−2716		2021.42932	32.785	0.252	19.30518	0.08485	10.082	0.060	13.948	0.062	1
14576−3108		2021.40340	91.924	0.888	7.29712	0.11314	11.506	0.086	12.432	0.087	2
14595−3432		2021.42932	206.706	0.418	12.64929	0.09220	13.417	0.061	12.752	0.061	1
14597−3547		2021.42929	299.096	0.116	34.98148	0.07071	10.478	0.070	12.622	0.070	1
15009−3409		2021.40338	67.409	0.638	7.95330	0.08852	12.028	0.065	12.296	0.065	2
15017−3231		2021.40340	46.517	0.997	4.88075	0.08499	13.404	0.064	13.675	0.064	4
15023−3239		2021.40340	220.469	0.095	51.35530	0.08499	13.103	0.063	14.230	0.065	4
15083−2928		2021.40340	113.235	0.180	25.95536	0.08145	15.597	0.076	16.381	0.103	2
15094−3007		2021.40339	124.002	0.106	38.25787	0.07071	13.198	0.061	13.312	0.061	2
15155−3038		2021.37748	327.733	0.355	13.70678	0.08485	9.864	0.070	12.660	0.070	1
15156−3005		2021.37747	46.432	0.795	6.64531	0.09220	10.461	0.070	12.548	0.071	1
15161−3044		2021.37748	85.734	0.080	60.49743	0.08485	7.947	0.070	12.898	0.071	1
15162−3035	AB	2021.37748	273.603	0.397	12.25396	0.08485	9.231	0.070	11.066	0.070	1
15162−3035	AC	2021.37748	37.660	0.139	35.06663	0.08485	9.231	0.070	10.809	0.070	1
15183−3151	AB	2021.37746	109.086	0.439	12.89114	0.09899	9.560	0.080	12.476	0.080	2
15187−3110		2021.37746	115.043	0.511	9.52032	0.08485	11.252	0.070	13.295	0.071	1
15187−3113		2021.37746	69.401	0.211	23.08018	0.08485	.	.	14.554	0.074	1
15192−3110		2021.37746	90.154	0.261	18.64919	0.08485	12.558	0.070	12.771	0.071	1
15193−3202	AB	2021.37746	95.175	0.123	41.18524	0.08852	8.668	0.065	10.788	0.065	2
15193−3202	BC	2021.37746	346.017	1.061	4.78908	0.08852	10.788	0.065	12.132	0.066	2
15196−2846		2021.37743	46.834	0.953	5.10150	0.08485	10.828	0.060	12.614	0.061	1

15239−3111		2021.37744	172.315	0.261	18.61722	0.08485	12.359	0.070	12.780	0.071	1
15240−3116		2021.37744	197.689	0.393	12.36458	0.08485	11.992	0.070	14.776	0.074	1
17022−3110		2021.51290	291.528	0.553	8.79006	0.08485	10.488	0.070	10.950	0.070	2
17032−3247		2021.51290	47.884	0.830	5.85923	0.08485	12.778	0.076	12.256	0.076	2
17084−3155		2021.51291	278.410	2.004	4.65287	0.16279	11.506	0.125	12.897	0.128	2
17172−3241		2021.51292	60.362	0.566	8.59430	0.08485	12.417	0.061	12.075	0.061	2
17183−3233		2021.51292	172.359	0.247	19.28139	0.08317	.	.	11.710	0.063	4
17184−3223		2021.51292	9.196	0.414	11.51551	0.08317	8.801	0.063	9.093	0.063	4
17186−3223		2021.51292	242.216	0.742	6.42890	0.08317	10.777	0.063	12.556	0.064	4
17186−3224		2021.51292	19.845	0.994	4.79452	0.08317	12.510	0.063	13.240	0.065	4
17193−2949		2021.51292	316.710	0.393	11.87097	0.08148	14.156	0.074	14.421	0.075	2
17195−3221		2021.51292	60.765	1.397	3.34229	0.08148	11.192	0.066	12.262	0.067	2
17200−3026		2021.51293	223.524	0.691	7.03357	0.08485	8.633	0.070	13.409	0.085	2
17265−3305		2021.51293	325.397	0.429	11.32296	0.08485	9.850	0.070	11.848	0.070	2
17273−2759		2021.51431	240.691	0.991	5.33169	0.09220	16.284	0.119	13.814	0.073	1
17297+4004		2021.50681	244.022	0.451	12.59159	0.09928	12.656	0.161	13.555	0.161	2
17313−3327		2021.51294	83.014	1.303	4.97454	0.11314	11.569	0.081	12.517	0.082	2
17328−2856		2021.51295	38.916	0.202	22.09987	0.07778	13.284	0.062	14.129	0.065	2
17331−3035		2021.51295	254.842	1.313	4.79053	0.10972	13.761	0.089	13.774	0.089	2
17342−3230		2021.51296	233.520	0.340	14.30519	0.08485	9.651	0.065	12.941	0.066	2
17344−3421		2021.51295	109.608	1.318	4.91684	0.11314	11.385	0.091	13.204	0.094	2
17346−3235		2021.51296	212.982	0.809	6.01106	0.08485	12.521	0.066	12.779	0.066	2
17355−2942	AB	2021.51297	16.067	0.785	8.00159	0.10964	9.398	0.090	10.885	0.090	6
17355−2942	AC	2021.51297	92.715	0.713	8.81371	0.10964	9.398	0.090	13.856	0.098	6
17355−3009		2021.51297	74.428	0.987	6.36933	0.10972	9.791	0.090	11.775	0.091	2
17356−2933		2021.51160	120.395	1.296	4.84999	0.10972	15.526	0.101	15.985	0.111	2
17357−2933		2021.51160	210.480	1.823	3.47494	0.10972	15.475	0.101	16.624	0.170	2
17358−2932		2021.51160	344.169	1.776	3.55252	0.10972	15.365	0.101	15.397	0.102	2
17361−2941		2021.51252	59.874	1.408	4.51395	0.11086	13.893	0.094	15.131	0.110	3
17362−2931		2021.51252	28.940	1.211	5.25372	0.11086	12.938	0.091	14.633	0.100	3
17363−2931		2021.51160	297.451	1.679	3.75029	0.10972	14.163	0.093	15.937	0.128	2
17365−3212		2021.51298	72.008	1.397	4.35470	0.10607	13.378	0.099	12.537	0.089	2
17411−3120		2021.51298	232.483	0.559	8.91073	0.08670	12.434	0.069	12.916	0.071	4
17411−3132		2021.51298	101.883	1.577	3.15393	0.08670	12.651	0.062	12.434	0.059	4
17413−3135	AB	2021.51299	74.570	2.273	2.85703	0.11336	10.622	0.091	10.993	0.091	2
17413−3135	AC	2021.51253	185.120	0.808	6.86454	0.09671	10.600	0.074	14.860	0.109	3
17413−3135	AD	2021.51299	350.719	0.298	21.83080	0.11336	10.622	0.091	11.839	0.091	2
17479−3152		2021.51299	38.151	1.212	5.34930	0.11314	11.436	0.091	11.721	0.092	2
18140−1426		2021.50059	66.501	1.062	4.21339	0.07810	12.209	0.071	11.984	0.071	1
19245−3221		2021.61005	225.279	0.656	7.73105	0.08852	9.867	0.060	11.160	0.061	2
19258−3225		2021.61005	163.803	0.531	9.57143	0.08852	11.617	0.060	12.259	0.061	2
19262−3252		2021.61006	67.533	2.554	2.84133	0.12556	13.310	0.093	13.873	0.102	4
19266−3251	AB,C	2021.61006	286.179	0.706	10.19889	0.12556	10.450	0.091	14.710	0.103	4
19266−3251	AB,D	2021.61006	8.128	0.183	39.23199	0.12556	10.446	0.091	10.271	0.091	4
19337−2946		2021.61007	348.018	0.093	54.44642	0.08852	12.075	0.065	13.782	0.067	2
19337−3213		2021.61006	54.352	0.323	15.71039	0.08852	12.030	0.070	12.145	0.070	2
19354−3240		2021.61007	75.458	1.073	6.43196	0.12042	12.721	0.093	12.016	0.091	2
19374−3055	AB	2021.61282	147.109	0.340	16.66575	0.09915	10.383	0.070	10.796	0.070	3
19374−3055	BC	2021.61282	213.452	0.501	11.33650	0.09915	10.796	0.070	10.760	0.070	3
19389−2808		2021.61832	309.131	0.717	9.61816	0.12042	11.796	0.091	13.542	0.093	1
19396−3534		2021.61834	323.227	0.040	120.11712	0.08485	10.141	0.070	15.611	0.086	1

19419−2646		2021.61834	208.230	1.282	5.37991	0.12042	11.138	0.091	11.575	0.092	1
19433−3045		2021.61834	179.982	0.119	40.80000	0.08485	15.139	0.077	15.721	0.085	1
19454−2858		2021.61835	61.710	0.313	15.52985	0.08485	12.697	0.071	12.314	0.070	1
19454−3507		2021.61835	108.023	1.406	3.45828	0.08485	10.269	0.060	10.884	0.061	1
19459−3521		2021.61835	349.380	0.915	5.31098	0.08485	10.735	0.060	10.762	0.060	1
19497−2727		2021.61835	162.021	0.212	22.89808	0.08485	13.082	0.061	16.283	0.110	1
19528−2653		2021.61836	165.368	0.590	8.95027	0.09220	9.453	0.070	10.174	0.070	1
19551−3221	AB	2021.61836	357.748	2.232	2.90224	0.11314	10.823	0.122	10.990	0.122	1
19551−3221	AC	2021.61836	212.147	0.368	17.59792	0.11314	10.823	0.122	11.338	0.120	1
19555−2649		2021.61837	42.465	0.447	10.88531	0.08485	10.357	0.060	13.465	0.062	1
19575−3449		2021.61837	128.218	0.294	16.51957	0.08485	10.423	0.060	11.313	0.060	1
20049−3059		2021.61837	282.229	0.470	11.23629	0.09220	14.405	0.065	15.199	0.071	1
20077−3144		2021.61838	290.421	0.115	42.16080	0.08485	12.371	0.070	12.640	0.071	1
20078−3007		2021.61838	242.358	1.541	3.42707	0.09220	14.340	0.070	14.467	0.071	1
20081−3014		2021.61838	19.612	0.061	86.41411	0.09220	16.809	0.159	15.611	0.091	1
20098−3127		2021.61838	36.431	0.821	4.93432	0.07071	11.877	0.061	12.216	0.062	1
23256−3234		2021.76063	24.846	0.192	23.24510	0.07789	12.750	0.068	14.031	0.069	3
23264−3016		2021.76336	339.838	0.268	15.20174	0.07107	11.292	0.060	11.732	0.060	2
23276−3308		2021.76064	92.910	0.669	6.29325	0.07359	13.379	0.065	13.242	0.065	3
23284−2907		2021.76336	124.342	0.145	22.51220	0.05702	13.938	0.067	16.527	0.125	2
23297−3157		2021.76337	67.864	0.490	7.15236	0.06117	13.460	0.072	15.348	0.084	2
23306−2831		2021.76337	65.269	0.347	11.72465	0.07107	10.154	0.075	14.610	0.080	2
23307−3053		2021.76338	93.059	0.722	4.78257	0.06036	12.134	0.066	12.802	0.066	2
23336−2947		2021.76338	132.818	0.144	36.74531	0.09220	10.525	0.065	11.517	0.065	2
23364−3313		2021.76339	33.136	0.043	85.19811	0.06451	10.057	0.065	12.499	0.065	2
23366−3242		2021.76339	242.439	0.073	50.44127	0.06403	14.804	0.071	15.864	0.103	2
23388−2802		2021.76340	62.463	0.372	9.80942	0.06364	13.043	0.066	14.481	0.070	2
23403−3142		2021.76340	247.574	0.218	18.54232	0.07071	16.035	0.095	15.675	0.083	2
23428−3038		2021.76341	3.208	0.306	11.99905	0.06403	9.987	0.065	15.142	0.074	2
23432−2904		2021.76341	204.799	0.702	6.06416	0.07444	9.398	0.065	15.204	0.126	2
23434−2912		2021.76341	270.052	0.390	10.92740	0.07444	10.565	0.065	12.133	0.065	2
23436−2923		2021.76341	136.326	0.194	20.15803	0.06821	12.653	0.071	15.651	0.088	2
23497−3008		2021.76070	323.510	0.065	64.21379	0.07317	14.335	0.071	15.025	0.076	3
23504−2951	AB	2021.75794	356.199	0.109	39.05727	0.07441	13.533	0.067	16.854	0.147	2
23504−2951	BC	2021.75794	348.159	0.815	5.23136	0.07441	16.854	0.147	16.133	0.099	2
23521−2745		2021.76070	37.043	0.656	5.80599	0.06626	14.574	0.062	16.093	0.100	3
23541−3317		2021.76071	182.257	0.680	6.36833	0.07566	13.550	0.068	14.636	0.072	3
23544−3100		2021.76071	164.643	0.065	60.48944	0.06872	8.788	0.064	10.271	0.064	3
23553−3055		2021.75796	122.327	0.601	6.76948	0.07107	14.954	0.069	16.915	0.149	2
23591−3042		2021.76072	263.387	0.170	23.18473	0.06872	12.679	0.064	12.830	0.064	3
23596−3151		2021.76072	70.748	1.116	6.54193	0.12743	11.002	0.114	12.968	0.115	3

Content description

WDS_ID	001-010	a10	WDS Designator
Comp	012-016	a5	Left justified component designator. If blank this is AB
Date	018-027	f10.5	Observation date, in years
PA	030-036	f7.3	Position angle, in degrees
e_PA	038-043	f6.3	Formal theta error, in degrees
Sep	046-054	f9.5	Separation, in arcseconds
e_Sep	057-063	f7.5	Separation error, in arcseconds
M1	066-071	f6.3	Primary magnitude, in Vmag
e_M1	073-077	f5.3	Primary magnitude error, in Vmag
M2	080-085	f6.3	Secondary magnitude, in Vmag. If mag1 is blank, Mag2 is the magnitude difference or if mag2 is actually the secondary magnitude then column 79 should be "s"
e_M2	087-091	f5.3	Secondary magnitude error, in Vmag
N	093-094	i2	Number of nights averaged into mean measure

Objects of specific interest

3.1	02305+2514	STF 271 AC: Chris Thuemen (private communication) found for this object a meanwhile corrected erroneous most recent measurement in the WDS catalog based on a misidentification of the C component. To provide an own measurement I took a few images in January 2022 and included the results in this report. This is the only northern sky object in this report. The images were taken with remote telescope iT24 located in Auberry, California and plate solving was done with Gaia DR2 for astrometry and URAT1 for photometry
3.2	04522−2512	BRT2857: A is an eclipsing binary itself and listed as variable star VSX76623
3.3	04528−2521	B 75 BC: Not yet listed in the WDS catalog. B 75 B has actually a close companion for which Gaia EDR3 suggests common proper motion, yet parallax values do not support a realistic likelihood of a gravitational relationship
3.4	08147−3051	DAM 465 AC: No resolution of C with the given setup. Has to be far fainter than 14.3 mag listed in the WDS catalog, most likely 15.3 mag (EDR3 15.14 *G*mag)
3.5	08155−2820	TDS5652: No hint of the secondary. No Gaia object for secondary. Bogus assumed
3.6	08177−2941	DAM 467 AC: No resolution of C. No Gaia object for C. Bogus assumed
3.7	14258−3305	PRO 113: No secondary to be found. Already marked as bogus in WDS
3.8	15183−3151	DAM 692 AC: No resolution of C. No Gaia object for C. Bogus assumed
3.9	17113−2725	CHN 26 AC: Both components too faint to be resolved with the given setup. EDR3 *G*mag for the primary >20. PanSTARRS shows a potentially corresponding object for C with a separation $\sim 6''.3$ and a position angle of $\sim 194^\circ$, but certainly much fainter than WDS 15 mag. The primary itself is listed as binary as COR 10 Aa,Ab. This object seems even more curious with WDS magnitudes in the K-band of 9.2/10.8 while EDR3 lists a red band magnitude >18 for the combined object. Simbad lists here EM∗ LkHA 346 as Young Stellar Object. The source for the curious magnitude data is the 2MASS catalog
3.10	17273−2759	VVV 42: WDS magnitude for the primary far off by nearly 3 magnitudes, measurement supported by EDR3
3.11	17322−3233	PRO 171: No corresponding object at the given WDS catalog position, most likely bogus. Object with similar separation, position angle and magnitudes nearby at position 17 32 17.146 −32 34 23.87 - but of little interest because according to EDR3 it is most likely optical
3.12	17413−3135	DAM 94 DE: No resolution of E with the given setup. Has to be fainter than the 16 mag listed in the WDS catalog, most likely ∼17.5mag (EDR3 17.23 *G*mag)
3.13	23504−2951	UC 5033: EDR3 parallaxes suggest that component A is optical and components BC are likely to be physical

Summary

About one third of the objects measured show the expected significant magnitude difference >0.5 compared to the WDS catalog data, especially for the secondary but often also for the primary. For another third of the objects the given WDS magnitudes are simply confirmed within 3 sigma and the rest is in between.

Acknowledgements

The following tools and resources have been used for this research:
- Washington Double Star Catalogue
- GAIA DR2 and EDR3 catalogue
- UCAC4 catalogue
-iTelescope iT32: 430 mm CDK with 2912 mm focal length. Resolution 0.64 arcsec/pixel. V-filter
- (located in Siding Spring, Australia. Elevation 1122 m)
- Aladin Sky Atlas v11.0
- AAVSO VPhot
- Astrometrica v4.10.0.427
- AstroPlanner v2.2
- MaxIm DL6 v6.08

MEASUREMENTS OF DOUBLE STARS WITH ROBOTIC TELESCOPES IN 2021

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Abstract

These observations and measurements were made with the LCO Global Telescope Network. I have been using the Gaia EDR3 catalogue since December 3rd, 2020. This is how I added the parallax of the components of each observed pair when known, the G-band magnitude (specific to Gaia), and the precise coordinates of each component. The aim of this work is to measure the polar coordinates of the observed pairs but also to determine whether they are optical or physical couples. In the latter case, when the components have same parallax and if they have common proper motion within the errors, one can conclude their probable physicality.

Explanation of Table I

Col.1	WDS designation (based on 2000 coordinates)
Col.2	Component
Col.3	Gaia EDR3 Absolute stellar parallax (mas) / standard error of parallax (mas)
Col.4	Gaia EDR3 Proper motion in RA (mas/yr)/ standard error of proper motion in RA (mas/yr)
Col 5.	Proper motion in declination (mas/yr)/ standard error of proper motion in declination (mas/yr)
Col.6	Mean date of observation (2021+)
Col.7	Number of observations
Col.8	Position Angle (°)
Col.9	Separation (″)
Col.10	Magnitude of components (in G band, GAIA-EDR3)
Col.11	Observatory code
Col.12	Notes

Table 1 - Measures

1	2	3	4	5	6	7	8	9	10	11	12
19171+0920	A	3.1187	10.113	-1.63	0.739	1	13.78	19.457	7.8	Z17	2,4
		±0.0856	± 0.080	±0.074			±0.40	±0.092			
	B	3.2045	10.163	-2.55					8.7		
		±0.0322	±0.036	±0.030							
20567+3047	A	29.9508	198.818	90.74	0.872	1	199.68	10.134	13.1	F65	2
		±0.019	±0.009	±0.011			±0.16	±0.024			
	B	29.9382	196.681	88.29					13.5		
		±0.0145	±0.010	±0.013							
21174+2053	A	32.7868	308.290	285.29	0.869	1	341.10	4.431	11.6	F65	2
		±0.0256	±0.023	±0.018			±0.37	±0.019			
	B	32.7539	299.502	297.48					12.5		
		±0.0237	±0.021	±0.017							
23389+2101	A	25.4015	275.846	179.03	0.869	1	111.15	9.507	12.9	F65	2
		±0.027	± 0.028	±0.022			±0.32	±0.040			
	B	25.3666	273.432	176.13					17.7		
		±0.0996	± 0.099	±0.079							

Table 2 - Gaia positions and catalogue numbers

Star	Gaia positions (J2000)	Gaia EDR3
STT 370A	191703.17+092019.6	4308972570185288960
STT 370B	191703.48+092038.6	4308972776343720064
LDS 2935A	205634.94+304751.9	1858771621343683712
LDS 2935B	205634.67+304742.5	1858771518264467200
KUI 106A	211722.74+205354.7	1791309809807683200
KUI 106B	211722.65+205358.6	1791309814098901120
LDS 5108A	233855.68+210121.6	2826254717479033344
LDS 5108B	233856.32+210118.3	2826254713186397440

Notes

1 Orbital
2 Physical pair (same parallax and common proper motion within the errors)
3 Optical pair
4 Calibration pair
5 Inverted quadrant
6 Neglected couple
7 Identification uncertain in the WDS

Observatory code

MPC code F65: FTN Faulkes Telescope North T2m, Haleakala, Hawaii, LCO
MPC code Z17: T0.40m, Teide Observatory, Tenerife, Canary Islands, Spain, LCO

Table 2 - Residuals from WDS

Name	(O-WDS)θ (°)	(O-WDS)ρ ($''$)	Date	Interval
STT 370 AB	−0.02	−0.071	1972	49
LDS 2935	−0.32	+0.134	1999	22
KUI 106	−1.90	+0.331	2001	20
LDS 5108	−0.75	+0.147	2000	21

Explanation of Table 2

Col.1	usual name
Col.2+3	difference between our measures of θ(°) and ρ($''$) called 'O' and the most ancient measures of θ(°) and ρ($''$) listed in the WDS catalogue.
Col.4	date of the first reliable measure in the WDS catalogue.
Col.5	interval (in years) between the earlier reliable measures and our measures

Acknowledgments

This research has made use of
- the VizieR catalogue access tool, CDS, Strasbourg, France (DOI: 10.26093/cds/vizier). The original description of the VizieR service was published in A&AS 143, 23
- the Washington Double Star Catalog maintained at the U.S. Naval Observatory
- the REDUC software (Florent Losse) (`http://www.astrosurf.com/hfosaf/uk/tdownload.htm#reduc`)
- the WDSTOOL software (David Chiron)

- Special thanks to Florent Losse, REDUC[1] software, David Chiron, WDSTOOL2 database[2], and Paul Roche, Faulkes Telescope project, Cardiff University

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1. http://www.wdstool.com/

A TIGHT COMMON RADIAL VELOCITY PAIR IN CANIS MINOR

John Greaves

Introduction

The increased number of Gaia DR3 radial velocity data (Gaia Collaboration 2022) enables the identification of likely physically associated pairs otherwise not obviously truly proximate when viewed via traditional means such as orbital motion or significant common proper motion, whilst also being capable of splitting tight pairs that have remained unresolved in prior surveys. Consequently objects of significantly large radial velocity that were neither adequately resolved in previous wide field surveys nor having proper motions higher than a few milliarcseconds per year yet are still moving significantly in space relative to the Sun were formerly missed. The Gaia Survey also provides parallax data of good to reasonable quality out to considerable distances as an extra confirmatory datum.

The pair

Such a pair of roughly 11th magnitude stars in the constellation of Canis Minor lie separated by only 1″.9 in a position angle of 144° . The particulars for this double star are given here, where the Right Ascension and Declination are given for the primary and are both to Epoch and Equinox 2016.0, the magnitudes are Gaia G :-

RA(°)	DEC(°)	Year	PA (°)	Sep (″)	G_1	G_2
114.63778	0.71378	2016.0	143.6	1.88	10.72	10.96

Both stars have proper motions of about -4.6 milliarcseconds in Right Ascension and roughly −2.5 milliarcseconds in Declination, which no matter how similar to each other and how close the pair are on the sky, of the pair would normally be insufficient to suggest a confident common proper motion, despite the parallax values being similar, at a distance of roughly 1 kiloparsec even slightly discrepant values can amount to significant difference in the physical radial distance. Given the extra information of this AB pair having non-trivial barycentric radial velocities of 56.8 kms^{-1} and 54.8 kms⁻1 adds to the argument of physicality, in fact reveals the case distinctly. At 1 kiloparsec a separation in arcseconds is the same value as a projected separation in kAU (where k is kilo and AU is Astronomical Unit such that 1 kAU = 1000 AU). In other words, this pair of similar mass stars (assumed from their similar magnitudes and parallax) lie around 1900 AU from each other upon the plane of the sky, equivalent to roughly 0.007 of the distance from the Sun to Proxima Centauri.

The GAIA DR3 release also includes astrophysical parameters, derived predominantly via models based on not only the photometry and parallax measurements but also the spectral information from ‘blue’ and ‘red’ low resolution spectra continua for stars sufficiently bright, albeit the latter being somewhat more akin to spectrophotometric as opposed to spectroscopic data. In this case this predicts, albeit only for the primary, an effective temperature (Teff) of ∼ 5000 K and a surface gravity (log$g$) of ∼2.9 cms^{-2} (in astronomy surface gravity appears to still be quoted in cgs rather than SI units). This equates to a mid-G subgiant, or say G5 IV for an approximate estimate. The metallicity of the pair appears to be just slightly less than Solar.

With Gaia G magnitudes of 10.72 and 10.96 respectively and Gaia B_P-R_P colours of 1.19 and 1.17 respectively for this AB pair the two stars are very similar, although not quite twins, yet sufficiently similar (along with the parallax) to suggest that the particulars for the secondary (which has no astrophysical parameters given in the full Gaia Data Release 3) are only marginally

different, it being just a little fainter than and pretty much the same colour as the primary. Indeed, if the measured photometry and parallax values are used to simply derive absolute G magnitude and B_P-R_P colours and placed upon a Gaia photometry based HR diagram (e.g. Greaves 2021, figure 6) the two stars lie in a region expected for yellow subgiants.

An adjusted distance based on these derived astrophysical quantities, and allied in derivation to their derivation, and that also takes into account Gaia DR3 derived interstellar extinction for the star, is also presented in Data Release 3. This leads to a value of $\sim$ 840 parsecs for the primary which fortunately doesn't significantly change the conclusions based on a 1000 parsec (1 kpc) distance, merely making the pair ever so slightly intrinsically brighter with the spectral type just slightly earlier but still G. After all this derivation is based on the same measurements used to derive the above astrophysical parameters.

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