Double Star Measures for the Year 2005

James A. Daley
Ludwig Schupmann Observatory
New Ipswich NH
E-mail: rigel@net1plus.com

Abstract: This yearly report contains 130 measures, 7 of which are new discoveries. The instrumentation has remained unchanged over nearly three years. A review of the system characteristics is included.

Telescope

The telescope is a Schupmann medial of 9-inch clear aperture. This form of refractor is completely free of the usual secondary color of the normal Fraunhofer design. The unamplified focal length is 100-inches. A high quality Barlow lens is employed to reach a focal length of 278.82-inches which gives ~ 0.3 arc-seconds per pixel at the CCD detector. Ray trace results show the focal length stability is very high, varying only a few mm over the seasonal temperature spread. Atmospheric dispersion is easily compensated by decentering the pupil image on the Schupmann corrector.

CCD Detector

The CCD is manufactured by SBIG Astronomical Instruments and is their ST-7XE model. This detector was purchased without the usual anti-blooming gate, thus increasing both the sensitivity and dynamic range significantly. The pixel size is 9x9 microns arranged in a 765x510 array on a KAF0401E chip. The CCD camera operates with a high grade mechanical shutter. Cooling is by a single stage TE cooler

Photometric filters

Photometry is performed in the standard BVRI-bands. The filter manufacturer is Schüler Astro Imaging (now Astrodon) and the filters are made to Michael Bessel's formula as described in CCD Astronomy, Fall1995. Spectral characteristics in nanometers when used with the above CCD as follows:

Center wavelength: B= 433, V= 548, R= 639, I= 811

Half bandwidth: B=100, V=110, R=147, I=179

General Information

Data is presented in a fairly standard way; the top row gives (left to right) the discoverer designation, WDS Epoch 2000 RA & Dec, WDS magnitudes (LSO mags in brackets), LSO measured position angle in degrees, LSO measured separation in arcseconds, Decimal date and number of nights object was observed. Lastly, a notes column where a variety of data is presented as well as the note numbers which are found in the notes section after the measures & discovery notes found in the last part of the notes section. Delta m photometry results are shown as in the following example: R= 0.11 N9. This simply means that the difference in magnitude in R-band is 0.11 and 9 CCD frames were analyzed to obtain a mean value. Often included is the number of measures and time in years since the last measure: 2m105. Additional photometry data is included throughout the notes section. Astrometry values are a minimum of 12 frame means.

Double Star Measures for the Year 2005

Discoverer Des.	WDS α,δ(2000)	WDS Mags	θ (deg)	ρ(arcsec)	Date	n	Notes
BU 860	00000+3852	6.6 11.4	107.4	6.60	2005.973	1	8m72, Fixed
STI1264	00049+5933	12.1 13.8	354.8	7.19	2005.989	1	2m87, opening slightly
BU 997	00049+4540	7.47 9.63	338.1	3.96	2005.948	1	
ES 1293 AB	00052+4514	6.5 13.5	110.2	14.62	2005.951	1	2m81
BU 997 AC	00052+4514	6.71 8.83	235.9	21.36	2005.951	1	7m15
STT 547 AB	00057+4549	8.20 8.26	184.3	6.02	2005.945	1	
POP 217 AP	00057+4549	8.20 13.0	353.7	10.00	2005.945	1	2m9, Probably Optical
HJ 1001	00092+4443	8.20 10.73	77.9	15.50	2005.953	1	Practically Fixed
STF 3	00100+4623	7.51 8.86	82.4	4.98	2005.962	1	
STF 60 AB	00491+5749	3.46 7.24	318.9	12.90	2005.044	1	
BU 1 AB	00528+5638	8.58 9.33	80.1	1.13	2005.962	1	
STF 180 AB	01535+1918	3.88 3.93	0.8	7.43	2005.077	1	R=0.11N9, I=0.09 N11
STF 93 AB	02318+8916	1.97 8.2	227.7	18.23	2005.197	1	Polaris, See JDSO, this issue
STF 93 AC	02318+8916	1.97 (13.8)	96.7	38.74	2005.197	1	2m105
STF 93 AD	02318+8916	1.97 (14.3)	187.5	82.67	2005.197	1	
STF 93 BC	02318+8916	8.2 13.5	81.2	52.96	2005.197	1	
STF 93 BD	02318+8916	8.2 13.2	177.6	69.36	2005.197	1	
KUI 11 AB	03042+6142	6.62 12.5	313.1	61.0	2005.082	1	1m74, Optical ?
STF 353 AB	03075+1753	10.8 13.1	52.6	12.42	2005.079	1	3m93, R=1.65 N7
FOX 128 AC	03075+1753	10.8 13.7	16.5	30.04	2005.079	1	1m94, R=3.78 N4
STI 428	03086+6028	12.8 13.2	80.3	1.88	2005.082	1	2m83, Rapid Motion
MLB 115	03162+5810	10.53 10.81	5.9	4.90	2005.088	1	Note 1
STF 362 AB	03163+6002	8.5 8.8	141.6	7.15	2005.085	1	
STF 362 AC	03163+6002	7.9 10.5	45.5	26.69	2005.085	1	
STF 362 AD	03163+6002	7.9 11.1	285.7	28.94	2005.085	1	
STF 362 AE	03163+6002	7.9 9.9	242.1	35.17	2005.085	1	
STF 362 BE	03163+6002	8.8 9.9	253.1	37.16	2005.085	1	2m97
STI1969 AB	03165+5649	(13.7 14.0)	311.0	9.60	2005.085	1	1m94, Note 2
DAL 22 AC	03165+5649	(13.7 14.4)	222.1	32.34	2005.087	2	see Note 2
COU2164 Aa	03166+4943	10.0 11.3	------	-------	2005.088	1	Round, single image
ES 463 Aa-B	03166+4943	9.8 12.2	258.9	5.58	2005.088	1	PA ~fixed, Sep. increasing
STF 370	03166+3238	8.8 10.9	319.2	16.84	2005.090	1	5m91
BU 1039 AB	03174+0739	7.39 13.4	-------	-------	2005.101	1	not found, see BU 1039 AC

Double Star Measures for the Year 2005

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BU 1039 AC	03174+0739	(7.35 7.70)	37.6	155.7	2005.101	1	see note 3
TOR 1	03181+2611	(10.5 13.0)	147.0	5.59	2005.096	1	1m27 Note 4
HU 545	03182+4915	9.37 10.06	81.2	3.55	2005.099	1	V=0.57 N4, I=0.33 N=8
STI1972	03184+5700	(12.44 13.01)	334.5	193.35	2005.099	1	V=0.57 N4, I=0.64 N5
PLQ 41 AB	03210+0827	8.3 12.5	310.2	42.71	2005.101	1	1m104
PLQ 41 AC	03210+0827	8.3 12.7	7.9	50.75	2005.101	1	2m85
STF 410	03350+3201	6.6 10.6	212.8	5.21	2005.118	1	closing slightly
BRT1177	03508+1418	11.2 11.5	181.3	4.19	2005.120	1	2m23, closing slightly
KUI 14	03519+3422	5.77 13.2	29.7	14.97	2005.120	1	1m47, little motion
STI2051	04312+5858	12.7 12.7	62.42	9.31	2005.134	2	White Dwarf & M4 pair
STI2055	04340+5808	12.4 12.4	330.4	4.74	2005.159	1	3m16
DAL 23	04343+5910	(12.05 13.03)	108.1	4.41	2005.128	2	discovery note 1
ES 1524	04509+4300	9.0 14.2	85.9	6.33	2005.148	1	1m89,PA incr.,opng slightly
STF 688 A-BC	05145-0812	0.3 10.4	203.8	9.42	2005.148	1	Rigel
STF 738 AB	05351+0956	3.51 5.45	43.5	4.33	2005.189	1	I=2.09 N18, Lambda Ori
STF 738 AC	05351+0956	3.51 10.7	183.6	28.45	2005.189	1	
STF 738 AD	05351+0956	3.51 11.2	271.3	78.10	2005.189	1	
STT 134	06093+2426	(7.38 8.94)	189.4	31.06	2005.170	1	V=1.56 N9, I=2.52 N6
STF 872 AB	06156+3609	6.89 7.38	216.3	11.37	2005.159	1	V=0.60 N8, I=0.66 N8
STF 943 AB	06378+2311	(9.04 9.43)	135.4	30.37	2005.170	1	V=0.39 N6, I=0.05 N5
STF1066	07201+2159	3.55 8.18	226.8	5.66	2005.189	1	Delta Gem
STF1083	07256+2030	7.32 8.13	45.3	6.69	2005.236	1	
STF1110 AB	07346+3153	1.93 2.97	61.1	4.25	2005.227	1	Castor
STF1196 AC	08122+1739	5.31 5.85	71.3	6.34	2005.263	1	Zeta Cancri
KU 32	08413+1916	8.06 10.24	165.8	2.19	2005.274	1	
STF1273 AB-C	08468+0625	3.49 6.66	300.2	3.01	2005.244	1	Epsilon Hydrae
STF1273AB-D	08468+0625	3.49 12.5	200.0	18.11	2005.293	1	
HDS1318	09050+2250	7.46 10.56	------	------	2005.299	1	secondary not detected
STF1311 AB	09074+2259	6.92 7.13	198.9	7.72	2005.296	1	I=0.33 N8
HO 644 AC	09074+2259	6.3 12.6	116.8	27.87	2005.299	1	cpm, see note 5
STF1321 AB	09144+5241	7.79 7.88	94.5	17.12	2005.315	1	
POU3077	10170+2326	12.4 12.9	276.6	4.76	2005.340	1	2m95, little motion
STT 523	10172+2306	5.81 11.4	298.9	7.73	2005.337	1	I=4.62 N10

Double Star Measures for the Year 2005

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STF1421	10181+2731	8.19 9.12	330.9	4.50	2005.318	1	V=1.01 N12, I= 1.21 N11
STF1424 AB	10200+1950	2.37 3.64	126.0	4.57	2005.362	1	Gamma Leo
LDS1251	10374+3133	11.8 17.2	47.5	32.03	2005.356	1	cpm pair, WD candidate
STF1458	10395+3142	9.39 9.39	216.7	18.13	2005.353	1	very slow binary
STF1459	10402+3824	8.34 8.85	152.7	5.39	2005.359	1	
STF1524	11185+3306	3.48 10.1	148.6	7.35	2005.362	1	
LDS6246 AB	11378+4150	10.3 16.0	340.1	28.53	2005.367	1	1m45, PA decr, sep incr
DAL 24 AC	11378+4150	10.3 (17.0)	174.7	5.85	2005.367	1	discovery measure
STT 237	11390+4109	8.11 9.32	247.1	1.92	2005.367	1	
STF1622	12161+4040	5.86 8.71	260.2	11.54	2005.399	2	2 CVn
STF3127 Aa-B	17150+2450	3.14 8.3	283.3	11.77	2005.627	1	Delta Her, B Optical
STF2186	17358+0100	7.55 7.72	78.6	2.83	2005.641	1	
STF2213	17449+3108	7.69 8.57	327.8	4.73	2005.644	2	V=0.82 N8
DAL 25	17556+2250	(9.6 11.1)	153.7	44.23	2005.655	1	discovery note 2
STF2271 AB	18003+5251	8.17 9.24	268.0	3.30	2005.674	1	V=0.77 N6, I=0.64 N6
STF2280 Aa-B	18078+2606	5.79 5.83	183.2	14.21	2005.679	1	V=-0.05 N8, I=0.03 N8, var
STF2323 AB	18239+5848	4.98 7.98	348.7	3.76	2005.693	1	39 Dra
HO 432 AB	18240+3844	6.4 12.9	285.5	17.49	2005.696	1	5m71, PA decr. difficult pair
STF2349	18366+3328	5.4 9.4	204.6	7.22	2005.699	1	
H 4 59	18367+3841	10.0 11.1	299.0	29.86	2005.627	1	6m75, PA smoothly decr.
H 5 39 AB	18369+3846	0.03 9.5	182.3	79.20	2005.833	1	Vega
HJ 1337	18409+3132	(8.62 11.51)	153.5	9.29	2005.679	1	V=2.89 N 8, I=1.86 N14
STF2398 AB	18428+5933	8.94 9.69	175.5	12.24	2005.627	1	11.6 ly, M4 M5 Binary
STF 38 AD	18448+3736	4.34 5.73	149.9	43.58	2005.718	1	
STF2375 Aa-Bb	18455+0530	5.82 5.82	118.9	2.44	2005.731	1	
ES 2028 BC	18545+3654	11.2 11.6	135.5	1.92	2005.715	1	
STF2434 A-BC	19027-0043	8.36 8.80	91.7	26.82	2005.742	1	
STF2446 AB	19058+0633	6.97 8.88	153.1	9.45	2005.756	1	
STF2455	19069+2210	7.24 9.38	28.5	8.99	2005.764	1	
STF2457	19071+2235	7.43 9.60	200.6	10.13	2005.764	1	
STF2486 AB	19121+4951	6.54 6.67	205.8	7.31	2005.723	1	V=0.16 N8, I=0.18 N8
BUP 188	19198+6423	6.25 9.8	179.9	115.2	2005.731	1	
STI 888	19210+6405	11.1 11.4	172.7	3.80	2005.742	1	3m22, PA decr, sep incr

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STI2426	19210+5631	(13.1 13.3)	160.2	10.83	2005.753	1	see note 6
STI 890	19213+6412	10.1 10.4	146.6	4.85	2005.731	1	sep & PA decreasing
STI 887	19213+6227	11.4 11.7	90.3	7.91	2005.742	1	1m102, little motion
DAL 26	19260+6353	(10.7810.95	301.7	18.30	2005.731	1	discovery note 3
DAL 20 AB	19346+5039	11.38 11.45	50.2	28.74	2005.803	1	
ES 793 AB	19351+5046	10.9 11.2	245.3	44.84	2005.803	1	
ES 793 BC	19351+5046	11.2 13.6	282.7	4.04	2005.805	1	1m96, large PA incr, closing
ES 793 Aa	19351+5046	10.3 14.8	91.1	14.98	2005.805	1	1m96, slight PA incr
DAL 19 AB	19352+5048	11.32 13.4	191.1	2.80	2005.803	1	difficult CCD pair
DAL 19 AC	19352+5048	11.32 12.9	39.4	9.41	2005.803	1	opening ?
STF 46	19418+5032	6.00 6.23	133.2	39.51	2005.756	1	photometric calibration pair
DAL 27 AD	19508+0852	0.76 11.7	95.6	32.12	2005.838	2	Altair, discovery note 4
HJ 2921	20027-0036	(8.36 11.84)	341.1	21.72	2005.762	1	3m94, PA incr, Sep incr
STF2725	20462+1554	7.09 7.90	11.2	6.07	2005.759	1	
STF2727	20467+1607	4.27 5.15	266.4	9.12	2005.759	1	Gamma Del
BU 678 AB	21008-0821	8.20 11.26	255.5	2.67	2005.875	2	under-measured binary!
STF2758 AB	21069+3845	5.20 6.05	151.0	30.93	2005.753	1	61 Cyg
STF 11 AB	21221+1948	4.20 7.56	311.6	36.10	2005.871	1	1 Peg
STF2863 Aa-B	22038+6438	4.26 6.34	275.0	7.94	2005.888	1	
STF2909	22288-0001	4.36 4.57	175.4	1.86	2005.937	1	Zeta Aqr
STF2922 Aa-B	22359+3938	5.73 6.60	185.7	22.26	2005.882	1	8 Lac
A 1469 Aa-C	22359+3938	5.73 10.5	168.3	48.33	2005.882	1	
STF2922 BC	22359+3938	6.45 10.3	154.5	27.86	2005.882	1	
A 1469 CD	22359+3938	10.3 9.6	116.2	42.11	2005.882	1	
A 1469 Da	22359+3938	9.6 13.3	228.0	9.65	2005.885	1	5m70, PA incr
DAL 28 Aa-G	22359+3938	5.73 13.6	193.7	78.60	2005.885	1	CCD discovery
DAL 28 Ga	22359+3938	13.6 14.0	77.0	6.51	2005.885	1	CCD discovery
STI1116	22360+6347	11.2 11.7	169.9	8.26	2005.888	1	1m96, PA incr, Sep incr
ES 2133	22360+3520	9.4 12.9	91.9	3.53	2005.896	1	1m81, PA incr, Sep decr
POU5724	22360+2523	12.5 13.5	140.5	6.33	2005.901	1	1m107, closing only
MLB 97	22361+6053	9.9 11.4	62.5	7.18	2005.901	1	3m87, little motion

Double Star Measures for the Year 2005

2005 Notes

1) MLB 115 - A delightful CCD binary, this gem's distance is listed as only 43.9 light years. The pair shows fairly fast motion which can be detected on a yearly basis with some care. Photometric work on this system proved perplexing as the components seem redder than the Hipparcos combined V-I value of 1.75 would indicate. The LSO determined Δm and colors as follows V-band = 0.20 N9, I band = 0.07 N8, V-I primary = 2.44, secondary 2.57. The pair was spot checked on the next night which confirmed these results.

2) STI 1969 AB - This pair is visually much fainter than Stein's photographic measure of 12.6 and required good dark adaption to center it up. The V-band measure reverses Stein's designation for the primary and is reflected in the LSO position angle flip. Very little (~3°) actual PA motion since discovery, however, the separation has increased about 0.40 arcseconds. The magnitudes listed in this report are LSO values. A third component (DAL 22AC) was found by CCD, thus the AB designation. Δm and colors as follows: V-band AB=0.38 N7, AC=0.66 N7, I-band AB=0.36 N7, AC=0.55 N7, V-I A=1.19, B=1.21, C=1.30.

3) BU 1039 AC- This wide pair is a distinctive sight in the 3-inch finder, the brighter component being the primary of BU 1039 AB which was the neglected double for that night. 107 years have past since the last measure, but since it showed an opening indication between 1889 and 1898 it was thought that it might be possible to image it. Every sort of exposure and filter was tried to image the 13.4 magnitude companion without success. Setting the proper motion command to 1,500 years in *Guide-8* revealed that the primary had a substantial vector length, however, and more surprising, both components of the wide pair showed the same vector length and direction. (See Figure 1) Hipparcos PM values in milliarcseconds are A=RA 169.3 , Dec -7.64 and B= RA 170.4, Dec -7.48. This carries the pair along about 4.6 arcminutes in 1,500 years in PA 92.5 degrees. If BU 1039 was not bound it should have revealed itself. A 13.4 magnitude star was easily found in the trailed-off direction , but over 1'49" away, much too far to be caused by proper motion of "A" alone. Getting back to BU 1039 AC, the Δm and colors follow: V-band =0.35 N4, I-band = 0.38 N6, V-I A=0.77, C=0.74. The listed distance to the pair is about 155 ly, so if we are observing them "broadside" the physical separation is only 0.1 light years or so, thus a fair possibility of true duplicity.

4) TOR 1 - LSO measured V magnitudes (10.51 12.96) are very close to one magnitude fainter than TOR values for both the primary and secondary. Δm and colors as follows: V-band = 2.45 N3, I-band = 2.07 N4, V-I primary = 0.84, V-I secondary = 1.22. This photometric data is a four frame average in each color. Colors hint at a physical system. Good student project. Very little motion since discovery. PA increasing ~1 degree and opening slightly.

5) HO 644 AC - This distant component of STF 1311 AB shows no significant change in position since the last measure in 1909 even thought the AB pair's proper motion is quite large (.168 mas / yr mostly in RA) and should have changed the separation about 16 arcseconds if a background star. To fully confirm the apparent physical connection to the main pair, photometry in V & I-bands was performed. Δm and color as follows: V-band = 6.39 N6, I-band = 4.87 N3, V-I for C = 2.11. The color indicates an M0 or M1 red dwarf and the Δm agrees with what one would expect for an ~M0 dwarf at the distance of the main pair (192 ± 15 ly.).

6) STI 2426 - Stein's original measure of 1917 gives a PA of 144° and a separation of 10.3". Now, 88 years later we find this neglected pair's PA has increased 16° and has widened about 0.5". This is enough motion to take the next step: a look at the colors to see if, perhaps, the pair is a binary . First off, LSO V-band measures find the pair roughly 2 magnitudes fainter than Stein's measure. This cannot be

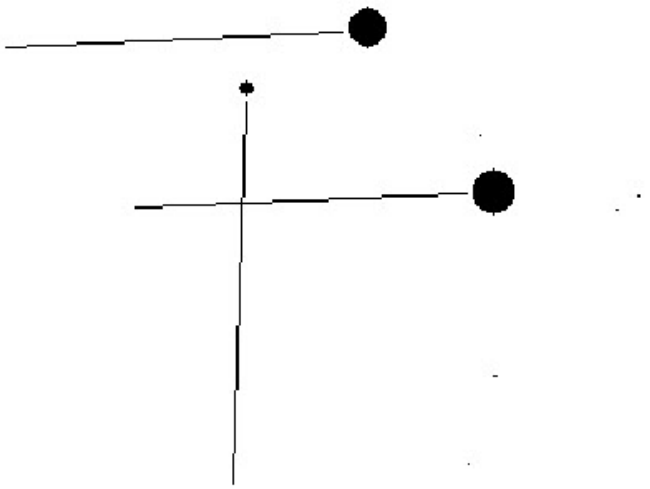

Figure 1: Guide-8 chart of BU1039 AC showing 1500 year pm.

explained by Stein's use of blue plates; as we shall see, the pair is distinctly orange. LSO listed mags are, however, in reasonable agreement with the GSC values of 13.1 13.8.

LSO Δm values as follows: V-band 0.20, R-band 0.40, I-band 0.44. LSO colors as follows: V-I primary = 0.84, secondary = 0.60. It appears that the secondary is the "bluer"; not a hopeful sign. More study of this pair may be needed to resolve the pair's nature.

Discovery Notes

1) DAL 23 - 04hr 34m 19.7142s +59deg 10' 29.680". Found while sweeping for STI 2051. A conspicuous visual pair even in nearby moonlight. The primary is GSC identifier 3744 1389 with proper motion in milliarcseconds / yr as follows: RA 26 ± 3, dec -20 ± 3. LSO magnitudes 12.05 and 13.03 . These are both, more or less, reddish stars with LSO V-I values for the primary of 0.90 and 1.69 for the secondary. Δm as follows V-band =0.98 N7, R-band =0.59 N3, I-band= 0.19 N10. It is quite possible that the secondary is a wide range variable which would explain this pair being missed in the past. Fig 2 below shows a CCD image of the pair.

2) DAL 25 - 17hr 55m 35.549s + 22deg 50' 14.007". CPM pair: Tycho-2 catalog data for proper motion (MAS/yr) of primary: RA: -54 , dec: -21, secondary: RA: -54, dec: -23, all with an uncertainty of ±1. LSO V-I colors : primary = 0.78, secondary = 1.09. Δm V-band = 1.49 N10, I-band = 1.20 N4. Another interesting student project!

3) DAL 26 - 19hr 26m 03.6001s +63deg 53' 25.573" CPM pair: Tycho-2 catalog for proper motion (MAS/yr) of primary: RA: -17, dec 31, secondary : RA: -14, dec 35, all uncertain by ± 4. LSO magnitudes listed in results. LSO V-I colors: Primary = 0.81, secondary = 0.82. Δm B-band = 0.16 N7, V-band = 0.17 N7, I-band = 0.17 N7. This is a great one for the catalog mining gurus. Bet it's a binary!

4) DAL 27 AD - A new, comparatively close, component of Altair. Discovered in the process of testing LSO's new stellar coronagraph. Altair lies at only 16.7 ly, thus attendants, even faint ones, cannot be simply dismissed as remote field stars. LSO colors weakly suggest a K5 or later object, however, the errors of measurement even leave open the possibility of some sort of white dwarf! The color and magnitude of this object puts it approximately at Altair's distance. Whether or not this is a physical attendant will be decided in short order, say 2 years, as the proper motion of Altair is very high. Perhaps next Summer a publishable measure of color will be possible. Figure 3 shows Altair, mostly hidden behind the occulting bar, with the new component to the left. The occulting bar runs from lower left to upper right leaving the orthogonal spillover. The center wavelength is 580nm and the FWHM is around 200nm. North is down and East is left.

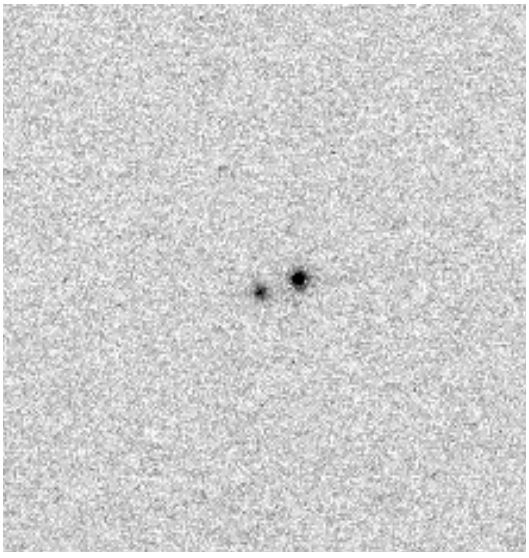

Figure 2: CCD image of DAL 23.

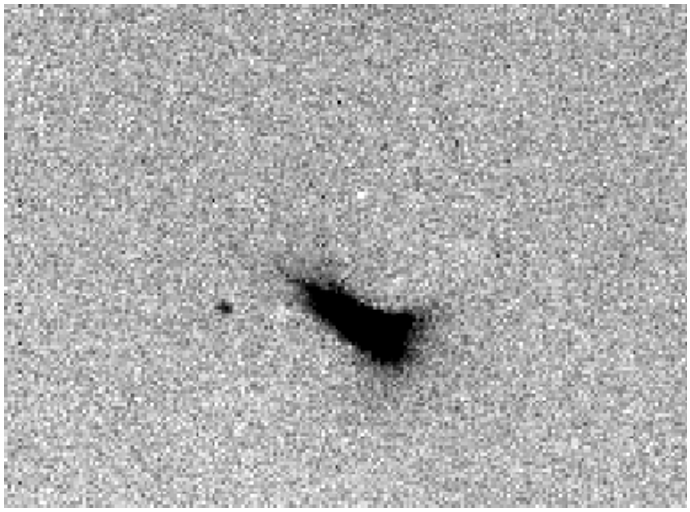

Figure 3: Altair's light about 96% occulted, showing companion. Exposure 25 seconds, 3X3 binned.