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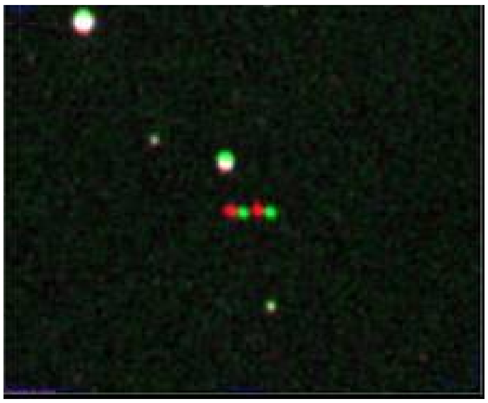

Composite image of a possible new cpm binary showing the movement of the pair between 1954 (green) and 1990 (red). See "Finding New Common Proper Motion Binaries by Data Mining" by R. Caballero, pg 156.

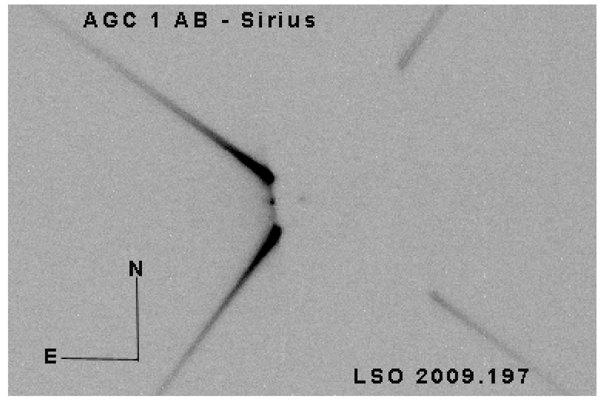

Image of Sirius B taken by James Daley using his stellar coronograph to obscure Sirius A. See "Ludwig Schupmann Observatory Measures of Large Dm Pairs", page 149.

Inside this issue:

Divinus Lux Observatory Bulletin: Report #18

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Abstract: This report contains theta/rho measurements from 92 different double star systems. The time period spans from 2008.989 to 2009.200. Measurements were obtained using a 20-cm Schmidt-Cassegrain telescope and an illuminated reticle micrometer. This report represents a portion of the work that is currently being conducted in double star astronomy at Divinus Lux Observatory in Flagstaff, Arizona.

The double star measurements contained in this report form part of a series of articles that have been continuously released at Divinus Lux Observatory since the spring of 2001. The primary emphasis of the astronomical research at the observatory has been focused upon double star work since that time. The purpose of these efforts is to help provide current information for the maintenance of the Washington Double Star Catalog (WDS). Because valuable research can be conducted with modest and inexpensive equipment, others who are seeking to initiate a research program are encouraged to join in this rewarding endeavor.

As has been done in previous articles, the selected double star systems, which appear in this report, have been taken from the 2001.0 version of the Washington Double Star Catalog, with published measurements that are no more recent than ten years ago. Several systems are included from the 2006.5 version of the WDS as well. There are also some noteworthy items that are discussed pertaining to the following table.

Consistent with what has been mentioned in previous reports, there are a couple of double stars that have displayed significant theta/rho shifts, during the past ten years, because of proper motions by both of the components. First of all, proper motions by the components, for ENG 25, have caused what appears to be a 2 degrees increase in the theta value from that which was reported in 1999. Even though a theta value of 20.2 degrees was measured, there is some uncertainty about this result because the WDS and Hipparcos/Tycho catalogs suggest an extrapolated value of 18.4 degrees for the date of 2009.044. Additional measurements of this double star would help to determine which theta value is more accurate.

Proper motions by the component stars, in HJ 807 AB, have caused a rho value increase of approximately 5.5% since 1999. The theta value has increased by one degree during this period.

The table below also contains listings for possible common proper motion double stars that do not appear to have been previously cataloged. The first such pair is labeled as ARN 104 (07158-0048), which is located near STF 1056 in Monoceros. The second listed pair is identified as ARN 105 (08400+2009), which is located in the M44 open star cluster in Cancer.

Divinus Lux Observatory: Report #18

NAME	RA DEC	MAGS	PA	SEP	DATE	NOTES
HJ 712	05498+0605	9.4 9.8	84.7	9.38	2009.044	1
ENG 25	06061+3525	6.1 10.1	20.2	150.10	2009.044	2
STF 854	06085+0548	8.8 9.8	321.1	5.43	2009.044	3
GAL 399	06215-1625	9.3 9.5	330.3	19.26	2009.082	4
H 37AB	06321+0458	10.2 10.6	82.0	5.43	2009.044	5
STF 986	06549+0930	8.2 9.0	163.5	5.43	2009.082	6
HJ 3902AB	06574-1821	10.1 10.2	236.3	14.81	2009.082	7
AG 130AB	07016+3950	10.6 10.7	151.9	13.33	2009.044	8
ARN 104*	07158-0048	10.1 10.5	226.8	21.73	2009.044	9
HJ 2386	07283+0345	10.3 10.5	251.2	6.91	2009.082	10
HJ 763	07384+0958	10.1 10.5	212.5	7.41	2009.082	11
STF1123	07415+3325	9.2 9.7	165.7	3.46	2009.082	12
BAL2311	07468+0245	9.5 9.6	223.1	8.89	2009.082	13
STF1185	08071+0121	9.5 10.2	94.0	3.95	2008.992	14
ES 144AB	08080+4611	9.3 9.5	337.0	6.42	2009.085	15
HJ 782	08163-1134	9.2 10.6	236.5	13.83	2008.989	16
BHA 56	08233-1804	9.9 10.4	270.9	18.76	2008.989	17
STT 191	08248+2009	7.3 8.6	191.7	37.53	2008.992	18
SCJ 9	08258+0557	10.4 10.4	330.5	3.95	2008.992	19
FEN 14	08267-1910	10.3 10.3	309.5	4.44	2008.992	20
STF1238	08319+3309	9.1 10.7	320.5	29.13	2008.989	21
STF1234	08331+5521	7.7 9.5	64.6	24.69	2009.085	22
ARN 105*	08400+2009	8.9 9.7	153.7	91.34	2009.085	23
STF1254AB	08404+1940	6.4 10.4	54.9	20.74	2009.085	24
STF1254AC	08404+1940	6.4 7.6	343.4	64.19	2008.085	24
STF1254AD	08404+1940	6.4 9.2	43.3	82.95	2008.085	24
STF1261	08407-1156	7.6 9.5	302.9	29.63	2008.989	25
H 107	08425-0830	7.0 10.5	151.1	93.32	2008.989	26
STF1256	08430+4918	8.6 10.5	216.3	28.14	2008.989	27
ENG 38AB	08433+2128	4.7 10.2	66.5	115.54	2008.992	28
STF1268	08467+2846	4.0 6.0	307.5	30.61	2008.992	29
HJ 4140	08491-1325	9.2 10.6	285.2	10.37	2008.989	30
HJ 2314	08504-0002	10.2 10.7	133.4	16.29	2008.989	31
STF1282	08508+3504	7.5 7.8	279.0	3.46	2009.085	32
AG 156	08508+3418	10.2 10.4	249.8	10.86	2008.992	33

Table continued on next page.

Divinus Lux Observatory: Report #18

NAME	RA DEC	MAGS	PA	SEP	DATE	NOTES
STT 96AB	08520+2543	7.5 8.4	313.1	49.38	2008.992	34
STT 96AC	08520+2543	7.5 10.7	266.7	35.01	2008.992	34
ES 1083	09013+4843	10.6 10.6	336.2	6.42	2009.008	35
AG 160	09051+3931	9.8 9.8	60.0	3.95	2009.085	36
AG 161	09057+3227	10.1 10.5	224.0	4.44	2009.008	37
HJ 1164AB	09081+4510	9.5 9.8	174.2	5.93	2009.008	38
POU3029	09082+2353	10.0 10.3	315.5	7.90	2009.008	39
HJ 807AB	09124-0709	9.6 10.0	289.9	15.31	2009.085	40
BU 908A-BC	09143-0817	9.1 10.7	182.6	60.73	2009.008	41
WEI 21	09149-0845	7.3 10.5	15.3	26.17	2009.008	42
BGH 4CA	09207-0742	7.4 9.2	326.4	135.29	2009.008	43
HJ 810AC	09212+2728	10.4 10.7	26.0	22.22	2009.008	44
STF1358	09309+4441	7.8 9.2	175.2	23.70	2009.008	45
HJ 2503	09445+4830	10.4 10.7	158.5	37.03	2009.008	46
STF1396AB	09564+1040	8.8 10.4	129.5	3.95	2009.101	47
STF 6AB	10084+1158	1.4 8.1	307.5	175.78	2009.101	48
STF1416	10123-1605	7.6 9.3	277.0	11.85	2009.101	49
CHE 148	10284+0310	10.0 10.3	64.5	4.94	2009.104	50
HU 635	10285+4733	10.4 10.7	174.0	4.44	2009.101	51
STF1443	10333+3740	9.8 9.9	160.1	5.43	2009.101	52
STF1447	10338+2321	7.5 8.8	124.5	4.44	2009.104	53
STF1448AC	10344+2136	7.4 9.5	259.2	10.86	2009.101	54
FIL 26	10457-0130	10.0 10.1	260.4	20.74	2009.101	55
STF1490	10566+1739	8.6 10.4	100.9	17.28	2009.200	56
STF1495	10598+5854	7.1 8.7	36.3	34.07	2009.101	57
STF1509	11065-1325	7.3 9.3	16.3	33.08	2009.104	58
STF1544	11313+5942	7.3 8.0	90.5	12.34	2009.200	59
STF1558AB-C	11367+2128	9.8 9.8	276.7	43.45	2009.104	60
STT 239	11442+2513	6.0 10.4	30.7	35.54	2009.200	61
TDS8014AC	11454-1128	9.7 10.5	237.1	38.51	2009.104	62
STF1579AB-D	11551+4629	6.7 7.0	113.7	63.20	2009.104	63
STF3076	11566-0514	10.2 10.6	54.5	5.93	2009.200	64
ES 2642	12280+4753	10.1 10.3	257.2	28.14	2009.121	65
BAL1162	12432+0000	10.0 10.7	303.3	14.81	2009.121	66
STF1679AB	12460+4949	9.6 9.9	206.5	5.93	2009.121	67

Table continued on next page.

Divinus Lux Observatory: Report #18

NAME	RA DEC	MAGS	PA	SEP	DATE	NOTES
STF1683	12517-0608	8.3 10.6	197.3	15.31	2009.121	68
BRT2731	12519-1404	9.9 9.9	74.5	3.95	2009.121	69
STF1692	12560+3819	2.9 5.5	230.2	18.76	2009.200	70
HJ 2628	12584+5822	8.4 10.6	26.4	31.11	2009.121	71
HJ 2649	13184+5420	10.2 10.5	345.4	20.74	2009.162	72
STF1744AB	13239+5456	2.2 3.9	153.2	14.32	2009.200	73
STF1746	13282+0928	7.6 10.4	245.5	22.71	2009.162	74
STF1750	13304-0628	6.1 10.6	16.2	29.13	2009.162	75
STF1766	13372+3005	9.3 10.7	67.4	20.24	2009.162	76
STF1762	13376-1048	9.3 9.8	276.5	4.44	2009.162	77
STF1764AB	13377+0223	6.7 8.5	31.6	15.80	2009.162	78
STF1764AC	13377+0223	6.7 10.4	138.5	171.83	2009.162	78
WAL 64AD	13377+0223	6.7 10.6	142.6	207.38	2009.162	78
WNC 5	13455-0301	10.2 10.2	163.0	3.95	2009.162	79
STF1791	13568+1426	9.3 10.6	158.8	21.23	2009.162	80
BGH 49	14031-1736	8.7 9.1	24.7	139.24	2009.164	81
STT 274	14067+3447	7.0 10.4	54.9	12.84	2009.164	82
STF1821	14135+5147	4.5 6.6	237.4	13.83	2009.181	83
STF1811	14135-0900	8.7 10.7	332.2	42.46	2009.164	84
STF 26AB	14162+5122	4.7 7.3	33.0	39.00	2009.181	85
ENG 51	14193+1300	5.4 10.7	219.1	163.93	2009.164	86
A 1618AB	14218+4229	10.4 10.6	161.5	3.95	2009.181	87
ES 609AC	14375+4743	10.1 10.1	117.5	78.51	2009.164	88
HU 477	14490-1700	9.7 9.8	212.6	4.94	2009.181	89
HJ 1261	14539+5734	10.4 10.5	17.0	8.89	2009.164	90
HJ 4720	14573-0551	10.4 10.5	212.5	12.84	2009.181	91
STF1921	15120+3840	8.5 8.7	282.4	30.61	2009.181	92

* Not listed in the WDS Catalog.

Notes

1. In Orion. Sep. & p.a. increasing. Spect. A0.
2. In Auriga. Sep. & p.a. increasing. Spect. G0V.
3. In Orion. Relatively fixed. Spect. A2.
4. In Canis Major. Separation decreasing; position angle increasing.
5. In Monoceros. Relatively fixed. Spect. A3V.
6. In Monoceros. Common proper motion; p.a. decreasing. Spect. A2.
7. In Canis Major. Sep. & p.a. increasing. Spect. A2.
8. In Auriga. Separation slightly decreasing. Spect. A4V.

Divinus Lux Observatory: Report #18

9. In Monoceros. Possible common proper motion. Near STF 1056.
10. In Canis Minor. Common proper motion; sep. & p.a. increasing.
11. In Canis Minor. Position angle increasing. Spect. G5.
12. In Gemini. Common proper motion; p.a. increasing. Spect. F8.
13. In Canis Minor. Relatively fixed.
14. In Canis Minor. Common proper motion; p.a. decreasing. Spect. K0, K0.
15. In Lynx. Separation decreasing. Spect. G5, G5.
16. In Puppis. Sep. increasing; p.a. decreasing. Spect. F2.
17. In Puppis. Position angle slightly decreasing. Spect. F5.
18. In Cancer. Relatively fixed. Common proper motion. Spect. A5, A5.
19. In Hydra. Relatively fixed. Common proper motion. Spect. F8.
20. In Puppis. Common proper motion. Sep. increasing; p.a. decreasing.
21. In Cancer. Relatively fixed. Common proper motion. Spect. A2.
22. In Lynx. Sep. increasing; p.a. decreasing. Spect. K1III, F8.
23. In M44 in Cancer. Possible common proper motion pair. Spect. A5, G5.
24. In M44 in Cancer. All components = relfix; c.p.m. Spect. K0III, F2, A0, F2.
25. In Hydra. Relatively fixed. Common proper motion. Spect. G5.
26. In Hydra. Separation increasing. Spect. B9.
27. In Ursa Major. Sep. & p.a. increasing. Spect. K2.
28. Gamma or 43 Cancri. Separation increasing. Spect. A1IV, G5.
29. Iota Cancri. Relatively fixed. Common proper motion. Spect. G7.5III, G8II.
30. In Hydra. Common proper motion; p.a. slightly increasing. Spect. F2.
31. In Hydra. Relatively fixed. Common proper motion. Spect. F8.
32. In Lynx. Common proper motion; p.a. decreasing. Spect. F8, F8.
33. In Lynx. Position angle slightly decreasing. Spect. G0, G0.
34. In Cancer. AB = sep. inc. AC = p.a. inc. Spect. AB = K2III, F8.
35. In Ursa Major. Common proper motion; p.a. decreasing.
36. In Lynx. Position angle decreasing. Spect. G5.
37. In Cancer. Sep. & p.a. slightly increasing.
38. In Lynx. Common proper motion; p.a. decreasing. Spect. K0.
39. In Cancer. Relatively fixed. Common proper motion. Spect. F5, F5.
40. In Hydra. Sep. & p.a. increasing. Spect. G, G.
41. In Hydra. Sep. inc.; p.a. decreasing. Spect. F8.
42. In Hydra. Separation decreasing. Spect. A1III.
43. In Hydra. Relatively fixed. Common proper motion. Spect. F8, K0.
44. In Cancer. Sep. increasing; p.a. decreasing. Spect. K0, F5.
45. In Ursa Major. Position angle increasing. Spect. M4.
46. In Ursa Major. Position angle decreasing. Spect. K0, F8.
47. In Leo. Relatively fixed. Common proper motion. Spect. A0, A0.
48. Regulus (Leo). Relatively fixed. Common proper motion. Spect. B7V, G.
49. In Hydra. Relatively fixed. Common proper motion. Spect. A3III.
50. In Sextans. Position angle increasing. Spect. K2.
51. In Ursa Major. Common proper motion. Sep. increasing; p.a. decreasing.
52. In Leo Minor. Common proper motion. Sep. & p.a. increasing. Spect. G0, G0.
53. In Leo. Relatively fixed. Common proper motion. Spect. A2, A2.
54. In Leo. Relatively fixed. Common proper motion. Spect. K0, F8.

Divinus Lux Observatory: Report #18

55. In Sextans. Position angle decreasing. Spect. G, G.
56. In Leo. Relatively fixed. Common proper motion. Spect. A3, F8.
57. In Ursa Major. Position angle decreasing. Spect. K2III, K0.
58. In Crater. Relatively fixed. Spect. K0III.
59. In Ursa Major. Relatively fixed. Spect. A5, A2.
60. In Leo. Relatively fixed. Common proper motion. Spect. F8, F5.
61. In Leo. Position angle increasing. Spect. K4III.
62. In Crater. Relatively fixed. Common proper motion. Spect. G0.
63. In Ursa Major. Relatively fixed. Spect. A3V, B9.
64. In Virgo. Common proper motion; sep. & p.a. increasing.
65. In Canes Venatici. Relatively fixed. Common proper motion.
66. In Virgo. Relatively fixed. Common proper motion. Spect. F8, G.
67. In Canes Venatici. Separation increasing. Spect. F6IV, F8.
68. In Virgo. Relatively fixed. Common proper motion. Spect. K0, K0.
69. In Corvus. Sep. & p.a. slightly increasing. Spect. G8.
70. Cor Caroli in Canes Venatici. Common proper motion; sep. dec. Spect. A0, A0.
71. In Ursa Major. Sep. increasing; p.a. decreasing. Spect. F5.
72. In Ursa Major. Separation decreasing. Spect. K0, K0.
73. Mizar in Ursa Major. Common proper motion; p.a. inc. Spect. A2V, A2V.
74. In Virgo. Sep. & p.a. decreasing. Spect. K0.
75. 72 Virginis. Sep. & p.a. decreasing. Spect. F2V.
76. In Canes Venatici. Common proper motion; sep. increasing. Spect. G8V, G5.
77. In Virgo. Common proper motion; sep. & p.a. decreasing. Spect. G5.
78. In Virgo. AB = relfix.; cpm. AC = relfix. AD = sep. decreasing. Spect. K2III.
79. In Virgo. Common proper motion; sep. & p.a. decreasing. Spect. G0.
80. In Bootes. Relatively fixed. Common proper motion. Spect. G5.
81. In Virgo. Relatively fixed. Common proper motion. Spect. G0, G5.
82. In Canes Venatici. Common proper motion; p.a. decreasing. Spect. G9III, K0.
83. Kappa or 17 Bootis. Sep. & p.a. increasing; c.p.m. Spect. A7V, F1V.
84. In Virgo. Sep. & p.a. increasing. Spect. F0.
85. Iota / 21 Bootis. Relatively fixed. Common proper motion. Spect. A7IV, K0V.
86. 18 Bootis. Sep. & p.a. increasing. Spect. F5IV.
87. In Bootes. Common proper motion; sep. slightly increasing.
88. In Bootes. Relatively fixed. Spect. G5, K0.
89. In Libra. Separation increasing. Spect. K1III.
90. In Draco. Relatively fixed. Common proper motion.
91. In Libra. Relatively fixed. Common proper motion.
92. In Bootes. Common proper motion; p.a. slightly decreasing. Spect. A2, A2.

Neglected Double Star Observations Conducted at Kitt Peak Advanced Observer Program

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Abstract: I report 76 measures of double stars (27 of them "neglected" doubles) found between 2219.0 and 2221.1 RA and +51 to +60 DEC. The observations were conducted with a 20in f/8.4 Ritchey-Chretien reflector. Eight new doubles found in the same CCD field as a neglected double are reported. The observing run was conducted at the National Optical Observatory at Kitt Peak Visitor's Center Advanced Observer Program. Information about instrumentation, methodology, results and notes is included.

Introduction and Instrumentation

For some time I had been interested in using the Advanced Observer Program (AOP) [noao.edu] run by the Visitors Center of the National Optical Observatory located at Kitt Peak, Arizona to measure neglected double stars. To that end, I reserved two nights, September 30th and October 1st, 2008 for my observing run. The first night was rained out.

The Kitt Peak AOP has equipment not usually available to amateurs. The telescope used for the observations was a RC Optical Systems 20in f/8.4 Ritchey-Chretien carbon truss reflector on a Paramount ME German equatorial mount. The CCD camera was a SBIG STL-6303E non-ABG. No filter was used. This instrumentation gave an effective focal length of 4,103 mm and a field of view of 22 X 15 arcminutes and a plate scale of 0.45 arcseconds/pixel. Telescope control and CCD imaging were managed by MaximDL software.

I was assisted by AOP guides who operated the telescope and the CCD imaging software during most of the duration of my observing run. For the safety of the equipment, the guides retain primary control of the telescope.

The combination of the location on Kitt Peak, the 20 in telescope and the wide CCD field of the camera made for a productive session. Nearly every CCD image of a neglected double included several other Washington Double Star Catalog (WDS) doubles.

Methods

The target list of neglected doubles was provided by Dr. Brian Mason of the U.S. Naval Observatory (USNO).

As a "sanity" check, the imaging session started with several doubles that had recent high quality measures [Daley, 2006]. A quick review of the data obtained at the start of the observing session indicated excellent agreement with the published measures.

An unguided CCD exposure of 10 seconds gave good S/N and little trailing. For each neglected double the telescope was slewed to reported position and between three and seven images of the star field were taken. This procedure was repeated until dawn. Twenty-two star fields were imaged, resulting in more than 75 doubles being available for measurement. The total observing run produced almost 2 GB of data.

Back at home, each CCD image was examined and any sub-par image was discarded. Any image that the plate reduction software could not reach a plate solution was also excluded. MOP Canopus [Warner, 2006] was the primary measurement and plate solution software. Canopus produces a plate solution and raw instrumental magnitudes based on its internal catalogs (USNO-V2.0 and Tycho 2 datasets)[Monet, 1998, Schwekendiek, 2000]. All the CCD images were copied to archival CD-ROM disks and are available from the author by request. The first and last CCD image from each star field were blinked to determine if they held anything else of interest (asteroids, etc). Nothing of note was found.

Results

Table 1 shows the results from the double stars measured. It includes the WDS designation, discoverer, WDS magnitudes, arithmetic means of the measured separations and position angles, the epoch, number of measures, standard deviations of the measurements, the date of previous measures, number of previous measures and a reference note number if applicable.

In the notes and tables I report the RA and DEC and raw instrumental magnitudes of some stars. Neither the positions nor magnitudes should be considered precision astrometry or photometry. The Canopus software attempts to derive a useful estimate of star image magnitudes by comparing the CCD images to its internal catalogs. Correlation between the computed raw instrumental values and catalog values was usually within .5 magnitude. Of course, the raw instrumental values and the catalogs have numerous systematic errors.

I report the raw instrumental magnitudes of some new, and faint secondaries of known doubles. It has long been known that when doubles are about the same magnitude, they are generally of the same color. With doubles of unequal brightness, color differences increase [Aitken, 1935]. Therefore, the reported raw instrumental magnitudes of those faint companions are likely to be even less accurate.

Stein double stars were originally measured on blue sensitive photographic plates. It is not uncommon for the primary and secondary to be reversed in CCD and visual observations [Daley, 2006]. I report several of those here.

New Doubles

Table 2 lists eight new doubles discovered during the observing run. All the new doubles reported here are in the same CCD field as a known neglected double. The author is well aware that the WDS catalog is not in need of additional doubles. However, it seemed wasteful not to measure the new doubles when high quality data was available

The CCD images taken with the 20in from Kitt Peak easily reach 17.5 magnitude and show dozens, if not scores, of close and faint doubles. The criteria used to select the reported eight new doubles included magnitude and separation. All new doubles are in the same 10-13 magnitude range of the neglected doubles that were the reason for the CCD image and have separations of 10 arcseconds or less. As an example, Figure 1 shows one of the new doubles, listed as double number 1 in Table 2. Probability theory indicates that the eight new doubles are likely to be physical systems [Romero, 2007]. The pairs should be easy CCD targets for future measurements. The USNO team can add the new doubles to the WDS catalog --- or not, at their discretion.

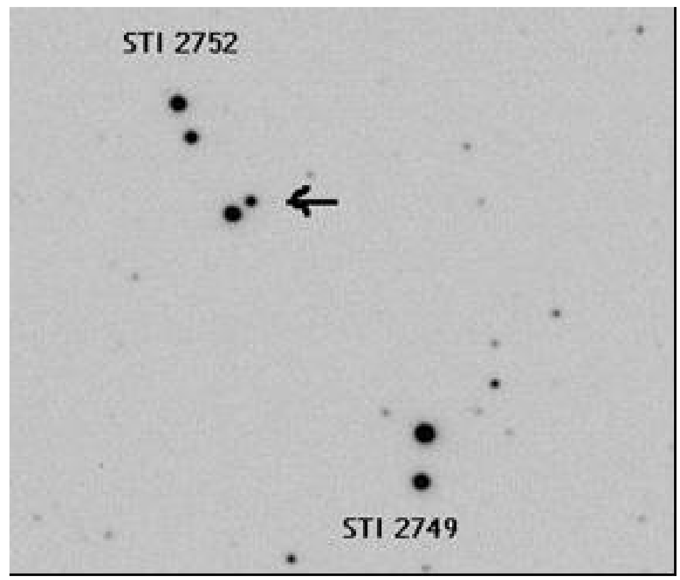

Figure 1: New double in the same CCD field as two WDS binaries.

Acknowledgments

Thanks to Dr. Brian Mason of the USNO for encouragement and for observing lists. Special thanks to Jim Daley for allowing me to sit in on one of his double star measuring sessions and for providing me with his expert advice. Thanks also to telescope operators/ guides Kevin Bays and Roy Lorenz of the Kitt Peak Advanced Observers Program, who took a personal interest in my attempt to do some science.

References

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(Continued on page 140)

Neglected Double Star Observations Conducted at Kitt Peak Advanced Observer Program

Table 1: Summary data for doubles measured at Kitt Peak AOP are reported. WDS ID and Discovr. are Washington Double Star Catalog identifiers and discoverer codes. PAsd and SEPsd refer to standard deviations of the respective angle (PA) and separation (SEP) based on (No.) of CCD images measured followed by date of last measure, total number of previous measures, and the number of associated note.

WDS ID	Discovr.	WDS mags	PA	SEP	Epoch	No.	PAsd	SEPsd	Last	Prev.	Notes
22019+5506	ABH 157AD	11.1, 14.2	269.6	11.70	2008.75	3	0.11	0.012	1987	1	
22019+5506	ABH 157AG	11.1, 14.3	348.2	38.72	2008.75	3	0.04	0.067	1999	2	
22019+5506	ABH 157AL	11.1, 15.7	146.5	66.35	2008.75	3	0.03	0.072	1999	2	
22019+5506	ABH 157AI	11.1, 14.6	280.7	30.88	2008.75	3	0.03	0.059	1999	2	
22019+5506	ABH 157AH	11.3, 14.3	321.8	32.74	2008.75	3	0.1	0.071	1999	2	
22019+5506	ABH 157AF	11.1, 14.7	95.4	14.62	2008.75	3	0.16	0.014	1999	2	
22019+5506	ABH 157AK	11.1, 13.9	225.9	40.78	2008.75	3	0.04	0.050	1999	2	
22019+5506	ABH 157AJ	11.1, 13.9	239.0	47.88	2008.75	3	0.06	0.031	1999	2	
22019+5506	ABH 157AM	11.1, 15.2	282.3	68.57	2008.75	3	0.04	0.054	1999	2	
22019+5506	ABH 157AE	11.1, 12.6	144.6	31.03	2008.75	3	0.04	0.025	1999	3	
22019+5506	HJ 1718AB	10.4, 11.3	219.0	9.33	2008.75	3	0.11	0.054	1999	5	
22019+5506	HJ 1718BC	11.3, 12.4	301.0	12.65	2008.75	3	0.05	0.038	1999	4	
22019+5506	HJ 1718AC	10.4, 12.4	267.7	16.72	2008.75	3	0.17	0.009	1999	3	
	HJ 1718B-D		83.3	5.05	2008.75	3	0.48	0.025	New		1
22029+5512	STI2608	12.7, 12.7	41.3	7.20	2008.75	3	0.08	0.012	2006	2	2
22158+5519	STI2668	11.2, 11.8	211.9	15.30	2008.75	7	0.14	0.039	1999	4	
22161+5453	STI2673	12.1, 12.4	199.1	7.98	2008.75	5	0.31	0.038	1999	3	
22164+5454	STI2675	13.1, 13.1	339.7	3.89	2008.75	5	0.61	0.037	1917	1	3
22164+5525	STI2674	13.1, 13.1	141.9	4.87	2008.75	7	0.27	0.024	1999	2	
22170+5515	STI2677	13.1, 13.1	76.2	10.82	2008.75	7	0.08	0.013	1999	2	
22170+5526	STI2678	11.3, 13.1	284.0	14.52	2008.75	7	0.08	0.031	1999	2	
22177+5444	STI2681	12.5, 12.5	104.8	7.79	2008.75	5	0.17	0.026	1917	1	4
22178+5452	STI2685	13.1, 13.1	61.6	8.44	2008.75	5	0.1	0.056	1917	1	5
22182+5523	STI2686	12.5, 13.1	130.2	1.11	2008.75	7	1.94	0.066	1917	1	
22185+5525	STI2688	13.1, 13.1	4.2	8.24	2008.75	7	0.12	0.010	1917	1	6
22185+5526	STI2687	9.5, 12.2	139.6	11.83	2008.75	7	0.19	0.043	2000	4	
22187+5521	STI2691	11.6, 13.1	168.5	4.17	2008.75	7	0.45	0.014	2000	2	
	A 1461AG		304.7	2.96	2008.75	6	2.95	0.397	New		7
22191+5607	HJ 1751AC	10.2, 10.5	267.7	16.72	2008.75	3	0.17	0.009	1999	9	
22191+5607	HJ 1751AD	10.3, 13.6	75.9	24.81	2008.75	7	0.11	0.079	2000	6	
22191+5607	HJ 1751CF	11.0, 13.0	32.6	8.74	2008.75	7	0.29	0.029	1987	2	
22191+5607	HJ 1751DF	13.6, 13.0	250.8	10.03	2008.75	7	0.17	0.037	2000	2	
22191+5607	HJ 1751AE	10.3, 13.6	27.1	25.60	2008.75	7	0.16	0.053	2000	4	
22192+5603	STI2696	12.4, 12.8	267.8	5.67	2008.75	6	0.2	0.034	2000	3	
22192+5605	STI2697	12.1, 13.1	354.2	7.74	2008.75	7	0.22	0.015	2000	2	
22200+5115	HU 980	8.5, 14.1	40.7	0.92	2008.75	7	5.11	0.216	1945	3	

Table continues on next page.

Neglected Double Star Observations Conducted at Kitt Peak Advanced Observer Program

Table 1 (continued): Summary data for doubles measured at Kitt Peak AOP ...

WDS ID	Discovr.	WDS mags	PA	SEP	Epoch	No.	PAsd	SEPsd	Last	Prev.	Notes
22200+5603	STI2706	13.2, 13.8	80.4	13.56	2008.75	7	0.23	0.046	1917	1	8
22203+5607	STI2708	9.8, 13.0	253.4	9.84	2008.75	7	0.23	0.046	1917	3	
22207+5606	STI2711	12.5, 13.1	91.2	12.39	2008.75	7	0.1	0.031	1917	1	
22213+5109	VBS 36AC	11.0, 11.4	103.0	47.02	2008.75	7	0.1	0.058	1998	3	
22213+5109	VBS 36AB	11.1, 12.5	8.0	12.19	2008.75	7	0.08	0.042	1998	2	
22217+5112	HJ 1757	10, 12							1828	1	9
22223+5657	STI2730	13.4, 13.4	155.3	6.71	2008.75	7	0.26	0.035	1917	1	
22237+5514	STI2744	12.1, 12.5	207.0	15.26	2008.75	7	0.12	0.022	2000	2	10
22239+5739	STI2749	11.4, 11.6	178.7	10.11	2008.75	7	3.7	2.762	2000	3	
22240+5740	STI2752	12.5, 13.1	22.9	8.31	2008.75	6	0.24	0.063	1920	1	11
22241+5523	STI2750	12.5, 13.1	175.5	4.04	2008.75	7	0.48	0.035	1917	1	
22247+5516	STI2759	12.5, 13.1	43.4	11.49	2008.75	7	0.25	0.044	2000	2	
22248+5518	STI2761	13.1, 13.1	2.1	11.77	2008.75	7	0.01	0.027	1917	1	
22249+5738	STI2762	11.1, 12.1	187.2	3.10	2008.75	6	1.31	0.282	2003	2	
22279+5600	STI2786AB	12.5, 13.1	48.8	18.90	2008.75	7	0.06	0.029	1917	1	
	STI2786AC		187.0	4.07	2008.75	7	0.32	0.123	New		12
	STI2786AD		96.9	6.55	2008.75	7	0.17	0.035	New		12
22282+5603	STI2790	11.6, 12.6	13.3	5.95	2008.75	7	0.13	0.037	1999	3	
22353+6025	STI1114	12.4, 12.4	35.1	14.64	2008.75	7	0.05	0.046	1907	1	
22388+5244	SMA 176AB	11.0, 12.0	19.0	17.26	2008.75	6	0.15	0.033	1911	1	
	SMA 176AC		295.0	7.17	2008.75	4	0.4	0.050	New		13
	SMA 176BD		110.7	6.83	2008.75	4	0.5	0.042	New		13
22395+5236	SMA 177AB	11.0, 12.0	76.1	10.88	2008.75	6	0.21	0.038	1911	1	
22410+5541	STI2841	14.1, 14.1	59.8	12.27	2008.75	7	0.12	0.047	1917	1	
22421+5445	ES 1027AB	10.0, 13.0	226.9	5.71	2008.75	7	0.75	0.115	1910	1	
22421+5445	ES 1027AC	9.0, N/A	170.3	8.29	2008.75	7	0.44	0.030	1910	1	14
22427+5446	STI2846	13.2, 14.7	23.6	15.83	2008.75	7	0.09	0.044	1917	1	
22437+5451	ES 1029	9.5, 14.2	86.6	5.83	2008.75	7	0.6	0.245	1910	1	
22469+5637	STI2857	11.1, 12.6	156.6	7.77	2008.75	7	0.43	0.039	1917	1	
22482+5704	STI2861	12.6, 12.6	162.3	6.66	2008.75	6	0.76	0.048	2000	2	
	STI2865AC		332.7	10.15	2008.75	5	0.36	0.044	New		15
22496+5656	STI2865AB	12.0, 12.6	23.0	8.67	2008.75	6	0.51	0.047	1917	1	
22501+5621	STI2869	9.0, 12.6	250.4	13.98	2008.75	7	0.29	0.062	2000	2	
22503+5652	STI2871	11.3, 11.7	9.0	4.42	2008.75	5	0.19	0.030	2003	3	
22514+5619	STI2876	12.6, 12.6	59.0	12.38	2008.75	7	0.39	0.087	1917	1	
22519+5620	STI2877AB	12.6, 12.6	28.7	11.96	2008.75	7	0.35	0.089	2000	2	
22519+5620	STI2877BC	12.6, 12.6	83.8	3.74	2008.75	7	0.73	0.155	2000	2	
22538+5459	STI2895	12.2, 12.6	137.6	12.28	2008.75	7	0.23	0.035	1917	1	
22543+5747	STI2897	12.3, 12.3	163.4	14.08	2008.75	6	0.13	0.073	1904	1	

Neglected Double Star Observations Conducted at Kitt Peak Advanced Observer Program

Table 1 Notes:

1. The HJ 1718AB and ABH 157 group appear in the CCD images to perhaps be a coarse open cluster. It looks as if there are two actual doubles: HJ 1718AB and the pair no one measured until now, HJ1718BD. See Figure 2.
2. STI 2608. Check star. J. Daley reported PA 40.6 and SEP 7.23 on 2006.860. *JDSO* **3**:75
3. STI 2675 "A" is USNO 2150/29353.
4. STI 2681. CCD image shows "A" and "B" reversed. Raw instrumental mags; A 13.77, B 12.69.
5. STI 2685. Listed position in WDS appears to be USNO 2150/35297, which is not a member of the pair. STI 2685 "B" is USNO 2150/35139, catalog position 22:17:52.75 + 54:51:50.0. Canopus plate solution gives "A" at 22:17:52.36 +54:51:47.6, "B"at 22:17:53.16 +54:51:51.2
6. STI 2688. Listed position in WDS appears to be USNO 2006/23241, catalog position 22:18:22.18 +55:25:39.0, which is not a member of the pair. Canopus plate solution gives "A" at 22:18:31.5 +55:24:38.5. "B" at 22:18:31.0 +55:24:46.6.
7. A1461. AB pair was too close to measure. "A" has a 13.88 (raw instrumental magnitude) companion measured here. See Figure 3.
8. STI 2706. "A" and "B" reversed in CCD image. "A" is USNO 2007/160, catalog mag 14.66, "B" is USNO 2007/251, catalog mag 11.69.
9. HJ 1757. Not found at listed position. No obvious candidates near that location. In the CCD image, there are a number of nearby doubles, but none are even close to the reported PA and SEP.
10. STI 2744. "A" and "B" reversed in CCD image. "A" is USNO 2007/12060, catalog mag 13.35. Canopus reports "B" raw instrumental mag 12.26.
11. STI 2752. "A" and "B" reversed in CCD image. "B" is USNO 2007/13317 catalog mag 11.41. Canopus give "A" raw instrumental mag 12.11.
12. STI 2786. CCD image shows "A" has two companions "C" and "D". Raw instrumental mags are 16.29 and 16.44 respectively. See Figure 4.
13. SMA 176. "A" is USNO 2152/29837. Both "A" and "B" components have companions. "C" and "D" have raw instrumental mags of 16.40 and 16.13 respectively. See Figure 5.
14. ES1027 AC. "C" magnitude is not listed in WDS. Canopus gives raw instrumental magnitude of 14.93
15. STI 2865 "B" has companion "C" . Canopus gives raw instrumental mag of 14.73. See Figure 6.

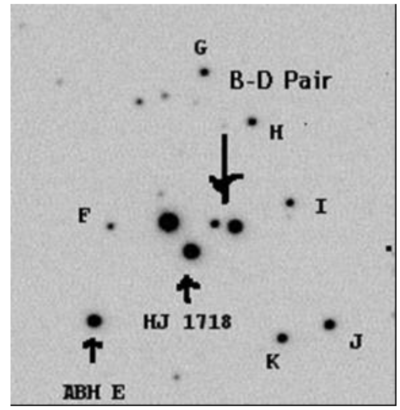

Figure 2: HJ 1718AB and BD pair. ABH157 E through K also marked.

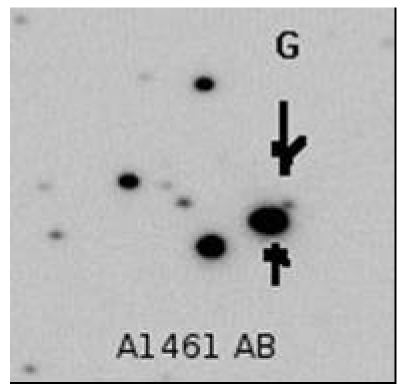

Figure 3: A1461AB appears elongated. Image shows new companion "G"

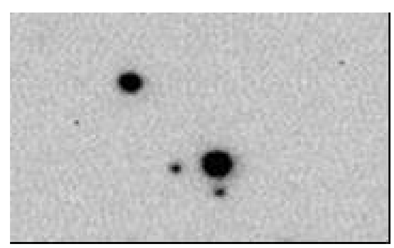

Figure 4: STI 2786 with new measured companions "C" and "D".

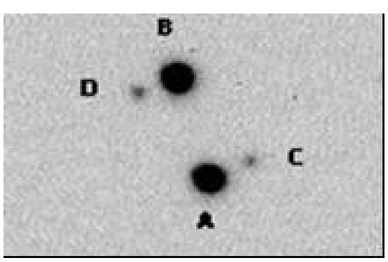

Figure 5: SMA 176 with new companions "C" and "D"

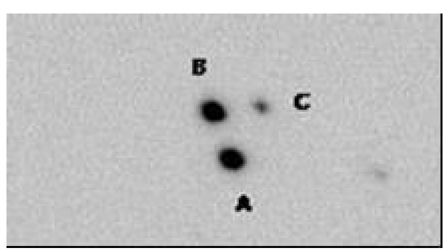

Figure 6: STI 2865 with new companion "C"

Table 2: Summary data for new doubles discovered are reported. Data marked with asterisks (*) is the arithmetic mean of the measures supplied by Canopus' plate solution and photometry routines. The magnitudes are the raw instrumental measures taken with a clear filter. The data reported should NOT be considered precision astrometry or photometry. PAsd and SEPsd refer the the standard deviations of the results based on the number (No.) of images measured. USNO 2.0 catalog numbers are given for the primary.

Name	RA (P)*	DEC (P)*	USNO-2.0	Ins. Mag S, P *	PA	SEP	Epoch	No.	PAsd	SEPsd
7	22:22:17.50	56:53:14.60	1425-13286071	12.4, 12.2	76.0	5.12	2008.75	7	0.25	0.04
1	22:23:59.69	57:40:48.30	1425-13336933	12.3, 10.7	306.2	4.99	2008.75	7	0.31	0.04
2	22:24:51.97	57:38:10.50	1425-13368133	13.4, 12.0	188.6	2.70	2008.75	7	1.09	0.18
4	22:27:01.77	56:05:08.30	1425-13438519	13.2, 11.0	116.8	7.61	2008.75	7	0.08	0.02
3	22:40:11.76	52:34:11.60	1425-13846340	12.6, 11.2	306.6	9.37	2008.75	7	0.24	0.06
5	22:46:49.50	56:33:42.00	1425-14048943	11.5, 10.6	198.4	2.72	2008.75	5	1.10	0.13
8	22:50:11.97	56:25:06.20	1425-14149016	11.4, 11.2	126.8	2.86	2008.75	6	1.12	0.13
6AB	22:51:54.39	54:56:46.50	1425-14198161	13.6, 11.0	351.0	11.74	2008.75	7	0.30	0.06
6AC	22:52:16.70	54:59:34.70		13.6, 9.6	260.5	9.12	2008.75	7	0.67	0.06

(Continued from page 136)

Kitt Peak National Optical Observatory Visitors Center Advanced Observer Program. (http://www.noao.edu/outreach/aop/)

Mason, B.D. 2006. Requested double star data from the U.S. Naval observatory, JDSO. 2:21-35.

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The author is a retired Federal Civil Service employee who enjoys learning about double stars, hiking, snow shoeing and target shooting. He resides in southern New Hampshire with his wonderful wife Luann, who tolerates him being lost in space most of the time.

Results of Measurements for Struve and Baillaud Stars

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Abstract: In this paper I report the measurements of the pairs whose parameters (Rho and Theta) have not been updated for a long time. I made use of digitized plates from several photographic surveys downloaded from Internet and the astrometric software FV

Introduction

Looking up neglected double stars in the Washington Double Star Catalog (Mason, Wycoff & Marcoff, 2006 ;hereafter WDS), I chose those systems, observed by F.G.W. Struve (Σ STF) and one by R. Baillaud, whose parameters have not been updated for a long time (at least 50 years).

For this work, I used the NASA free software FV (http://heasarc.gsfc.nasa.gov/docs/software/ftools/fv/fv_download.html) and the digitized plates from Digitized Sky Survey (hereafter DSS; http://stdatu.stsci.edu/cgi-bin/dss_plate_finder), SuperCosmos Sky Survey (hereafter SCSS; http://www-wfau.roe.ac.uk/sss/) and Two Micron All Sky Survey (hereafter 2MASS; http://irsa.ipac.caltech.edu/).

For the measures, the software FV has a tool named Ruler with which I made, manually, the measurements of every plate. To decrease the mean error in the measures, I took 10 measurements by plate. After, they were processed in a statistical software, obtaining average value and standard deviation. The results of these measurements are given in Table 1.

Additionally, from historical measures of WDS and my measures, I fitted in, using linear adjustment, the annual relative proper motion (both RA and DEC) in those system that have enough measures allowing such adjustment.

Results

STF 565AD(WDS 04381+4207)

See Figure 1. According to historical data of WDS, this pair was observed the first time in 1896 (Rho: 69.96”, Theta: 51.7º; Epoch: 1896.13) (Urban et al. 1998). The last measure was performed in 1910 by Farman (1907) (Rho: 71.62”, Theta: 52.1º; Epoch: 1906.02). In 14 years, before our measurements, Rho changed 1.66” and Theta 0.4º

This system is composed by two stars with magnitudes (The Tycho Reference Catalog, Hog et al. 1998) of 7.53 and 11.3. The value of magnitudes in infrared bands (2MASS Cutri et al. 2003, herafter 2MASS) are J:5.11; H: 4.69; K:4.47 (component A) and J:10.76; H: 10.69; K:10.61 (component D).

The annual proper motion for the primary component is $\mu(\alpha) = 55.2 \pm 1.6$ mas*yr^{-1} and $\mu(\delta) = -58.3 \pm 1.3$ mas*yr^{-1} (TYCHO-2, Hog et al. 2000, hereafter TYCHO-2); and for the other, $\mu(\alpha) = -9 \pm 1.1$ mas*yr^{-1} and $\mu(\delta) = 0.8 \pm 0.7$ mas*yr^{-1} (UCAC2, Zacharias et al. 2004, hereafter UCAC2).

Their different proper motion shows its optical nature. Still, I calculated the relative proper motion for this system (from historical data of WDS and our

(Continued on page 144)

Results of Measurements for Struve and Baillaud Stars

Table 1: Results of the measurements.

Discoverer	RA+DEC	Mag 1	Mag 2	PA (deg)	Sep (as)	Epoch	Notes
STF 565AD	04381+4207	7.55	11.3	48.5	70.63	1994.030	3
				45.8	69.54	1998.854	2
STF 629	05328+8324	9.08	11.04	20.5	18.46	1955.074	1
				23.8	20.53	1983.846	1
				27.5	21.10	1998.056	1
STF1104AC	07294-1500	6.02	11.59	185.9	21.50	1999.061	2
STF 1257	08466+6527	7.73	11.20	133.8	26.56	1954.894	1
				141.0	27.19	1984.167	1
				142.6	27.41	1998.016	1
				142.3	27.61	1999.193	1
				143.1	27.80	2000.154	1
				143.0	27.65	2000.206	2
STF 1845	14237+6159	8.35	11.30	312.5	39.13	1953.202	1
				312.8	39.15	1955.203	1
				311.9	42.12	1984.099	1
				311.6	41.41	1984.165	1
				311.9	42.50	1990.076	1
				311.5	42.95	1991.207	1
				312.0	42.77	1992.321	1
				311.5	43.30	1995.253	1
				311.8	43.26	1995.308	1
				311.7	43.03	1996.146	1
				311.1	43.59	1996.438	1
				311.5	42.89	1997.217	1
				311.7	42.71	1997.268	1
				311.3	42.77	1997.296	1
				310.9	42.87	1997.531	1
				311.3	42.86	1999.270	2
STF 1876AC	14464-0723	7.90	12.70	296.2	56.91	1953.451	1
				293.4	51.55	1983.347	1
				293.1	50.84	1986.484	1
				293.0	50.62	1989.324	1
				292.6	48.81	1996.297	1
				292.2	48.39	1999.301	1

Table continues on next page.

Results of Measurements for Struve and Baillaud Stars

Table 1, continued: Results of the measurements.

Name	RA+DEC	Mag 1	Mag 2	PA (deg)	Sep (as)	Epoch	Notes
STF 2042	16258+0542	8.57	11.43	117.0	16.25	1950.294	1
				122.1	12.78	1983.452	1
				122.5	12.78	1990.385	1
				122.8	11.74	1993.391	1
				125.9	11.29	1997.293	1
				125.6	10.81	1999.305	2, 4
BAL 2913	18066+0452	12.52	12.76	14.99	12.82	1950.518	1
				15.04	12.76	1982.478	1
				15.42	12.58	1983.674	1
				13.68	12.87	1988.362	1
				14.80	12.69	1991.456	1
				15.61	12.42	1993.566	1
				14.24	12.40	1999.548	2
STF 2952AC	22542+2801	7.74	10.41	244.7	171.00	1954.656	1
				244.5	168.14	1982.880	1
				244.4	167.75	1986.839	1
				244.4	167.31	1989.531	1
				244.5	167.81	1990.806	1
				244.3	167.20	1991.754	1
				244.5	166.58	1992.652	1
				244.4	167.65	1994.678	1
				244.5	167.29	1995.650	1
				244.5	167.58	1995.716	1
				244.4	167.15	1997.873	2

Table Notes

1. DSS
2. 2MASS
3. SCSS
4. Revised by Francisco Rica (coordinator of LIADA's Double Star Section, in a private communication)

Results of Measurements for Struve and Baillaud Stars

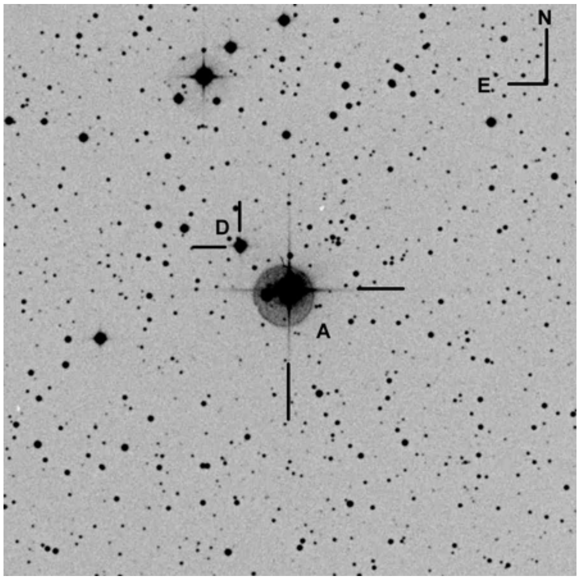

Figure 1: SCSS Image for STF565AD, January 11th, 1994

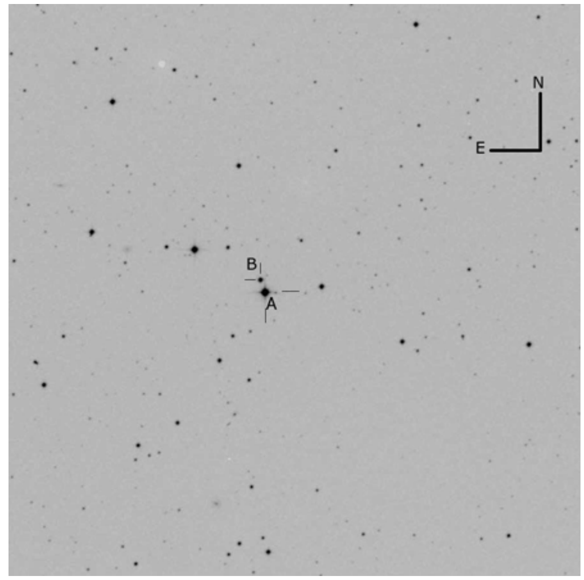

Figure 2: DSS Image for STF 629, January 21st, 1998

(Continued from page 141)

measures) to confirm or not its optical nature: $\Delta\mu(\alpha)$ = -57.3 ± 9.5 mas*yr^{-1} and $\Delta\mu(\delta)$ = 55.36 ± 5.6 mas*yr^{-1}.

STF 629 (WDS 05328+8324)

See Figure 2. This pair was first measured in 1832 by F. G. Wilhelm Struve (Rho:13.16"; Theta: 342.1º; Epoch: 1832.77) (Struve 1837). The last measure dates in 1999 (Cutri et al., 2003). In between the last measure was done in 1911 by K. Schiller (Rho:16.30"; Theta: 7.5º; Epoch: 1911.31)(Schiller 1913)

The system is composed of two stars of magnitudes 9.08 and 11.04 (The Hipparcos and Tycho Catalogues ESA 1997, hereafter HIPPARCOS/TYCHO). Additionally, their IR bands value are the next (2MASS, Cutri et al. 2003):

For A: J:7.77 ; H: 7.46; K: 7.40

For B: J:10.61 ; H: 10.45; K: 10.37

The annual proper motions (HIPPARCOS) for the primary and secondary component are, respectively, $\mu(\alpha)$ = -58.76 ± 0.84 mas*yr^{-1} and $\mu(\delta)$: -43.06 ± 0.93 mas*yr^{-1}; and $\mu(\alpha)$: -28.8 ± 39.2 mas*yr^{-1} and $\mu(\delta)$: -12.2 ± 38.2 mas*yr^{-1}.

Their very different proper motion indicates its optical nature. In addition, the high relative proper motion, $\Delta\mu(\alpha)$: 82.6 ± 1.6 mas*yr^{-1} and $\Delta\mu(\delta)$: 40.1 ± 2.8 mas*yr^{-1}, confirms that nature.

STF 1257 (WDS 08466+6527)

See Figure 3. This pair was first measured in 1893 (Rho: 26.49"; Theta: 120.8º; Epoch: 1893.21)(Urban et al. 1998). The last measure dates from 1905 (Rho: 26.05"; Theta: 124.3º; Epoch: 1905.33) by S.W. Burnham (Burham 1906).

According to TYCHO/HIPPARCOS catalog, the magnitudes for primary and secondary components are, respectively, 7.84 and 11.20. Their IR magnitudes in J, H, K bands are (2MASS):

For A: J:5.87 ;H:5.31 ;K:5.19

For B: J:10.76 ;H:10.40 ;K:10.34

With respect to their proper motion, the only available value is for primary component, $\mu(\alpha)$: 30.62 ±

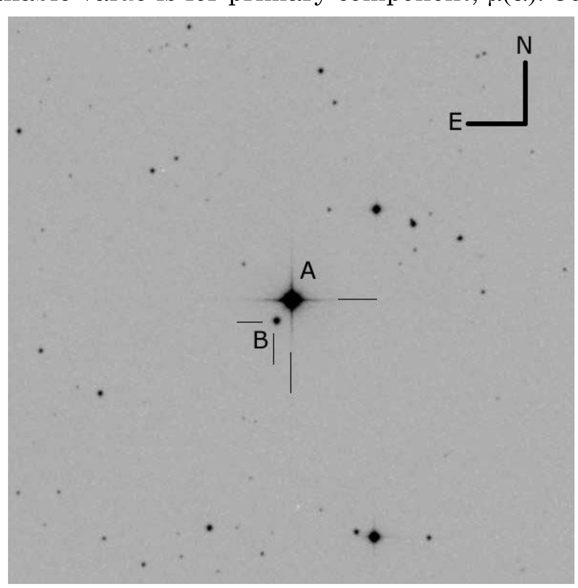

Figure 3: DSS Image for STF 1257, February 26th, 2000

Results of Measurements for Struve and Baillaud Stars

0.62 mas*yr^{-1} and μ(δ): 25.01 ± 0.6 mas*yr^{-1} (HIPPARCOS). Thus, to get more information about its nature, we calculated the annual relative proper motion from the historical data of WDS and our measures, obtaining: Δμ(α): -54.63 ± 1.72 mas*yr^{-1} and Δμ(δ): -80.37 ± 1.48 mas*yr^{-1}. This high value indicates that it is an optical pair.

STF 1845 (WDS 14237+6156)

See Figure 4. This pair was measured the first time in 1906 by S.W. Burnham (Rho:34.38"; Theta: 313.8º; Epoch: 1906.15) (Burnham 1906) and the last measurement, was in 1908 (Rho:34.66"; Theta: 315.1º; Epoch: 1908.42)(Urban et al. 1998)

The magnitudes for the primary and secondary components are, respectively, 8.35 and 11.30. In IR (2MASS), their magnitudes in the different bands are:

For A: J:7.31 ;H:7.12 ;K:7.08

For B: J:10.87; H:10.50 ;K:10.45

The proper motion, from Hipparcos is only available for the primary component: μ(α): 28.58 ± 0.54 mas*yr^{-1} and μ(δ): -6.47 ± 0.69 mas*yr^{-1}. Using the historical data requested to WDS database and our own measurements, I calculated the relative proper motion for this system, obtaining: Δμ(α): -82.62 ± 2.1 mas*yr^{-1} and Δμ(δ): 47.0 ± 2.1 mas*yr^{-1}. The high value indicates its optical nature

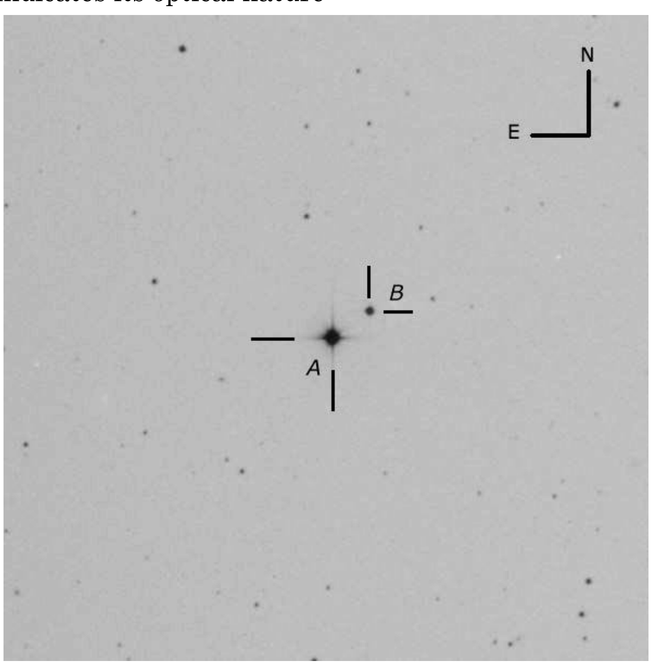

Figure 4: DSS Image for STF 1845 February 13th, 1997

STF 1876AC (WDS 14464-0723)

See Figure 5. According to historical data of WDS, this system has been measured 5 times. The first time was in 1891 (Rho: 70.66"; Theta: 302.2º; Epoch: 1891.39)(Hough 1906). The last measurement is dated in 1999 (Rho: 48.27"; Theta: 292.0; Epoch: 1999.21) (2MASS).

This pair is composed of two stars of magnitudes 7.89 (TYCHO) and 12.70 (NOMAD Catalog, Zacharias et al. 2005, herafter NOMAD). The magnitudes in infrared bands (2MASS) are J: 6.71; H: 6.47; K: 6.39 (component A) and J:11.47; H: 11.13; K:11.01 (component C).

The proper motion for both components comes from different catalogs. For primary, μ(α): -10.0 ± 2.4 mas*yr^{-1} and μ(δ): -107 ± 2.6 mas*yr^{-1} (PPMS, Bastian & Roeser 1993; hereafter PPMS), and for D μ(α): -2 ± 1 mas*yr^{-1} and μ(δ): -38 ± 4 mas*yr^{-1} (USNO B-10, Monet et al. 2003, hereafter USNO B-10)). However, I calculated, using our own measures and the historical data of WDS, the annual relative proper motion for this system, Δμ(α) = 136.65 ± 3.95 mas and Δμ(δ): -174.04 ± 6.06 mas. The large difference in the individual proper motions (and the annual relative proper motion) indicates its optical nature.

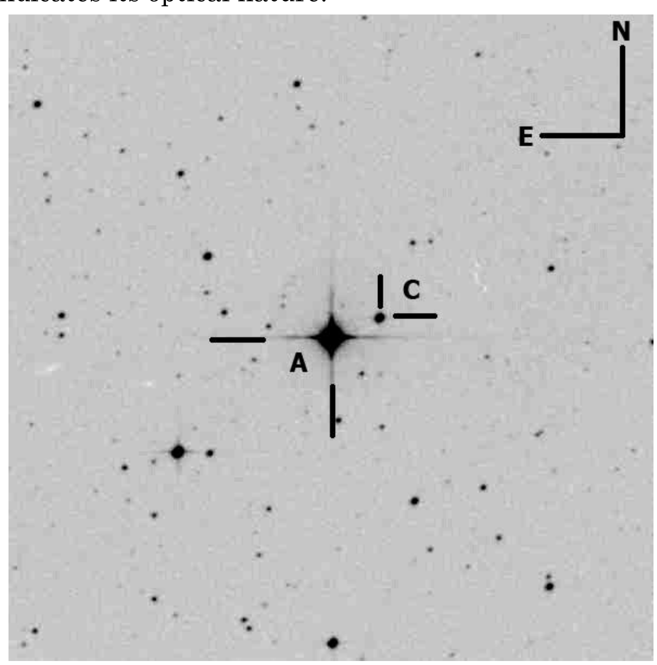

Figure 5: DSS Image for STF 1876AC, Avril 20th, 1999

STF 2042 (WDS 16258+0542)

See Figure 6. This pair has been measured three times, the first being in 1901 (Rho: 20.35"; Theta: 108.9º; Epoch: 1901.39) (Burnham 1903). Recently, one more measurement appeared in the historical data of the WDS: in 2007 (Rho: 10.19"; Theta: 128.5º;

Results of Measurements for Struve and Baillaud Stars

Epoch: 2007.440; Mason, Hartkopf & Wycoff 2008).

This system is composed of two stars of magnitudes 8.57 and 11.43 (TYCHO-2). Their magnitudes in infrared bands are: J: 7.64; H: 7.50; K: 7.39 (Primary component) and J: 9.37; H: 8.71; K: 8.56. (2 MASS)

The proper motions of both stars were obtained from the HIPPARCOS catalog. The A component shows a motion: $\mu(\alpha)$: 37.7 ± 9.3 mas*yr^{-1} and $\mu(\delta)$: -41.9 ± 9.1 mas*yr^{-1}; and the B component, $\mu(\alpha)$: -2.5 ± 2.8 mas*yr^{-1} and $\mu(\delta)$: -3.4 ± 2.7 mas*yr^{-1}. The large difference in their motion indicates the optical nature for this pair. (The calculated annual relative motion proper is: $\Delta\mu(\alpha)$ = -104.59 ± 3.67 mas and $\Delta\mu(\delta)$: 2 ± 3.97 mas)

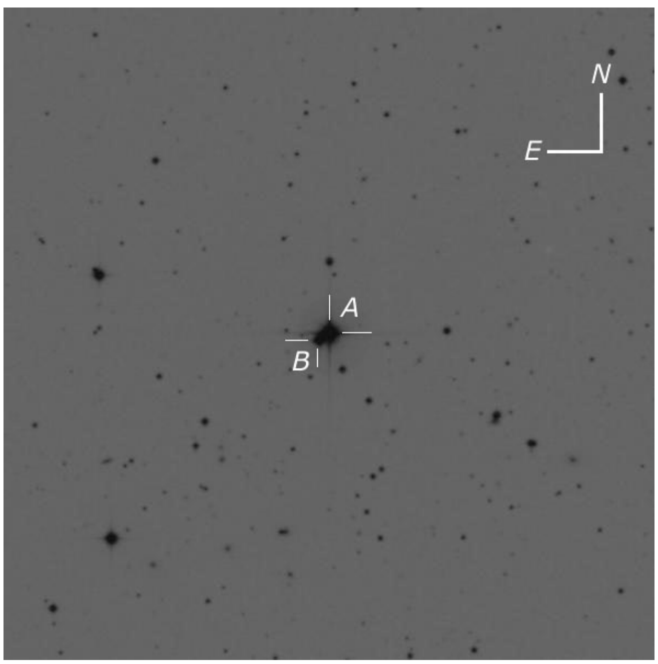

Figure 6. Digitized Sky Survey Image for STF 2042, May 23st, 1993

BAL 2913 (WDS 18066+0452)

See Figure 7. This double star was observed by R. Baillaud in 1910 (Rho: 12.2", Theta: 15.6°; Epoch: 1910.45)(1943). In 2007, a last measure appears in the historical data from WDS (Rho: 12.54"; Theta: 14.2"; Epoch: 2007.470; Mason, Hartkopf & Wycoff 2008). In 97 years, before our measurements, Rho had changed 0.34" while Theta 1.4°.

This system is composed of two stars with similar magnitudes (A: 12.52; B: 12.76, WDS). In the J, H, K bands are not very different. So, A (J: 11.63; H: 11.43; K:11.35) and B (J:11.97; H: 11.83; K:11.75).

According to UCAC2, the annual proper motion for the primary component is $\mu(\alpha)$ = 0.3 ± 2 mas*yr^{-1} and $\mu(\delta)$ = -8 ± 1.9 mas*yr-1 ; for the secondary, $\mu(\alpha)$ = 0.2 ± 2 mas*yr^{-1} and $\mu(\delta)$ = -4.2 ± 1.9 mas*yr^{-1} Additionally the calculated relative proper motion for this system is: $\Delta\mu(\alpha)$ = -2.16 ± 1.55 mas*yr^{-1} and $\Delta\mu(\delta)$ = 3.62 ± 3.13 mas*yr^{-1} . Could it be a physical pair?

The difference between their visual brightness is only 0.24 magnitudes, while their J-H and H-K colors are very similar; for the primary, J-H = 0.20; H-K = 0.08; and the secondary, J-H = 0.14; H-K = 0.08. This may mean both components are very similar.

The parallax value for the primary component (HIPPARCOS) is 13.1 mas (76.3 parsecs). The parallax of the secondary is not available.

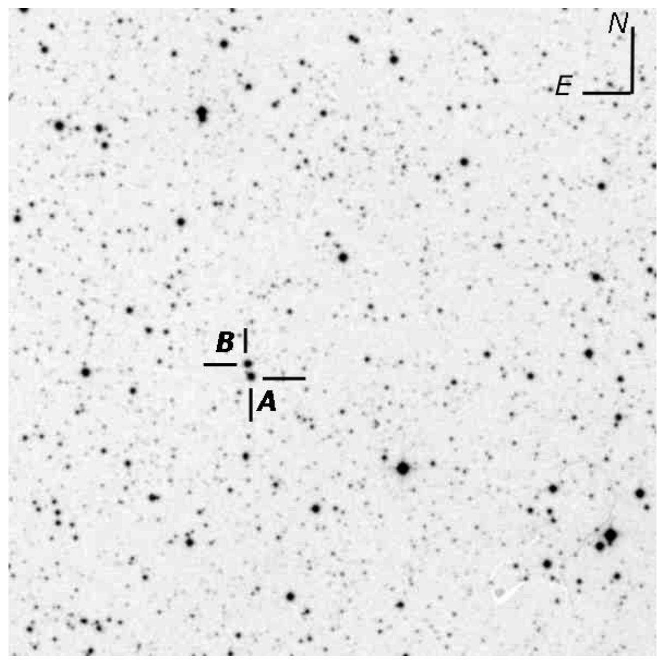

Figure 7: DSS Image for BAL 2913 , July 26th, 1993

STF2952 AC (WDS 22542+2801)

See Figure 8. According to the historical data of WDS, this system has been measured in 5 times. The first time in 1925 (Rho: 200"; Theta: 230°; Epoch: 1925.94)(Opik 1927) . The last measurement is dated 2007 (Rho: 165.90"; Theta: 244.4°; Epoch: 2007.608) (Arnold 2008).

This pair is composed of two stars of magnitudes 7.74 and 10.43 (TYCHO-2). In the infrared bands, their magnitudes in J, H and K bands are 6.73; 6.54 and 6.49 (Component A); and 9.12, 8.81 and 8.74 (Component C)

The proper motions, from TYCHO-2, for both components are: $\mu(\alpha)$ = 65.3 ± 1.0 mas*yr^{-1} and $\mu(\delta)$ =

Results of Measurements for Struve and Baillaud Stars

— 37.6 ± 1.1 mas*yr^{-1} (A); $\mu(\alpha)$ = 35.5 ± 1.5 mas*yr^{-1} and $\mu(\delta)$: -13.7 ± 1.4 mas*yr^{-1} . For the C component, the relative proper motion is $\Delta\mu(\alpha)$ = 53.72 ± 12.94 mas*yr^{-1} and $\Delta\mu(\delta)$: 519.07 ± 129.45 mas*yr^{-1}.

This large difference in the proper motion of both stars indicates its optical nature.

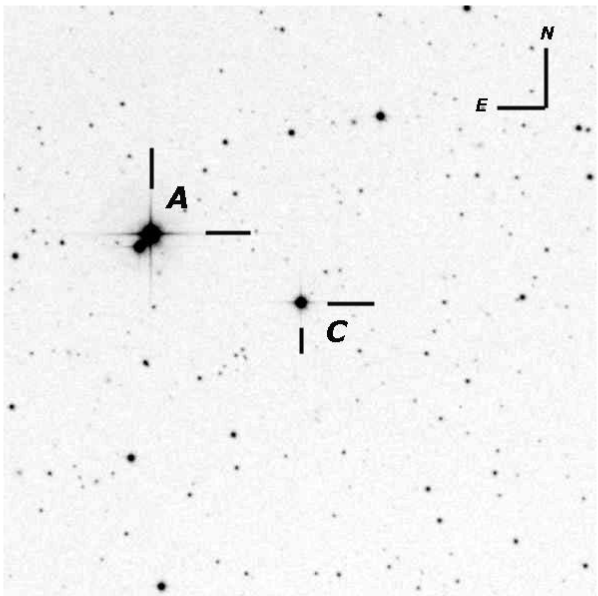

Figure 8: Digitized Sky Survey Image for STF 2952C, August 26th, 1995

Acknowledgements

This work has made use SIMBAD and VIZIER tools from CDS (http://cdsweb.u-strasbg.fr/)

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

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Software

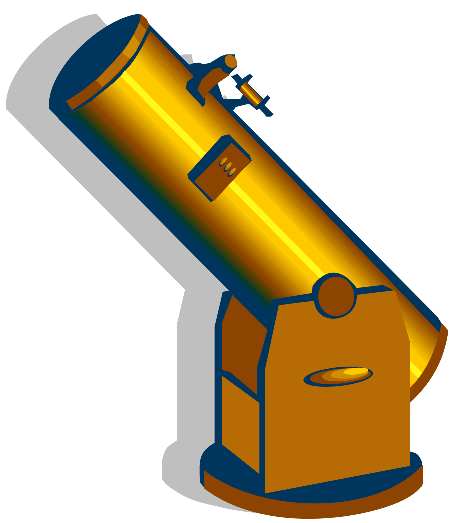
FV: http://heasarc.gsfc.nasa.gov/docs/software/ftools/fv/fv_download.html

Digtized Sky Survey: http://stdatu.stsci.edu/

SuperCosmos Sky Survey: http://www-wfau.roe.ac.uk/sss/pixel_intro.html

Two Micron All Sky Survey:http://irsa.ipac.caltech.edu/

Mr Ángel Manuel López has been a member of Agrupación Astronómica Madrid (www.aam.org.es) for seven years, where he is the coordinator of the double star section and a member of the solar section.



Ludwig Schupmann Observatory Measures of Large Δm Pairs - Part Three

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Abstract: This is the final report of a three part series devoted to the measurement of double stars having a large difference in stellar magnitude. Results are given in theta and rho space for 100 components lying in 47 systems. A comparatively small number of these pairs are physical, however, due to the typically large elapsed time since discovery, the cataloged proper motion values of their bright primaries may, in many objects, be further honed. A few measures of more usual pairs associated with these systems are also given such as the close, fast-moving binary pair called "Capella H".

Introduction

One may get an idea of the difficulties encountered in measuring large Δm pairs by reading the author's article in the Fall 2007 issue of the JDSO (Daley 2007). A description of the special tailpiece instrumentation employed to carry out these observation is also described there.

The visual discovery of these faint components is just amazing and shows just how keen-sighted these early observers were.

The Measures

The following data is listed in the conventional way. From left to right: the discoverer's designation, WDS identifier (Epoch 2000 RA & Dec), WDS mags rounded off to the first place (LSO unfiltered CCD "red" magnitudes in bold italics are Δm inferred from known stars in the system), LSO position angle in degrees, LSO separation in seconds of arc, decimal date of observation (note that these observations span mid October 2008 through late March 2009), number of nights observed and a notes column. In the notes column "neglected pair" entries such as "8m84" signifies 8 previous measures, the last being 84 years ago. Other self explanatory items, perhaps of interest, appear in this column. Extensive notes are also indicated in the notes column and appear at the end of the article. Most measures are the mean of at least 12 CCD frames. Images made with the stellar coronograph of some of the doubles are at the end of this article.

Future Plans

Development of a more powerful stellar coronagraph is underway at LSO. The chief aim being to measure much closer pairs, such as Procyon AB and similar difficult objects. This new instrumentation will be part of a 14-inch Schupmann medial, now nearing completion. In the meantime, the present telescopic system, a 9-inch Schupmann medial, will be used to image the few remaining large Δm systems in the original obs list that was kindly provided by Dr. Brian Mason of the USNO. These results will be worked into upcoming reports of mostly "normal" systems.

Epilogue

With 1,000 plus measures published, I enter my 11th year of double star observations. Now and then I have pondered dreamily: will the future of amateur double star work lean toward specialized observations as more and more powerful astrometric satellites record nearly every double in the sky to accuracies unimaginable? Will we all become "data miners" (many already have)? What is the future of earth-based visual double star astrometry? Even the data miners could go extinct as doubles are machine analyzed, automatically computing orbits, spectral classes and component masses by the millions! From this the astrophysicists will benefit tremendously, surprising us with crisper theories of galactic formation and evolution.

My guess is that, with professional guidance, we who love observing under the stars will find a place to fit in meaningfully for a long time to come.

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

Table 1: Measures made at Ludwig Schupmann Observatory

Discoverer	RA+DEC	Mags	PA	Sep	Date	n	Notes
BUP 3 AB	**00132+1511**	**2.8 11.8**	**285.1**	**163.57**	**2008.915**	**1**	**Gamma Peg**
BUP 3 BC	00132+1511	11.8 12.4	195.2	20.08	2008.915	1	
HJ 1953 AB	00194-0849	3.5 12.9	18.0	68.37	2008.915	1	Iota Cet
HJ 1953 AC	00194-0849	3.8 8.6	191.0	106.25	2008.915	1	
BU 499 AC	00567+6043	2.2 12.9	345.3	53.35	2009.055	1	Gamma Cas
BU 505	01240-0811	3.6 14.8	49.3	78.93	2009.057	1	8m85, Theta Cet
BUP 19	01258+6014	2.7 11.5	59.2	110.33	2009.055	1	2m84, Delta Cas
STF 93 AB	02318+8916	2.1 9.1	231.5	18.19	2009.208	1	Polaris
STF 93 AC	02318+8916	2.1 13.8	97.6	38.73	2009.208	1	
STF 93 AD	02318+8916	2.1 13.0	188.5	82.09	2009.208	1	
BUP 34 AB	02506+3819	4.3 12.8	122.6	76.66	2009.085	1	16 Per
EDG 1 Aa-B	02543+5246	4.0 12.3	107.3	51.58	2009.057	1	Tau Per
BU 1376 Aa-C	02543+5246	4.0 12.7	106.4	55.46	2009.057	1	1m131
BU 1376 BC	02543+5246	10.7 11.8	86.4	4.17	2009.057	1	2m89
BU 526 Aa-B	03082+4057	2.0 12.7	155.5	58.51	2009.071	1	Algol
BU 526 Aa-C	03082+4057	2.0 12.5	146.3	67.72	2009.071	1	
BU 526 Aa-D	03082+4057	2.0 10.5	192.9	81.67	2009.071	1	
BU 526 Aa-E	03082+4057	2.0 12.5	185.9	85.52	2009.071	1	
DAL 46 Aa-F	03082+4057	2.0 13.7	111.2	93.23	2009.071	1	new component
DAL 46 FG	03082+4057	13.7 14.7	283.4	6.19	2009.071	1	CCD pair
ES 2596	03095+4451	4.0 13.5	318.8	44.06	2009.088	1	3m76, Kappa Per
HL 7 AB	03449+2407	3.7 13.	143.7	99.52	2009.079	1	Electra
HL 7 AC	03449+2407	3.7 13.	121.5	142.72	2009.079	1	
ES 2601 AB	03452+4235	3.8 11.9	49.9	31.56	2009.088	1	Nu Per
STG 3 AC	03452+4235	3.8 13.0	185.8	55.67	2009.088	1	1m85
DAL 47 Aa	03452+4235	3.8 13.8	71.9	22.77	2009.088	1	new component
DAL 47 Bb	03452+4235	11.9 14.3	267.6	7.74	2009.088	1	new component
HJ 3251 AB	03452+2428	4.3 8.1	329.0	71.50	2009.104	1	Taygeta
HL 9 AC	03452+2428	4.3 14.	53.9	52.08	2009.104	1	
HL 11	03458+2422	3.9 13.	73.3	112.43	2009.104	1	Maia

Table continues on next page.

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

Table 1, continued: Measures made at Ludwig Schupmann Observatory

Discoverer	RA+DEC	Mags	PA	Sep	Date	n	Notes
HL 29 Aa-B	03492+2403	2.9 13.	285.1	94.53	2009.111	1	Atlas
HL 29 Aa-C	03492+2303	2.9 15.	37.2	48.78	2009.111	1	
HL 29 Aa-D	03492+2303	2.9 14.	61.3	111.59	2009.111	1	1m124
DAL 48 DE	03492+2303	14. ***14.7***	122.5	5.41	2009.111	1	new component, see note 1
STF 464 AB	03541+3153	2.8 9.2	207.7	13.33	2009.111	1	Zeta Per, physical
STF 464 AC	03541+3153	2.8 11.2	286.3	32.83	2009.111	1	
STF 464 AD	03541+3153	2.8 10.4	195.3	98.28	2009.111	1	
STF 464 AE	03541+3153	2.8 10.0	185.5	119.95	2009.111	1	physical
SLV 2 BC	03541+3153	9.2 11.2	309.5	33.09	2009.111	1	
SLV 2 BD	03541+3153	9.2 10.4	193.4	85.44	2009.111	1	
STF 464 CD	03541+3153	11.2 9.9	177.0	104.24	2009.111	1	
STF 464 CE	03451+3153	11.2 9.9	171.2	130.26	2009.111	1	
STF 464 DE	03541+3153	10.4 10.0	149.5	28.59	2009.111	1	
STF 471 AC	03579+4001	3.0 13.9	10.3	79.94	2009.131	1	Epsilon Per
HJ 3608 AB	03580-1331	3.2 14.4	284.0	36.43	2009.129	1	Zaurak, see note 2
HJ 3608 AC	03580-1331	3.2 12.7	253.7	56.11	2009.129	1	
STT 73 AB	04149+4825	4.2 10.3	350.6	14.68	2009.123	1	9m29 Mu Per, see note 3
H 6 20 AC	04149+4825	4.2 10.4	233.8	83.27	2009.123	1	
STT 73 Ab	04149+4825	4.3 12.6	122.7	48.06	2009.123	1	
BUP 55 Aa-B	04230+1732	3.8 12.6	336.3	111.82	2009.131	1	Delta 1 Tau
STT 560 AB	04498+0658	3.2 11.3	168.5	73.90	2009.142	1	Pi 3 Ori
DAL 50 Aa	04498+0658	3.2 ***13.1***	5.3	22.15	2009.142	1	new component
BUP 74	05078-0505	2.8 10.9	136.5	116.82	2009.142	1	Beta Eri
BAR 25 AB	05167+4600	2.1 ***13.7***	6.7	89.83	2009.153	1	1m111, Capella, see note 4
BU 1392 AC	05167+4600	2.1 15.1	331.9	130.51	2009.153	1	1m131
BU 1392 AD	05167+4600	2.1 13.6	193.6	73.23	2009.153	1	1m131,
BU1392 AE	05167+4600	2.1 12.1	325.7	191.15	2009.173	1	2m101
HJ 2256 AF	05167+4600	0.2 10.2	135.7	109.19	2009.153	1	19m10
ST 3 HL	05165+4600	10.5 13.7	171.4	3.27	2009.173	1	18m10, “Capella H”
BUP 78	05251+0621	1.6 12.2	144.2	178.00	2009.194	1	Bellatrix

Table continues on next page.

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

Table 1, continued: Measures made at Ludwig Schupmann Observatory

Discoverer	RA+DEC	Mags	PA	Sep	Date	n	Notes
BUP 90 AB	06377+1624	1.9 11.2	296.4	140.50	2009.203	1	Gamma Gem
BUP 90 AC	06377+1624	1.9 10.9	334.8	148.05	2009.203	1	2m102
AGC 1 AB	06451-1643	-1.5 8.5	94.8	8.44	2009.197	1	Sirius, see note 5
DIC 1 AD	07393+0514	0.4	322.8	115.43	2009.216	1	17m25, Procyon
BU 580 AB	07453+2802	1.1 13.7	75.7	39.82	2009.208	1	6m109, Pollux
BU 580 AG	07453+2802	1.3 11.3	352.0	151.83	2009.208	1	
BUP 182 Aa-B	18211+7244	3.6 11.8	356.9	177.78	2008.792	1	3m94, Chi Dra
BUP 182 BC	18211+7244	11.8 13.3	303.0	9.30	2008.792	1	1m100, possible binary
BUP 198 AB	19463+1037	2.7 10.8	256.5	134.19	2008.800	1	Gamma Aql
DAL 44 AC	19463+1037	2.7 ***10.9***	329.1	65.61	2008.800	1	new component
DAL 44 AD	19463+1037	2.7 ***11.4***	267.3	53.54	2008.800	1	new component
DAL 27 AD	19508+0852	0.8 11.7	98.1	31.20	2008.800	1	Altair
H 6 27 Aa-B	20113-0049	2.2 13.0	259.3	115.80	2008.803	1	Theta Aql
BU 295 AB	20176-1230	4.2 14.1	211.9	53.19	2008.803	1	Alpha Cap
BU 298 Aa-B	20396+1555	3.9 13.4	231.5	35.28	2008.803	1	Alpha Del
HJ 1554 Aa-C	20396+1555	3.9 11.9	277.3	47.79	2008.803	1	
BU 298 Aa-D	20396+1555	3.9 12.9	159.5	45.55	2008.803	1	
BU 298 Aa-E	20396+1555	3.9 12.6	303.2	56.49	2008.803	1	
BU 298 Aa-F	20396+1555	3.9 10.7	117.7	72.62	2008.803	1	
H N 73	20414+4517	1.2 11.7	105.0	75.55	2008.803	1	Deneb
BUP 227 AB	21129+3014	3.2 11.6	205.3	65.57	2008.814	1	Zeta Cyg
BUP 227 AC	21129+3014	3.2 11.3	299.5	91.49	2008.814	1	
BUP 227 AD	21129+3014	3.2 12.6	62.8	104.61	2008.814	1	4m101
BU 1502 AB	21186+6235	2.5 11.5	17.6	197.21	2008.822	1	Alpha Cep
BU 1502 B-CD	21186+6235	10.4	164.5	21.94	2008.822	1	1m101
H 5 76 AB	21316-0534	2.9 11.0	318.6	37.01	2008.822	1	Beta Aqr
BU 73 AC	21316-0534	2.9 11.6	187.9	60.48	2008.822	1	
S 798 AB	21442+0953	2.4 12.7	322.3	82.73	2008.822	1	Epsilon Peg
BUP 232	22058-0019	3.0 12.2	39.8	109.96	2008.822	1	Alpha Aqr
HJ 3106	22217-0123	3.8 12.2	149.5	33.29	2008.822	1	Gamma Aqr

Table continues on next page.

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

Table 1, continued: Measures made at Ludwig Schupmann Observatory

Discoverer	RA+DEC	Mags	PA	Sep	Date	n	Notes
BU 702 AB	22292+5825	4.2 13.0	281.5	21.20	2008.882	1	6m47, Delta Cep
STF 58 AC	22292+5825	4.2 6.3	191.0	40.75	2008.882	1	Cal check, see note 6
DAL 45 AD	22292+5825	4.2 ***13.9***	38.3	108.48	2008.882	1	new component
DAL 45 DE	22292+5825	***13.9 14.0***	22.7	1.39	2008.882	1	neat close pair for a CCD
BU 703	22313+5017	3.8 11.8	286.2	45.83	2008.882	1	Alpha Lac
HJ 1842 AB	23038+2805	2.4 11.8	213.5	126.62	2008.882	1	Beta Peg
STF 12 A-BC	23159-0905	4.2 9.2	311.9	49.93	2008.833	1	Psi 1 Aqr, fixed
BU 1220 AD	23159-0905	3.2 13.5	273.4	110.07	2008.833	1	6m84, flying apart
BU 1220 BC-E	23159-0905	9.2 14.3	293.5	42.32	2008.833	1	6m84, flying apart
BUP 240 AB	23399+0538	4.1 13	305.4	122.59	2008.882	1	Iota Psc

Table Notes

1) DAL 48 DE forms a fairly close double, the primary of which is Asaph Hall's "D" component of Atlas. Somewhat surprisingly, Hall, the elder I presume, did not spot it but then again if "E" is a red star that would explain it. Figure 1 shows the system as imaged at LSO with the exposure best for the new pair's measure.

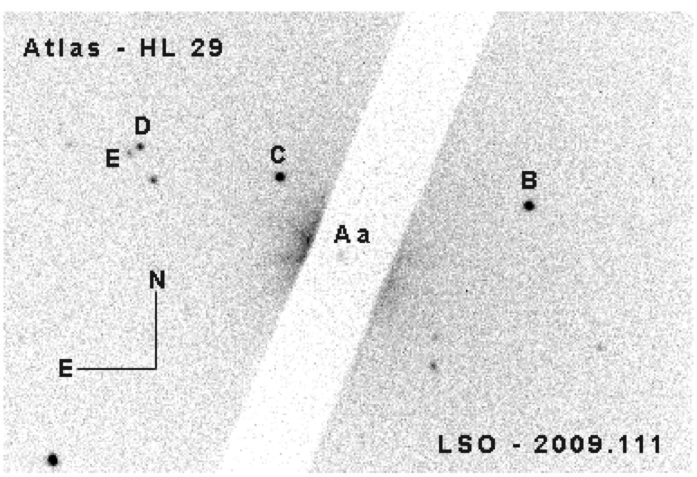

Figure 1

2) A faint component was found while measuring HJ 3608. Interestingly, it is very close to Herschel's original position for the secondary of PA 286 degrees and 30.0" separation. The fainter component is easily seen in the CCD image shown in Figure 2. The motion of the currently cataloged and well measured secondary is such that it could never have occupied the position of the original HJ 3608 measure. It therefore appears that the fainter component's position confirms John Herschel's original discovery and is in all probability cpm with the primary. Much later other observers picked up the more distant but brighter component providing a string of measures that show a linear apparent motion of 19.5" parallel to and agreeing with, the proper motion of the primary. Thus we now have HJ 3608 AB and AC.

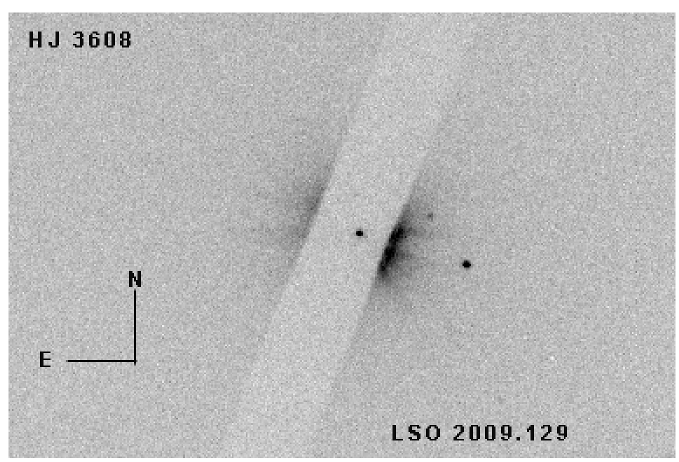

Figure 2

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

3) STT 73 AB is a common proper motion (cpm) pair. The LSO determination indicates that the position angle has changed little since the 1851 discovery; showing about a 1 degree increase. On the face of it the separation shows a small closing on the order of 0.3 arc seconds, however the measurement errors compete with this value as is also the case for PA but of a lesser extent (see below). The orbital period of the AB pair may be many thousands of years. It is nearly impossible to show A and B well in a single image range setting. In the actual measurment process it's easy to visually position the analysis box and set the area to determine individual component centroids by using the digital range and background adjustments in CCDOPS. I have therefore presented the image at two settings to give the reader not familiar with the process a fuller understanding of the operation I customarily use for these very difficult pairs. These adjustments do not affect the actual centroid calculations.

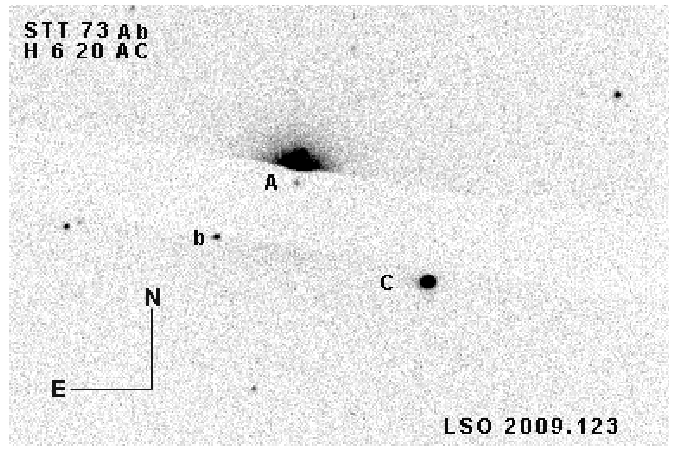

Figure 3A: STT 73

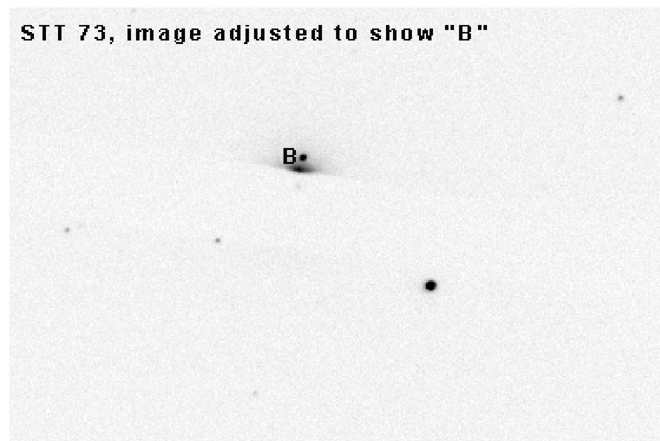

Figure 3B

The CCD image in Figures 3a and 3b also shows the additional two WDS listed components whose individual motions are not clearly parallel to the primary's cataloged proper motion vector. The standard deviation of the mean of my 11-plate measure of AB is 0.46 deg in PA and 0.26" in separation. This fascinating system may take another 100 years to sort out!

4) Capella, only 42 ly distant, is a most fascinating multiple star. In 1899 Campbell discovered Capella to be a double-lined spectroscopic binary from his observations at Lick Observatory and almost simultaneously and independently by Newall at University Observatory, Cambridge, England. Subsequent interferometric resolution by J.A. Anderson in 1919-20 with his tiny visual interferometer (Candler 1951) located just 2-feet inside focus of the 100-inch Hooker reflector, is a delightful and scientifically powerful story.

All but one of the cataloged faint companions are, without doubt, optical. The one exception is the most distant component, "Capella H". Discovered by R. Furuhjelm in 1895, this red dwarf is WDS listed as FRH 1AH and lies a full 12' from Capella with both apparently exhibiting the same space motion. Capella H lies well outside my camera's FOV so AH could not be measured, thus preventing a confirmation of Furuhjelm's single measure (nice project for data-miners).

In 1935 "H" was split by Charles L. Stearns (ST 3 HL) and this close pair has shown rapid orbital motion over the ensuing years. The primary of ST 3 HL is a relatively bright 10.2 magnitude class M1V and its rather faint secondary a class M5Vof 13.7magnitude. These visual magnitude estimates are by Charles E. Worley as mentioned in Burnham's Celestial Handbook.

Great care was taken in determining the theta and rho values for ST 3 HL reported here. Only the sharpest eleven images from a string of at least 100 CCD frames were measured for determining the mean, yielding a standard deviation for theta of 1.2° and 0.07" for rho. The eleven selected images were photometrically measured as well, giving an unfiltered delta m value of 2.27 ± 0.1. Being essentially an R-band measure of what are very red stars, I expect and do see a smaller delta m than the visual estimate.

Figure 4 is a cropped CCD image of Capella H and a neat close-by field star, the proper motion of which is on the order of 1 mas/yr. The field star's relative posi-

Ludwig Schupmann Observatory Measures of Large Δ m Pairs -Part Three

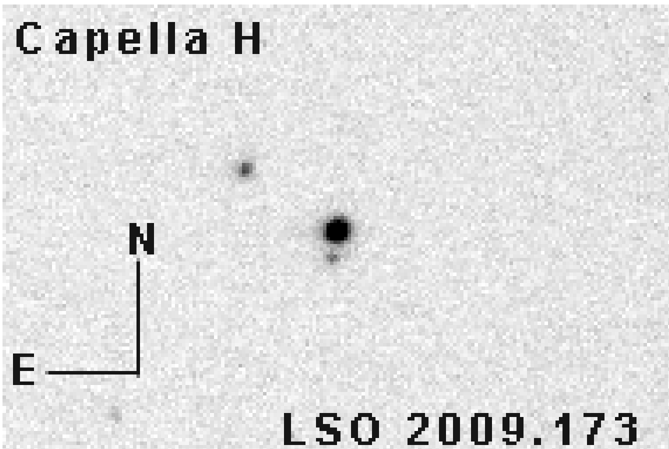

Figure 4

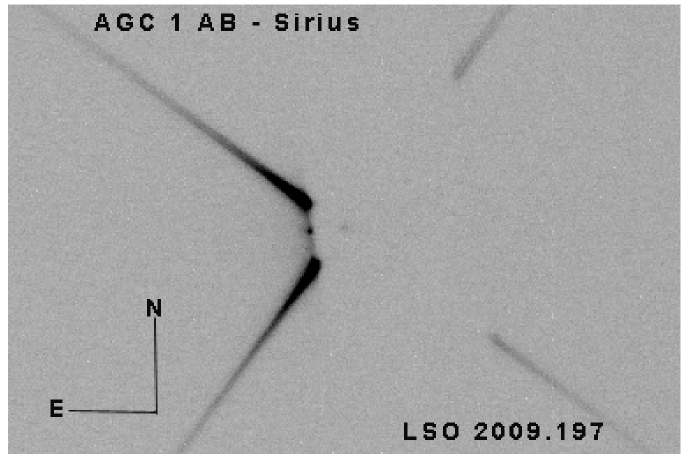

Figure 5

tion is PA = 56.1° and separation = 13.65" 2009.173). For various astrometric purposes, it may be useful to include this handy field star in future measures. Capella H is a great target for small CCD equipped telescopes. The position angle is presently changing about one half degree per year and the separation may have past its greatest extent so careful measures every few years should be interesting and rather valuable too.

A few words on Capella's optical components, three of which are LSO confirmations: using the first cataloged measures and the LSO measures reported here, the optical components AB and AE show a position shift parallel with the proper motion of Capella. Component AC is in slightly less agreement and for objects AD and AF even greater misalignment is observed. The problem may simply be the quality of the first measures, likely the 20 measures of AF, when plotted will give a better fit. The possibility of distinct proper motion of some of these faint components may also factor in.

5) AGC 1 AB - Measuring Sirius is usually tedious, primarily due to seeing conditions for such a low lying object as viewed from LSO. On the night of this measurement the seeing was superb for a short while and the "Pup" was a fine visual white dot steadily in view with the primary hidden behind the occulting filter. In an absolute panic, images were taken using the fast framing "focus mode", saving the best as they appeared. Finally 13 of the saved images were selected and used for analysis. Figure 5 shows a typical CCD image used for measurement. The exposure time was 0.25 seconds. A square aperture mask measuring 5.4-inches on a side was employed in conjunction with the stellar coronagraph for this and all other exposures of Sirius. The square aperture mask could have been rotated slightly to a more favorable angle in this example image but there was no time to lower the scope, make the adjustment, and get back on target before the seeing possibly degraded, which it did shortly after the data collection phase.

6) STF 58 AC is a cpm pair the primary of which is Delta Cephei, the classic (prototype) Cepheid variable. Over 58 measurements of the bright AC pair have been made over the years, thus a reasonably accurate relative position can be determined. The reason for including this measure in a large dm program is to afford the user a way of judging the general accuracy of the rarely observed large dm objects reported here. The pair is nearly fixed and plenty wide for the purpose. My listed separation measure, with a standard deviation of 0.132", is in good agreement with Hipparcos catalog data where a separation of 40.756" is calculated. Regarding position angles: all position angles in this range of separation are accurate to ± 0.1 degrees and are verified by performing full frame width drift calibrations for each system.

References

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Candler C., 1951, Modern Interferometers, Hilger & Watts Ltd., Hilger Division, pp 238-239.

Finding New Common Proper-Motion Binaries by Data Mining

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Abstract: This paper presents new common proper-motion binaries detected by applying well-known statistical criteria over large subsets of the astrometric catalogs available online. All the pairs have been confirmed by checking the photographic plates and are not included in the Washington Double Star Catalog. An initial measurement of separation and position angle has been obtained for each pair.

Editor's note: this paper underwent review by professional astronomers.

Introduction

Common proper-motion binaries (CPMBs from now on) are pairs of stars where the two components share noticeable and very similar proper motion. Although not all the CPMBs need to correspond to orbiting binaries, their similar motion is a first clue that points out these pairs as possible candidates to true binaries.

The purpose of this research was to find new CPMBs not detected up to now in the available astrometric catalogs. The idea, of course, is not new: it was used for instance by Greaves (2004), who detected 705 new pairs in the UCAC2 catalog (Zacharias N. et al., 2004). In this study, we use the catalog NOMAD and discriminate CPM pairs by using the statistical criteria presented by Halbwachs (Halbwachs, 1983). The NOMAD catalog includes data from different catalogs such as UCAC2, USNOB1 (Monet D. et al., 2003), Tycho2 (Hog E. et al., 2000) and others, and therefore it is not a primary source. However, from the point of view of data mining this combination of data seemed very convenient since it allows for relating stars of different catalogs.

The Data Mining Process

Our main selection criteria used for distinguishing the new pairs was Halbwachs' selection criteria for distinguishing physical and optical pairs from their proper motion:

$$(\boldsymbol{\mu}_1 - \boldsymbol{\mu}_2)^2 < -2\,(\sigma_1^2 + \sigma_2^2)\ln(0.05)$$
$$\mu \geq 50 \text{ mas/yr}$$
$$\rho/\mu < 1000 \text{ yr}$$

where $\boldsymbol{\mu}_1$, $\boldsymbol{\mu}_2$ are the two proper motion vectors, σ_i is the mean error of the projections on the coordinate axes of $\boldsymbol{\mu}_i$, μ is the smaller proper motion vector module between $\boldsymbol{\mu}_1$ and $\boldsymbol{\mu}_2$, and ρ is the angular separation of the two stars. The first condition indicates whether the hypothesis $\boldsymbol{\mu}_1 = \boldsymbol{\mu}_2$ is admissible with a 95% confidence considering the given errors σ_1 and σ_2. The second condition establishes that the proper motion must be ≥ 50 mas/yr for both components of the pair, while the third condition is an empirical way of relating the separation and the modulus of the proper movement vector.

The initial database consisted of around three million entries of the NOMAD catalog. All were stars with:

- Visual magnitude < 17,
- Proper motion > 0 in both axes, and
- Positive declination, i.e. only northern stars were included.

The entries were obtained through VizieR (Allende & Dambert 1999), and were filtered following the next steps:

1. First, the second Halbwachs criterion was applied, deleting all the entries with proper motion vector module $\mu < 50$ ms/yr. We also removed the entries where the error σ was more than 25% of μ, since usually in these cases the entries do not correspond to

Finding New Common Proper-Motion Binaries by Data Mining

stars in the photographic plates. After this step, the set of entries was reduced to about 120 000 entries. We applied first the second criterion because it can be checked faster than the first one, and therefore it results more convenient for dealing with a large database.

2. The first Halbwachs criterion was then applied to combine the entries in pairs. Only about 600 pairs fulfilled this criterion.

3. The coordinates were crossed with the WDS (Mason et al., 2003), looking for WDS entries in a radius of 2 minutes. It was found that 115 pairs were already included in the catalog (most of them LDS and GIC pairs). Also the lists of new pairs in Lépine & Shara (2002), Lépine & Bongiorno (2007), and Chanamé & Gould (2003) were checked, finding that these pairs were already in the WDS and that consequently they had been considered already.

4. When examining the remaining pairs, it became apparent that a large number of the NOMAD entries in the list that didn't correspond to the Tycho2, USNOB1 or UCAC2 catalogs and did not appear in the photographic plates. Therefore, a final filter was applied, keeping only those pairs with the two stars in any of the Tycho2, USNOB1 or UCAC2. After this last filter 273 pairs were kept as "candidate" CPMBs.

Checking the photographic plates

In spite of all the initial filters, most of the 273 candidates didn't correspond to CPMBs in the photographic plates: galaxies, influence of bright stars, or crowded areas were typical situations where the entries did not match pairs of stars. Therefore, a final examination of each candidate pair was undertaken by using the photographic plates of the first and second Palomar Observatory Sky Surveys (Reid I.N. et al., 1991) available at Aladin (Bonnarel, F. et al., 2000). For every pair, a POSSI and a POSSII image was selected and combined, either by the RGB or the blink utilities of ALADIN, observing whether two stars with noticeable movement really existed in the expected place. See Figure 1 for an example. All the uncertain cases were discarded, leaving a set of 111 pairs.

Measuring the new pairs

Table 1 lists the new pairs. Since they are not in the WDS, the identifier CBL, corresponding to the author in this catalog, has been chosen for numbering the pairs. The astrometry of the pairs from the 2MASS catalog has been employed. The table includes the USNO-B1 identifier and J2000 coordinates of the primary, followed by the visual magnitudes of both components, position angle, separation and the date registered in the 2MASS catalog. It is worth noticing that for every pair in the list the dates for both components in the 2MASS catalog were usually the same. When this was not the case the values were so close that choosing one or another didn't affect the date displayed in the table. Using the astrometric data the condition 3 of the Halbwachs criterion was applied. This resulted in the rejection of only one pair in the list. The remaining 110 pairs are included in Table 1. Figure 2 is an image of one of the pairs. Table 2 lists the relevant proper motion data on these selected pairs, obtained from UCAC2, Tycho2, USNOB1, or YB6. While examining the plates, it was found that CBL 30 was in fact a triple system. The PM of the third star in the

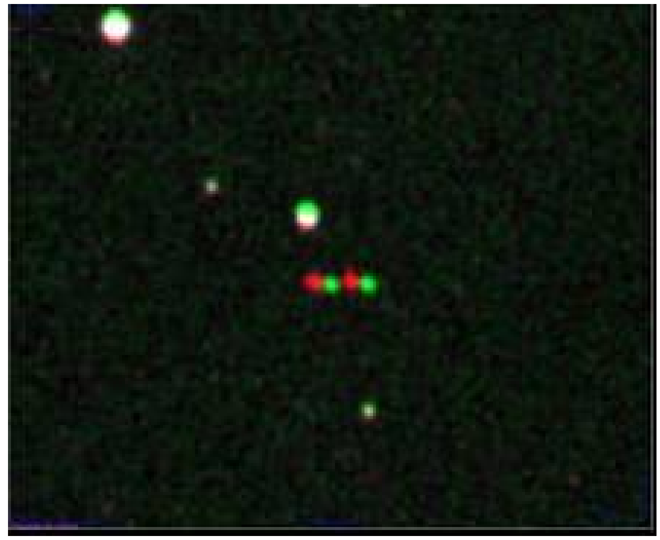

Figure 1: The ALADIN composite image showing the movement of the pair CBL 11 between 1954 (green) and 1990 (red)

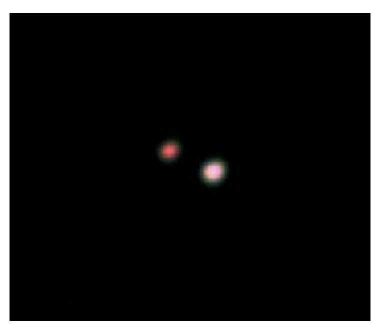

Figure 2: CBL 78. DSI Pro camera with LRGB filters.

(Continued on page 165)

Finding New Common Proper-Motion Binaries by Data Mining

Table 1: Measures of the New Pairs

NAME	USNO-B1.0	RA DEC	MAGS		PA	SEP	DATE	NOTES
CBL 1	1353-0003961	001028.93+452338.9	10.883	14.21	229.5	22.99	1998.842	
CBL 2	1444-0011384	001954.91+542703.8	13.4	14.33	111.6	22.00	2000.71	
CBL 3	1447-0012444	002107.56+544653.1	12.38	13.74	332.1	18.01	2000.743	
CBL 4	1287-0007926	002417.61+384223.1	12.21	13.54	115.3	29.15	1998.769	
CBL 5	1407-0013541	002712.68+504425.3	16.34	16.62	359.2	22.96	1998.848	(6)
CBL 6	1418-0017624	003032.07+514914.0	8.898	4.98	39.6	44.17	1998.848	
CBL 7	1110-0006139	003126.48+210130.5	14.55	15.44	228.2	12.46	1997.758	
CBL 8	1426-0031534	005656.07+523624.0	16.13	16.87	11.3	23.06	2000.003	
CBL 9	1154-0015804	011252.89+252828.6	11.736	12.99	326.9	58.92	1997.832	
CBL 10	1147-0015351	011300.89+244541.3	13.37	15.68	64.5	22.80	1997.832	
CBL 11	1062-0020609	015751.37+161332.0	15.98	16.27	90.5	12.22	1998.878	
CBL 12	1043-0020587	020134.39+142225.9	12.04	12.95	215.1	61.19	1997.701	
CBL 13	1356-0049068	020619.92+453803.7	10.235	11.343	317.4	49.95	1998.823	
CBL 14	1429-0089815	023928.67+525523.2	11.778	13.19	51.0	12.68	1999.804	(2)
CBL 15	1409-0078686	025459.28+505852.9	8.573	13.32	203.6	34.19	1999.14	(2)
CBL 16	1281-0063374	030035.78+380825.9	11.58	13.33	287	22.55	1998.791	
CBL 17	1096-0034009	030106.07+193649.4	11.239	15.12	193.8	31.01	2000.022	
CBL 18	1168-0036646	030257.20+264949.6	14.59	14.87	287.4	19.19	1997.881	
CBL 19	1358-0081082	031716.45+455327.6	11.511	13.29	232.2	48.20	2000.126	
CBL 20	1151-0077593	053018.38+251120.5	9.859	13.71	292.8	42.63	1997.961	
CBL 21	0953-0080081	060803.53+052120.3	14.71	16.41	246.6	9.78	1999.894	
CBL 22	1341-0171738	062813.24+440822.9	13.07	13.14	190.9	53.56	1998.837	
CBL 23	1048-0128030	065426.55+145312.7	14.19	15.31	80.9	20.63	1999.247	
CBL 24	1246-0150520	072830.99+343704.4	12.23	13.96	86.7	34.23	1998.9	
CBL 25	1496-0177151	073327.51+593707.1	10.399	13.38	300.3	9.93	2000.225	(2) (4)
CBL 26	1252-0153135	073604.63+351709.9	12.77	13.93	286.9	22.10	1998.9	
CBL 27	1434-0189951	073813.82+532819.1	13.09	13.35	13.4	11.14	1999.859	(4)
CBL 28	1267-0158795	074409.07+364633.0	10.351	12.56	0.4	17.81	1998.27	(4)
CBL 29	1305-0187245	075505.48+403116.7	12.63	13.03	199.1	65.57	1998.276	
CBL 30AB	1487-0179640	080208.67+584612.5	8.402	10.94	239.1	23.35	1998.993	
CBL 30AC	1487-0179640	080208.67+584612.5	8.402	?	227.1	25.38	1998.993	(3)

Table 1 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 1, continued: Measures of the New Pairs

NAME	USNO-B1.0	RA DEC	MAGS		PA	SEP	DATE	NOTES
CBL 31	1222-0199621	083309.74+321736.6	12.669	12.72	167.9	25.91	1998.218	
CBL 32	1175-0206398	084614.32+273541.3	7.294	10.504	173.9	41.07	1998.096	(5)
CBL 33	1435-0195073	090020.84+533209.1	9.634	12.146	113.7	29.48	1999.826	
CBL 34	1183-0183155	090232.02+282226.8	12.38	13.2	150.2	20.43	1998.89	(4)
CBL 35	1709-0032816	092834.47+805620.2	13.41	15.75	327.9	14.88	2000.042	
CBL 36	1301-0199025	093529.58+400613.5	10.438	12.17	131.9	13.23	1998.254	
CBL 37	1346-0214538	093815.48+443641.2	12.268	13.64	127.3	30.31	1999.141	
CBL 38	1350-0214920	095029.75+450501.3	7.424	12.41	10.8	53.06	1998.322	
CBL 39	1095-0176204	095239.48+193331.0	10.686	16.12	324.7	35.39	1998.063	
CBL 40		095500.70+483418.6	12.65	13.2	303.3	9.79	2000.17	(1)
CBL 41	1371-0247225	101259.22+471032.5	9.936	11.207	154.7	30.88	1999.141	
CBL 42	1518-0186169	103928.41+614902.4	9.993	13.41	151.8	46.73	1999.119	
CBL 43	1414-0218500	104208.57+512856.8	12.48	13.05	182	11.48	1998.936	
CBL 44	1220-0212432	104227.80+320526.4	11.059	13.02	327.5	14.82	1998.358	(2)
CBL 45	1475-0257755	105731.83+573301.4	11.076	13.48	24.6	23.44	2000.17	
CBL 46	1538-0178230	105903.58+635023.6	11.6	13	177.5	55.32	1999.092	
CBL 47	1132-0203695	105933.14+231547.1	10.838	11.88	182.7	19.83	1998.081	
CBL 48	1119-0215346	111354.31+215833.3	11.179	12.306	189.7	15.54	1999.272	
CBL 49	1353-0223882	111438.30+452055.2	10.487	10.667	38.3	64.18	1999.245	
CBL 50	1460-0216441	113140.46+560138.2	10.844	13.36	220.2	20.56	1999.905	
CBL 51	1405-0224403	114810.23+503557.1	13.18	13.25	303.6	36.96	1999.01	
CBL 52	1439-0216861	120547.60+535456.2	9.226	11.875	350.1	54.54	1999.021	
CBL 53	1600-0096810	123312.67+700308.3	13.39	13.43	26.9	26.28	1999.215	
CBL 54	1101-0213789	123711.56+200926.0	9.75	12.76	284	15.81	1999.313	(2)
CBL 55	1228-0268478	124700.48+325028.2	11.452	13.34	20.1	54.06	1998.183	
CBL 56	1459-0230437	132151.65+555404.2	9.281	12.41	76.3	25.07	1999.253	
CBL 57	1413-0245337	135451.37+512249.9	11.185	12.35	109.8	27.06	1999.376	
CBL 58	1420-0274134	142736.02+520408.0	11.013	13.46	289.1	13.41	2000.203	(2)
CBL 59	1419-0271126	143414.26+515958.7	11.986	12.602	298.4	21.68	2000.348	
CBL 60	1353-0255955	151423.82+451809.3	11.397	13.4	160.0	11.05	1999.395	
CBL 61	1197-0243959	161130.74+294234.2	14.73	16.11	185.4	15.92	1999.429	

Table 1 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 1, continued: Measures of the New Pairs

NAME	USNO-B1.0	RA DEC	MAGS	PA	SEP	DATE	NOTES
CBL 62	1187-0242471	161327.73+284350.	10.543 13.01	255.9	26.43	1999.428	
CBL 63	1367-0281313	161533.40+464623.7	15.77 16.66	160.8	44.14	1999.349	
CBL 64	1383-0279390	162552.67+482011.9	9.41 12.72	151.4	30.71	1998.462	
CBL 65	1493-0233771	162736.64+592211.8	10.439 12.96	322.0	12.70	1999.317	(2)
CBL 66	1316-0292197	171011.98+413914.3	10.482 13.54	331.6	22.60	1998.355	
CBL 67	1258-0257226	172138.79+354924.9	7.453 12.77	236.9	26.71	1998.274	(2)
CBL 68	1638-0096060	172312.27+734945.6	12.118 15.12	358.5	44.62	1999.39	
CBL 69	1300-0276871	172942.05+400351.1	13.14 13.7	243.7	12.47	2000.193	
CBL 70	1415-0281135	173727.32+513211.8	12.3 13.03	93.2	14.67	2000.256	
CBL 71	1260-0264228	174222.59+360448.8	9.38 11.135	195.6	26.77	1999.42	
CBL 72	1170-0333739	175050.13+270106.0	14.85 15.54	173.5	12.63	2000.201	
CBL 73	1351-0290580	180209.25+450628.2	12.64 13.74	292.5	31.72	1998.438	
CBL 74	1244-0267987	180511.26+342937.6	11.671 13.6	245.1	11.18	1998.29	(2)
CBL 75	1283-0322893	181538.79+381949.9	9.885 10.853	206.9	18.52	1998.405	
CBL 76	1431-0322292	181653.63+530852.1	10.755 11.784	8.5	44.87	2000.335	
CBL 77	1249-0279065	182702.20+345945.5	9.981 13.85	68.7	39.20	2000.256	
CBL 78	1269-0348025	190627.50+365745.0	10.855 11.442	66.9	25.12	1998.391	
CBL 79	1378-0417325	194543.80+474843.7	13.1 14.07	262.4	19.22	1998.449	
CBL 80	1351-0354479	195725.12+450724.7	15.21 16.03	66.6	17.70	2000.354	
CBL 81	1376-0418238	200014.11+473709.0	9.548 10.702	256.7	43.90	1998.902	
CBL 82	1170-0539954	200834.71+270415.9	14.09 14.43	320.3	24.32	1997.772	
CBL 83	1291-0409283	202841.83+391117.9	8.667 13.88	172.0	41.81	1998.471	
CBL 84	1325-0475984	204049.99+423110.5	14.62 15.99	160.1	15.95	1998.839	
CBL 85	1352-0390855	204335.50+451410.9	13.31 14.1	165.8	17.69	1998.839	
CBL 86	1186-0526736	204926.75+283955.2	10.693 15.86	317.4	53.66	1999.869	
CBL 87	1406-0375283	204953.89+503608.0	9.894 15.42	1.5	24.94	1999.467	
CBL 88	1073-0653047	204956.64+171813.7	14.38 15.11	103.8	43.45	2000.335	(4)
CBL 89	1442-0341333	205545.06+541646.1	11.966 16.87	145.5	14.50	2000.838	
CBL 90	1203-0545171	210911.99+302329.8	13.39 13.94	112.8	54.50	1999.754	
CBL 91	1641-0117598	211347.82+740857.1	15.4 16.84	167.8	32.70	1999.773	
CBL 92	1411-0392234	212509.09+510932.0	12.129 13.41	341.7	9.07	2000.504	(2)
CBL 93	1264-0490109	212511.74+362850.9	14.09 15.62	56.63	12.91	2000.901	

Table 1 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 1, continued: Measures of the New Pairs

NAME	USNO-B1.0	RA DEC	MAGS		PA	SEP	DATE	NOTES
CBL 94	1437-0362140	213137.11+534549.3	16.25	16.97	49.1	13.65	2000.504	
CBL 95	1078-0719224	214236.18+174835.5	13.64	16.12	222.3	37.13	1998.733	
CBL 96	1384-0425519	214314.94+482759.9	10.44	13.87	116.5	46.55	2000.767	
CBL 97	1249-0490039	215636.23+345953.3	13.1	14.45	61.8	20.60	2000.759	
CBL 98	1408-0434291	220421.06+504855.7	10.175	13.38	314.0	37.10	1999.702	
CBL 99	1144-0547052	221045.20+242504.6	10.241	16.08	135.2	72.02	1997.843	
CBL 100	1138-0544492	221120.70+235305.3	13.02	14.53	348.6	21.59	1997.843	
CBL 101	1390-0450716	221652.56+490251.5	8.63	11.315	180.2	48.67	1999.764	
CBL 102	1382-0525713	222537.82+481353.7	9.468	16.07	17.86	45.45	2000.857	
CBL 103	1510-0327596	222937.99+610029.8	16.11	16.62	279.5	19.88	1999.746	
CBL 104	1294-0507568	224342.95+392847.9	10.273	12.81	8.9	62.72	1998.774	
CBL 105	1191-0585926	230517.40+291138.6	15.96	16.88	247.4	8.33	1997.876	
CBL 106	0980-0730247	230622.56+080123.0	12.289	16.73	226.0	13.56	2000.688	
CBL 107	1486-0374980	230738.45+583716.7	9.707	16.84	71.0	30.69	1998.982	
CBL 108	1554-0278711	234600.91+652503.2	15.22	15.69	225.4	28.66	1999.787	
CBL 109	1381-0599542	234619.17+480839.1	10.846	11.471	216.2	53.84	1999.765	
CBL 110	0948-0596504	234934.29+045337.3	7.993	11.27	20.1	30.89	2000.622	(5)

Table Notes:

1. Primary in NOMAD but not in USNO-B1.0. NOMAD identifier: 1385-0209435
2. Secondary in NOMAD but not in USNO-B1.0
3. C component is in 2MASS but not in NOMAD, visual magnitude unknown
4. Pair with one MS and one SD according to the RPM criterion, possibly non-physical
5. Two MS or two SD stars, with the line connecting the two points in the RPM diagram not parallel to their corresponding MS or SD track for disk and halo binaries
6. Primary SD, secondary WD

Finding New Common Proper-Motion Binaries by Data Mining

Table 2: Proper motion of each component (mas/yr)

NAME	m_1	σ_1	m_2	σ_2
CBL 1	(-51.1, 69.1)	(.6, .8)	(-48, 68)	(3, 2)
CBL 2	(48, -28)	(3, 2)	(46, -22)	(4, 2)
CBL 3	(70.5, 10.5)	(4.5, 4)	(76, 10)	(1, 2)
CBL 4	(-53.3, -10.7)	(1.1, .7)	(-50, -2)	(7, 6)
CBL 5	(74, 24)	(4, 5)	(72, 26)	(2, 1)
CBL 6	(104.4, -22.1)	(.8, .6)	(104, -20)	(3, 3)
CBL 7	(64, 52)	(3, 3)	(62, 52)	(2, 3)
CBL 8	(108, 60)	(1, 1)	(100, 58)	(2, 5)
CBL 9	(66, 27.5)	(1.2, .9)	(60, 30)	(4, 1)
CBL 10	(65.9, 21.8)	(3.1, 3)	(66, 22)	(2, 2)
CBL 11	(160, 66)	(2, 5)	(150, 64)	(4, 1)
CBL 12	(36.9, 50.7)	(2.7, 2.6)	(38, 48)	(5, 2)
CBL 13	(35.4, -49.6)	(1.1, 1.2)	(34.1, -51.4)	(1.7, 1.3)
CBL 14	(50.8, -49.9)	(.6, 1)	(55.7, -59.6)	(9, 9)
CBL 15	(104.1, -43.3)	(.9, .9)	(107.2, -42.8)	(9, 9)
CBL 16	(88.9, -77.2)	(2.1, .7)	(94, -76)	(5, 5)
CBL 17	(41.8, 35.4)	(1.3, 1.3)	(46, 38)	(4, 3)
CBL 18	(62, 46)	(2, 4)	(66, 44)	(1, 1)
CBL 19	(80.7, -88.4)	(1.1, 1.1)	(78, -92)	(4, 1)
CBL 20	(31.2, 44)	(.8, .7)	(30, 44)	(2, 2)
CBL 21	(122, 40)	(5, 5)	(128, 42)	(2, 6)
CBL 22	(-34, -44)	(5, 2)	(-34, -46)	(4, 8)
CBL 23	(48, 44)	(1, 1)	(48, 44)	(1, 1)
CBL 24	(97.5, -53.4)	(5.9, 7.2)	(92, -48)	(3, 3)
CBL 25	(14.5, -48.5)	(2.7, 2.7)	(12.2, -59.4)	(9, 9)
CBL 26	(34, -80)	(1, 3)	(34, -82)	(3, 3)
CBL 27	(50, 24)	(13, 7)	(58, 38)	(7, 5)
CBL 28	(-50.4, -25.1)	(.7, .9)	(-56, -30)	(0, 8)
CBL 29	(42, -28)	(1, 4)	(50, -24)	(3, 3)
CBL 30	(52.7, -26.8)	(1.3, 1.3)	(51.8, -21.8)	(2.3, 2.3)
CBL 31	(-52.7, -40.4)	(1, 1)	(-56, -40)	(3, 0)

Table 2 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 2, continued: Proper motion of each component (mas/yr)

NAME	m_1	σ_1	m_2	σ_2
CBL 32	(3, -81.8)	(1, .8)	(1.8, -82.5)	(.7, .9)
CBL 33	(-43.8, 24.5)	(1.1, 1.3)	(-45.2, 22.5)	(3.2, 3)
CBL 34	(-38.4, -88.3)	(1.4, 5.7)	(-38, -90)	(3, 2)
CBL 35	(54, 66)	(3, 4)	(56, 62)	(2, 3)
CBL 36	(28.3, -54.7)	(.7, .7)	(37.7, -57.8)	(9, 9)
CBL 37	(-50.6, -13.7)	(.7, .7)	(-50, -8)	(4, 2)
CBL 38	(-81.9, -94.5)	(.6, .4)	(-84.4, -95.8)	(3.4, .7)
CBL 39	(50.2, 36)	(.7, .8)	(48, 34)	(2, 2)
CBL 40	(173.1, -10)	(9, 9)	(147.3, 2.3)	(9, 9)
CBL 41	(-125, 9.9)	(1, 1.1)	(-123.8, 11.4)	(.7, .7)
CBL 42	(-53.2, -70.7)	(1.8, 1.8)	(-48, -70)	(2, 2)
CBL 43	(-86, -58)	(6, 12)	(-86, -62)	(5, 8)
CBL 44	(-77.7, -26.5)	(1, .7)	(-81.8, -34)	(9, 9)
CBL 45	(-72.7, -28.6)	(3.2, 3.2)	(-72, -24)	(2, 2)
CBL 46	(-60, -21.1)	(5, 5.2)	(-62, -16)	(1, 5)
CBL 47	(44.6, -37.8)	(1, .7)	(46, -34)	(7, 4)
CBL 48	(-73.8, -6.2)	(.7, 1.1)	(-71.2, -7.7)	(2.2, 2.2)
CBL 49	(-51.7, 7.9)	(.6, .6)	(-52.9, 8.1)	(.7, .6)
CBL 50	(-57.2, -52)	(3.7, 3.7)	(-54, -52)	(3, 3)
CBL 51	(-52, 16)	(2, 2)	(-50, 16)	(2, 1)
CBL 52	(-108.7, -82)	(1.3, 1.3)	(-111.2, -78.5)	(4, 4.4)
CBL 53	(-68, 10)	(2, 3)	(-70, 14)	(1, 3)
CBL 54	(-91.9, -14.8)	(3.7, 2.3)	(-110.2, -16.7)	(9, 9)
CBL 55	(40.6, -66.3)	(1, 1.4)	(40, -60)	(6, 2)
CBL 56	(-68.7, -2.5)	(.8, .9)	(-60, -10)	(8, 5)
CBL 57	(-55, 27.3)	(1.8, 1.8)	(-58, 22)	(4, 2)
CBL 58	(-64.5, 13)	(1.6, 1.6)	(-68.3, 13.6)	(9, 9)
CBL 59	(-52.5, -5)	(3.3, 3.1)	(-60.8, -2.6)	(3.6, 3.2)
CBL 60	(48.7, -15.1)	(.8, .9)	(56.9, -24)	(9, 9)
CBL 61	(32, 48)	(6, 2)	(34, 44)	(1, 0)
CBL 62	(60.8, -78.5)	(.7, .7)	(58, -74)	(5, 2)

Table 2 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 2, continued: Proper motion of each component (mas/yr)

NAME	m_1	σ_1	m_2	σ_2
CBL 63	(48, 58)	(2, 4)	(52, 58)	(3, 2)
CBL 64	(52.5, -64.9)	(1.8, 1.8)	(58, -54)	(8, 13)
CBL 65	(-73.5, 44.7)	(2.7, 2.7)	(-91.3, 47.7)	(9, 9)
CBL 66	(-6.8, 92.6)	(1, 1.2)	(-6, 94)	(3, 4)
CBL 67	(-16.2, 58.7)	(.5, .7)	(-20.8, 58.4)	(9, 9)
CBL 68	(106.5, 123.5)	(2.1, 2.2)	(104, 118)	(3, 4)
CBL 69	(-66, -50)	(12, 6)	(-66, -48)	(13, 6)
CBL 70	(-78, 28.5)	(7, 6.5)	(-76, 18)	(2, 3)
CBL 71	(-17.1, -143.6)	(2.1, 1.8)	(-14, -140.8)	(.7, 1)
CBL 72	(44, 36)	(3, 1)	(44, 36)	(2, 5)
CBL 73	(-64, -84)	(6, 3)	(-60, -86)	(5, 0)
CBL 74	(-39.3, 75.6)	(.7, .7)	(-49.4, 67)	(9, 9)
CBL 75	(21.1, 98.9)	(.7, .8)	(18.9, 98)	(1.5, .7)
CBL 76	(4.7, 58.3)	(2.6, 2.3)	(4, 67)	(3.3, 3.1)
CBL 77	(2.2, -75)	(1.4, 1.5)	(2, -74)	(1, 6)
CBL 78	(42.9, 35.8)	(.8, 1)	(42.6, 36.5)	(1, 1)
CBL 79	(82, 36)	(7, 0)	(76, 36)	(1, 6)
CBL 80	(130, 224)	(3, 4)	(124, 232)	(1, 7)
CBL 81	(64.4, 65.4)	(1.6, 1.6)	(63.3, 67.9)	(2.6, 2.3)
CBL 82	(50, 40)	(2, 4)	(46, 42)	(2, 2)
CBL 83	(28.4, 49.8)	(.7, .7)	(28, 54)	(3, 1)
CBL 84	(32, 46)	(4, 6)	(32, 42)	(2, 2)
CBL 85	(138, 68)	(2, 0)	(138, 74)	(1, 4)
CBL 86	(23.7, 60.8)	(1.2, 1.4)	(26, 60)	(1, 3)
CBL 87	(106, 85.7)	(1.8, 1.8)	(110, 92)	(4, 5)
CBL 88	(52, 38)	(9, 3)	(48, 38)	(1, 2)
CBL 89	(39.8, 39.8)	(3.3, 3.1)	(42, 44)	(3, 4)
CBL 90	(38, 54)	(3, 1)	(40, 54)	(2, 3)
CBL 91	(30, 74)	(2, 3)	(32, 74)	(3, 3)
CBL 92	(41.7, 30)	(3.1, 2.7)	(35.9, 41.2)	(9, 9)
CBL 93	(66, 48)	(3, 1)	(70, 46)	(3, 0)

Table 2 continues on next page.

Finding New Common Proper-Motion Binaries by Data Mining

Table 2, continued: Proper motion of each component (mas/yr)

NAME	m_1	σ_1	m_2	σ_2
CBL 94	(86, 28)	(3, 4)	(80, 30)	(1, 3)
CBL 95	(36, 42)	(2, 2)	(34, 42)	(2, 1)
CBL 96	(60.3, 31.1)	(1.6, 1.5)	(56, 34)	(8, 0)
CBL 97	(84.2, 34.7)	(5.3, 6.5)	(84, 32)	(3, 2)
CBL 98	(65.5, 37.2)	(1.6, 1.6)	(68, 38)	(2, 3)
CBL 99	(68.7, 56.5)	(.8, 1.1)	(70, 62)	(6, 2)
CBL 100	(44, 28)	(3, 5)	(48, 30)	(1, 2)
CBL 101	(79.5, 57.2)	(1.5, 1.5)	(79.7, 60.7)	(3.2, 2.8)
CBL 102	(104.7, 103.9)	(1.3, 1.3)	(98, 110)	(4, 5)
CBL 103	(56, 50)	(1, 2)	(52, 52)	(2, 2)
CBL 104	(76.4, 55.3)	(.7, .7)	(78, 58)	(2, 4)
CBL 105	(36, 46)	(4, 4)	(40, 48)	(7, 4)
CBL 106	(90.2, 27)	(3.9, 3.1)	(88, 30)	(3, 1)
CBL 107	(116, 67.2)	(1.6, 1.6)	(112, 64)	(4, 4)
CBL 108	(52, 26)	(2, 1)	(54, 24)	(3, 1)
CBL 109	(50.5, -.8)	(1, .8)	(53.2, -.7)	(.9, .9)
CBL 110	(54.5, 22.8)	(1, .5)	(53.2, 20.7)	(2.4, 3.8)

(Continued from page 157)

photographic plates seems to be very similar to that of the other two components, but no entry in the available catalogs includes data that can confirm this suspicion.

Reduced Proper Motion Diagram

The Reduced Proper Motion (RPM) diagram and its associated RPM discriminator η were introduced by Salim & Gould (2003) and have been proposed for discriminating binaries in Chanamé and Gould (2003). The diagram plots the V_{RPM}, defined as $V_{RPM} = V + 5 \log \mu + 5$, with V the apparent magnitude and μ the proper movement in arcseconds per year, versus a color. It can be considered as a kinematic equivalent of the HR diagram which uses the V_{RPM} as a substitute of the star's intrinsic luminosity. The discriminator η is defined as $\eta = V_{RPM} - 3.1\,(V\text{-}J) - 1.47|\sin b| - 2.73$, with b the Galactic Latitude of the star. According to this discriminator, stars are classified as disk (or main sequence, MS) if h < 0, as halo (or subdwarf, SD) if 0 < h < 5.15 and as white dwarf (WD) if h > 5.15. The idea is that both components of a binary must have similar metallicities and proper motions, although possibly different luminosities. The criterion used in Chanamé and Gould (2003) is that the members of a pair are considered unrelated when:

- It is composed of one MS and one SD. 5 pairs verify this property: CBL 25, CBL 27, CBL 28, CBL 34, and CBL 88.
- It is composed of two MS or two SD stars, but the line connecting the two points in the diagram is not approximately parallel to their corresponding MS or SD track for disk and halo binaries (Figure 12 of Salim and Gould 2003). CBL 32 and CBL 110 are in this situation. It must be noticed that in some cases the module of the vectors connecting the points was too short to discriminate clearly whether the line was correctly oriented.

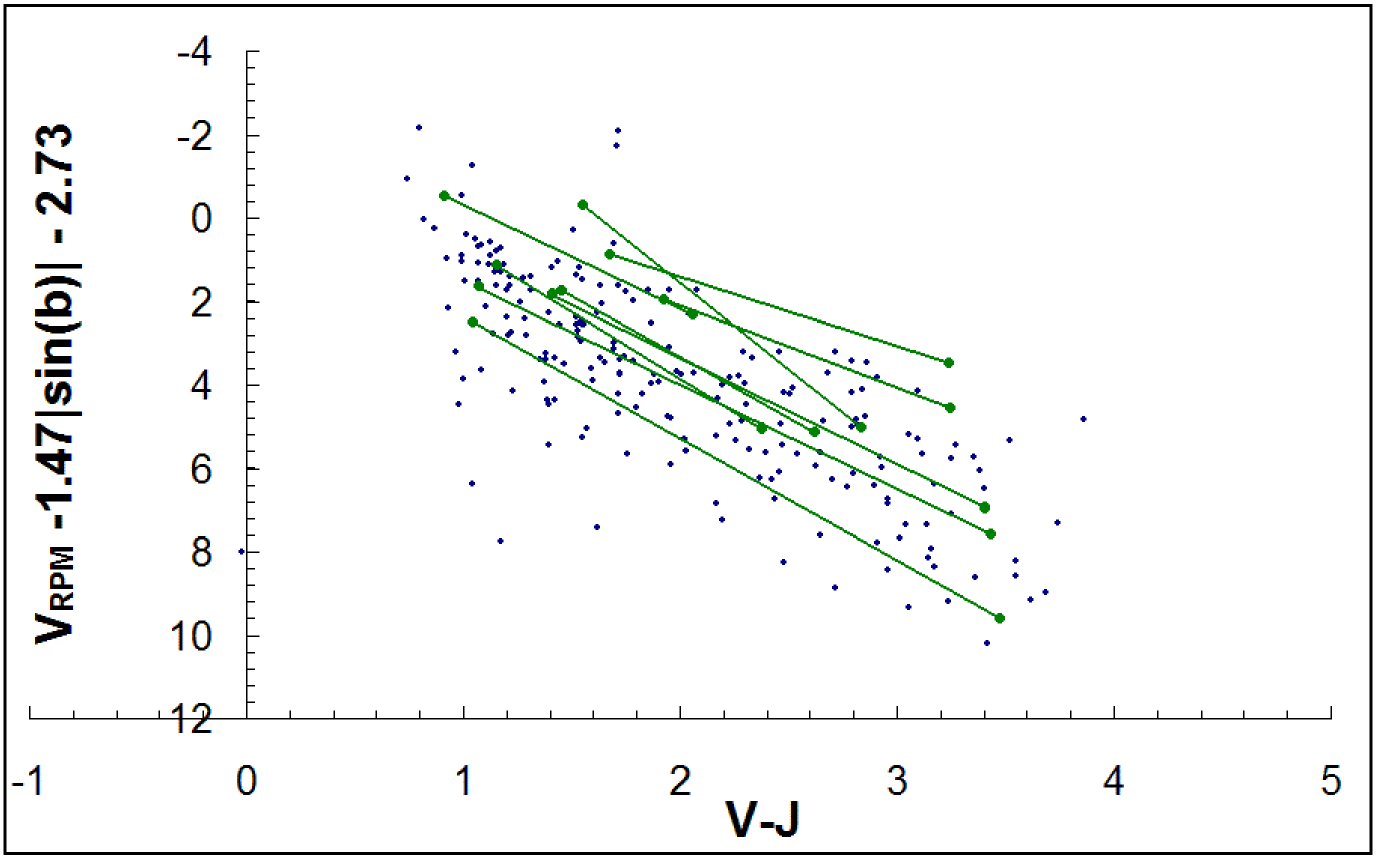

Figure 3: Reduced Proper Motion diagram including some of the lines connecting the new CPMBs.

Therefore 7 of the 110 pairs are possibly non-physical pairs (see notes (4) and (5) in Table 1). The RPM diagram for the new CPMBs can be seen in Figure 3. A few lines including some of the pairs are depicted in the diagram. It is worth noticing that only one WD was found, the secondary of CBL 5, and that there are very few pairs with SD components. This is an effect of our initial filtering of stars with visual magnitude >17, since WD and SD components are usually fainter.

Conclusions and Future Work

We have shown that new CPMBs not included in the WDS can be still found in the catalogs. A list of 110 such new pairs have been obtained and their existence verified in the photographic plates. All of them verify the Halbwachs criteria, although according the criteria based on the RPM diagram, 7 of these 110 CPMBs must be taken with caution.

Although data mining has proven to be an efficient tool for finding new CPMBs, during the visual inspection of the "candidate pairs" some other possible new pairs not included in the catalogs were found. They are not included in the Table 1 since their PM data were not found explicitly. These pairs will be left as future work.

Acknowledgements

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Finding New Common Proper-Motion Binaries by Data Mining

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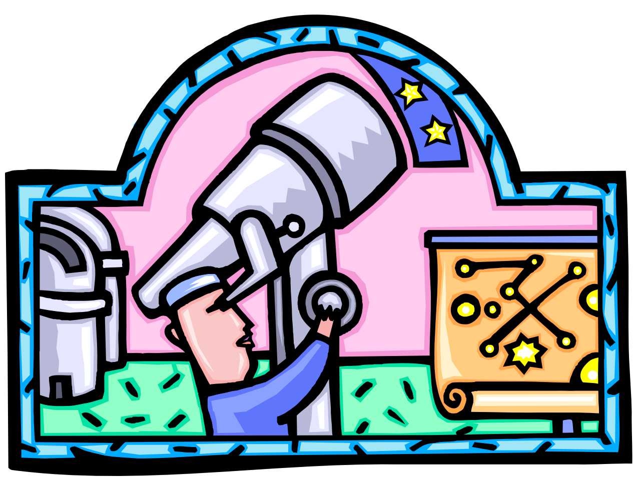

Double Star Measures Using a DSLR Camera #3

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Abstract: This article contains measures by the author made with a DSLR camera. The images used for the measures were taken in the period between 2007.276 - 2007.284. The result is 185 positive and 7 negative measures.

Introduction

Continuing the measures of my photos taken in 2007, the next results to come are from the measuring period between 11 Apr – 14 Apr 2007. The equipment used for photographing and the methods of photo processing and measuring are the same as those detailed in my previous article (Berko, 2008). Therefore, I would only like to note that I was working with a Canon 350D digital camera with a 35.5 cm Newtonian telescope and focal length increased to 4200 mm. The pictures were measured with Florent Losse's program (Reduc 3.85). I used approximately 1490 photos for the present publication. It contains the data of 1855 independent measures of 192 pairs.

Also, the structure of the tables, the contents of the notes section and the appendix with the images have all been created according to the previous publications.

In the case of some doubles, when the available measures show a significant deviation in the parameters, I tried to explore the reason of this difference. I downloaded the DSS images of the area (POSS 1 Blue and POSS 2 IR): in these it can be checked if the doubles under scrutiny changed in the period between the different measures. In some cases it has been proved that the proper motion of one of the components causes this change. I employed the same method when I could not identify a double in or near the position given by WDS.

I have also included images of some of the doubles I measured, Figures 1 through 6. The complete image archive of the article and table referring to the photos can be accessed at http://csillag.bacska.hu/dcam/JDSO/2009 2/.

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Double Star Measures Using a DSLR Camera #3

RA +/- Dec	Discoverer	Mags		PA	+/-	Sep	+/-	Epoch	N	Notes
04067+6221	CTT 7	8.08	9.47	215.15	0.10	44.17	0.06	2007.284	16	1
04076+6222	Anon. 1	14.2	14.4	0.88	0.24	11.84	0.06	2007.284	2	2
04078+6220	STF 485AC	6.91	10.39	355.53	0.72	10.83	0.06	2007.284	4	3
04078+6220	STF 485AE	6.91	6.94	304.06	0.19	17.90	0.06	2007.284	14	4
04078+6220	STF 485AF	6.91	12.2	318.56	0.53	36.07	0.01	2007.284	5	4
04078+6220	STF 484AG	6.91	9.63	259.15	0.28	60.15	0.06	2007.284	9	4
04078+6220	STF 484AH	6.91	10.5	255.29		57.42		2007.284	1	4
04078+6220	STF 484AI	6.91	9.81	277.87	0.19	69.90	0.06	2007.284	15	4
04078+6220	STF 485AL	6.91	10.4	70.73	0.10	98.02	0.06	2007.284	5	4
04078+6220	HZG 2AN	6.91	9.62	205.37	0.07	116.34	0.04	2007.284	3	4
04078+6220	STF 485AO	6.91	9.40	76.90	0.08	138.97	0.05	2007.284	6	4
04078+6220	STF 485EC	6.94	11.7	86.98		14.12		2007.284	1	5
04078+6220	STF 485EF	6.94	11.9	331.53	0.27	19.51	0.07	2007.284	8	5
04078+6220	STF 485EG	6.94	9.63	244.37	0.28	49.27	0.06	2007.284	9	5
04078+6220	STF 484EH	6.94	10.5	239.12	0.27	47.70	0.10	2007.284	2	5
04078+6220	STF 484EI	6.94	9.81	269.58	0.17	54.58	0.07	2007.284	14	5
04078+6220	STF 484GH	9.63	10.5	133.00		3.95		2007.284	1	6
04078+6220	STF 484GI	9.63	9.81	333.96	0.20	23.24	0.07	2007.284	8	6
04078+6220	STF 484HI	10.5	9.81	330.82		27.26		2007.284	1	7
04078+6220	HZG 2LO	10.4	9.40	91.26	0.14	42.81	0.06	2007.284	11	8
04078+6220	HZG 2OP	9.40	12.0	227.96	0.32	17.29	0.06	2007.284	9	9
04079+6217	STI 492	10.8	11.1					2007.284		10
05062+3721	ALI 527	11.5	12.6	74.06	0.13	19.92	0.05	2007.282	17	11
05063+3728	ES 2339	10.7	10.7					2007.282		12
05063+3722	SEI 60	11.95	12.60					2007.282		13
05073+3726	SEI 64	10.8	11.0	326.38	0.71	8.49	0.08	2007.282	9	14
05100+3747	SEI 82	11.11	11.29	224.99	0.15	13.66	0.05	2007.282	18	15
05103+3718	STF 644AB	6.96	6.78					2007.279		16
05103+3718	VBS 10AC	6.96	10.48	191.72	0.22	72.50	0.08	2007.279	6	17
05104+3742	SEI 85	10.8	11.0	312.78	0.37	15.50	0.05	2007.282	12	18
05104+3741	SEI 84AB	10.35	11.02	177.22	0.15	13.73	0.04	2007.282	17	19
05104+3741	Anon. 2Ax	10.35	14.0	28.14		8.57		2007.282	1	19
05107+3707	SEI 86AB	11.2	11.7	279.86	0.18	23.65	0.06	2007.279	14	20
05107+3707	Anon. 3Ax	11.2	12.7	3.99	0.25	20.82	0.07	2007.279	12	20
05108+3707	Anon. 4AB	12.7	14.5	331.99	0.23	8.86	0.05	2007.279	7	21
05108+3707	Anon. 4AC	12.7	13.0	341.67	0.15	19.23	0.05	2007.279	17	21
05111+3718	BLL 13	8.80	9.48	241.66	0.03	135.55	0.07	2007.279	11	22
05111+3710	MLB 974AB	10.0	11.5	292.43	0.32	8.67	0.05	2007.279	13	23
05111+3710	MLB 974AC	10.0	12.5	340.68	0.28	13.37	0.07	2007.279	10	23
05111+3708	SEI 88AB	10.5	11.0	44.11	0.34	14.90	0.07	2007.279	11	24
05111+3708	Anon. 5Bx	11.0	14.5	290.65		4.13		2007.279	1	24
05111+3707	Anon. 6AB	10.9	13.5	160.80	0.27	8.02	0.05	2007.279	13	25
05111+3707	Anon. 6AC	10.9	13.4	327.68	0.25	13.71	0.04	2007.279	17	25

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Double Star Measures Using a DSLR Camera #3

RA +/- Dec	Discoverer	Mags		PA	+/-	Sep	+/-	Epoch	N	Notes
05113+3712	SEI 89	11.22	11.74	256.31	0.09	27.21	0.04	2007.279	18	26
05118+3655	Anon. 7	12.2	13.0	193.09	0.25	11.78	0.07	2007.279	12	27
05120+3717	Anon. 8	13.0	13.5	14.97	0.22	8.68	0.06	2007.279	11	28
05121+3650	SEI 94	11.0	11.0	177.39	0.24	17.13	0.06	2007.279	11	29
05123+3719	SEI 95AB	11.0	11.0	151.76	0.10	22.69	0.03	2007.279	11	30
05123+3719	Anon. 9Ax	11.0	13.5	112.70	0.19	23.89	0.04	2007.279	11	30
05126+3657	SEI 99	10.2	11.0	102.87	0.16	19.33	0.06	2007.279	15	31
05127+3727	SEI 101	11.0	12.3	156.46	0.18	14.41	0.08	2007.279	6	32
05130+3753	SEI 103AB	11.0	11.0	13.32	0.12	21.59	0.08	2007.279	14	33
05130+3753	Anon.10Bx	11.0	13.0	351.12	0.36	12.91	0.07	2007.279	13	33
05130+3748	SEI 102	10.5	11.0	84.27	0.38	9.83	0.07	2007.279	16	34
05133+3720	SEI 105AB	6.48	11.0	27.32	0.30	34.08	0.07	2007.279	8	35
05133+3720	Anon.11BC	11.0	12.0	287.95		4.40		2007.279	1	35
05134+3727	SEI 106AB	11.0	11.0	120.89	0.58	6.70	0.06	2007.279	8	36
05134+3727	Anon.12xy	12.2	12.5	2.34	0.12	40.06	0.07	2007.279	8	36
05134+3727	Anon.12xz	12.2	12.5	354.62	0.04	43.49	0.07	2007.279	9	36
05135+3725	SEI 107	10.3	11.0	4.49	0.09	38.02	0.06	2007.279	10	37
05136+3749	SEI 110	10.7	11.0	348.22	0.44	10.98	0.07	2007.279	6	38
05136+3747	Anon.13	12.8	14.0	74.38	0.35	7.67	0.05	2007.279	4	39
05136+3729	SEI 108	10.5	11.0	300.10	0.49	12.55	0.08	2007.279	8	40
05137+3755	SEI 111	9.6	11.6	105.70	0.45	19.74	0.09	2007.279	8	41
05172+3755	SEI 150	10.8	13.0	287.61	0.22	25.12	0.05	2007.279	14	42
05173+3755	Anon.14	13.0	14.5	77.54	0.24	5.97	0.07	2007.279	7	43
05174+3753	SEI 151	10.0	11.0	290.69	0.28	13.14	0.03	2007.279	14	44
05177+3801	SEI 158	10.7	11.0	147.94	0.19	23.94	0.06	2007.279	16	45
05177+3757	SEI 156AB	10.7	10.8	243.64	0.13	24.93	0.06	2007.279	18	46
05177+3757	Anon.15Bx	10.8	13.0	42.84	0.35	6.39	0.04	2007.279	5	47
05178+3805	SEI 159AB	9.7	11.0	65.95	0.20	13.10	0.06	2007.279	18	48
05178+3805	Anon.16Ax	9.7	13.3	26.46	0.34	12.47	0.06	2007.279	10	48
05178+3805	Anon.16Ay	9.7	14.6	288.84	0.21	17.21	0.06	2007.279	8	48
05178+3805	Anon.16Az	9.7	14.7	101.55	0.27	18.10	0.05	2007.279	11	48
05179+3758	SEI 161	9.7	11.0	310.24	0.17	13.38	0.05	2007.279	16	49
05182+3800	ALI 536	12.43	12.88	163.15	0.32	7.28	0.04	2007.279	16	50
05185+3800	SEI 171	11.0	11.0	169.55	0.23	7.80	0.05	2007.279	10	51
05186+3745	SEI 172	9.7	11.4	2.33	1.20	5.71	0.11	2007.282	3	52
05186+3745	SEI 173	9.7	11.0	101.44	0.25	8.84	0.07	2007.282	6	53
05195+3759	Anon.17	13.0	14.0	55.60	0.30	9.30	0.07	2007.279	4	54
05197+3755	SEI 184	11.0	11.0	109.26	0.12	25.16	0.06	2007.279	7	55
05198+3756	Anon.18AB	12.7	13.5	112.13	0.30	16.70	0.05	2007.279	5	56
05198+3756	Anon.18BC	13.5	14.0	84.19		8.92		2007.279	1	57
05198+3755	SEI 188	10.0	11.0	157.39	0.33	15.26	0.06	2007.279	12	58
05199+3928	ALI1054	11.5	13.6	341.83	0.08	10.58	0.08	2007.279	3	59
05201+3923	Anon.19	13.0	14.0	182.08	0.29	9.84	0.07	2007.279	7	60

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Double Star Measures Using a DSLR Camera #3

RA +/- Dec	Discoverer	Mags		PA	+/-	Sep	+/-	Epoch	N	Notes
05201+3921	HJ 3272AB	7.44	11.4	343.69	0.42	17.57	0.05	2007.279	9	61
05201+3921	HJ 3272AC	7.44	11.1	294.69	0.28	28.32	0.08	2007.279	13	61
05201+3921	HJ 3272AD	7.44	10.4	46.94	0.08	32.50	0.05	2007.279	9	61
05201+3921	BUP 77AE	7.44	9.16	319.22	0.04	188.91	0.06	2007.279	14	61
05201+3921	ABH 28AF	7.44	12.56	234.98	0.11	50.75	0.10	2007.279	9	61
05201+3921	ABH 28AG	7.44	11.72	216.78	0.10	48.65	0.08	2007.279	9	61
05201+3921	ABH 28AH	7.44	13.08	199.91	0.19	43.87	0.05	2007.279	9	61
05201+3921	ABH 28AI	7.44	15.4	147.48	0.65	26.78	0.06	2007.279	7	61
05201+3921	ABH 28AJ	7.44	12.05	156.19	0.15	86.69	0.06	2007.279	11	61
05201+3921	ABH 28AK	7.44	14.01	179.84	0.37	89.80	0.07	2007.279	3	61
05201+3921	ABH 28AL	7.44	12.29	291.34	0.11	62.24	0.08	2007.279	8	61
05201+3921	ABH 28AM	7.44	14.9	286.87	0.10	80.97	0.08	2007.279	7	61
05201+3921	ABH 28AN	7.44	14.1	276.65	0.07	86.97	0.06	2007.279	7	61
05201+3921	ABH 28AO	7.44	12.88	253.81	0.10	84.12	0.08	2007.279	8	61
05201+3921	ABH 28AP	7.44	12.74	242.94	0.02	121.02	0.09	2007.279	6	61
05201+3921	ABH 28AQ	7.44	13.82	227.42	0.03	135.27	0.06	2007.279	7	61
05201+3919	Anon.20	13.0	13.5	173.61	0.41	5.13	0.10	2007.279	6	62
05201+3918	Anon.21AB	12.8	13.5	345.79		8.71		2007.279	1	63
05201+3918	Anon.21BC	13.5	13.6	88.82		2.90		2007.279	1	63
05202+3924	Anon.22	13.5	13.5	100.06	0.29	7.51	0.09	2007.279	6	64
05202+3918	Anon.23	13.5	13.6	272.90	0.29	7.70	0.09	2007.279	9	65
05216+3752	SEI 206	10.20	11.38	86.81	0.15	19.49	0.04	2007.279	16	66
05227+3758	Anon.24	12.7	14.0	77.73	0.20	16.58	0.06	2007.279	12	67
05227+3755	SEI 219	11.0	11.0	123.06	0.21	11.08	0.04	2007.279	16	68
05228+3754	Anon.25	13.8	14.0	163.96	0.21	8.17	0.05	2007.279	13	69
05231+3802	SEI 225	10.0	10.5	87.42	0.10	26.31	0.07	2007.279	16	70
05234+3802	Anon.26	14.3	14.6	295.53	0.31	9.91	0.07	2007.279	9	71
05234+3758	Anon.27	12.8	13.8	82.01	0.19	15.73	0.08	2007.279	13	72
05236+3803	Anon.28AB	13.4	13.5	323.56	0.24	11.01	0.06	2007.279	10	73
05236+3803	Anon.28AC	13.4	14.5	178.47	0.24	14.51	0.06	2007.279	10	73
05256+3803	STF 699AB	7.90	8.61	344.60	0.27	8.57	0.08	2007.282	11	74
05256+3803	WAL 39AC	7.90	13.11	336.98		50.89		2007.282	1	75
05256+3803	WAL 39BC	8.61	13.11	335.70		43.41		2007.282	1	76
05262+3808	SEI 250	11.6	12.1	127.43	0.08	10.51	0.00	2007.282	2	77
05264+3804	SEI 255	10.3	12.4	89.98	0.32	14.74	0.06	2007.282	7	78
05403+3757	SEI 367	11.5	11.7	348.04	0.24	11.93	0.03	2007.276	16	79
05404+3752	Anon.29	13.5	13.5	311.02	0.05	5.59	0.00	2007.276	2	80
05406+3703	Anon.30	14.0	14.5	201.09	0.29	7.19	0.02	2007.276	6	81
05412+3658	TOB 36AB	12.33	13.8	124.17	0.17	29.92	0.05	2007.276	17	82
05412+3658	Anon.31Ax	12.33	14.5	90.73	0.42	16.89	0.07	2007.276	8	82
05413+3659	SEI 371AB	11.0	11.0	127.20	0.18	23.84	0.05	2007.276	11	83
05413+3659	Anon.32Bx	11.0	12.5	250.96		2.57		2007.276	1	83
05422+3710	SEI 375	10.4	12.4	180.76	0.16	29.87	0.06	2007.276	13	84

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Double Star Measures Using a DSLR Camera #3

RA +/- Dec	Discoverer	Mags		PA	+/-	Sep	+/-	Epoch	N	Notes
05425+3717	SEI 377	9.9	11.9	172.83	0.07	29.52	0.07	2007.276	15	85
05427+3756	SEI 378	10.99	12.01	110.40	0.17	14.94	0.03	2007.276	19	86
05446+2901	STF 783	8.05	9.70	0.07	0.40	8.44	0.07	2007.276	16	87
05474+2858	HJ 709	11.0	12.2	114.49	0.52	9.09	0.04	2007.276	11	88
05494+3742	SEI 387	11.0	11.0	95.73	0.07	44.10	0.08	2007.276	10	89
05496+3701	SEI 388AB	10.6	11.6	166.49	0.43	5.70	0.06	2007.276	7	90
05496+3701	SEI 389AC	10.6	11.6	135.72	0.17	28.52	0.06	2007.276	9	90
05499+3701	Anon.33	11.0	13.0	332.18	0.11	5.90	0.07	2007.276	2	91
05506+3648	SEI 393	10.5	11.0	24.44	0.13	27.23	0.06	2007.276	14	92
05514+3535	HJ 710	10.0	10.0	300.49		6.67		2007.276	1	93
05514+3506	SEI 394	10.15	10.78	325.99	0.20	14.32	0.03	2007.276	16	94
05523+3442	GYL 87	10.3	10.7	326.94	0.22	10.38	0.04	2007.276	16	95
05524+3618	AG 101	9.6	11.1	353.67	0.12	22.96	0.05	2007.276	11	96
05530+3624	HJ 5540	10.65	11.59	285.69	0.38	13.52	0.08	2007.276	9	97
05533+3624	SEI 429	11.0	11.0	157.67	0.28	15.32	0.07	2007.276	14	98
05533+3619	Anon.34	13.0	14.0	288.70	0.40	9.78	0.05	2007.276	4	99
05545+3109	SEI 433AD	10.16	12.5	22.28	0.14	24.80	0.06	2007.284	8	100
05545+3109	SEI 433AE	10.16	10.03	82.51	0.08	26.30	0.05	2007.284	16	100
05554+3647	SEI 437	9.1	11.6	75.25	0.07	26.51	0.05	2007.276	11	101
05557+3127	SEI 440	9.3	10.7	332.95	0.27	13.95	0.06	2007.284	14	102
05579+3603	SEI 449	11.04	14.04	329.98	0.16	19.51	0.04	2007.276	14	103
05589+3143	SEI 450	10.2	10.2	178.06	0.24	28.88	0.06	2007.284	10	104
06012+3132	SEI 453	8.07	9.1	213.52	0.31	19.54	0.05	2007.284	9	105
07081+2016	SLE 401	11.0	11.9	204.14	0.16	12.68	0.07	2007.276	18	106
07091+2023	Anon.35	11.7	12.4	14.74	0.31	16.04	0.07	2007.276	13	107
07093+2027	Anon.36	11.8	12.8	182.56	0.18	13.61	0.06	2007.276	16	108
08113+0117	STF1198	8.72	8.77	337.88	0.14	33.28	0.07	2007.282	19	109
08155+0202	DOB 9	8.11	9.66	126.71	0.34	12.72	0.05	2007.282	13	110
08158+0248	STF1210AB	7.25	9.45	113.23	0.34	15.55	0.08	2007.282	4	111
08158+0248	WAL 54AC	7.25	13.10	73.62	0.01	67.71	0.04	2007.282	2	111
08258+3104	HJ 446AB	8.88	11.50	343.46	0.05	39.37	0.05	2007.284	15	112
08258+3104	OPI 14AC	8.88	9.26	260.29	0.02	239.58	0.06	2007.284	17	112
08258+3104	OPI 14AD	8.88	9.32	41.37	0.02	362.67	0.08	2007.284	15	112
08291+3245	SEI 501	11.0	11.0	35.53	0.59	6.20	0.07	2007.284	7	113
08299+3123	STF1231	9.50	9.93	211.17	0.13	25.07	0.04	2007.284	14	114
08314+3156	STF1236	8.92	9.34	110.26	0.12	38.31	0.06	2007.284	19	115
08319+3309	STF1238	9.13	10.85	320.70	0.10	29.50	0.04	2007.284	14	116
08325+3729	STF1239	9.64	11.03	289.60	0.30	12.86	0.05	2007.284	14	117
08332+3326	STF1240AB	7.7	10.7	79.69	0.30	28.88	0.06	2007.284	14	118
08332+3326	STF1240AC	7.7	10.5	243.24	0.17	52.65	0.06	2007.284	13	118
08334+3348	MLB 838	10.0	10.2	18.57	0.40	4.65	0.06	2007.284	12	119
08335+3346	MLB 839	12.05	10.0	282.31	0.23	11.19	0.06	2007.284	19	120
08356+3116	SEI 505	9.7	11.0					2007.284		121

Table continues on next page

Double Star Measures Using a DSLR Camera #3

RA +/- Dec	Discoverer	Mags		PA	+/-	Sep	+/-	Epoch	N	Notes
08364+3703	SEI 506	11.0	11.0					2007.284		121
08408+3115	SEI 507	10.16	11.98	118.27	0.18	15.33	0.03	2007.284	19	122
08419+3546	SEI 508	11.0	11.0					2007.284		121
08423+3631	ALI 353	8.2	11.9	190.27	0.50	6.77	0.06	2007.284	5	123
08483+3436	STF1272	8.07	10.19	343.51	0.13	20.46	0.04	2007.284	15	124
08498+3113	SEI 509	9.54	9.59	195.28	0.08	35.15	0.05	2007.284	12	125
08498+3045	SEI 510AB	11.12	11.18	322.10	0.06	21.64	0.04	2007.284	15	126
08498+3045	Anon.37Bx	11.18	14.5	306.19		6.89		2007.284	1	126
08571+3241	Anon.38	10.16	12.6	13.20	0.22	14.05	0.07	2007.284	6	127
08573+3236	SEI 513	11.23	11.64	197.14	0.09	27.26	0.03	2007.284	17	128
09175+1419	ROE 35	10.6	11.6	271.89	0.18	11.10	0.06	2007.282	15	129
09289+1235	ARY 49	7.89	9.94	270.57	0.09	52.52	0.08	2007.282	8	130
09290+0938	CHE 138AB	9.98	10.16	6.16	0.17	28.29	0.05	2007.282	10	131
09290+0938	LAD 1AC	10.0	13.0	203.83	1.22	8.73	0.16	2007.282	4	132
09323+1046	ARY 50	7.92	10.50	252.24	0.02	120.43	0.07	2007.282	12	133
09369+0927	DAL 17	10.32	11.84	279.16	0.15	29.13	0.04	2007.282	15	134
09388+1047	STT 204AB	6.70	11.6	99.23	0.34	7.61	0.04	2007.282	3	135
09388+1047	WAL 56AC	6.70	10.65	81.22	0.03	85.46	0.06	2007.282	11	135
09446+0845	Anon.39	11.19	13.2	347.75	0.29	17.32	0.07	2007.282	17	136
09453+0853	STF1379	7.16	10.75	176.06	0.32	9.75	0.04	2007.282	17	137

Table Notes

1. A=GSC 4068 1436.
2. B=GSC 4068 1466.
3. A=GSC 4068 1652. True for the entire system, but measuring the members accurately is difficult due to the great DM.
4. A=GSC 4068 1652.
5. E=GSC 4068 1651.
6. G=GSC 4068 1192.
7. H does not appear in GSC.
8. LM=GSC 4068 1339 non star.
9. O=GSC 4068 1127.
10. I did not find such a double at the specified location, but its earlier measures are similar to STF 484GH, so the two doubles are the same, in my opinion.
11. A=GSC 2401 179.
12. It is not at the specified location, but on the basis of the DSS images, it could be the same as BRT 2587 located 10' from here, but I did not photograph that one.
13. Possibly it is the same as ALI 527, the parameters change due to the proper motion.
14. AB=GSC 2401 427 non star.
15. A=GSC 2896 918.

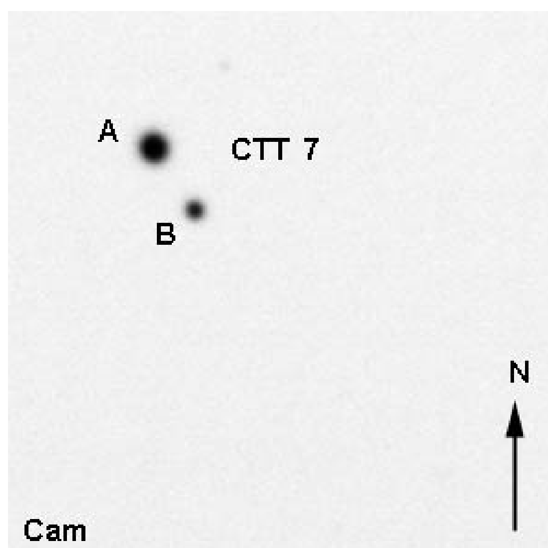

Figure 1: CTT 7 (WDS 04067+6221). See note 1.

16. A=GSC 2401 31 1. Cannot be measured.
17. A=GSC 2401 31 1.
18. A=GSC 2896 958.
19. A=GSC 2896 528.
20. A=GSC 2401 517 (05107+3706!).
21. A=GSC 2401 633.
22. A=GSC 2401 523.
23. A=GSC 2401 763 non star (05111+3709!).
24. A, B do appear in USNO (05110+3705!). Far from the specified location (3.5').
25. AB=GSC 2401 55 non star.
26. A=GSC 2401 795 (05113+3711!).
27. A=GSC 2401 557.
28. A, B do appear in USNO (051203+371644).
29. A=GSC 2401 1077 (05121+3651!).
30. A=GSC 2401 449.
31. A=GSC 2401 1071 (05125+3657!).
32. A=GSC 2401 713.
33. A=GSC 2896 1098.
34. A=GSC 2896 990 non star.

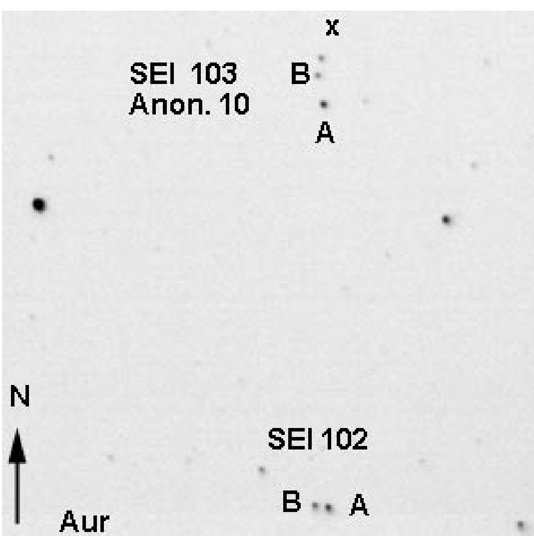

Figure 2: SEI 102 (WDS 05130+3748), SEI 103 (WDS 05130+3753), and Anon. 10. See notes 33 and 34.

35. A=GSC 2401 203. A separate article has been written on this system (Berko, 2009).
36. SEI 106AB=GSC 2401 113 non star. x=GSC 2401 437 if this is the primary of SEI 107 (the measures of 1982). So y= SEI 106 B, and z= SEI 106 A.
37. B=GSC 2401 117. Very different parameters. The images available do not show significant proper motion of the nearby stars. There is a nearer star, too, marked as "b" in the picture, PA=340; s=35,7", but it differs significantly from the original parameters of SEI 107. The 1982 measures could be based on GSC stars. In this case the primary is GSC 2401 437, and its pair is GSC 2401 113, non star object. This latter object includes the two components of SEI 106.
38. A=GSC 2896 556 (05137+3749!).
39. A=GSC 2896 752.
40. A=GSC 2401 163.
41. A=GSC 2896 1062.
42. A=GSC 2896 1076.
43. A does appear in USNO.
44. A=GSC 2896 550 (05174+3752!).
45. A does appear in USNO (05178+3800!). B=GSC 2896 2050.
46. A does appear in USNO (05177+3756!).
47. Bx=GSC 2896 564 non star (05177+3756!).
48. A=GSC 2896 1892.
49. A=GSC 2896 434.
50. AB=GSC 2896 1909 non star (05183+3804!). Far from the specified location (4.5').
51. A=GSC 2896 2081 non star.
52. A=GSC 2896 636. Difficult to measure.
53. AB=GSC 2896 678 non star.
54. A=GSC 2896 2093.
55. A=GSC 2896 688 (05196+3754!).
56. A=GSC 2896 1272. This could be SEI 184, but with much fainter members. In this case the double measured by me as SEI 184 is Anon.
57. A=GSC 2896 1272.
58. A=GSC 2896 1282.
59. A=GSC 2900 1956.
60. A does appear in USNO (052005+392308).
61. A=GSC 2909 547.
62. AB=GSC 2909 469 non star.
63. ABC=GSC 2909 507 non star.
64. A=GSC 2913 2170 non star.
65. A=GSC 2909 513 non star.
66. A=GSC 2909 1370.
67. A=GSC 2909 1079.
68. A=GSC 2909 1072. The difference is significant.
69. A, B do appear in USNO.

Double Star Measures Using a DSLR Camera #3

70. A=GSC 2909 1144.
71. A, B do appear in USNO (052322+380142).
72. A, B do appear in USNO (052322+375804).
73. B=GSC 2909 1673.

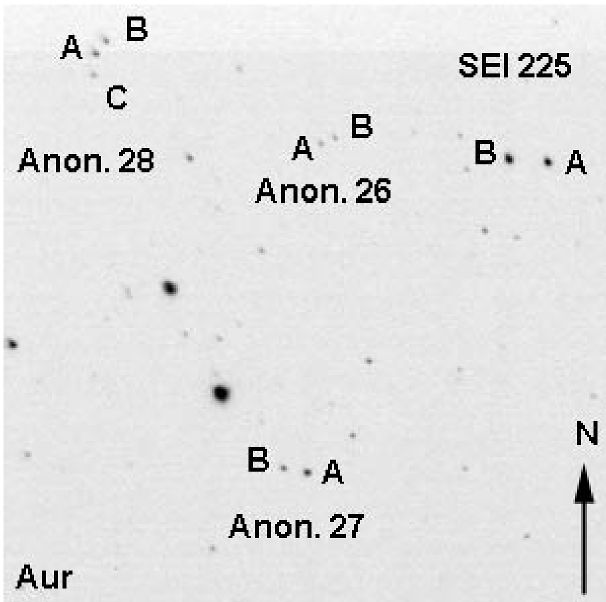

Figure 3: SEI 225 (WDS 05231+3802) and several previously unreported doubles. See notes 70 - 73.

74. A=GSC 2909 953 1.
75. C=GSC 2909 1312. The position of AC seems stable on the basis of the GSS images, GSC and my own photos. I do not understand the significant difference.
76. C=GSC 2909 1312. The reason why I measured this relation is because - regarding distance - it is closer to the parameter of WAL 39.
77. AB=GSC 2909 1211 non star.
78. A=GSC 2909 1110.
79. A=GSC 2911 1139 non star.
80. AB=GSC 2911 1287 non star.
81. It cannot be found in GSC and USNO, visible in DSS images.
82. A=GSC 2416 1051.
83. Bx=GSC 2416 1172 non star.
84. A=GSC 2417 40.
85. A=GSC 2417 498.
86. A=GSC 2911 1531.
87. A=GSC 1874 1623 1.
88. It cannot be found in GSC, (05474+2859!).
89. A=GSC 2911 1341 (05483+3746!). It is not sure that this is the original double. I found only this in the vicinity, 13,5' from the specified location. They are stars of similar brightness and position, though they form a looser pair.
90. A=GSC 2417 381 (05495+3701!).
91. AB=GSC 2417 1062 non star.
92. A=GSC 2417 492.
93. A=GSC 2418 1337 (05514+3540!). Far from the specified location (5.3'). The proper motion in PA140 direction of component B accounts for the changes of the measured parameters.

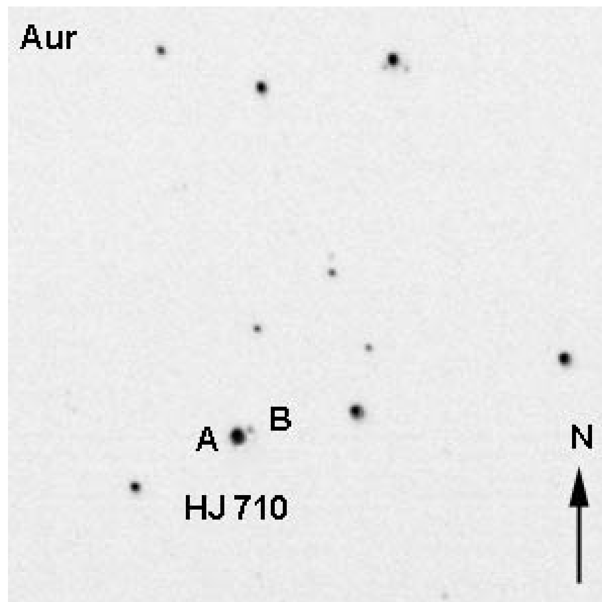

Figure 4: HJ 710 (WDS 05514+3535). See note 93.

94. A=GSC 2414 1223.
95. AB=GSC 2414 1299 non star (05522+3441!).
96. A=GSC 2418 771.
97. A=GSC 2418 1443.
98. A=GSC 2418 1183.
99. A=GSC 2418 882.
100. A=GSC 2406 1301 (05545+3110!). The faint Aitken members cannot be measured.
101. A=GSC 2418 1128.
102. A=GSC 2406 412.
103. A=GSC 2418 780.
104. A=GSC 2406 694.
105. A=GSC 2419 96.
106. A=GSC 1353 764 (07081+2026!). Far from the specified location (10').
107. A=GSC 1353 494. Stars forming a pair similar to SLE 401.

Double Star Measures Using a DSLR Camera #3

108. A=GSC 1353 119. Stars forming a pair similar to SLE 401.
109. A=GSC 195 2724 (08113+0116!).
110. A=GSC 200 925.
111. A=GSC 200 2526.
112. A=GSC 2483 822.
113. AB=GSC 2486 1312 blended object.
114. A=GSC 2483 580.
115. A=GSC 2483 1345.
116. A=GSC 2486 920.
117. A=GSC 2489 1033.
118. A=GSC 2486 2268.
119. AB=GSC 2486 2262 non star (08334+3350!).
120. A=GSC 2486 2142 (08335+3349!).
121. I did not find it in the vicinity, neither in DSS images, nor in GSC. By looking through the DSS images, the stars of the area do not seem to have a significant proper motion.
122. A=GSC 2484 981 (08407+3114!).
123. A=GSC 2490 1584. Difficult to measure. The proper motion in PA300 direction of component B accounts for the changes of the measured parameters.
124. A=GSC 2488 949.
125. A=GSC 2485 1126. In the location of the previous measures (1894, 1991), GSC indicates a star (GSC 2485 9990), but this star cannot be seen in my own photos or in the DSS images. What I measured as the pair is GSC 2485 110, and this can be found in every photo. I cannot see any sign of proper motion in the images, either.
126. A=GSC 2485 1216.
127. A=GSC 2488 1021.
128. A=GSC 2488 1151.
129. A=GSC 825 498 non star (09176+1418!).
130. A=GSC 826 1078. The proper motion in PA230 direction of component B accounts for the changes of the measured parameters.

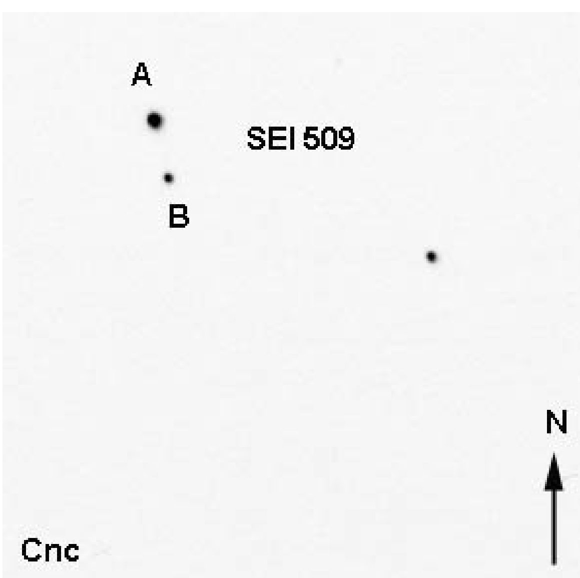

Figure 5: SEI 509 (WDS 08498+3113). See note 125.

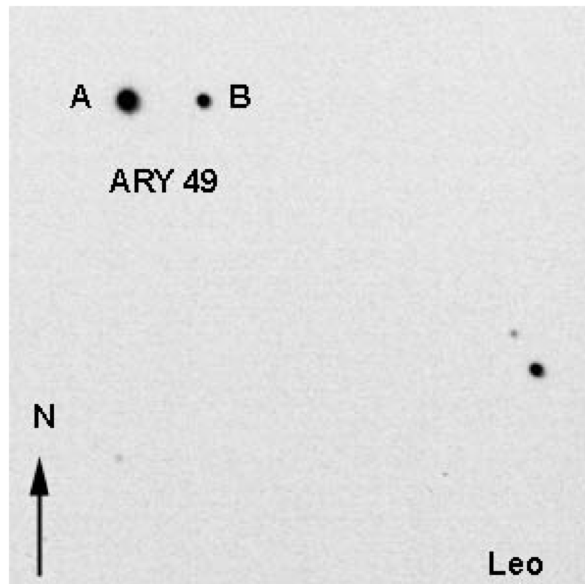

Figure 6: ARY 49 (WDS 09289+1235). See note 130.

131. A=GSC 820 211 non star (09289+0938!).
132. A=GSC 820 211 non star (09289+0938!). Difficult to measure.
133. A=GSC 824 803.
134. A=GSC 821 889.
135. A=GSC 824 1224. Component A has proper motion, but component C has proper motion, too, in PA220 direction, which is larger than that of component A. The measured parameters contradict this.
136. A=GSC 828 1149. First I measured it as CHE 142, but what I find more possible is that CHE 142 is the same as STF 1379 located 10' from here.
137. A=GSC 828 904 1.

The Peculiarities of the SEI 105 System

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Abstract: As described in the previous article, measurement of SEI 105 in the constellation Auriga took place on 12 April 2007. The only measures of this system are from 1895 with parameters of 16.8" and 354 degrees. The present article was written because due to the significant proper motion of the primary star, the angular distance of the main pair has changed, and also because a third member has been measured in our own photos (Figure 1), which has caused no little surprise during its thorough examination.

The primary star of SEI 105 – due to its brightness of 6.5 magnitude – has the code HIP 24332 in the Hipparcos Catalog, the database to be mentioned first, henceforth. This F3 star is 85 light-years away and its luminosity is 1.4 times that of the Sun. The proper motion is -145 mas/year in right ascension, -135 in declination. The GSC number of its companion discovered by Scheiner is 2401 329, and its magnitude is 11.3. Before we start analyzing SEI 105, let us say a few words about the two nearby stars that can be found in the Guide (ver. 7) (Figure 2).

The origin of the star numbered as GSC 2401 1313, with brightness of 11.5 cannot be defined precisely. It can be found as 280571 in the Henry Draper Catalog – a star list almost 100 years old, which is still in use partly because of the spectral classifications it contains. In the course of time, it must have been taken over from this database, so it appears in both USNO ACT and A2.0 catalogs, but it cannot be seen in our own photos. By its position, it would fall exactly on the rim of the main star's Airy disc in Schmidt's 1954 image, taken at Mount Palomar, but we found no sign indicating this in the digitized picture.

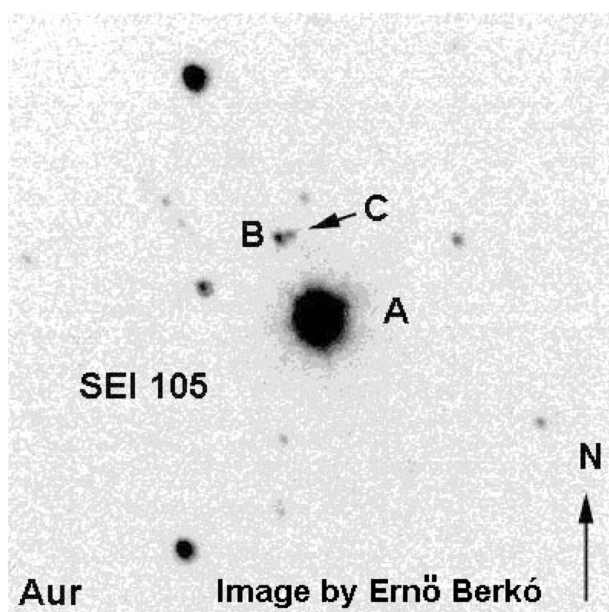

Figure 1: DSLR image of SEI 105.

Even more mysterious is the detectability of GSC 2401 983 (magnitude 13.9) a non-star object, due to

The Peculiarities of the SEI 105 System

Figure 2: The region of SEI 105 according to Guide, v7.

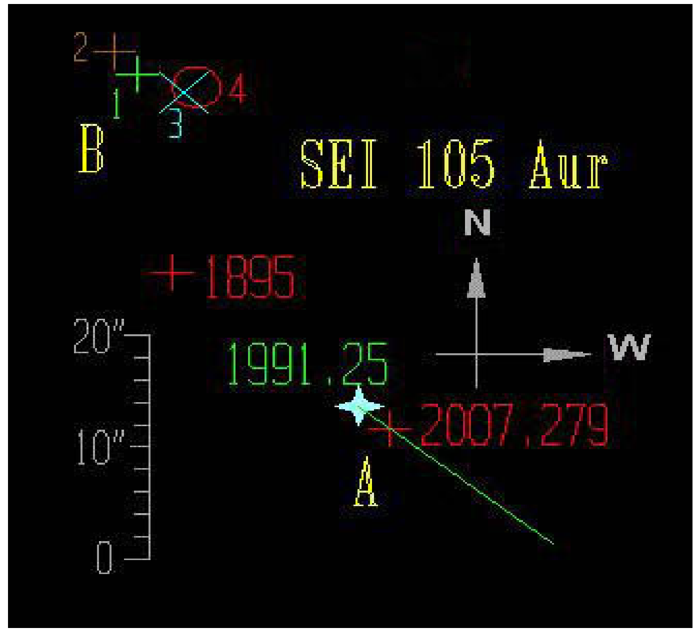

Figure 3: Measured positions of the B component. See text.

the bright star in the vicinity. In our images, the brightness of the star found at the same declination as B-C pair, to the right – that is to the west of it – is 15.4m (B) and 14.9m (R) in A2.0, so it is understandable that it did not get into the GSC. After this, we can continue with the old and new components of SEI 105.

The position of component B, measured by Scheiner, is the following according to the different sources (Figure 3): 1 (green color) is GSC, 2 (brown) stands for the Tycho catalogs (we'll talk about USNO-A2.0 later). The red circle marked 4 and the blue "X", marked 3, indicate the position related to the primary star as measured by Scheiner and Ernő Berkó: it is surprising that these two positions are much closer to each other than the astrometrical coordinates, and it also makes it likely that component B has no significant proper motion.

Due to the primary star's proper motion, the parameters of A-B pair at 2007.279 are: PA = 27.32°, sep. = 34.01". It can be seen that the angular distance has doubled in the past 112 years, and the position angle has increased 33 degrees.

While measuring the images, it was immediately obvious that component B has another close companion, at 4.4" distance and 288 degrees position angle. In order to check this, we downloaded the DSS images: the first original plate (Figure 4) was created on 29.11.1954, and the second (Figure 5) on 23.10.1993. at Palomar Observatory.

The difference between the two images is easily visible, it is obvious that BC pair is changing, too. At the same time, with the help of the diffraction spikes, it can be clearly seen how the main star has changed its position in relation to its surroundings in the past 39 years.

How can we define the movement of BC members numerically? Unfortunately, as could be expected, there are no exact coordinates available for the different epochs of such relatively faint stars located close to each other; and it is this second fact that is of primary significance. The USNO-A2.0 star catalog, which contains the data of more than 526 million stars and was created by analyzing the discs of POSS1 sky survey

Figure 4: DSS image of SEI 105 taken in 1954.

Figure 5: Palomar image of SEI 105 taken in 1993.

The Peculiarities of the SEI 105 System

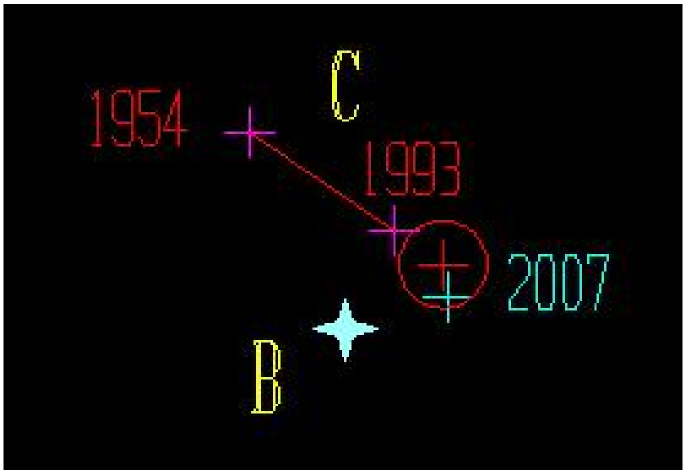

Figure 6: Estimate of the relative positions of the B and C components for 1954 and 1993.

(where Figure 4 originates), gives the coordinates of the center of BC pair's common Airy discs as 1200-03012567. We found this by using a software called "fv", developed for images in FITS format. With the same program, it was necessary to estimate the relative position of B and C components for 1954 and 1993: the results can be found in Figure 6.

The position taken by component B in the two different times is the same within the resolution of the digital images, in C's case the difference is 5-6 pixels. This is -152 mas/year proper motion in right ascension and -104 mas/year in declination with ±5-10% accuracy according to our estimates. The similarity to the primary star's proper motion is striking – taking the factor of inaccuracy into consideration, we could say it is the same. A circle of about 1.8" radius marks the position of member C, extrapolated to 2007 by the proper motion: we can see that measuring our own photos indicates smaller difference. If we calculate C's position for 1895, we get 19" as its distance from B, which could explain why Scheiner did not take it into consideration.

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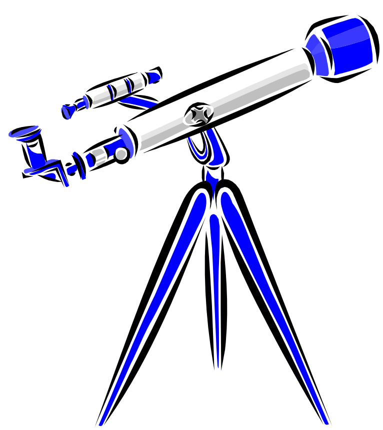

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