ASTRONOMICAL ASSOCIATION OF QUEENSLAND 2022/23 PROGRAMME

BLUE STAR OBSERVATORY MEASUREMENT OF NEGLECTED SOUTHERN MULTIPLE STARS

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ABSTRACT

This paper presents the final results of a 2022/23 programme of photographic measurements of fifteen southern multiple stars. All results were obtained using an Atik 460EX mono CCD camera used in conjunction with an equatorially mounted 400mm F4.5 Newtonian reflector

The mean 95% confidence intervals for the new measures are ± 0.596° in PA and ± 0.074" in separation.

System	Last listed measure			New measure			Comment
	PA º	Sep. ″	Epoch	PA º	Sep. ″	Epoch*	
B247	317	2.5	1960	311.279	4.150	2022.382	Clear movement in both axes over 62 years.
BRT3000	310	2.8	1913	163.3	11.012	2022.382	Large variation in both measurements.
DAM1225	88	13.2	2015	88.224	13.173	2023.061	Confirmation of 2015 measurement. Little probable change.
DAM1389AC	207	19.6	2015	207.963	19.333	2022.918	Confirmation of 2015 measurement. Little probable change.
DAM1636	317	5.6	2015	316.82	5.600	2023.283	Confirmation of 2015 measurement. Little probable change.
I 183	139	3.3	1999	137.907	3.802	2023.053	Little probable movement over 21 years.
I 461	332	3.2	1986	331.286	3.034	2022.382	Possible minor reduction in both axes over 37 years.
I 1062	180	3.3	1980	177.406	3.21	2023.053	Continuing decrease in PA. Separation appears static.

LDS201 A-B	241	46.1	2018	236.697	47.758	2023.053	Both figures similar to original 1911 measure.
LDS201 A-C	256	74.5	2015	254.840	74.02	2023.053	Possible slight decrease in PA.
LDS201 C-D	57	4.0	2015	58.041	3.943	2023.053	Possible slight increase in PA.
MLO63	291	3.2	1895	140.494	3.529	2022.382	Large difference in PA.
RSS205	312	10.4	2015	312.988	10.188	2023.176	Possible slight increase in PA.
SKF415	255	33.7	2015	255.366	33.467	2023.053	Possible very small decrease in PA.
TDS7065	175	2.6	1991	178.022	11.174	2023.283	Considerable increase in separation over 32 years.

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

Also included in a separate table below are the details of three possible new pairs found while studying the fifteen known pairs. These new pairs were located usually within or near the instrument field of view while searching for/imaging the known pairs.

System	R.A.	Dec.	Mag.	PA º	Sep. ″	Epoch*
Possible new pair near TDS7065 Vela	10 08.16	-56 55 48	14.55 & 14.56	155.964	4.974	2023.387
Possible new pair near DAM1389 (Beta Fornax)	02 48.50	-32 28	12.09 & 14.77	215.341	6.673	2022.916
Possible new pair near DAM1636 Antlia	09 30.25	-39 28 20	14.68 & 16.38	351.423	5.596	2023.285

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

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 analyzed 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 Des Janke provided invaluable assistance processing the original FITS image files into JPEG photographs, along with his use of Vizie-R to gather details of the possible new pairs.

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).

Results as detailed in the tabulated results above, along with the fifteen known/neglected pairs:

- Three possible new pairs recorded in the constellations of Antlia, Fornax & Vela.

- Confirmation checks were carried out on a number of pairs recently measured in 2015 & 2018. These pairs were located in the same field of view as the nearby target pairs and were measured as part of the programme.

- Large variation in position of BRT3000 secondary compared to the original measure. Images appear to show a possible close companion to the secondary. Reference to Gaia DR2 Catalog data represented in Cartes du Ciel as reproduced below shows the following data suggesting this is a double star system:

Gaia DR2 6188321238085200384 (primary)
Visual magnitude: 11.07
Proper motion in right ascension: -8.150 [mas/y]
Proper motion in declination: -28.878 [mas/y]
Distance: 907.2 light years

Gaia DR2 6188321027631669376 (original secondary)
Visual magnitude: 17.28
Proper motion in right ascension: -8.521 [mas/y]
Proper motion in declination: -28.394 [mas/y]
Distance: 1112.7 light years

Gaia DR2 6188320928846317184 (possible triple companion)
Magnitude BP: 18.138
Proper motion in right ascension: -8.741 [mas/y]
Proper motion in declination: -29.220 [mas/y]
Distance: 918.6 light years

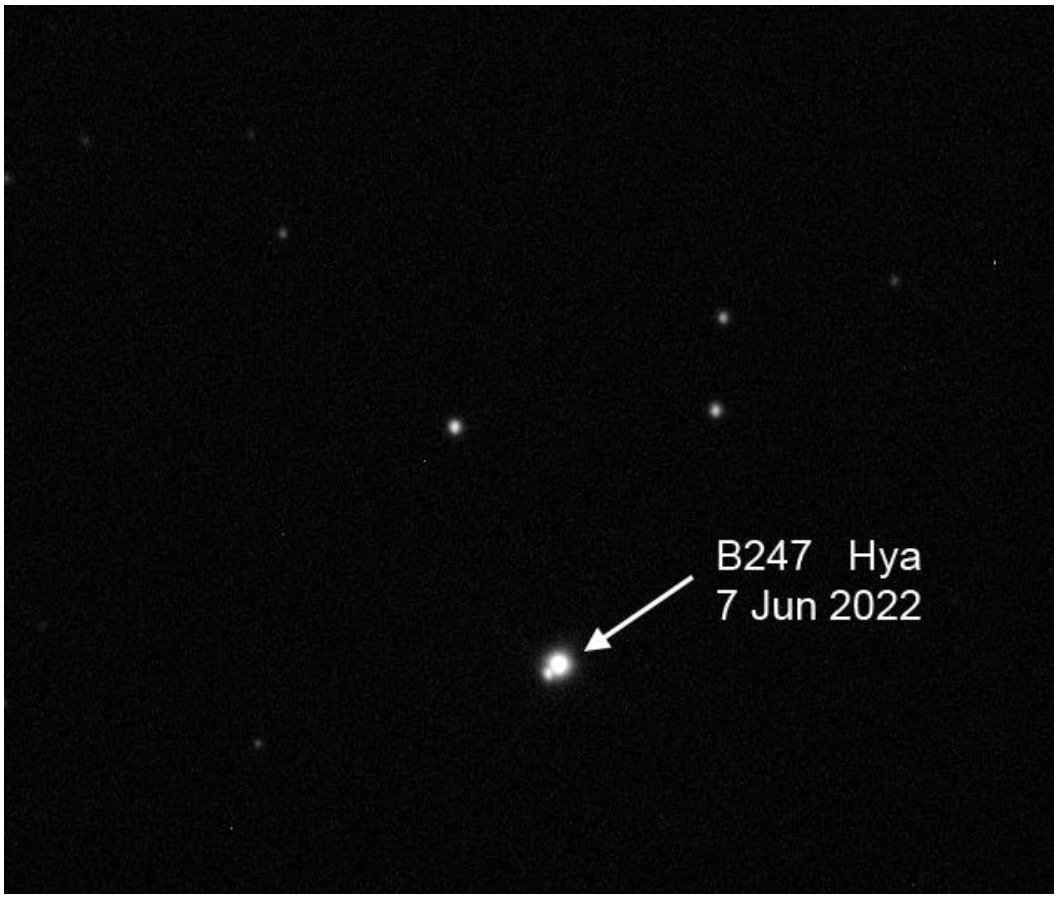
Image shows secondary in quite a different position angle. Looking at Gaia DR2 data it appears the secondary is a double, and forms a triple system, with primary due to similar proper motion.

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

B247	RA. 13 19.9	DEC. -27 48	Last Measure 1960
Hydra	MAG. 9.56 & 12.70	PA. 317°	SEP. 2.5"
Date	**No. images**	**PA°**	**Sep"**
12 Apr 2022	10	311.82	4.235
14 Apr 2022	10	313.15	3.901
15 Apr 2022	10	311.04	4.412
18 Apr 2022	10	310.94	4.110
04 May 2022	10	310.99	4.090
06 Jun 2022	10	310.89	4.204
07 Jun 2022	10	310.12	4.099
Mean		**311.279**	**4.150**
Standard deviation		0.961	0.157
95% CI +/-		0.889	0.146
P(t) movement		0.000	0.000

COMMENTS

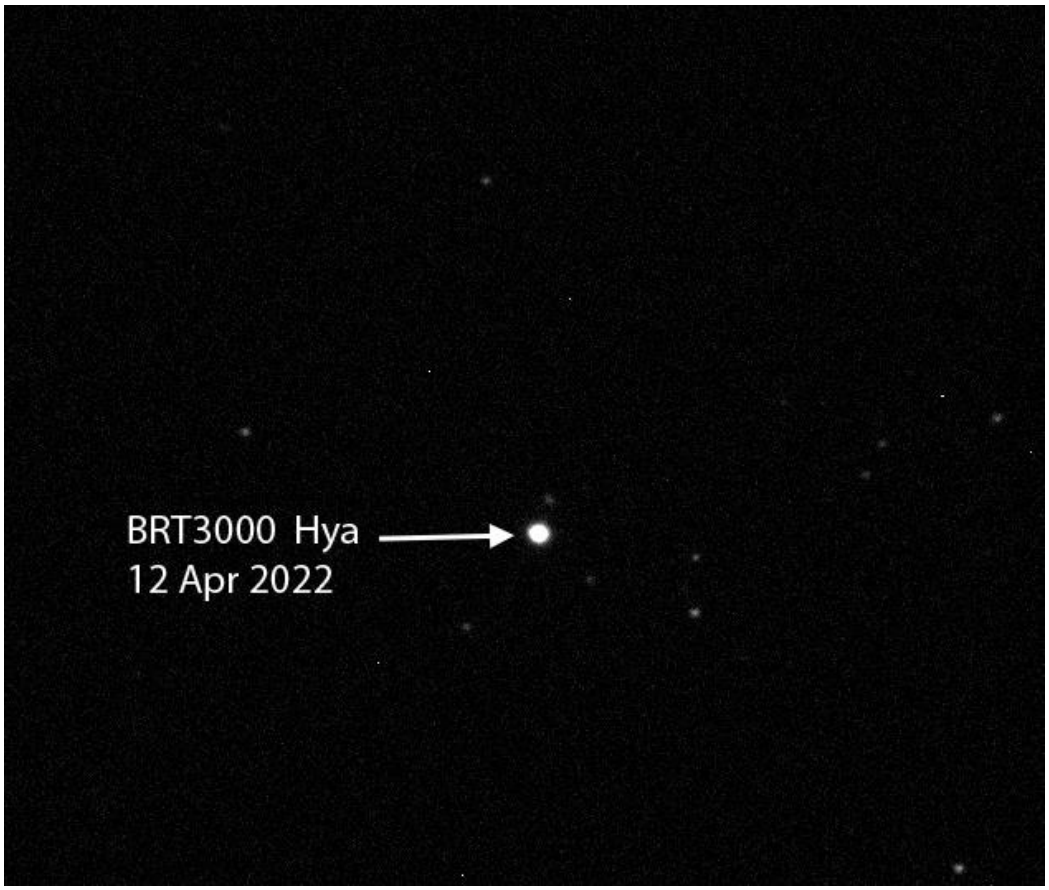
Movement in both axes over 62 years.



BRT3000	RA. 13 24.5	DEC. -28 37	Last Measure 1913
Hydra	MAG. 12.53 & 12.62	PA. 310°	SEP. 2.8"
Date	**No. images**	**PA°**	**Sep"**
12 April 2022	10	162.70	11.116
14 April 2022	10	163.41	11.130
15 April 2022	10	163.88	10.927
18 April 2022	10	162.84	10.829
04 May 2022	10	162.65	11.098
06 June 2022	10	164.14	10.978
07 June 2022	10	163.48	11.008
Mean		**163.300**	**11.012**
Standard deviation		0.589	0.111
95% CI +/-		0.545	0.103
P(t) movement		0.000	0.000

COMMENTS

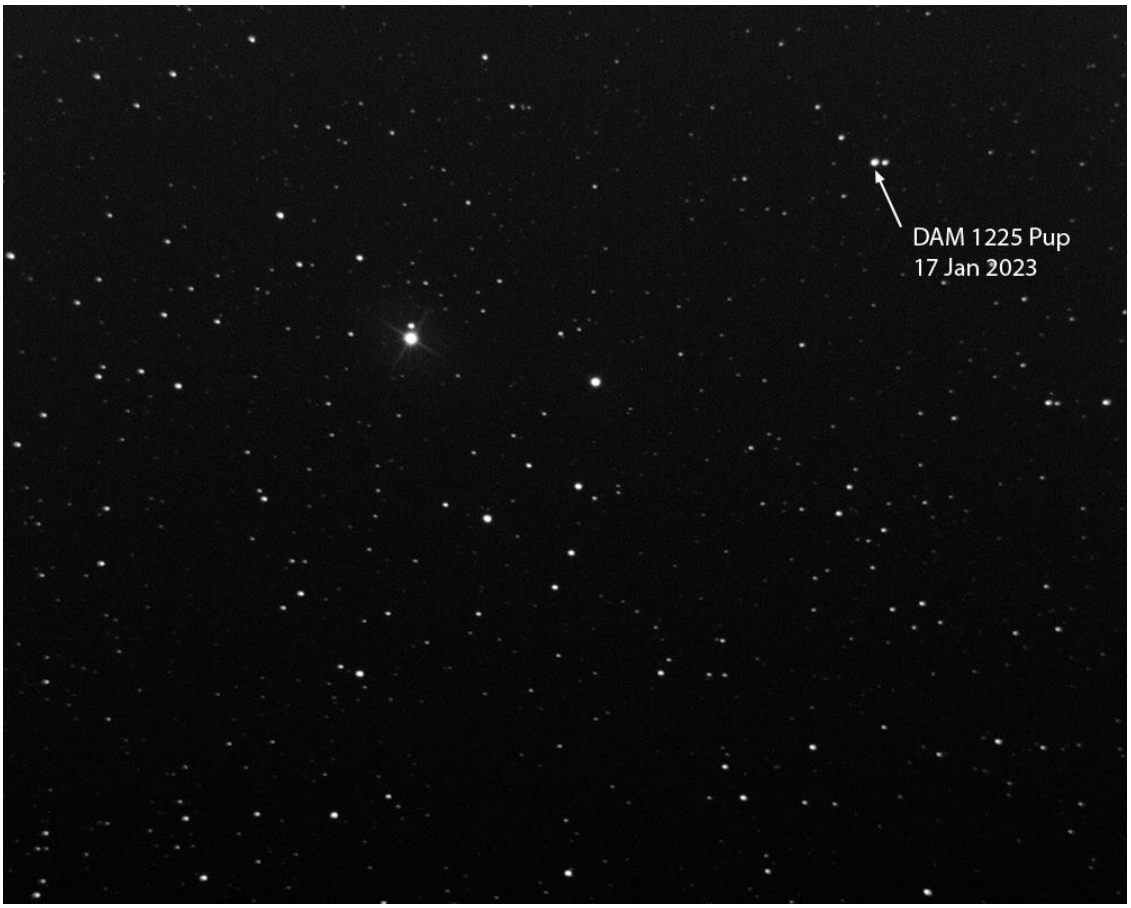
Large unexplained variations in both PA and separation measurements. The secondary also appears to show a barely resolved very close & faint companion.



DAM1225	RA. 08 01.7	DEC. -14 12	Last Measure 2015
Puppis	MAG. 10.8 & 11.9	PA. 88.0°	SEP. 13.2"
Date	**No. images**	**PA°**	**Sep"**
20 December 2022	10	88.26	13.175
17 January 2023	10	88.19	13.152
18 January 2023	10	88.30	13.171
21 February 2023	10	88.20	13.164
24 February 2023	10	88.22	13.185
25 February 2023	10	88.11	13.199
27 February 2023	10	88.29	13.168
Mean		**88.224**	**13.173**
Standard deviation		0.066	0.015
95% CI +/-		0.061	0.014
P(t) movement		0.000	0.000

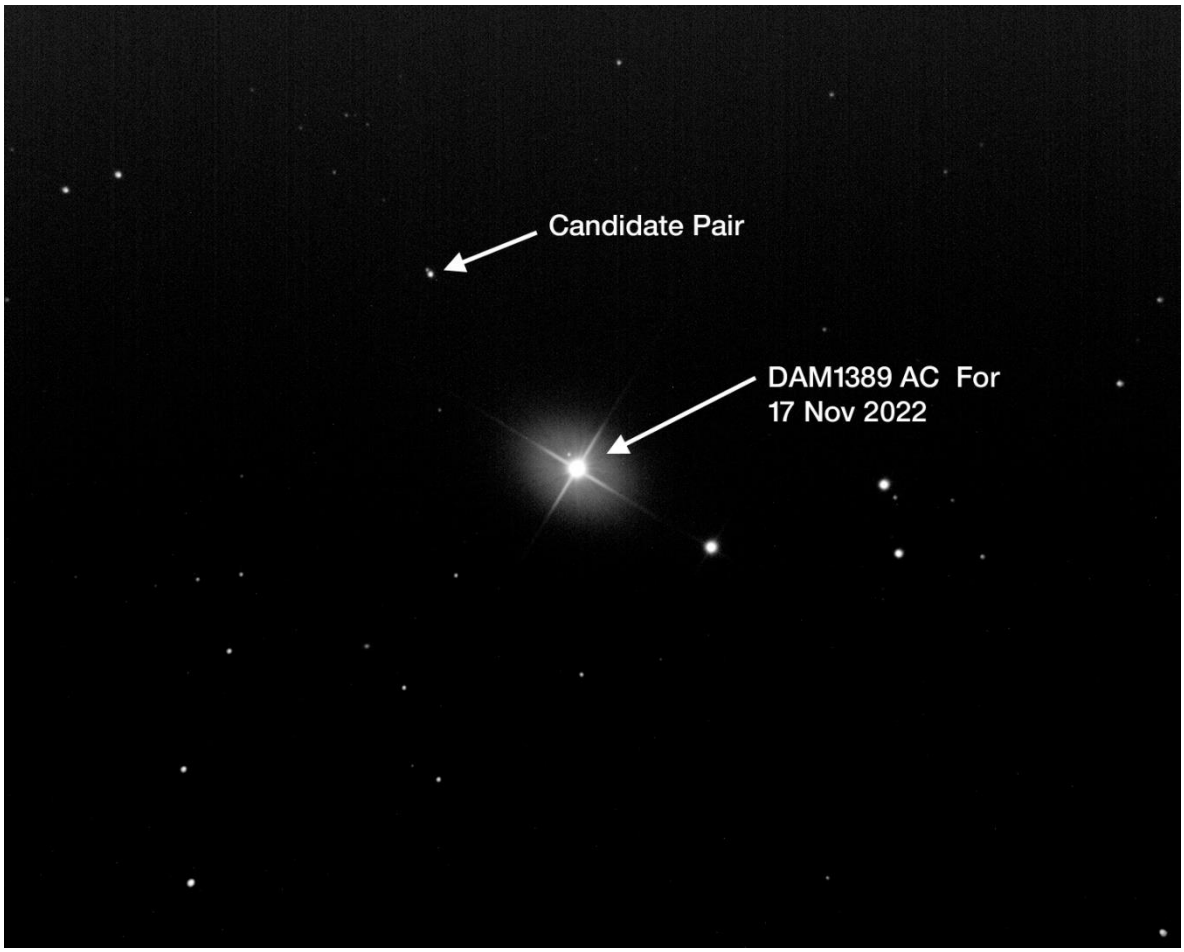
COMMENTS

Little probable movement since previous measure.



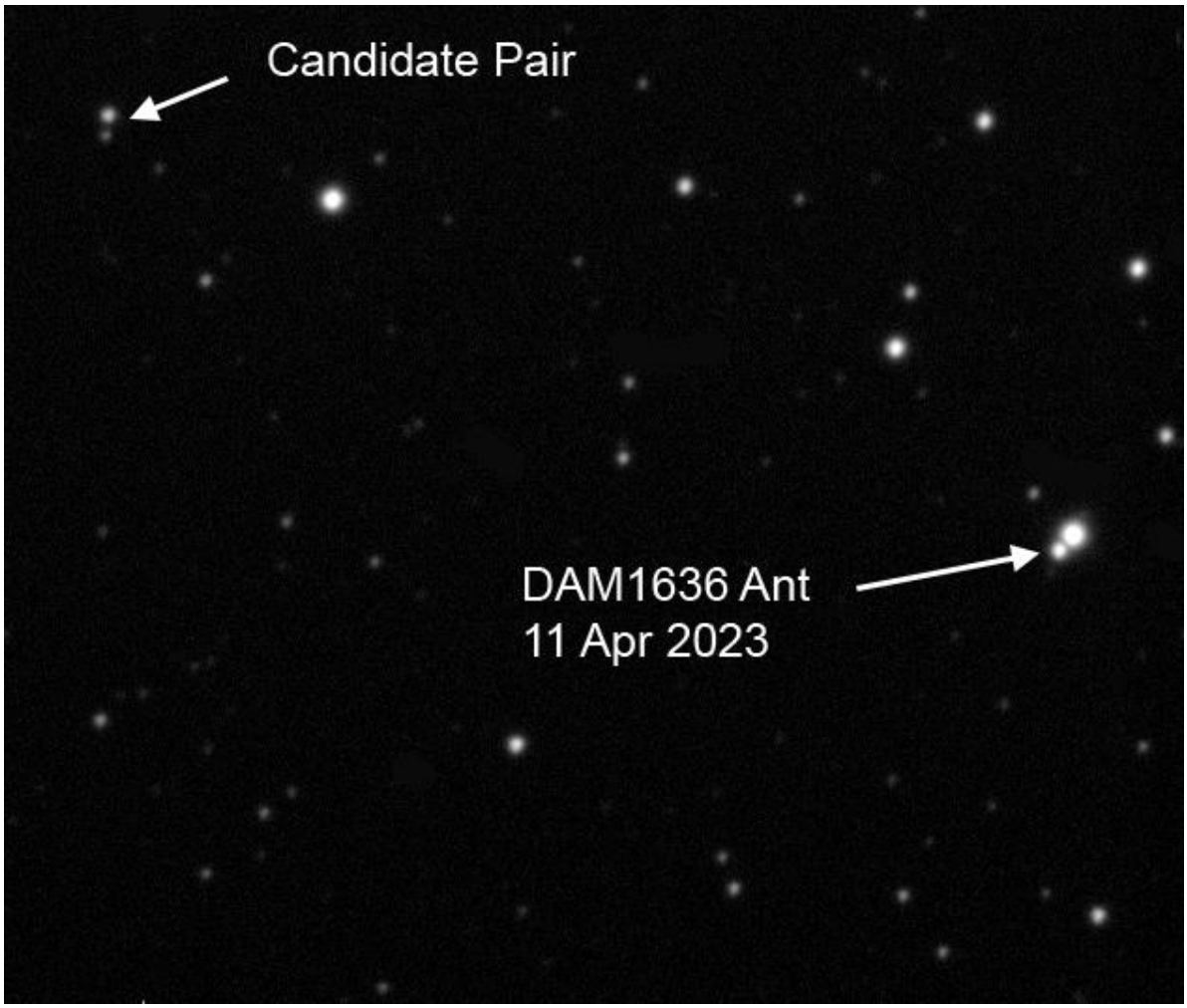
DAM 1389AC	RA. 02 49.1	DEC. -32 24	Last Measure 2015
Fornax	MAG. 4.46 & 13.2	PA. 207°	SEP. 19.6"
Date	**No. images**	**PA°**	**Sep"**
17 November 2022	10	207.93	19.468
18 November 2022	10	208.05	19.226
19 November 2022	10	207.94	19.370
25 November 2022	10	207.49	19.321
26 November 2022	10	207.81	19.372
14 December 2022	10	208.50	19.266
16 December 2022	10	208.02	19.310
Mean		**207.963**	**19.333**
Standard deviation		0.302	0.079
95% CI +/-		0.279	0.073
P(t) movement		0.000	0.000

COMMENTS
Possible slight increase in PA over seven years.



DAM1636	RA. 09 30.5	DEC. -39 26	Last Measure 2015
Antlia	MAG. 11.5 & 13.00	PA. 317°	SEP. 5.6"
Date	**No. images**	**PA°**	**Sep"**
11 April 2023	10	316.71	5.595
12 April 2023	10	316.70	5.609
13 April 2023	10	316.92	5.597
17 April 2023	10	316.95	5.598
Mean		**316.820**	**5.600**
Standard deviation		0.133	0.006
95% CI +/-		0.212	0.010
P(t) movement		0.074	0.942

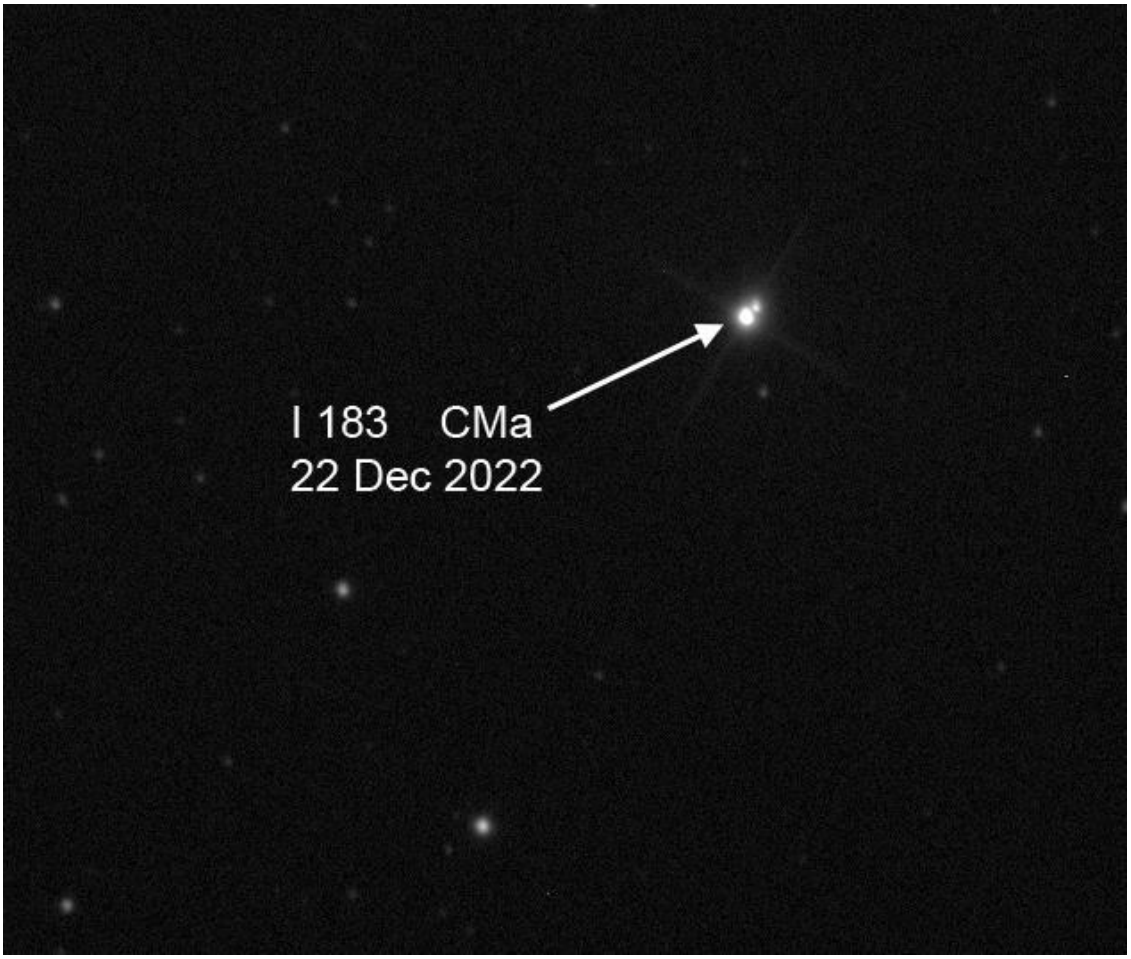
COMMENTS
Four nights imaging only due to inclement weather.
Little probable movement since previous 2015 measure.



I 183	RA. 07 00.8	DEC. -25 39	Last Measure 1999
Canis Major	MAG. 7.41 & 9.93	PA.139 °	SEP. 3.3"
Date	**No. images**	**PA°**	**Sep"**
20 December 2022	10	140.15	3.606
21 December 2022	10	137.11	3.848
22 December 2022	10	135.17	3.923
17 January 2023	10	138.44	3.723
22 January 2023	10	136.80	3.940
18 February 2023	10	139.77	3.770
Mean		**137.907**	**3.802**
Standard deviation		1.905	0.128
95% CI +/-		1.999	0.134
P(t) movement		0.219	0.118

COMMENTS

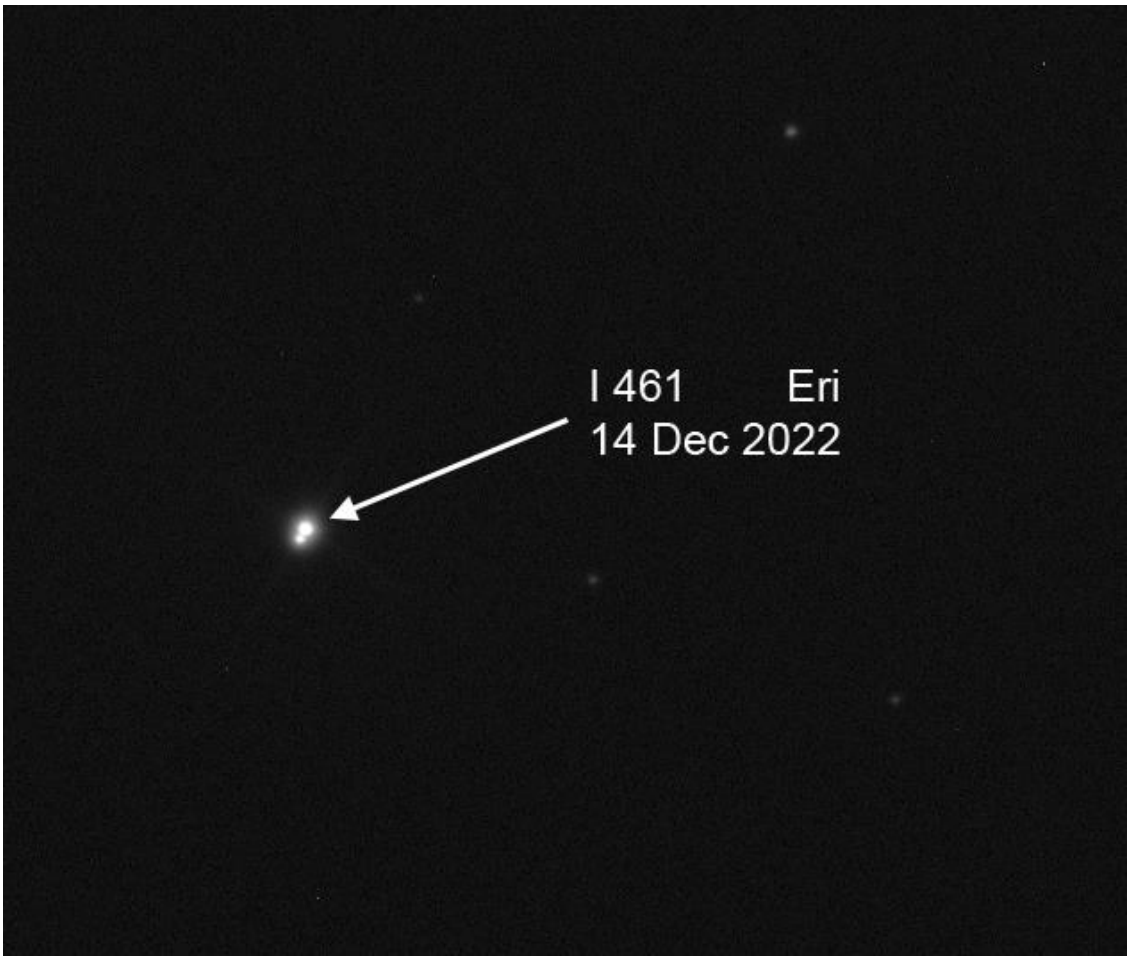
Six nights imaging only due to inclement weather.
Little if any probable movement over 21 years.



I 461	RA. 02 51.2	DEC. -21 25	Last Measure 1986
Eridanus	MAG. 9.04 & 10.6	PA. 332°	SEP. 3.2"
Date	**No. images**	**PA°**	**Sep"**
17 November 2022	10	332.79	3.091
18 November 2022	10	332.01	2.737
19 November 2022	10	331.78	3.027
25 November 2022	10	331.23	3.050
26 November 2022	10	331.29	3.124
14 December 2022	10	329.75	3.223
16 December 2022	10	330.15	2.986
Mean		**331.286**	**3.034**
Standard deviation		1.055	0.152
95% CI +/-		0.976	0.140
P(t) movement		0.124	0.027

COMMENTS

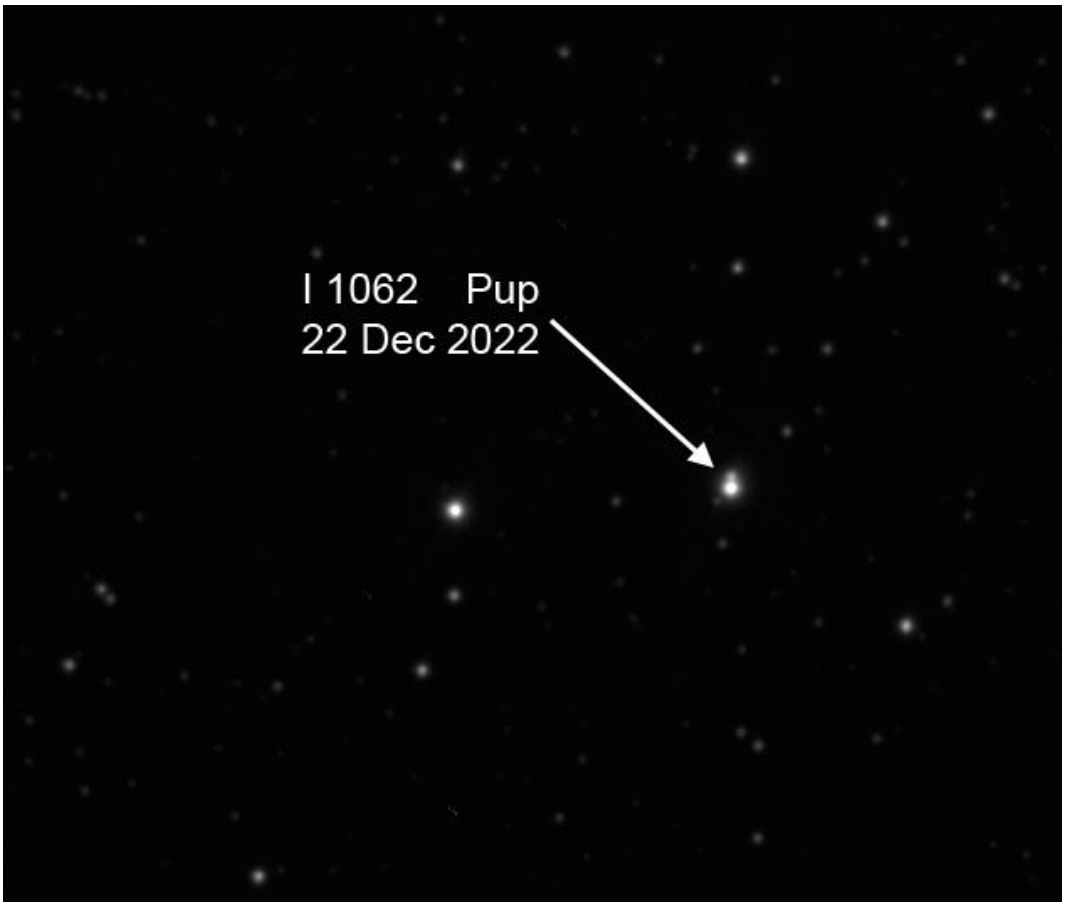
Possible minor reduction of both axes over 37 years.



I 1062	RA. 08 04.3	DEC. -31 24	Last Measure 1980
Puppis	MAG. 9.23 & 11.70	PA. 180°	SEP. 3.3"
Date	**No. images**	**PA°**	**Sep"**
21 December 2022	10	177.30	3.249
22 December 2022	10	176.55	3.240
26 December 2022	10	177.64	3.112
17 January 2023	10	177.65	3.234
18 January 2023	10	177.07	3.094
22 January 2023	10	177.75	3.187
18 February 2023	10	177.88	3.354
Mean		**177.406**	**3.210**
Standard deviation		0.468	0.089
95% CI +/-		0.433	0.082
P(t) movement		0.000	0.036

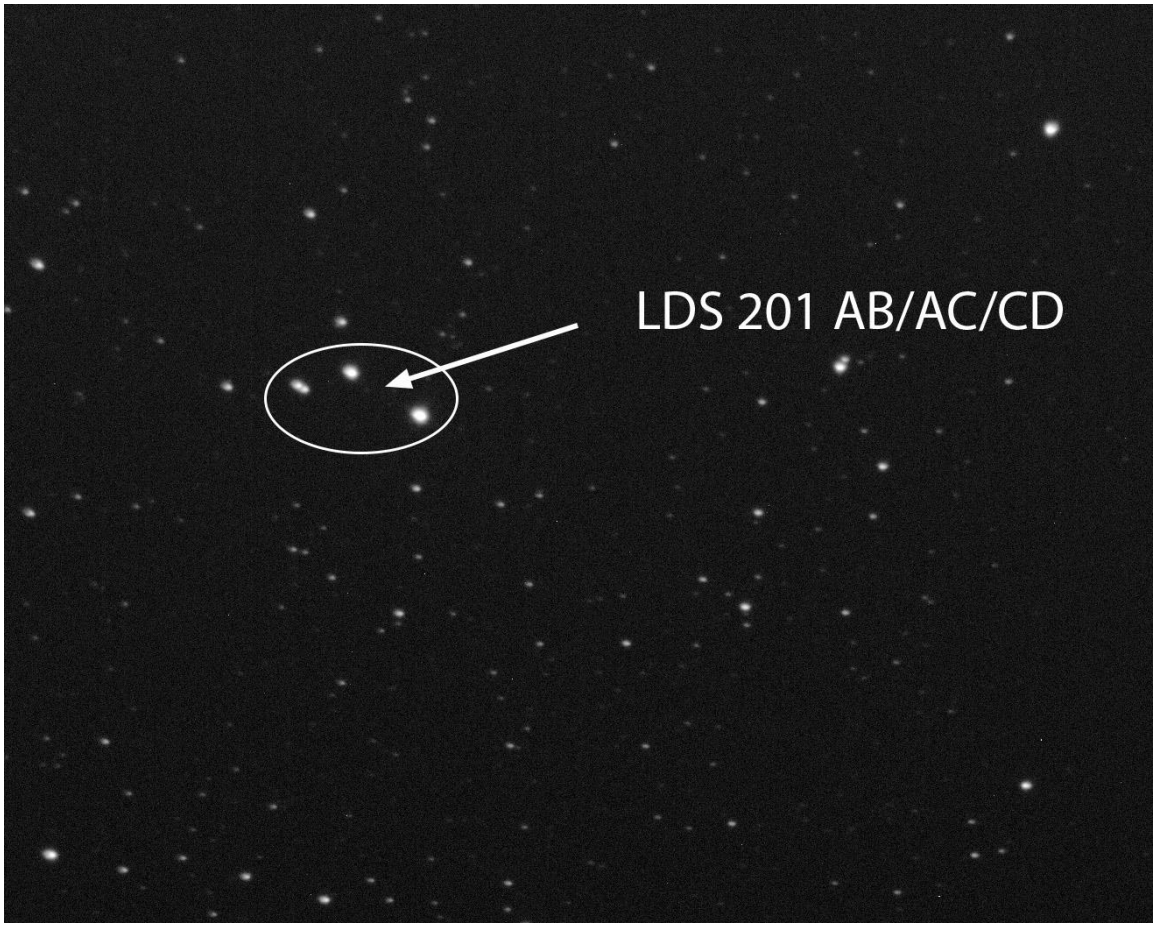
COMMENTS

Continuing decrease in PA since the first 1911 measure of 183°.
Separation would appear static since 1980 measure.



LDS201 A-B	RA. 08 03.9	DEC. -31 33	Last Measure 2018
Puppis	MAG. 8.8 & 9.71	PA. 241°	SEP. 46.1 "
Date	**No. images**	**PA°**	**Sep"**
21 December 2022	10	236.75	47.769
22 December 2022	10	236.66	47.753
26 December 2022	10	236.63	47.642
17 January 2023	10	236.78	47.759
18 January 2023	10	236.68	47.771
22 January 2023	10	236.68	47.813
18 February 2022	10	236.70	47.802
Mean		**236.697**	**47.758**
Standard deviation		0.052	0.056
95% CI +/-		0.048	0.052
P(t) movement		0.000	0.000

COMMENTS
Both measures seem to have returned to very similar figures from the first 1911 observation.



LDS201 A-C	RA. 08 03.5	DEC. -31 33	Last Measure 2015
Puppis	MAG. 8.8 & 10.93	PA. 256°	SEP. 74.5"
Date	**No. images**	**PA°**	**Sep"**
21 December 2022	10	254.88	74.127
22 December 2022	10	254.83	74.036
26 December 2022	10	254.84	73.938
17 January 2023	10	254.92	73.931
18 January 2023	10	254.83	74.043
22 January 2023	10	254.78	74.048
18 February 2023	10	254.80	74.016
Mean		**254.840**	**74.020**
Standard deviation		0.047	0.068
95% CI +/-		0.044	0.063
P(t) movement		0.000	0.000

COMMENTS
Possible slight decrease in PA.

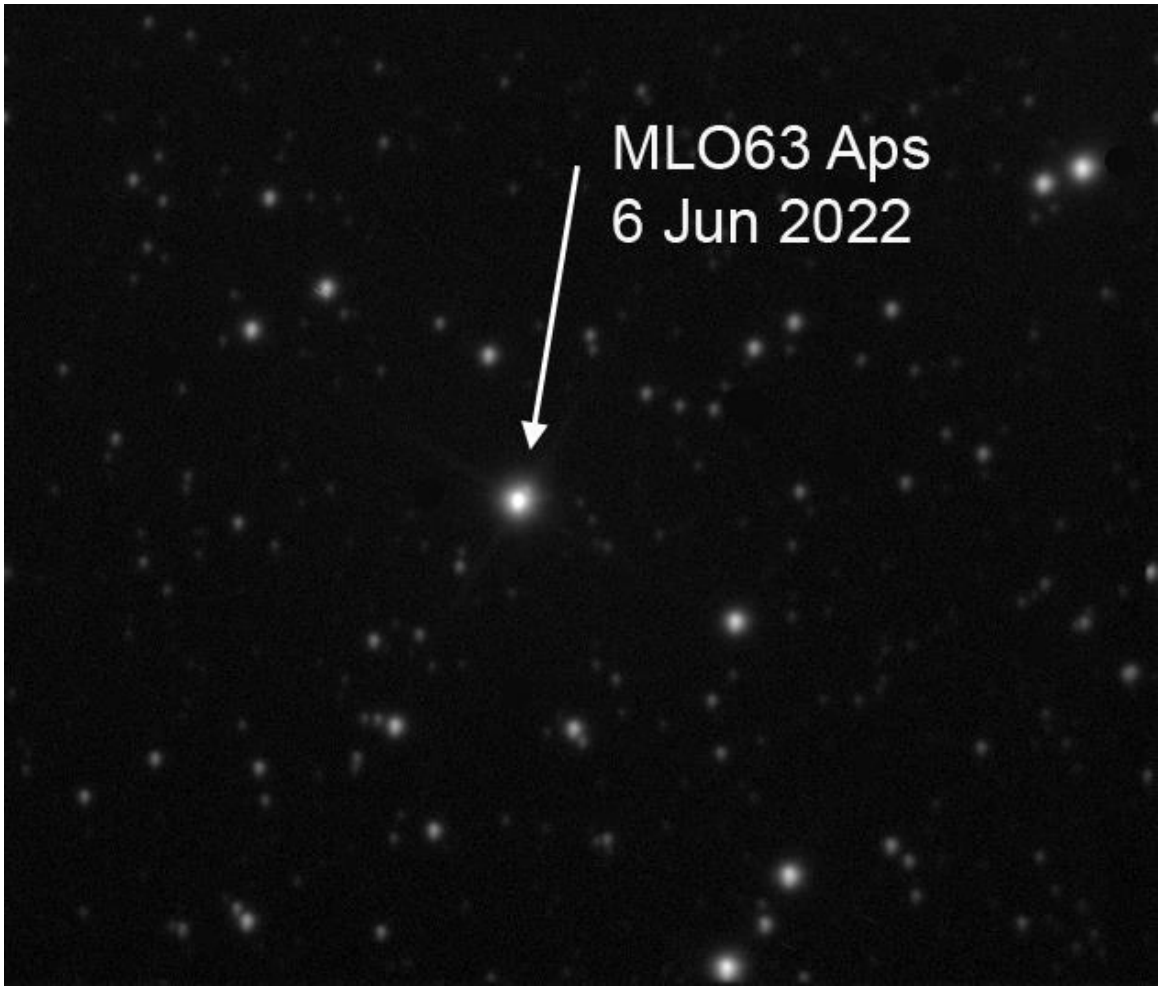
LDS201 C-D	RA. 08 03.5	DEC. -31 33	Last Measure 2015
Puppis	MAG. 10.93 & 11.54	PA. 57°	SEP. 4.0"
Date	**No. images**	**PA°**	**Sep"**
21 December 2022	10	57.59	4.063
22 December 2022	10	58.09	3.846
26 December 2022	10	58.48	3.914
17 January 2023	10	58.25	3.809
18 January 2023	10	58.65	3.97
22 January 2023	10	57.36	3.905
18 February 2023	10	57.87	4.091
Mean		**58.041**	**3.943**
Standard deviation		0.467	0.105
95% CI +/-		0.431	0.097
P(t) movement		0.001	0.200

COMMENTS
Possible slight increase in PA.

MLO63	RA. 15 07.4	DEC. -70 36	Last Measure 1895
Apus	MAG. 9.8 & 11.3	PA. 291°	SEP. 3.2"
Date	**No. images**	**PA°**	**Sep"**
12 Apr 2022	10	141.44	3.602
14 Apr 2022	10	145.93	3.434
15 Apr 2022	10	140.08	3.419
18 Apr 2022	10	138.88	3.303
04 May 2022	10	139.42	3.600
06 Jun 2022	10	140.72	3.627
08 Jun 2022	10	136.99	3.717
Mean		**140.494**	**3.529**
Standard deviation		2.790	0.146
95% CI +/-		2.580	0.135
P(t) movement		0.000	0.001

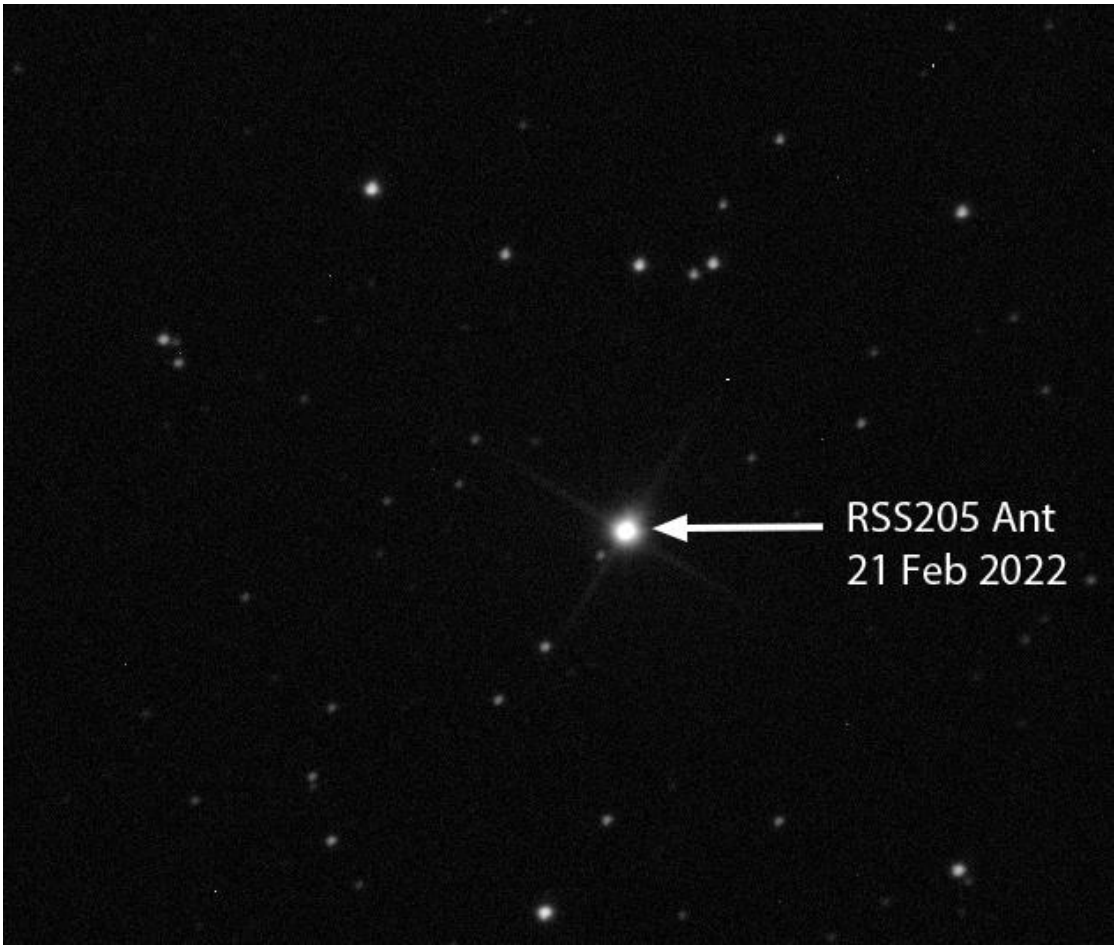
COMMENTS

Large difference in PA – possible incorrect north-south alignment of original 1895 measurement?



RSS205	RA.09 29.8	DEC. -35 21	Last Measure 2015
Antlia	MAG. 8.56 & 14.5	PA. 312°	SEP. 10.4 "
Date	**No. images**	**PA°**	**Sep"**
21 February 2023	10	313.05	10.204
24 February 2023	10	313.59	10.091
25 February 2023	10	313.31	10.172
27 February 2023	10	312.90	10.203
16 March 2023	10	312.68	10.223
18 March 2023	10	312.40	10.237
Mean		**312.988**	**10.188**
Standard deviation		0.429	0.052
95% CI +/-		0.450	0.055
P(t) movement		0.002	0.000

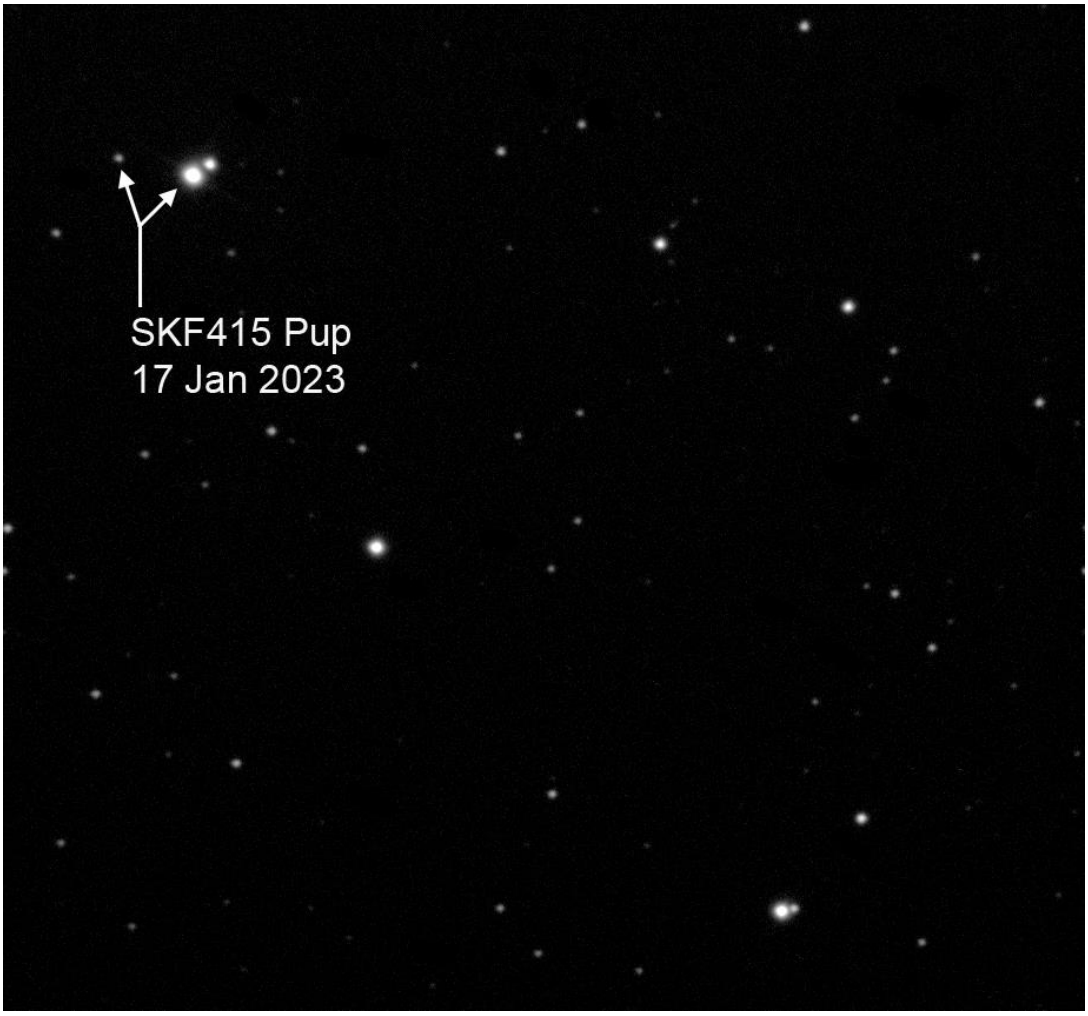
COMMENTS
Six nights imaging only due to inclement weather.
Possible slight increase in PA over 8 years.



SKF415	RA. 06 50.07	DEC. -44 31	Last Measure 2015
Puppis	MAG. 9.7 & 12.6	PA. 255°	SEP. 33.7"
Date	**No. images**	**PA°**	**Sep"**
20 December 2022	10	255.35	33.463
21 December 2022	10	255.42	33.443
22 December 2022	10	255.43	33.370
26 December 2022	10	255.34	33.408
17 January 2023	10	255.32	33.452
22 January 2023	10	255.32	33.566
18 February 2023	10	255.38	33.566
Mean		**255.366**	**33.467**
Standard deviation		0.045	0.075
95% CI +/-		0.042	0.069
P(t) movement		0.000	0.000

COMMENTS

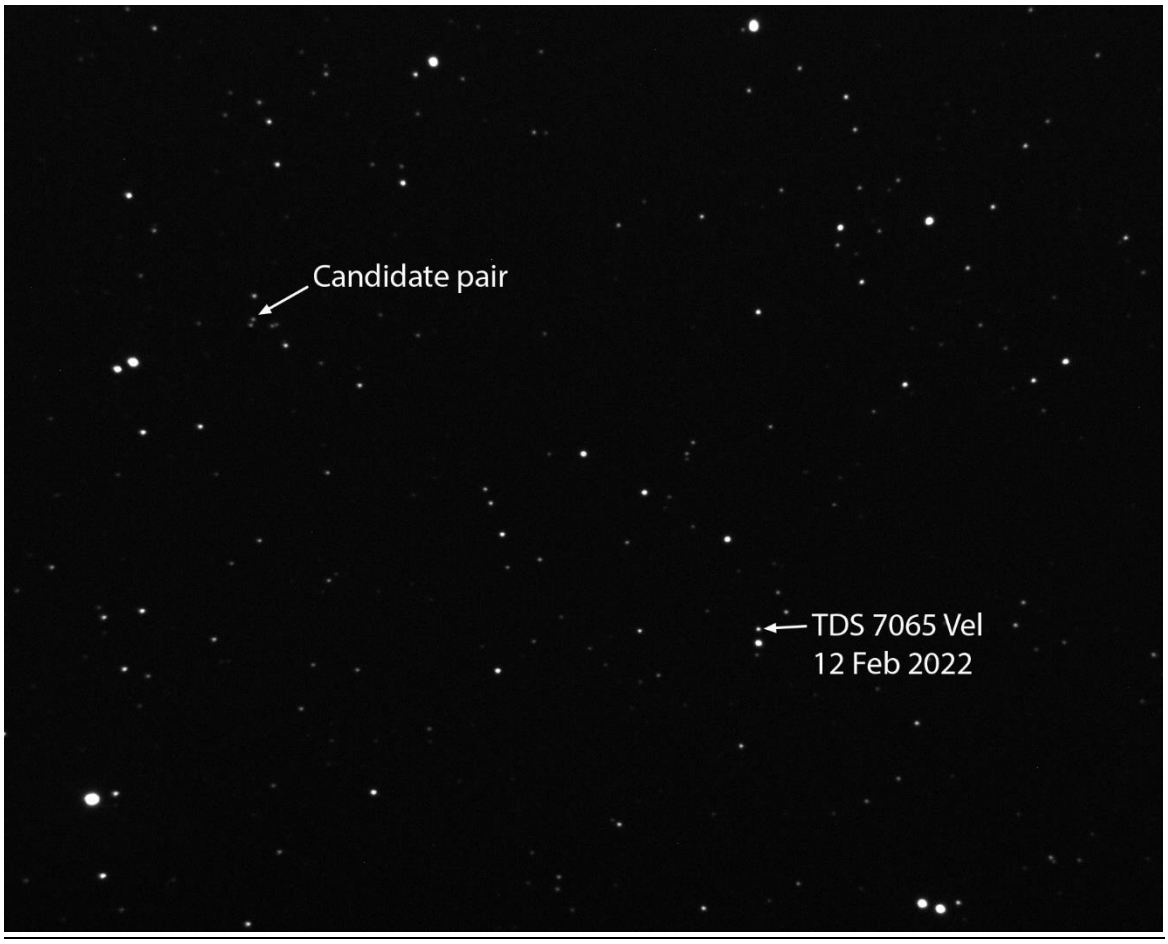
Possible very small decrease in separation over eight years.



TDS7065	RA. 10 09.1	DEC. -56 51	Last Measure 1991
Vela	MAG. 12.17 & 13.28	PA. 175°	SEP. 2.6"
Date	**No. images**	**PA°**	**Sep"**
11 April 2023	10	177.98	11.18
12 April 2023	10	177.96	11.184
13 April 2023	10	178.05	11.196
14 April 2023	10	178.24	11.132
17 April 2023	10	177.88	11.179
Mean		**178.022**	**11.174**
Standard deviation		0.136	0.025
95% CI +/-		0.169	0.030
P(t) movement		0.000	0.000

COMMENTS

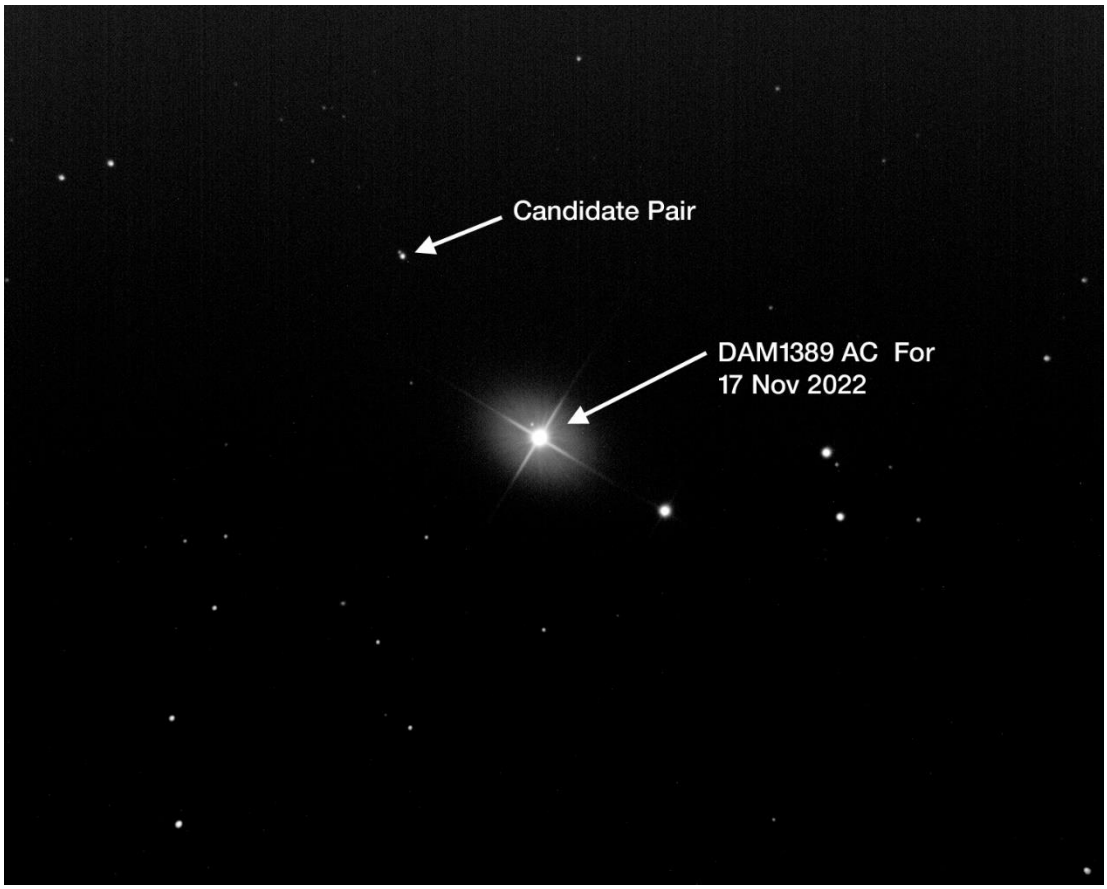
Five night's observations only due to inclement weather.
Considerable increase in separation over thirty two years.



POSSIBLE NEW PAIRS

Possible new pair near DAM1389 (Beta Fornax)	RA.02 48.5	DEC. -32 28	Last Measure n/a
	MAG. 12.09 & 14.77	PA. n/a	SEP. n/a
Date	**No. images**	**PA°**	**Sep"**
17 November 2022	10	215.06	6.689
18 November 2022	10	215.27	6.701
19 November 2022	10	215.73	6.726
25 November 2022	10	214.97	6.533
26 November 2022	10	215.34	6.681
14 December 2022	10	215.3	6.691
16 December 2022	10	215.72	6.692
Mean		**215.341**	**6.673**
Standard deviation		0.294	0.064
95% CI +/-		0.272	0.059
P(t) movement		n/a	n/a

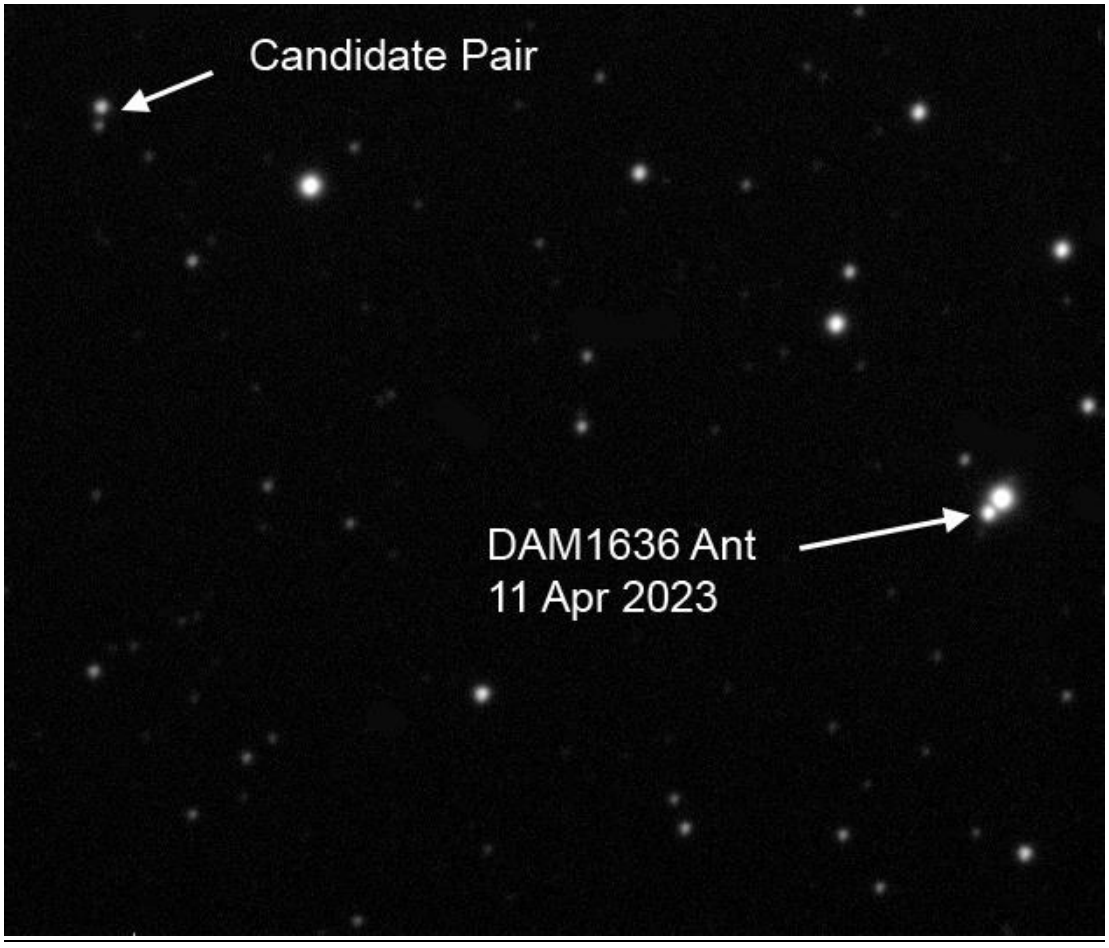
COMMENTS
Possible new pair nearby (S.W.) to Beta Fornax.
Gaia #DR2 5064312147648202496 – brighter component.
Gaia #DR2 5064306272132941696 – fainter component.



Possible new pair near DAM1636 Antlia	RA. 09 30 25	DEC. -39 28 20	Last Measure n/a
	MAG. 14.68 & 16.38	PA. n/a	SEP. n/a
Date	**No. images**	**PA°**	**Sep"**
12 April 2023	10	352.03	5.591
13 April 2023	10	351.24	5.597
17 April 2023	10	351.00	5.601
Mean		**351.423**	**5.596**
Standard deviation		0.539	0.005
95% CI +/-		1.339	0.013
P(t) movement		n/a	n/a

COMMENTS

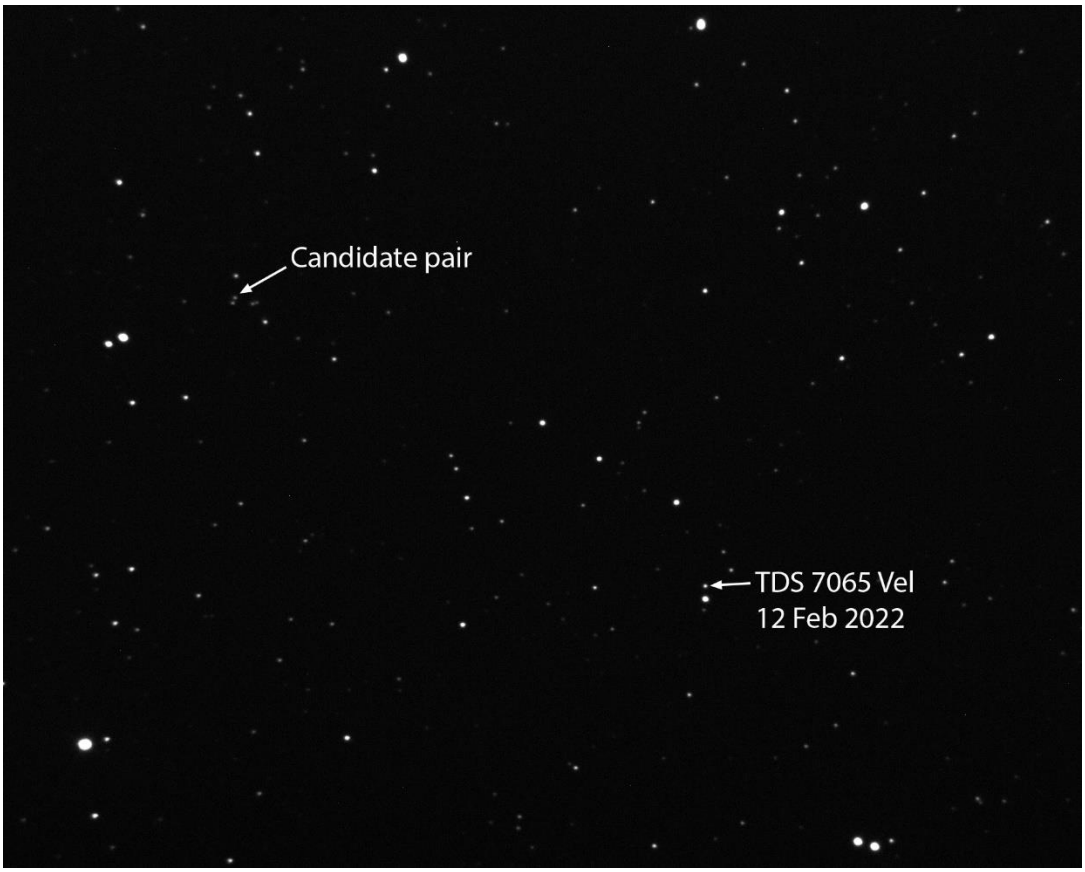
Three nights imaging only due to inclement weather.
Possible new pair SW of DAM1636.
Gaia #DR2 5429699618410021376 – brighter component.
Gaia #DR2 5429699618410021248 – fainter component.



Possible new pair near TDS7065 Vela	RA. 10 08 16	DEC. -56 55 48	Last Measure n/a
	MAG. 14.55 & 14.56	PA. n/a	SEP. n/a
Date	**No. images**	**PA°**	**Sep"**
11 April 2023	10	156.11	4.928
12 April 2023	10	155.72	5.002
13 April 2023	10	156.16	4.984
14 April 2023	10	155.73	4.982
17 April 2023	10	156.1	4.973
Mean		**155.964**	**4.974**
Standard deviation		0.219	0.028
95% CI +/-		0.272	0.034
P(t) movement			

COMMENTS

Five nights imaging only due to inclement weather.
Possible new pair nearby (S.W) of TDS7065.
Gaia #DR2 5258930344338350976 – brighter component.
Gaia #DR2 5258930344338350848 – fainter component.



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