Blue Star Observatory Measurement of Nine Neglected Southern Multiple Stars

Graeme Jenkinson and Des Janke
Astronomical Association of Queensland, Australia.
Email – bluestars@iprimus.com.au

Abstract: This paper presents some results of our ongoing photographic measurements of southern multiple stars throughout 2020.

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 pairs were selected from the Washington Double Star Catalogue (WDSC) and were observed in Queensland, Australia from a latitude of approximately 27° South.

Method:
All results were obtained using an Atik 460EX mono CCD camera used in conjunction with an equatorially mounted 400mm F4.5 Newtonian reflector. As per our regular procedure nightly sets of one hundred images were obtained with the equipment as described. The images were then stacked using Atik DAWN software and 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 400mm reflector, close doubles with considerable magnitude difference between the components have been successfully measured.

Fellow AAQ member Janke provided invaluable assistance with 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).

The mean 95% confidence intervals for the new measures were ± 0.618 in PA and ± 0.059 in separation.

Please note that all attached images are aligned with North to the bottom and East to the right.

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System	Last listed measure			New measure			Comment
	PA º	Sep. ″	Epoch	PA º	Sep. ″	Epoch*	
TDS3997	310	3.1	1991	327.07	2.46	2020.936	Significant increase in PA.
BAL75	19	8.9	2000	18.39	8.9	2018.092	Small increase in PA.
BRT711AB	93	2.3	1898	100.19	4.87	2020.044	Small increase in both axes. ‘C” component not found.
BRT722	27	4.8	1909	290.37	6.93	2020.087	Questionable large change in PA.
BRT722 “C”	N/A	N/A	N/A	53.80	3.65	2020.087	Possible new “C” component.
BRT738	141	3.1	1904	139.58	5.78	2020.035	Clear changes in both axes.
BRT2806	349	4.0	1894	205.72	5.64	2020.274	Large decrease in PA.
BRT2071	49	4.0	1893	103.84	7.34	2020.274	Large increase in PA.
HDS2319	226	10.1	2015	225.90	10.05	2020.553	No clear movement evident.

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

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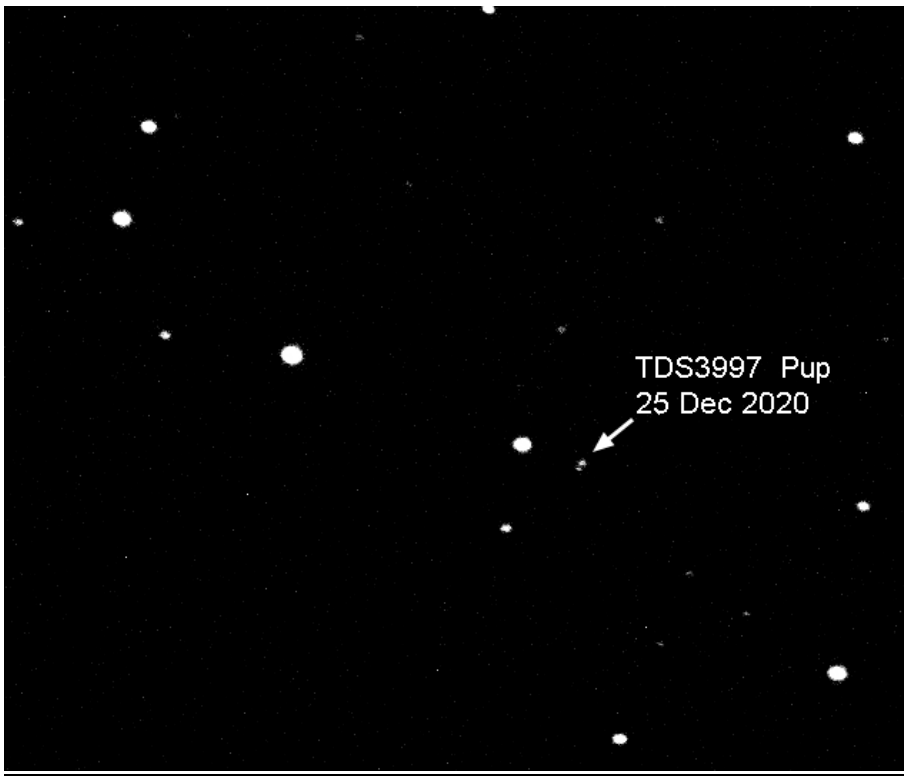
TDS3997	RA. 06 38.9	DEC. -45 43	Last Measure 1991
Puppis	MAG. 12.04 & 13.28	PA. 310°	SEP. 3.1"
Date	**No. images**	**PA°**	**Sep"**
20 November 2020	10	329.81	2.41
21 November 2020	10	326.66	2.503
22 November 2020	10	327.3	2.348
25 November 2020	10	331.75	2.652
27 November 2020	10	328.38	2.465
19 December 2020	10	325.93	2.556
25 December 2020	10	319.66	2.307
Mean		**327.07**	**2.463**
Standard deviation		3.820	0.120
95% CI +/-		3.533	0.111
P(t) movement		0.000	0.000

COMMENTS
Significant increase in PA over 29 years.



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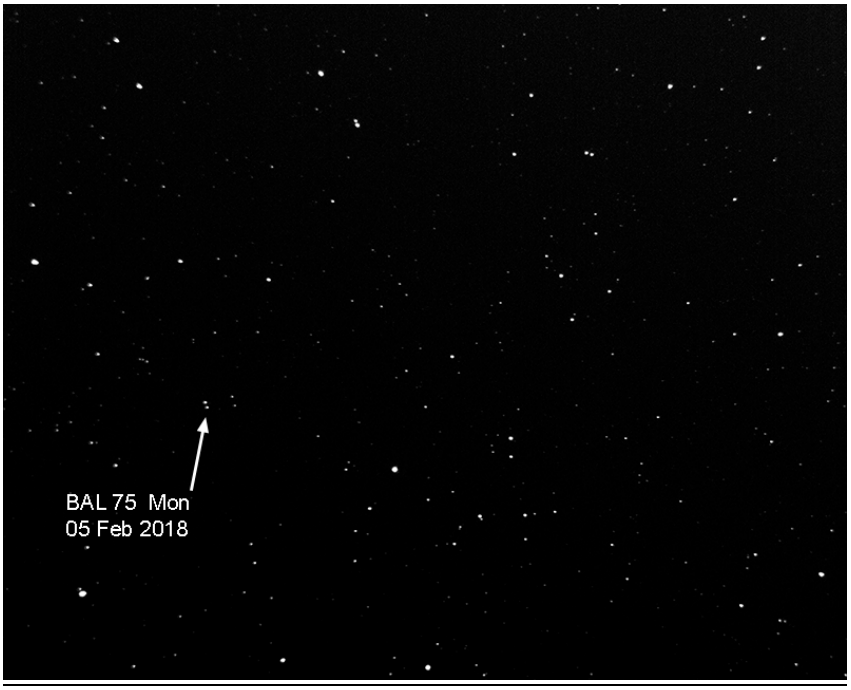
BAL75	RA. 06 45.8	DEC. -02 26	Last Measure 2000
Monceros	MAG. 12.6 & 13.1	PA. 19.0°	SEP. 8.9"
Date	**No. images**	**PA°**	**Sep"**
27 January 2018	10	18.28	8.902
28 January 2018	10	18.23	8.905
05 February 2018	10	18.37	8.921
07 February 2018	10	18.51	8.969
09 February 2018	10	18.56	8.908
Mean		**18.390**	**8.921**
Standard deviation		0.143	0.028
95% CI +/-		0.177	0.035
P(t) movement		0.001	0.166

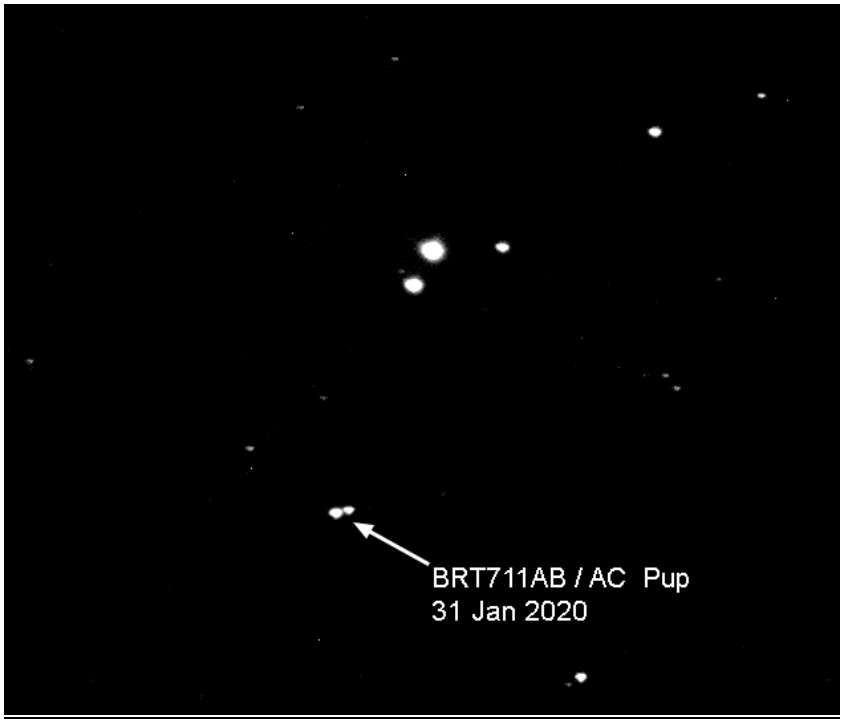
COMMENTS
Five nights imaging only due to poor weather. Possible small decrease in PA over 18 years.



Blue Star Observatory Measurement of Nine Neglected Southern Multiple Stars

BRT711AB	RA. 07 32.8	DEC. -49 11	Last Measure 1898
Puppis	MAG. 12.38 & 13.2	PA. 93°	SEP. 2.3"
Date	**No. images**	**PA°**	**Sep"**
03 January 2020	10	100.12	4.869
04 January 2020	10	100.54	4.835
06 January 2020	10	100.55	4.583
07 January 2020	10	100.06	4.922
08 January 2020	10	100.3	4.875
30 January 2020	10	99.47	5.029
31 January 2020	10	100.29	4.956
Mean		**100.190**	**4.867**
Standard deviation		0.368	0.141
95% CI +/-		0.341	0.130
P(t) movement		0.000	0.000

COMMENTS
Small increase in both axes over 122 years. BC component as measured/recorded in 1898 not found.



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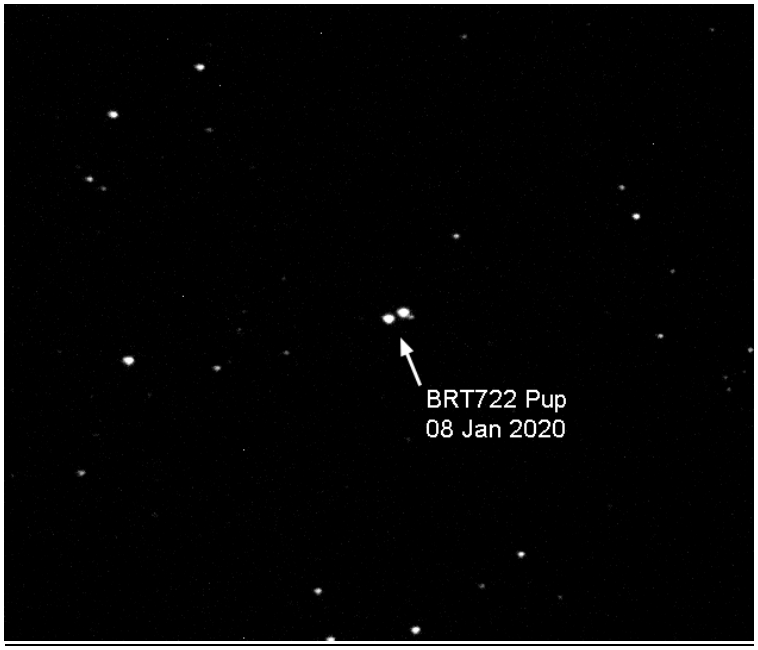
BRT722	RA. 07 59.6	DEC. -44 43	Last Measure 1909
Puppis	MAG. 13.09 & 13.11	PA. 27°	SEP. 4.8"
Date	**No. images**	**PA°**	**Sep"**
07 January 2020	10	290.38	6.953
08 January 2020	10	290.20	6.921
30 January 2020	10	290.52	6.932
31 January 2020	10	290.38	6.881
02 February 2020	10	290.12	6.937
28 February 2020	10	290.32	6.906
29 February 2020	10	290.57	6.970
Mean		**290.356**	**6.929**
Standard deviation		0.161	0.030
95% CI +/-		0.149	0.027
P(t) movement		0.000	0.000

COMMENTS

The A& B components are very similar magnitudes as listed in the original observation, but the very large change in PA is improbable. The 2020 measures of the possible "C" component would be more likely if not for the large magnitude difference evident in the new observation.



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BRT722 Puppis new "C" component?	RA. 07 59.6	DEC. -44 43	Last Measure n/a
	MAG. &	PA. n/a°	SEP. n/a"
Date	**No. images**	**PA°**	**Sep"**
07 January 2020	10	53.78	3.752
08 January 2020	10	54.58	3.544
30 January 2020	10	54.53	3.575
31 January 2020	10	53.06	3.712
02 February 2020	10	54.56	3.695
28 February 2020	10	52.87	3.757
29 February 2020	10	53.22	3.552
Mean		**53.800**	**3.655**
Standard deviation		0.760	0.095
95% CI +/-		0.703	0.088
P(t) movement		0.000	0.000

COMMENTS
Possible new A-C component of this pair.

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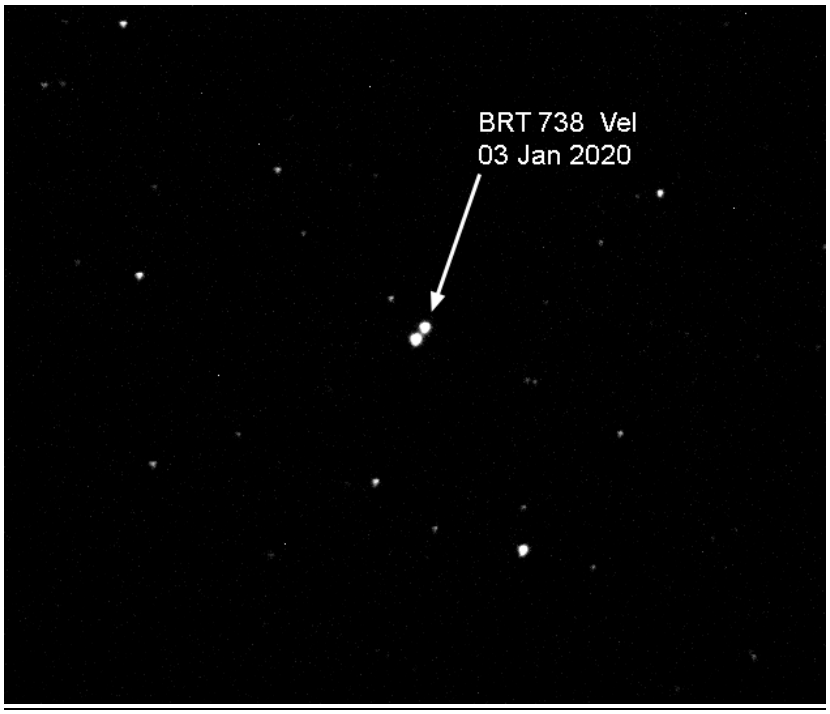
BRT738	RA. 08 35.1	DEC. -49 22	Last Measure 1904
Vela	MAG. 12.36 & 12.4	PA. 141°	SEP. 3.1"
Date	**No. images**	**PA°**	**Sep"**
03 January 2020	10	139.58	5.798
04 January 2020	10	139.64	5.757
06 January 2020	10	139.19	5.712
07 January 2020	10	139.48	5.792
08 January 2020	10	139.68	5.789
30 January 2020	10	139.92	5.789
31 January 2020	10	139.60	5.791
Mean		**139.584**	**5.775**
Standard deviation		0.220	0.031
95% CI +/-		0.204	0.029
P(t) movement		0.000	0.000

COMMENTS
Clear changes in both axes over 116 years.



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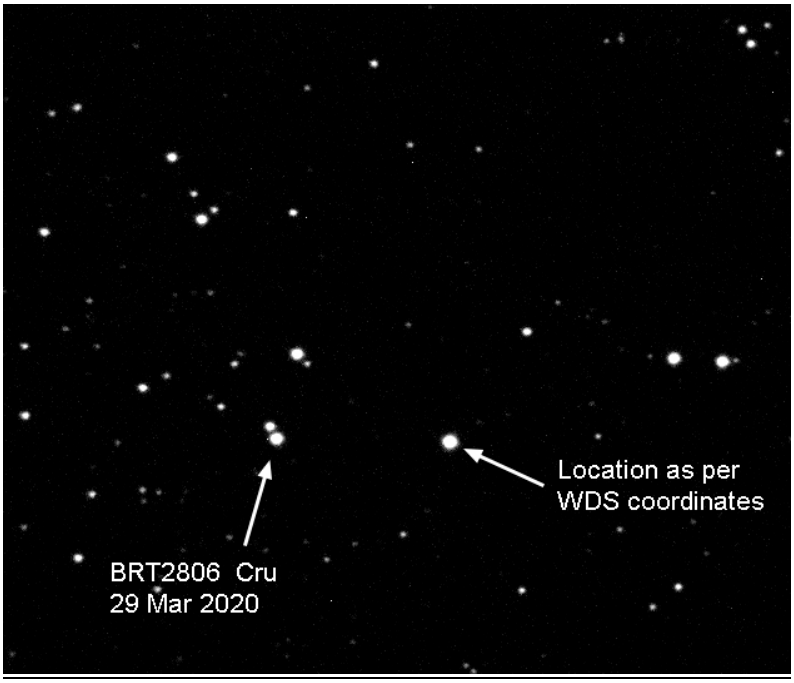
BRT2806	RA. 12 04 29	DEC. -57 24 52	Last Measure 1894
Crux	MAG. 11.9 & 13.1	PA. 349°	SEP. 4.0"
Date	**No. images**	**PA°**	**Sep"**
29 March 2020	10	205.63	5.663
30 March 2020	10	205.54	5.649
1 April 2020	10	205.77	5.690
4 April 2020	10	205.69	5.647
5 April 2020	10	205.69	5.635
6 April 2020	10	205.80	5.638
22 April 2020	10	205.94	5.580
Mean		**205.723**	**5.643**
Standard deviation		0.129	0.033
95% CI +/-		0.119	0.031
P(t) movement		0.000	0.000

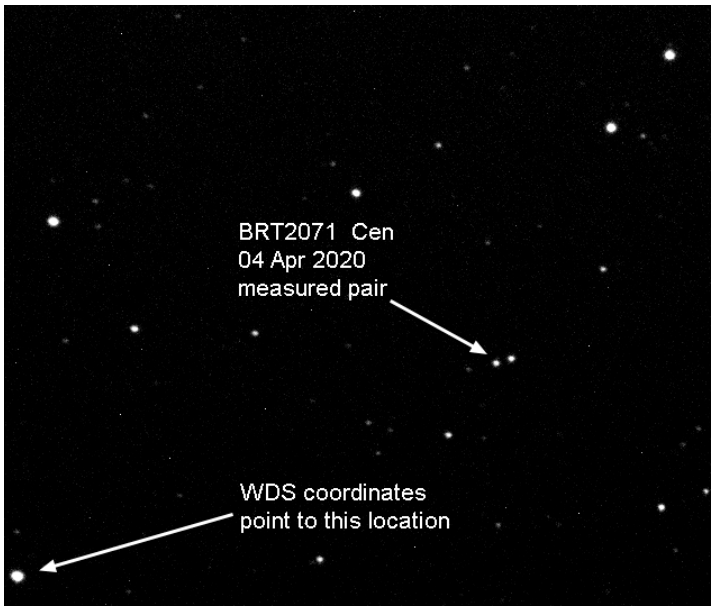
COMMENTS

Large decrease in PA since original measure 126 years ago.
Possible incorrect cataloguing of original co-ordinates.



BRT2071	RA. 12 42.0	DEC. -54 13	Last Measure 1893
Centaurus	MAG. 11.7 & 11.7	PA. 49°	SEP. 4.0"
Date	**No. images**	**PA°**	**Sep"**
29 March 2020	10	103.98	7.275
01 April 2020	10	103.52	7.336
04 April 2020	10	104.11	7.333
05 April 2020	10	103.89	7.349
06 April 2020	10	103.85	7.378
22 April 2020	10	103.87	7.353
23 April 2020	10	103.67	7.353
Mean		**103.841**	**7.340**
Standard deviation		0.195	0.032
95% CI +/-		0.180	0.030
P(t) movement		0.000	0.000

COMMENTS
Large increase in PA since initial measure in 1893.
Possible incorrect cataloguing of original co-ordinates.



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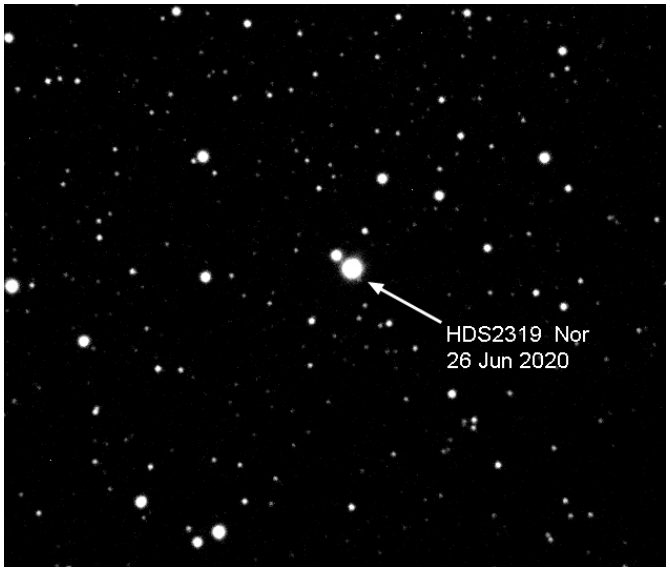
HDS2319	RA. 16 24 45	DEC. -53 28	Last Measure 2015
Norma	MAG. 9.1 & 12.05	PA. 226°	SEP. 10.1"
Date	**No. images**	**PA°**	**Sep"**
26 June 2020	10	225.75	10.114
28 June 2020	10	225.94	9.992
29 June 2020	10	225.95	9.957
18 July 2020	10	225.84	10.065
19 July 2020	10	225.64	10.108
20 July 2020	10	226.02	10.046
16 August 2020	10	226.14	10.078
Mean		**225.897**	**10.051**
Standard deviation		0.168	0.058
95% CI +/-		0.156	0.054
P(t) movement		0.000	0.000

COMMENTS
No clear movement evident since the previous measure.



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