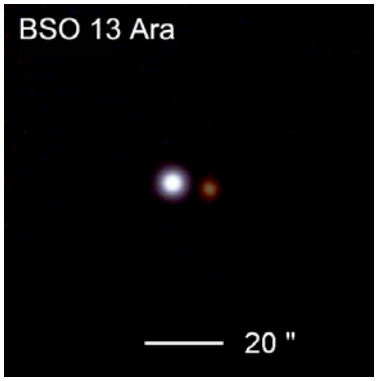
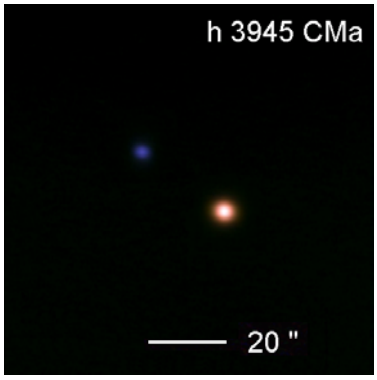
University of South Alabama

Journal of Double Star Observations

VOLUME 2 NUMBER 3 SUMMER 2006





Images from "Measurements of Double and Multiple Stars in the Southern Sky..." in this issue.

Inside this issue:

Divinus Lux Observatory Bulletin: Report #5 Dave Arnold	79
Divinus Lux Observatory Bulletin: Report #6 Dave Arnold	87
Five Previously Unreported Double Stars in Orion H. Varley and M. Nicholson	95
CCD Measurements of Multiple Component Stars Martin P. Nicholson	97
Double Star Imaging and Measurement with Unconventional Cameras, Part II: Binary Imaging with the Meade LPI and DSI Cameras Rod Mollise	100
Measurements of Double and Multiple Stars in the Southern Sky in 2002 Using an 8-Inch Schmidt-Cassegrain and a CCD Video Camera. Rainer Anton	108
Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars: Results of LIADA's Double Star Section for 2003 Francisco Rico Romero	118

Divinus Lux Observatory Bulletin: Report #5

Dave Arnold

Program Manager for Double Star Research
2728 North Fox Fun Drive
Flagstaff, AZ 86004
E-mail: dvdarn@aol.com

Abstract: This report contains theta/rho measurements from 94 different double star systems. The time period spans from 2005.351 to 2005.479. All 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.

Introduction

When one is interested in regularly making theta/rho measurements of double stars, which are known to be binary in nature, the thought may be that a large telescope, with expensive accessories, is a prerequisite for engaging in such efforts. While it is true that the majority of binaries, which have had orbital elements determined, might be out of reach for those who employ modest instrumentation, there are several binary systems that can be regularly monitored and measured with a small telescope. I am aware of at least four systems that have separations of over 10 seconds, which could be regularly studied. Additionally, there are another dozen or so that are within reach of a medium sized telescope. These binaries can be located in SKY CATALOGUE 2000.0, volume 2, in the visual binaries section. The four systems with 10+ seconds of separation are listed in Table 1 below for the convenience of the reader who might like to get started with this type of research program.

SKY CATALOGUE 2000.0 also provides an ephemeris for each listed system, so one can check on how well current measurements agree with the computed orbit. The systems mentioned above are all fairly bright, thereby enabling one to use an illuminated measuring device if that is desired.

As in previous articles, the selected double star systems, which appear in this report, have been taken from the 2001.0 version of the WDS CATALOG, with published measurements that are no more recent than ten years ago. Exceptions to this stipulation include STF 2140 Aa-B and STF 2272 AB, because the theta/rho shifts for these visual binaries are large enough to warrant more frequent measurements. There are also some noteworthy items that are mentioned in reference to the following table.

As has been reported in previous articles, this one lists double stars that have displayed significant theta/rho shifts, because of the effects of proper motion, by one or both of the components. To begin with, WFC 310 has undergone a 5 % decrease in separation and an increase of 2 degrees in position angle, since 1970, because of proper motion by the reference point star. A large proper motion by the reference point star has also caused major theta/rho shifts for WFC 359. Since 1902, the separation has increased by 45" and the position angle has increased by 27 degrees. Both of these double stars have been neglected, and there is a great need for additional measurements by others.

An extremely large proper motion by the reference point star, in BUP 176, has caused theta/rho shifts of 7 degrees and 16 seconds since the last published measure-

Name	Coordinates	Theta	Rho	Year Measured
STF 60 AB	00491+5749	318 degrees	12.7 seconds	1999
STF 296 AB	02442+4914	308 degrees	20.5 seconds	1996
STF 1321 AB	09144+5241	92 degrees	17.3 seconds	1997
STF 275 AB	21069+3845	150 degrees	30.7 seconds	2000

Table 1: Four binary systems with separation over 10 arc seconds.

Divinus Lux Observatory Bulletin: Report #5

ments in 1984. In a like manner, a large proper motion shift by the "BC" components, in STN 41 A-BC, has caused theta/rho shifts of 14 degrees and 6.5 seconds since 1991. A proper motion shift is also noted for HLM 7 AB. Since 1983, the theta value has increased by almost 2 degrees, while the rho value has decreased by 2.7%. SMA 79 has also displayed a noteworthy proper motion shift. Since 1991, the rho value has decreased by 3% and the theta value has increased by 3 degrees.

An extended length of time, amounting to several decades since the last published catalog measurements, has contributed to detectable proper motion shifts in five additional double stars. As a consequence, ES 2664 has displayed a 3.3% decrease in the rho value since 1934. Similarly, HJ 2823 has shown a 4.1% decrease in the rho value since 1922. Also of note is the fact that the 1879 theta value for HJ 2823 matches the theta value listed in this report more closely than the value reported in 1922. The Hipparcos/Tycho data seems to confirm this finding. Thirdly, the rho value for STF 2057 AC has increased by 10" since the last published measurements in 1906. Fourthly, regarding BUP 177AC, the theta value has decreased by 4.5 degrees and the rho value has increased by over 7 seconds, since 1912. Finally, for HZG 13, a large proper motion by both components has caused a 29 degrees increase in the theta value and a 5" increase in the rho value, since 1946.

The fact that older measurements seem to reflect more accuracy than more recent measurements, in some cases, is relevant to the situation regarding Vat 2. For this double star, the 1916 measurements appear to match more closely with the measurements in this article, and with the Hipparcos/Tycho data, than do the measurements that were reported in 1941. If the 1916 measurements have a high degree of reliability, then this double star would appear to be a relatively fixed system.

Orbital motion may be the cause of theta/rho shifts in some common proper motion pairs that are listed in the table. STF 2128 might be one such pair, which has apparently displayed a large enough motion of this type that can be measured. Since 1995, the separation has increased by 4.4%. Likewise, orbital motion might have contributed to a 3 degrees decrease in the theta value for STF 2228, which also seems to be suggested by the Hipparcos/ Tycho data. However, the situation for STF 2228 needs further study because the last published catalog measurements were in 1905

Four additional double stars, bearing the "WFC" prefix, are in need of additional measurements because only a few theta/rho recordings currently exist. As a consequence, the theta/rho measurements for WFC 341 (18518-0505) vary by 6 degrees in p.a. and 1" in separation since the first measurements were made in 1892. There are no trends of increasing or decreasing values for either theta or rho because of the paucity of the data. The theta/rho values listed in the table match up fairly closely with those that are given in the Hipparcos/Tycho data for this common proper motion pair.

The lack of measurements has placed WFC 335 (18344+0853) is in a similar situation with WFC 341. In this case, the separation value has been recorded with a variance of 1.2" over the past several decades, with no obvious trend among prior measurements. The rho listing in the table does not match up closer than 5% with any other values in the WDS CATALOG or with Hipparcos/Tycho data. This double star is also a common proper motion pair.

Similarly, only a few theta/rho measurements exist for WFC 192 (12021+1521) and WFC 348 (19125+4447). As in the above cases, the theta/rho values show a random scattering with no apparent trends. Specifically, for WFC 192, the theta value has been recorded with a variance of 4 degrees, while the rho value for WFC 348 has been recorded with a 6.7% variance. These two double stars are also common proper motion pairs, and all four of these "WFC" pairs have been neglected for many decades.

I might also mention that there are discrepancies in how the WFC double stars are listed in the WDS CATALOG. The listings that are appearing in my reports have been taken from the 2001.0 web site catalog, but the USNO Double Star CD 2001.0 lists a different numerical sequence for the "WFC" doubles. To avoid confusion, the reader may wish to refer to these double stars with their coordinates.

Additionally, WFC 351 (19212-1146) and WFC 363 (19533+0820), which appear in this report, are not listed in the main catalog of the double star CD. This should probably be addressed because these double stars represent more neglected pairs that are in great need of additional measurements. The web site catalog lists only one previous set of measurements for both of these pairs, which were done in 1969 and 1957 respectively. For WFC 363, as an example, this article reports a 9 degrees increase in the theta value and a 4% decrease in the rho value since the 1957 measurements were published.

Divinus Lux Observatory Bulletin: Report #5

Three measurement listings in the WDS catalog appear to be anomalous. In regards to BU 242 AD (17240-1142), the measurements for 1876 match fairly closely with the theta/rho values listed in this report, while the values for 1991 appear to be at a variance. Likewise, for SEI 696 AC (19508+3430), the measurements for 1894 closely match the measurements that were obtained for this report, while the listing for 1990 appears to deviate. Finally, the catalog measurements for HJ 1481 AB (20052+4923) are actually measurements for the "BC" components. The measurements listed in this report reflect the current parameters for the "AB" components.

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
WFC 192	12021+1521	10.2 10.5	141.2	8.39	2005.386	1n	1
BEM 21	16030+5112	10.4 10.7	104.2	18.76	2005.425	1n	2
AG 201	16041+4858	10.4 10.6	252.4	7.90	2005.425	1n	3
AG 202	16056+4739	10.5 10.5	284.1	21.73	2005.425	1n	4
KU 110	16105+0354	10.2 10.6	271.3	61.23	2005.425	1n	5
MTL 1	16111-0814	10.2 10.6	350.2	37.52	2005.425	1n	6
RST3934 AB	16125-1359	10.2 10.6	179.7	29.63	2005.425	1n	7
ARG 75	16138-0147	10.4 10.7	64.0	21.73	2005.425	1n	8
SHJ 223 AC	16167+2909	5.8 10.4	20.8	86.90	2005.425	1n	9
SHJ 223 AD	16167+2909	5.8 10.2	50.9	123.44	2005.425	1n	9
STF2057 AC	16316+1917	10.4 10.3#	48.5	173.80	2005.427	1n	10
HLM 7 AB	16365+4856	10.3 10.6	7.8	25.68	2005.427	1n	11
HJ 4879 AC	16395-1744	10.4 10.6	78.3	34.56	2005.427	1n	12
BU 42	16401+2901	10.1 10.6	40.2	7.41	2005.441	1n	13
KU 114	16490+0315	10.5 10.4#	111.2	59.25	2005.441	1n	14
HEI 13	16534+2925	10.0 10.2	120.3	7.90	2005.441	1n	15
LDS 986	16569+2541	10.6 10.7	266.0	8.40	2005.441	1n	16
STF2178	17033+5935	8.6 10.0	44.0	12.84	2005.370	1n	17
WFC 305	17122+2137	9.9 10.6	301.0	6.91	2005.351	1n	18
BUP 176	17129+4220	10.1 9.8#	300.2	129.36	2005.425	1n	19
STF2140 Aa-B	17146+1423	3.3 5.3	104.6	4.94	2005.351	1n	20
STF2149	17200-0626	10.0 10.2	22.1	7.41	2005.427	1n	21
POP 218	17205+3439	10.4 10.4	89.0	30.61	2005.427	1n	22

Divinus Lux Observatory Bulletin: Report #5

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
BU 242 AD	17240-1142	8.6 10.4	61.7	47.40	2005.427	1n	23
WFC 310	17288+0020	5.4 9.6	315.8	47.40	2005.351	1n	24
STF2178	17295+3456	7.2 9.0	126.9	10.86	2005.351	1n	25
HJ 1300 A-BC*	17344+2520	10.5 10.7	256.9	13.33	2005.427	1n	26
WFC 314	17352+2545	9.8 10.4	102.7	7.90	2005.351	1n	27
BHA 58	17371-1636	9.9 10.3	140.1	23.70	2005.427	1n	28
ES 2660	17372+4309	10.1 10.1	154.2	8.89	2005.427	1n	29
ES 1257 AC	17383+4500	10.4 10.4	123.4	52.34	2005.427	1n	30
BUP 177 AC	17387+1834	9.5 9.7	268.6	374.26	2005.427	1n	31
SMA 79	17483+4506	10.4 10.7	89.9	15.31	2005.447	1n	32
STF2228	17492+0909	10.5 10.7	105.0	19.26	2005.447	1n	33
STF2227	17500+0520	10.3 10.7	110.3	15.31	2005.447	1n	34
HJ 855	17503+0415	10.1 10.4	79.8	19.75	2005.447	1n	35
LEO 14 AC	17519-0329	10.3 10.3	250.2	61.23	2005.447	1n	36
STT 160	17534+1058	8.4 9.6	191.1	101.71	2005.351	1n	37
HDO 147	17536-1726	10.5 10.7	205.1	12.34	2005.447	1n	38
POU3323	17549+2347	10.1 10.6	189.1	8.89	2005.447	1n	39
STF2278 AB	18029+5626	7.8 8.1	28.1	36.54	2005.370	1n	40
STF2278 AC	18029+5626	7.8 8.5	37.3	33.58	2005.370	1n	40
STF2278 AD	18029+5626	7.8 10.1	188.9	196.51	2005.370	1n	40
STT 164	18032+0755	8.1 9.2	359.7	50.36	2005.370	1n	41
STF2272 AB	18055+0230	4.1 6.2	137.1	4.94	2005.370	1n	42
STN 41 A-BC	18072-1854	9.7 10.2	214.7	27.65	2005.427	1n	43
STF2287 AB	18103+0235	10.4 10.7	152.5	22.71	2005.425	1n	44
VAT 2	18125-1852	9.2 9.8	85.5	7.41	2005.427	1n	45
ES 473 AB	18130+4251	10.1 10.4	98.7	30.61	2005.425	1n	46
HJ 2823	18150-1955	9.7 10.3	331.0	19.75	2005.427	1n	47
ES 2664	18157+3723	10.5 10.7	82.1	9.38	2005.425	1n	48

Divinus Lux Observatory Bulletin: Report #5

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
AG 220	18172+5103	10.3 10.3	126.9	10.86	2005.425	1n	49
SLE 162	18227+0614	10.3 10.6	141.9	20.74	2005.447	1n	50
SLE 184	18303+3246	9.3 10.5	63.4	35.55	2005.447	1n	51
ARA 283 AB	18326-1657	10.3 10.5	34.7	11.36	2005.449	1n	52
SLE 495	18329+0539	10.0 10.6	100.0	8.39	2005.449	1n	53
WFC 335	18344+0853	10.0 10.7	51.3	7.90	2005.370	1n	54
TAR 3 AB	18506+3313	10.5 10.7	304.5	14.81	2005.447	1n	55
WFC 341	18518-0505	9.6 9.6	307.9	8.89	2005.370	1n	56
GYL 13	19011+3210	9.9 10.3	305.2	34.07	2005.463	1n	57
ES 2237	19047+3334	10.2 10.6	219.3	9.88	2005.463	1n	58
HZG 13	19059+3502	9.7 10.2	134.4	26.17	2005.463	1n	59
STF2460	19080+1945	10.0 10.2	197.9	9.38	2005.463	1n	60
WFC 348	19125+4447	9.8 10.1	352.1	9.38	2005.389	1n	61
A 99 AC	19164-0925	10.0 10.2	78.5	46.41	2005.463	1n	62
HJ 2860	19174-1134	10.5 10.2#	110.2	21.23	2005.463	1n	63
WFC 349	19186+2038	10.1 10.3	71.5	8.89	2005.389	1n	64
WFC 351	19212-1146	10.5 10.6	60.9	9.88	2005.411	1n	65
ES 653	19261+5409	10.3 10.5	106.1	11.85	2005.463	1n	66
SEI 604	19286+3808	10.5 10.7	170.0	16.79	2005.463	1n	67
HJ 1409	19315+3107	10.0 10.5	358.3	14.32	2005.463	1n	68
ES 129 AC	19333+5249	9.9 10.3	273.2	72.09	2005.466	1n	69
SEI 644	19357+3309	10.0 10.3	159.4	16.79	2005.463	1n	70
ES 490 AB	19366+4327	10.1 10.1	222.5	64.19	2005.466	1n	71
STF 46	19418+5032	5.9 6.2	133.4	39.50	2005.389	1n	72
GUI 27 AC	19421+5319	10.3 10.4	113.4	82.95	2005.466	1n	73
SEI 669	19435+3433	10.3 10.5	47.4	16.79	2005.466	1n	74
WFC 359	19455+5046	9.0 10.7	214.5	53.33	2005.389	1n	75
STF2578 AB	19457+3605	6.4 7.0	125.0	14.81	2005.389	1n	76

Divinus Lux Observatory Bulletin: Report #5

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
STF2578 AF	19457+3605	6.4 9.0	249.7	145.16	2005.389	1n	76
HDS2811	19467-1129	10.1 10.1	201.0	16.29	2005.466	1n	77
AG 240	19501+4748	9.6 9.7	256.5	13.83	2005.466	1n	78
SEI 696 AC	19508+3430	10.2 10.0#	309.2	19.26	2005.466	1n	79
ES 2683	19517+5339	10.2 10.4	320.1	9.88	2005.466	1n	80
WFC 363	19533+0820	10.3 10.5	214.3	8.89	2005.479	1n	81
ARG 87	19535+4939	10.5 10.5	271.3	14.81	2005.466	1n	82
SMA 109	19538+4436	10.6 10.6	111.7	21.73	2005.466	1n	83
SEI 743	19572+3646	10.4 10.5	36.9	29.63	2005.466	1n	84
H 47 AB	20014+5006	5.1 8.8	149.5	41.48	2005.411	1n	85
HJ 1481 AB	20052+4923	10.4 10.6	59.8	34.07	2005.479	1n	86
HJ 1481 AC	20052+4923	10.4 10.7	92.3	27.65	2005.479	1n	86
HJ 1473	20054+2716	10.4 10.6	139.1	10.86	2005.479	1n	87
SEI 936	20097+3600	10.4 10.5	123.0	27.65	2005.466	1n	88
STF2648	20104+4949	8.1 9.5	116.3	6.91	2005.411	1n	89
SEI 958	20108+3646	10.0 10.0	323.4	21.23	2005.466	1n	90
SEI 962	20110+3642	9.1 10.7	289.4	23.21	2005.479	1n	91
HJ 1489 AD	20113+3550	9.7 9.9	50.5	17.28	2005.466	1n	92
HJ 1492 A-BC	20129+2913	10.2 10.5	53.9	18.27	2005.479	1n	93
STT 208	20349+4651	7.7 8.5	240.1	81.96	2005.411	1n	94

The companion star is the brighter component.
* Not listed this way in WDS CATALOG. “BC” too dim to clearly resolve.

Notes

1. In Coma Berenices. Common proper motion. Relatively fixed? Spect.. A5.
2. In Draco. Separation slightly increasing.
3. In Hercules. Relatively fixed. Common proper motion. Spect. G5.
4. In Hercules. Relatively fixed. Spect. F0, F0.
5. In Serpens. Sep. & p.a. slightly increasing. Spect. F8.
6. In Ophiuchus. Sep. & p.a. slightly increasing.
7. In Scorpius. Sep. decreasing; p.a. increasing. Spect. K0.

(Continued on page 85)

Divinus Lux Observatory Bulletin: Report #5

(Continued from page 84)

8. In Serpens. Relatively fixed. Common proper motion. Spect. G0, G0.
9. Nu or 18 Coronae Borealis. AC & AD = sep. & p.a. dec. Spect. A3V, G, M8.
10. In Hercules. Separation increasing. Spect. K0.
11. In Hercules. Sep. decreasing; p.a. increasing. Spect. F0, F0.
12. In Ophiuchus. Sep. decreasing; p.a. increasing. Spect. A8IV.
13. In Hercules. Sep. & p.a. increasing. Spect. G0, G.
14. In Ophiuchus. Sep. & p.a. slightly increasing. Spect. F2.
15. In Hercules. Common proper motion; p.a. decreasing. Spect. G0, G0.
16. In Hercules. Relatively fixed. Common proper motion.
17. In Draco. Common proper motion; sep. inc. Spect. K4V, K0.
18. In Hercules. Relatively fixed. Common proper motion.
19. In Hercules. Sep. decreasing; p.a. increasing. Spect. M1V, K2.
20. Alpha or 64 Herculis. Position angle decreasing. Spect. M5I, M5II.
21. In Ophiuchus. Relatively fixed. Spect. G0.
22. In Hercules. Relatively fixed. Common proper motion. Spect. F8, F8.
23. In Serpens. Position angle slightly decreasing. Spect. A2.
24. In Ophiuchus. Sep. decreasing; p.a. increasing. Spect. A5, G5.
25. In Hercules. Position angle slightly decreasing. Spect. K0, K0.
26. In Hercules. Slight sep. increase and p.a. decrease.
27. In Hercules. Separation slightly increasing. Spect. G5, G5.
28. In Ophiuchus. Sep. decreasing; p.a. increasing. Spect. B9V, A1V.
29. In Hercules. Common proper motion; p.a. increasing. Spect. G, G.
30. In Hercules. Separation decreasing. Position angle increasing.
31. In Hercules. Sep. increasing; p.a. decreasing. Spect. K5, F5.
32. In Hercules. Sep. decreasing; p.a. increasing.
33. In Ophiuchus. Common proper motion; p.a. poss. decreasing. Spect. F8, G0.
34. In Ophiuchus. Sep. & p.a. decreasing. Spect. K5.
35. In Ophiuchus. Sep. increasing; p.a. decreasing. Spect. K2.
36. In Ophiuchus. Relatively fixed.
37. In Ophiuchus. Relatively fixed. Spect. B8, A0.
38. In Sagittarius. Relatively fixed. Common proper motion. Spect. B8.
39. In Hercules. Relatively fixed. Common proper motion. Spect. F0.
40. In Draco. AB = cpm; p.a. inc. AC = p.a. inc. Spect. A9V, A0, A0, G0.
41. In Ophiuchus. Position angle decreasing. Spect. K0.
42. 70 Ophiuchi. Sep. inc.; p.a. dec. Spect. K0V, K4V.
43. In Sagittarius. Sep. increasing; p.a. decreasing. Spect. K2/K3III.
44. In Ophiuchus. Sep. & p.a. slightly increasing.
45. In Sagittarius. Relatively fixed versus 1916 measurements. Spect. A2V.
46. In Hercules. Sep. & p.a. slightly decreasing. Spect. F2, F2.
47. In Sagittarius. Separation decreasing. Spect. B1III.
48. In Lyra. Sep. decreasing; p.a. increasing.
49. In Draco. Common proper motion. Sep. & p.a. decreasing. Spect. F8, F8.
50. In Serpens. Relatively fixed.
51. In Lyra. Sep. increasing; p.a. decreasing. Spect. K0, F2.
52. In Sagittarius & NGC 6645. Sep. increasing; p.a. decreasing.
53. In Serpens. Relatively fixed. Common proper motion. Spect. G0, G0.
54. In Ophiuchus. Common proper motion.
55. In Lyra. Sep. & p.a. increasing.
56. In Scutum. Common proper motion. Spect. G0, G0.
57. In Lyra. Separation increasing.

(Continued on page 86)

Divinus Lux Observatory Bulletin: Report #5

(Continued from page 85)

58. In Lyra. Sep. increasing; p.a. decreasing.
59. In Lyra. Sep. & p.a. increasing.
60. In Sagitta Relatively fixed. Spect. A0.
61. In Lyra. Common proper motion. Relatively fixed? Spect. F8, F8.
62. In Aquila. Sep. increasing; p.a. decreasing.
63. In Aquila. Sep. & p.a. increasing. Spect. G0, G0.
64. In Sagitta. Relatively fixed. Common proper motion. Spect. F8, F8.
65. In Aquila. Sep. & p.a. decreasing. Spect. A2. Only 1 catalog meas. in 1969.
66. In Cygnus. Relatively fixed. Common proper motion.
67. In Cygnus. Common proper motion. Separation decreasing.
68. In Cygnus. Separation increasing.
69. In Cygnus. Sep. slightly increasing. Spect. G0, G0.
70. In Cygnus. Relatively fixed.
71. In Cygnus. Separation slightly increasing.
72. In Cygnus. Relatively fixed. Common proper motion. Spect. G1.5V, G0.
73. In Cygnus. Separation slightly decreasing.
74. In Cygnus. Position angle slightly decreasing. Spect. A3.
75. In Cygnus. Sep. & p.a. increasing. Spect. G5.
76. In Cygnus. AB = cpm; relfix. AF = sep. inc. Spect. B9.5V, A0, K8.
77. In Aquila. Relatively fixed. Common proper motion. Spect. F8, F8.
78. In Cygnus. Relatively fixed. Common proper motion. Spect. A2, A2.
79. In Cygnus. Relatively fixed. Common proper motion.
80. In Cygnus. Relatively fixed. Common proper motion.
81. In Aquila. Sep. decreasing; p.a. increasing. Spect. F0.
82. In Cygnus. Relatively fixed. Common proper motion. Spect. F8, F8.
83. In Cygnus. Sep. increasing; p.a. decreasing. Spect. A.
84. In Cygnus. Relatively fixed.
85. 26 Cygni. Position angle increasing. Spect. K1II.
86. In Cygnus. AB = p.a. decreasing. AC = p.a. increasing. Spect. K2III.
87. In Vulpecula. Relatively fixed. Common proper motion. Spect. G0.
88. In Cygnus. Relatively fixed. Spect. B, A0.
89. In Cygnus. Relatively fixed. Common proper motion. Spect. F5, F5.
90. In Cygnus. Slight p.a. decrease. Spect. B8IV.
91. In Cygnus. Sep. increasing; p.a. decreasing. Spect. K1III, K1III.
92. In Cygnus. Relatively fixed. Spect. B2III, B2.
93. In Vulpecula. Sep. increasing; p.a. decreasing. Spect. A2, A2.
94. In Cygnus. Separation increasing. Spect. K0, A0.

Divinus Lux Observatory Bulletin: Report #6

Dave Arnold

Program Manager for Double Star Research
2728 North Fox Fun Drive
Flagstaff, AZ 86004
E-mail: dvdarn@aol.com

Abstract: This report contains theta/rho measurements from 101 different double star systems. The time period spans from 2005.479 to 2005.679. All 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.

Over the past 5 years, a primary part of the double star research, which has been conducted, has consisted of measuring double stars from the WDS CATALOG. During the time that this project has been in process, it was noticed that almost all of the double stars, which were labeled with the "WFC" prefix, have had no recent measurements. Many of these systems have only one published measurement, with several of them dating back to the 1890s. It was also noted that a number of these pairs were brighter than the magnitude listings in the WDS catalog, since several of these "WFC" systems could be measured that should have been out of the range of a 20-cm telescope.

As a consequence of making these discoveries, I asked Dr. Brian Mason if he would be able to supply me with the entire list of double stars having the "WFC" prefix, so that I would not have to search the entire catalog line by line. He promptly helped me with my request, and I wish to publicly thank him for his assistance. Several more of the neglected "WFC" double stars have now been measured during the past several months.

The reason for mentioning this is because the researcher can employ this type of approach to further enhance a double star measuring program. There are likely neglected doubles with other prefixes, which are listed in the catalog, that need additional study besides the particular one that came to my attention. By focusing upon such pairs, or by providing additional measurements of the "WFC" doubles that have appeared in this series of reports, one can make valuable contributions to astrometry. In addition, the vast majority of the "WFC" doubles are common proper motion pairs that are separated by less than 20 arc seconds, so measuring such pairs could provide information for eventually calculating orbits if such double stars are also binaries.

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. There are also some noteworthy items that are discussed pertaining to the following table.

As has been pointed out in prior reports, this one includes listings of some double stars that have displayed significant theta/rho shifts because of proper motion. To begin with, J 2324 AB has displayed an 11% increase in the rho value, since 1953, as a result of proper motion by the "A" component. Proper motion by the "B" component, in BU 1290 AB, is responsible for an increase of over 4 degrees in the theta value since 1997. In regards to ES 390, proper motion by both components has brought about an increase of 3 degrees in the theta value and a decrease of 10.5% in the rho value, since 1957.

Proper motion by both component stars has been the cause for a 7% increase in the rho value, for HJ 5548 AC, since 1983. Similarly, proper motion by both component stars, in HJ 3211, has resulted in an increase of almost 5% in the rho value since 1991. Proper motion in opposite directions, by both components of STI 1358, is the reason that a 6 % increase in the rho value has occurred in this system since 1984. In regards to STF 2975 Aa-B, proper motion by the "Aa" components has been responsible for a 3 degrees

Divinus Lux Observatory Bulletin: Report #6

increase in the theta value and a 4.5% increase in the rho value, since 1991. In addition, proper motion by the "A" component, in HJ 1109 AB, has caused the theta value to increase by over 3 degrees since 1984.

STT 17 is an optical multiple star system that has shown significant theta/rho shifts, since 1996, because of large proper motions by the "C" and "D" components. As a result, the "AC" part of this system has shown a 12 degrees increase in the theta value. In addition, the "CD" portion of STT 17 has displayed a 3 degrees decrease in the theta value and an increase of almost 4% in the rho value.

As has been mentioned in the opening paragraphs of this report, there are still a fair number of double stars, which haven't had published measurements for many decades, that should be at the top of the list for anyone who is focussing upon neglected pairs. HJ 3243 is one such double star, which has listed measurements in the following table. According to the 2001.0 version of the U.S. Naval Observatory double star CD, this double star has not been measured since 1831. This pair is not difficult to measure, with component magnitudes of +10.4 and +10.5, and a rho value of over 28 arc seconds. Because only one set of measurements was listed in 1831, the ones in this report depart from this earlier set by 6 degrees and 13.5 arc seconds. More measurements, by others, are obviously needed

In addition to HJ3243, a combination of several decades having passed since the last published measurements, and proper motion, is the cause for a 4.5 degrees decrease in the theta value for ES 532 since 1907. Likewise, the same two factors are the cause of a 9 degrees increase in the theta value and a 7.5% decrease in the rho value, since 1918, for ES 2709.

A possible error might exist in the WDS Catalog in reference to KU 59 AB. While the 1892 rho value in the Catalog, in the Hipparcos/Tycho data, and in this report display a separation range from 31.6 to 32.8 seconds, the 1991 Catalog value is listed at 28.5 seconds. It appears that the 1991 rho measurements for "AB" may have been made to the "C" component, since a separation of 28.5 seconds more closely matches the rho value for "AC."

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
HJ 1469	20038+1436	10.0 10.2	214.9	17.78	2005.504	1n	1
STF2622 AB	20041+1700	8.7 9.4	193.0	5.43	2005.504	1n	2
ES 132 AB	20099+5657	9.4 9.8	82.5	5.43	2005.479	1n	3
ES 132 AC	20099+5657	9.4 9 6	63.1	33.58	2005.479	1n	3
SEI1047	20158+3447	10.5 10.7	162.7	20.74	2005.479	1n	4
ES 660 AB	20173+5201	10.2 10.2	305.0	29.63	2005.479	1n	5
ES 660 BC	20173+5201	10.2 10.3	290.5	9.88	2005.479	1n	5
HJ 912 AC	20183+2002	10.5 9.0#	170.2	88.38	2005.501	1n	6
SEI1089 AC	20204+3840	10.5 10.6	196.8	28.14	2005.482	1n	7
SEI1120	20252+3522	10.2 10.4	216.5	27.16	2005.482	1n	8
ARG 92	20256+4155	9.7 10.5	309.6	41.48	2005.482	1n	9
KU 59 AB	20286+2404	10.0 10.0	142.0	32.09	2005.501	1n	10
SEI1142	20305+3540	10.4 9.6#	78.1	21.73	2005.482	1n	11
STF2690 Aa-BC	20312+1116	7.1 7.4	254.8	17.78	2005.504	1n	12

Divinus Lux Observatory Bulletin: Report #6

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
SEI1164	20331+3932	9.9 10.7	214.4	17.78	2005.482	1n	13
SMA 118	20370+0452	10.4 10.5	125.1	18.76	2005.504	1n	14
STT 211	20493+5845	6.9 7.8	267.8	95.79	2005.504	1n	15
J 2324 AB	20508-1135	10.0 9.8#	186.3	25.18	2005.501	1n	16
J 2326	20531-0651	10.3 10.4	67.2	7.41	2005.501	1n	17
STF2737 AB-C	20591+0418	5.9 7.0	66.7	10.86	2005.504	1n	18
ES 2703	21009+5931	10.4 10.5	230.2	10.37	2005.636	1n	19
BU 1290 AB	21009+4730	10.1 10.6	32.4	8.39	2005.504	1n	20
STT 214 AB	21039+4138	6.3 8.6	184.7	57.28	2005.482	1n	21
BAL1583	21126+0149	10.1 10.4	6.1	7.90	2005.523	1n	22
ES 2709	21234+5923	9.9 10.6	274.1	11.85	2005.636	1n	23
POU5414	21344+2443	10.5 10.7	128.5	24.69	2005.504	1n	24
HJ 5519	21417-0816	10.2 10.4	51.5	18.76	2005.523	1n	25
HJ 3053	21436+0700	9.9 10.4	192.0	24.69	2005.504	1n	26
STT 222	21441+0709	7.4 8.4	257.5	87.40	2005.504	1n	27
BU1305 A-BC	21460+1053	9.7 10.8	91.0	88.88	2005.526	1n	28
HJ 3063	21494+5830	10.1 10.5	64.7	11.36	2005.542	1n	29
HO 174 AB	21558+3716	10.3 10.7	333.3	7.41	2005.523	1n	30
STT 225	21575+0409	7.0 8.5	287.4	74.56	2005.504	1n	31
HJ 1712	21599+4843	10.5 10.7	189.4	11.36	2005.523	1n	32
STF2852	22006+5411	9.9 10.2	172.7	7.90	2005.526	1n	33
SCA 113	22007-0448	10.6 10.6	279.8	16.29	2005.526	1n	34
KU 134	22028+0345	10.2 10.7	261.1	55.30	2005.526	1n	35
HJ 3086	22059-1806	10.1 10.1	194.3	13.83	2005.542	1n	36
ES 532	22064+4716	10.3 10.7	241.6	9.88	2005.526	1n	37
HJ 1751 AC	22191+5607	10.2 10.4	113.4	11.36	2005.526	1n	38
ES 2718	22211+5428	9.4 9.7	83.6	20.24	2005.542	1n	39
ES 390	22226+3328	9.5 10.3	267.8	8.89	2005.542	1n	40

Divinus Lux Observatory Bulletin: Report #6

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
STT 231	22226+0956	8.0 8.9	113.2	90.85	2005.616	1n	41
KU 64 AB	22227+2849	10.1 10.6	160.1	35.55	2005.542	1n	42
HDO 319 AC	22290+0118	10.1 10.2	185.6	89.86	2005.542	1n	43
HDO 319 AD	22290+0118	10.1 9.8#	304.7	149.11	2005.542	1n	43
BU 478 AC	22294-0720	10.1 10.1	238.7	28.64	2005.542	1n	44
AG 285	22401+3242	10.1 10.7	309.9	37.53	2005.542	1n	45
HJ 1813	22486+4136	9.9 10.0	61.3	9.38	2005.575	1n	46
STF2946	22497+4031	8.1 8.2	261.2	5.43	2005.575	1n	47
HJ 1816	22499+4620	10.5 10.6	133.1	6.91	2005.575	1n	48
HJ 5548 AC	22506+5306	10.4 10.6	228.1	27.65	2005.616	1n	49
ES 542 AC	22533+5009	10.0 10.2	84.0	62.21	2005.616	1n	50
ES 1701	22540+4000	10.7 10.7	65.9	8.39	2005.616	1n	51
BU 712 AC	22548+5914	10.1 10.3	111.4	45.43	2005.638	1n	52
STF2956 AC	22559+0121	10.0 10.6	278.4	69.13	2005.616	1n	53
ES 1120	22582+5133	10.5 10.4#	207.3	8.89	2005.616	1n	54
STF2975 Aa-B	23067+3302	10.4 10.4	314.2	36.54	2005.619	1n	55
KU 137	23112+2919	9.9 10.3	88.8	33.58	2005.619	1n	56
HJ 5398	23254-1717	10.2 10.4	3.0	28.64	2005.619	1n	57
HJ 1894 AB	23359+5132	10.1 10.4	213.6	24.69	2005.619	1n	58
FOX 274 AD	23359+5132	10.1 9.5#	185.4	84.93	2005.619	1n	58
HJ 315	23376+1236	10.3 10.4	247.1	20.24	2005.619	1n	59
ES 2732	23413+4954	10.2 10.7	249.6	10.86	2005.619	1n	60
HJ 3211	23450+0346	10.3 10.6	77.5	72.09	2005.619	1n	61
STT 255	00054+1620	8.6 8.8	338.5	88.88	2005.638	1n	62
HJ 1000	00065+0155	10.3 10.7	205.9	7.41	2005.638	1n	63
STT 256 AB	00080+3123	7.1 7.3	113.3	109.61	2005.636	1n	64
AG 298	00087-0451	10.1 10.3	12.1	15.80	2005.638	1n	65
MLB 441 AB	00115+2949	10.1 10.4	358.8	14.32	2005.638	1n	66

Divinus Lux Observatory Bulletin: Report #6

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
BU 1341 AC	00138+3612	10.3 8.2#	228.4	180.71	2005.638	1n	67
STF 24	00185+2608	7.8 8.4	250.0	4.94	2005.636	1n	68
STI1358	00287+5700	10.4 10.7	302.2	14.32	2005.638	1n	69
HJ 5451	00314+3335	5.9 9.3	84.9	55.30	2005.636	1n	70
ALI 249	00333+3731	10.3 10.4	287.3	13.33	2005.638	1n	71
J 922 AC	00363+1701	9.9 10.1	1.0	49.38	2005.638	1n	72
ES 936	00400+5549	10.5 10.7	268.5	8.39	2005.638	1n	73
HJ 1044	00403+4343	10.0 10.0	138.9	21.73	2005.638	1n	74
ES 2581	00429+4722	10.3 10.6	70.7	10.86	2005.638	1n	75
ES 1408	00430+4405	10.1 10.3	262.5	7.90	2005.655	1n	76
KU 70	00512+2211	10.2 10.2	124.9	54.31	2005.658	1n	77
HJ 9	00534+1159	10.6 10.7	99.8	12.34	2005.658	1n	78
KU 71	00552+3814	9.9 10.0	247.8	22.71	2005.655	1n	79
STF 77	00581+2655	10.3 10.4	118.0	10.37	2005.655	1n	80
HJ 2003	00584+5426	10.6 10.7	332.6	16.79	2005.655	1n	81
ES 317	01004+3228	9.2 9.4	194.3	6.91	2005.658	1n	82
HJ 1067	01052+2614	10.4 10.7	239.1	15.80	2005.658	1n	83
H 66 AB	01072+5330	6.3 10.1	74.7	20.74	2005.658	1n	84
STF 94 AC	01103+1636	10.0 10.0	280.8	20.24	2005.679	1n	85
GAL 308	01241-1244	10.3 10.7	16.4	24.69	2005.679	1n	86
STT 17 AB	01245+3902	7.9 9.7	101.4	35.55	2005.658	1n	87
STT 17 AC	01245+3902	7.9 8.4	347.8	137.26	2005.658	1n	87
STT 17 CD	01245+3902	8.4 9.7	279.3	67.15	2005.658	1n	87
ES 2585	01331+5416	10.0 10.0	29.2	14.81	2005.658	1n	88
HJ 2047	01344+5553	10.6 10.7	55.4	13.33	2005.658	1n	89
PLQ 19	01376+0709	9.7 9.7	76.5	40.49	2005.679	1n	90
SEI 19	01395+3216	10.1 10.7	347.2	18.76	2005.658	1n	91
HJ 2066	01420+5547	10.5 10.7	71.7	20.74	2005.679	1n	92

Divinus Lux Observatory Bulletin: Report #6

NAME	RA DEC	MAGS	PA	SEP	DATE	N	NOTES
HJ 3455	01433-1736	9.9 10.0	73.9	23.70	2005.679	1n	93
AG 23	01459+1500	10.3 10.3	46.0	29.63	2005.679	1n	94
STF 172	01500+2706	10.2 10.3	194.1	17.78	2005.679	1n	95
HJ 3243	01572+2618	10.4 10.5	68.2	28.64	2005.679	1n	96
SMA 25	01588+5517	10.0 10.7	103.5	26.66	2005.679	1n	97
AG 302	01594+5036	10.0 10.3	1.6	14.81	2005.679	1n	98
HJ 1109 AB	02104+3911	10.2 10.7	184.2	24.19	2005.679	1n	99
STF 222	02109+3902	6.1 6.7	35.9	16.79	2005.679	1n	100
ES 1613	02505+4118	9.4 10.4	17.0	6.91	2005.679	1n	101

The companion star is the brighter component.

Notes

1. In Aquila. Relatively fixed. Spect. G0, G0.
2. In Sagitta. Relatively fixed. Spect. G5, G5.
3. In Cygnus. AB = cpm; relfix. AC = sep. decreasing. Spect. F8, F8, G5.
4. In Cygnus. Separation and position angle decreasing.
5. In Cygnus. AB & BC = relatively fixed. Spect. A0, A2, A0.
6. In Sagitta. Sep. & p.a. increasing. Spect. F8.
7. In Cygnus. Separation increasing. Position angle decreasing.
8. In Cygnus. Separation and position angle increasing.
9. In Cygnus. Position angle decreasing. Spect. A5.
10. In Vulpecula. Position angle increasing. Spect. A0, F0.
11. In Cygnus. Position angle slightly increasing.
12. In Delphinus. Separation increasing. Spect. B8V, A0.
13. In Cygnus. Relatively fixed. Common proper motion.
14. In Delphinus. Position angle increasing.
15. In Cepheus. Sep. decreasing; p.a. increasing. Spect. B9, K0.
16. In Aquarius. Sep. & p.a. increasing. Spect. G5.
17. In Aquarius. Position angle increasing. Spect. G0.
18. Epsilon or 1 Equulei. Common proper motion; p.a. decreas. Spect. F6IV, F5.
19. In Cepheus. Sep. & p.a. increasing.
20. In Cygnus. Sep. & p.a. increasing.
21. In Cygnus. Relatively fixed. Common proper motion. Spect. F3IV.
22. In Aquarius. Common proper motion. Separation decreasing. Spect. F8.
23. In Cepheus. Sep. decreasing; p.a. increasing.
24. In Pegasus. Position angle increasing.
25. In Aquarius. Position angle slightly increasing.
26. In Pegasus. Separation decreasing. Spect. M0.
27. In Pegasus. Relatively fixed. Common proper motion. Spect. F2V, F5.
28. In Pegasus. Relatively fixed. Common proper motion. Spect. K0, G.
29. In Cepheus. Separation slightly decreasing. Spect. A5, A5.

(Notes ontinued on page 93)

Divinus Lux Observatory Bulletin: Report #6

(Notes continued from page 92)

30. In Cygnus. Position angle decreasing. Spect. F2.
31. In Pegasus. Relatively fixed. Common proper motion. Spect. F5, F5.
32. In Cygnus. Sep. & p.a. increasing.
33. In Cygnus. Relatively fixed. Common proper motion. Spect. G0.
34. In Aquarius. Sep. decreasing; p.a. increasing.
35. In Pegasus. Separation decreasing. Spect. K0.
36. In Aquarius. Sep. & p.a. decreasing. Spect. G0.
37. In Lacerta. Sep. increasing; p.a. decreasing.
38. In Cepheus. Position angle slightly decreasing. Spect. O8V.
39. In Lacerta. Separation slightly decreasing. Spect. A2, A2.
40. In Pegasus. Sep. decreasing; p.a. increasing. Spect. K.
41. In Pegasus. Position angle increasing. Spect. F0, G0.
42. In Pegasus. Separation slightly increasing. Spect. M5.
43. In Aquarius. AC = sep. dec. AD = sep. & p.a. inc Spect. AD = G0, K2.
44. In Aquarius. Relatively fixed. Spect. F5.
45. In Pegasus. Sep. & p.a. slightly decreasing. Spect. F5.
46. In Lacerta. Sep. increasing; p.a. decreasing. Spect. A2, A5.
47. In Lacerta. Common proper motion; p.a. increasing. Spect. F8, F8.
48. In Lacerta. Position angle decreasing. Spect. K0.
49. In Lacerta. Separation increasing.
50. In Lacerta. Separation increasing. Spect. A2, F2.
51. In Lacerta. Common proper motion. Separation increasing.
52. In Cepheus. Separation decreasing. Spect. A0.
53. In Pisces. Separation slightly increasing. Spect. K2, K.
54. In Andromeda. Separation and position angle increasing.
55. In Pegasus. Sep. & p.a. increasing. Spect. K0, A2.
56. In Pegasus. Sep. increasing; p.a. decreasing. Spect. K2, G5.
57. In Aquarius. Common proper motion. Sep. slightly decr. Spect. F0V, G0.
58. In Cassiopeia. AB = sep. & p.a. inc. AD = sep. & p.a. dec. Spect. F2V.
59. In Pegasus. Common proper motion; sep. decreasing. Spect. K0, K0.
60. In Cassiopeia. Separation decreasing. Position angle increasing.
61. In Pisces. Sep. increasing; p.a. decreasing. Spect. F8.
62. In Pegasus. Relatively fixed. Common proper motion. Spect. G0, G.
63. In Pisces. Sep increasing; p.a. decreasing. Common proper motion.
64. In Andromeda. Sep. increasing; p.a. decreasing. Spect. A5, A3.
65. In Pisces. Common proper motion; p.a. increasing. Spect. G0.
66. In Andromeda. Common proper motion; p.a. decreasing. Spect. G1V, G.
67. In Andromeda. Separation increasing. Spect. F8, G0.
68. In Andromeda. Slight increase in p.a. Spect. A2, A2.
69. In Cassiopeia. Sep. increasing; p.a. decreasing.
70. In Andromeda. Sep. slightly decreasing. Spect. K1III, F8.
71. In Andromeda. Relatively fixed. Common proper motion.
72. In Pisces. Relatively fixed. Common proper motion. Spect. F8.
73. In Cassiopeia. Sep increasing; p.a. decreasing.
74. In Andromeda. Relatively fixed. Common proper motion. Spect. G5, K0.
75. In Cassiopeia. Sep decreasing; p.a. increasing.
76. In Andromeda. Relatively fixed. Common proper motion.
77. In Andromeda. Sep. & p.a. decreasing. Spect. F8, G0.
78. In Pisces. Common proper motion; p.a. decreasing.
79. In Andromeda. Sep. decreasing; p.a. increasing. Spect. F8.
80. In Pisces. Common proper motion; p.a. slightly decreasing. Spect. G, G.
81. In Cassiopeia. Sep. increasing; p.a. decreasing. Spect. A5.
82. In Pisces. Sep. & p.a. increasing.

(Notes continued on page 94)

Divinus Lux Observatory Bulletin: Report #6

(Notes continued from page 93)

83. In Pisces. Common proper motion; sep. decreasing. Spect. F8, F8.
84. In Cassiopeia. Sep. & p.a. decreasing. Spect. K2III.
85. In Pisces. Sep. & p.a. increasing. Spect. K0, K0.
86. In Cetus. Relatively fixed. Common proper motion.
87. In Andromeda. AB & CD = p.a. dec. AC = p.a. inc. Spect. G5, K0, G5, G8.
88. In Perseus. Relatively fixed. Spect. F0.
89. In Cassiopeia. Sep. & p.a. increasing.
90. In Pisces. Relatively fixed. Common proper motion. Spect. K0, K0.
91. In Triangulum. Sep. & p.a. increasing.
92. In Cassiopeia. Sep. & p.a. increasing.
93. In Cetus. Relatively fixed. Common proper motion. Spect. F5, F5.
94. In Pisces. Relatively fixed. Common proper motion. Spect. K0, K0.
95. In Triangulum. Relatively fixed. Common proper motion. Spect. F8.
96. In Triangulum. Sep. & p.a. increasing. Spect. K0.
97. In Perseus. Relatively fixed.
98. In Perseus. Sep. & p.a. increasing. Spect. A2.
99. In Andromeda. Sep. decreasing; p.a. increasing. Spect. F8.
100. 59 Andromedae. Relatively fixed. Spect. B9V, A1V
101. In Perseus. Separation slightly decreasing. Spect. F5.

Five Previously Unreported Double Stars in Orion

Hannah Varley

Dublin, Ireland
E-mail: hannahvfromdublin@yahoo.ie

Martin Nicholson

Daventry, England
E-mail: newbinaries@yahoo.co.uk

Abstract: We report the discovery of five previously unreported double stars in Orion. In all cases the stars are significantly brighter when observed using an R or I filter than the more usual V filter. This might explain why previous observers have overlooked them.

Introduction

These five new pairs were discovered serendipitously during our systematic search for new variable stars in the constellation of Orion. In view of the relatively small percentage of the sky surveyed so far it seems likely that there are many bright (<10.00) and close (< 10 arcsec) double stars still not in the standard catalogues.

Methodology

1 - The first set of values for each new discovery is based on data taken with the 1.3m Two Micro All Sky Survey (2MASS) telescopes as published within the 2MASS All-Sky Catalog of Point Sources (Cutri+ 2003)

2 - The second set of values was obtained using a Takahashi Epsilon 250mm F/3.8 astrograph and an

NAME	RA+DEC	Mag	Mag	SEP	PA	EPOCH	#
MNHV1	04534+0452	8.77	9.89	9.67	51.92	2000.063	1
MNHV1	04534+0452	8.77	9.89	9.40	51.65	2005.978	5
MNHV2	05465+0515	8.73	9.99	8.86	237.97	1999.774	1
MNHV2	05465+0515	8.73	9.99	8.72	238.22	2005.978	5
MNHV3	06016+0737	8.54	9.66	9.48	20.91	1999.716	1
MNHV3	06016+0737	8.54	9.66	9.20	21.02	2005.978	5
MNHV4	06107+0528	8.08	9.99	9.50	124.79	1999.894	1
MNHV4	06107+0528	8.08	9.99	9.53	124.46	2005.978	5
MNHV5	06214+1706	8.74	9.70	9.36	334.55	1999.962	1
MNHV5	06214+1706	8.74	9.70	9.32	334.99	2005.978	5

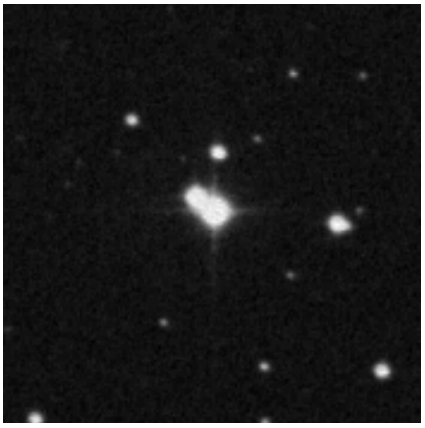
Five Previously Unreported Double Stars in Orion

ST-8XE CCD camera operated remotely in New Mexico under the auspices of the Remote Astronomical Society.
(http://www.ras-observatory.org/ras/front.htm)

3 - Quoted magnitudes are 2MASS J band (1.25 μm) values

Unfortunately, the available proper motion data for these pairs is inconclusive. Clearly, the data need to be available for both components of the pair and the value needs to be significantly larger than any error for firm conclusions to be drawn. This is not the case with these five pairs.

Images of the stars below are from the Digitized Sky Survey.



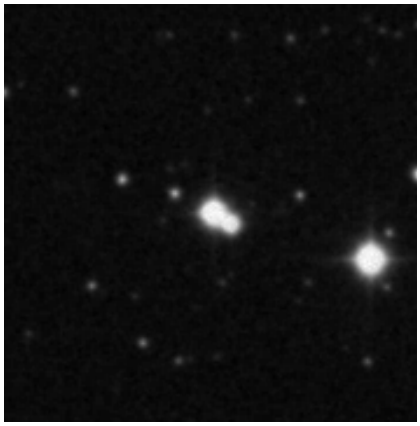
MNHV1

04h 53m 25.96s +04d 51m 51.66s

2MASS J-H = 0.50 and 0.62

2MASS B Mag = 11.58 and 11.10

2MASS R Mag = 10.71 and 9.6



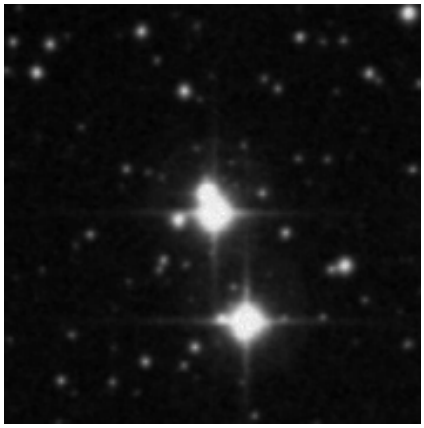
MNHV2

05h 46m 32.28s +05d 14m 37.31s

2MASS J-H = 0.67 and 0.83

2MASS B Mag = 12.66 and ?

2MASS R Mag = 11.18 and ?



MNHV3

06 h 01m 33.25s +07d 36m 37.90s

2MASS J-H = 0.03 and 0.54

2MASS B Mag = 9.04 and ?

2MASS R Mag = 8.95 and ?

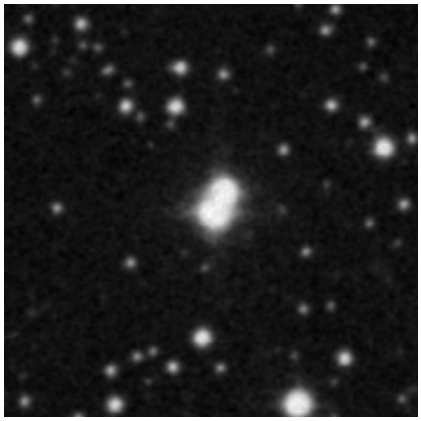
MNHV4

06h 10m 40.43s +05d28m 08.8s

2MASS J-H = 0.60 and 0.54

2MASS B Mag = 11.37 and ?

2MASS R Mag = 10.25 and ?



MNHV5

06h 21m 26.41s +17d 06m 05.76s

2MASS J-H = 0.17 and 0.40

2MASS B Mag = 10.28 and 9.74

2MASS R Mag = 9.60 and 8.70

Martin Nicholson is a retired teacher and Fellow of the Royal Astronomical Society of London. Hannah Varley is currently on maternity leave, but normally earns her living as a research scientist in Dublin, Ireland.

The co-authors do the vast majority of their observing over the internet using facilities provided by the Remote Astronomical Society in Mahill, New Mexico, USA.

CCD Measurements of Multiple Component Stars

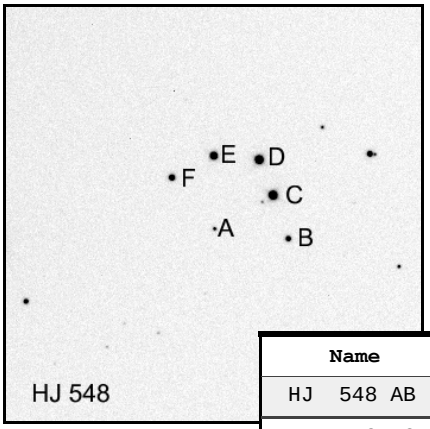
Martin P. Nicholson

3 Grovelands, Daventry,
Northamptonshire, England, NN114DH
E-mail: newbinaries@yahoo.co.uk

Abstract: As part of the preparatory work for the Remote Astronomical Society's double star survey, 15 second, unfiltered images have been taken of a number of multiple componennt double stars. The results of the trial are presented in this paper.

As part of the preparatory work for the Remote Astronomical Society's double star survey, 15 second unfiltered images have been taken of a number of multiple component double stars. The telescope used was a Takahashi Epsilon 250mm F/3.8 astrograph with an ST-8XE CCD camera on a Paramount GT1100ME mount. The results of the trial are presented below with the average of three results being used for the position angle and separation. Magnitudes are taken from the WDS catalog but in some cases these are missing and in other cases appear inaccurate.

Figures below are the 15-second unfiltered images taken by the author using the Remote Astronomical Society's facilities near Mahill, New Mexico.



HJ 548

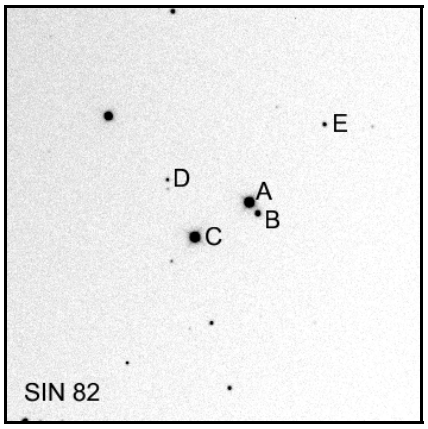
HJ 548 in Bootes

This is an unusual double star system in that the published position angles and separations are all measured from the faintest of the six stars rather than from the brightest of the stars as would be standard practice.

Name	RA + DEC	Mags	PA	Sep	Date	N
HJ 548 AB	14230+3616	13.00, 9.70	259.4	136.74	2006.124	3
HJ 548 AC	14230+3616	13.00, 9.20	286.9	124.08	2006.124	3
HJ 548 AD	14230+3616	13.00, 9.40	314.1	151.46	2006.124	3
HJ 548 AE	14230+3616	13.00, 9.70	347.6	134.72	2006.124	3
HJ 548 AF	14230+3616	13.00, 9.70	26.6	123.04	2006.124	3
HJ 548 BC	14230+3616	9.70, 9.20	32.6	84.70	2006.124	3
HJ 548 BD	14230+3616	9.70, 9.40	33.4	154.86	2006.124	3
HJ 548 BE	14230+3616	9.70, 9.70	55.2	205.27	2006.124	3
HJ 548 BF	14230+3616	9.70, 9.70	75.5	241.96	2006.124	3
HJ 548 CD	14230+3616	9.20, 9.40	34.5	70.19	2006.124	3
HJ 548 CE	14230+3616	9.20, 9.70	69.5	131.19	2006.124	3
HJ 548 CF	14230+3616	9.20, 9.70	92.2	188.95	2006.124	3
HJ 548 DE	14230+3616	9.40, 9.70	98.2	83.98	2006.124	3
HJ 548 DF	14230+3616	9.40, 9.70	114.7	163.88	2006.124	3
HJ 548 EF	14230+3616	9.70, 9.70	130.7	86.73	2006.124	3

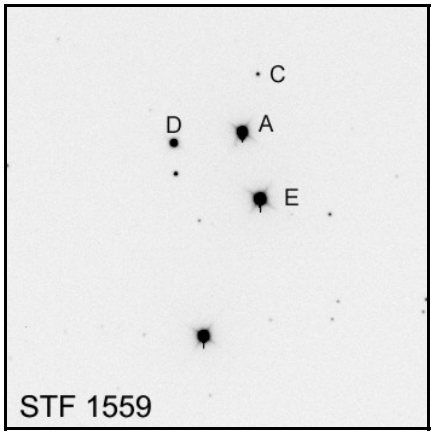
CCD Measurements of Multiple Component Stars

KU 47 in Canes Venatici



Name	RA + DEC	Mags	PA	Sep	Date	N
STF1778 AB	13431+3201	9.30, 11.40	203.9	25.66	2006.124	3
SIN 82 AC	13431+3201	9.30, 9.30	109.4	118.91	2006.124	3
SIN 82 AD	13431+3201	9.30, 14.70	61.5	156.11	2006.124	3
SIN 82 AE	13431+3201	9.30, 14.60	302.7	198.69	2006.124	3

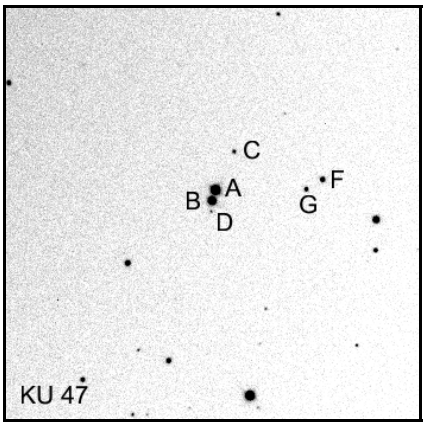
STF 1599 in Draco



Name	RA + DEC	Mags	PA	Sep	Date	N
STF 1599AC	12056+6848	7.35, 12.60	331.9	109.25	2006.124	3
STF 1599AD	12056+6848	7.35, 9.19	85.3	125.30	2006.124	3
STF 1599AE	12056+6848	7.35, 7.70	178.1	124.18	2006.124	3

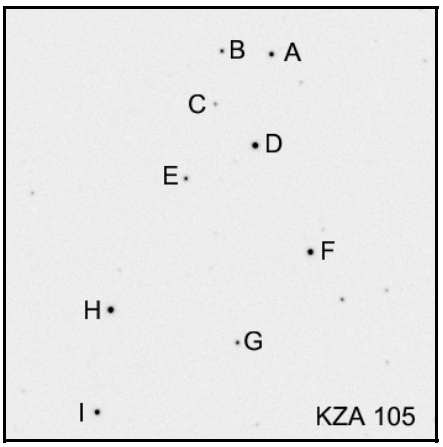
CCD Measurements of Multiple Component Stars

SIN 82 in Canes Venatici



Name	RA + DEC	Mags	PA	Sep	Date	N
KU 47 AB	13540+3209	10.70, 11.20	149.0	20.99	2006.124	3
KU 47 AC	13540+3209	10.70, ?	320.9	78.70	2006.124	3
KU 47 AF	13540+3209	10.70, 12.00	262.4	197.88	2006.124	3
KU 47 AG	13540+3209	10.70, 13.00	257.2	167.13	2006.124	3

KZA 105 in Bootes



Name	RA + DEC	Mags	PA	Sep	Date	N
KZA 105 AB	15367+3954	9.50, 11.0	73.2	87.91	2006.124	3
KZA 105 AC	15367+3954	9.50, 11.0	118.5	133.07	2006.124	3
KZA 105 AD	15367+3954	9.50, 10.0	156.7	164.11	2006.124	3
KZA 105 AE	15367+3954	9.50, 10.5	132.3	267.32	2006.124	3
KZA 105 AF	15367+3954	9.50, 10.0	178.0	356.83	2006.124	3
KZA 105 AG	15367+3954	9.50, 10.0	160.1	514.53	2006.124	3
KZA 105 AH	15367+3954	9.50, 10.5	134.7	534.92	2006.124	3
KZA 105 A1	15367+3954	9.50, 10.5	140.8	705.05	2006.124	3

Double Star Imaging and Measurement with Unconventional Cameras, Part II: Binary Imaging with the Meade LPI and DSI Cameras

Rod Mollise

Department of Physics
University of South Alabama
Mobile, AL 36688
Email: rmollise@hotmail.com

Abstract: The Meade LPI and DSI cameras are inexpensive imaging solutions for double star workers. They are both capable of obtaining high-quality, low-noise data suitable for use in astrometry. Double star images are easy to obtain with the LPI and DSI due to the cameras' noteworthy, innovative software "suite."

There's no denying the humble webcam has transformed amateur astrophotography. While its impact has been most profound in planetary imaging, it has changed (and improved) the way we take pictures of everything, including deep sky objects. Admittedly, its effect on deep sky imaging has been mostly indirect—advanced astrophotographers aren't going to use tiny webcam chips to capture M31—but its influence is felt even there in the form of innovative software and techniques. No, a Toucam pro, even one modified for long exposure, is not really suitable for imaging Andromeda, but the incredible software webcam users have been developing, wonderful applications like *Registax*, can improve the images delivered by any camera.

We in the double star "business" are caught somewhere in-between. Many of us use or have used webcams like the Toucam Pro or Quickcam as our primary tools, but, while the webcams have generally given results superior to anything we could accomplish with film, and have some advantages over "traditional" large-chip integrating CCD cameras, webcams are not without their problems for our application.

What problems? There are several. First and foremost is chip size. The tiny (about ¼ inch) CCD chips used by the Toucam Pro and other popular "astronomy" webcams can make image acquisition tedious. Even if your telescope is placed on a highly accurate goto mount, getting a double star centered on the chip at the long focal lengths we must use to provide good image scale for imaging close doubles can be a pain. A flip mirror is *de rigueur* if you want to keep your sanity (and hairline) intact when hunting pairs at f/20 or f/30. Noise can be a problem, too. I'm not talking about thermal noise—the relatively short exposures we use tend to keep this at bay—but about the "noise bars" and other electronic artifacts evident in webcam images taken under low light/high gain conditions. Finally, webcams are not exactly robust construction-wise, being designed to sit on a computer monitor in a nice cozy den rather than on the rear cell of a telescope on a damp observing field.

Until recently, there was no good alternative for the double star imager who found webcams less than ideal, but who certainly didn't want or need to invest 1500 US$ or more in a "real" CCD camera. Many of us have experimented with low light video cameras, but these, while workable for double star imaging (especially the "deep sky" video imagers like the Stellacam), are analog devices. You'll have to provide a means of getting your images into the computer, which adds cost and inconvenience to a setup.

Things finally began to look up for the penny-pinching double star imager about two years ago when Meade Instruments Corporation introduced their first new camera following the phase-out of the

Double Star Imaging and Measurement with Unconventional Imagers, Part II...

Figure 1: The LPI, Lunar and Planetary Imager from Meade

Pictor series of CCD imagers. This new webcam-like device, the LPI, the "Lunar and Planetary Imager," had some significant advances over the off-the-shelf Quickcam or Toucam, and, despite its name, signaled the beginning of a small revolution for double star photography.

The LPI, seen in Figure 1, actually looks a lot like a webcam. In fact, it's made for Meade by a far eastern manufacturer of these devices, Sonix. There are some significant differences between the LPI and the average webcam, however, both in hardware and software. In the former category, most important is that the 1/3-inch (775x525 pixels) detector used in the LPI is slightly larger than the typical ¼ inch webcam chip. You wouldn't think this relatively small increase in area would be enough to make much difference when searching for targets, but, in my experience, it does seem to make acquiring stars noticeably easier. On the downside, this chip, an Elecvision EEVS350A, is a CMOS device (the Toucam and Quickcam feature genuine CCD sensors). The principal drawback of CMOS detectors for the astronomical imager is their lower sensitivity when compared to CCDs. In practice, however, this doesn't have much effect on the LPI's suitability for use in binary imaging. Its CMOS chip is easily sensitive enough to provide good signal data under most conditions. Like all currently available webcams, the LPI is a USB device.

The main hardware advantage that attracted many webcam users to the LPI was not its larger chip, however. It was the camera's built-in *long exposure capability*. The LPI as delivered can expose for as long as 15 seconds, which is a considerable advance over the second-or-less maximum exposure times of most off-the-shelf webcams. 15 seconds, while not sufficient for serious deep sky picture taking, is more than good enough for the Lunar and planetary (and double star) work for which this little camera is best suited. Actually, I don't often find the need to expose for longer than a second when imaging doubles with the LPI, but the capability is there when needed, and tends to somewhat offset the CMOS detector's middling sensitivity.

The body of the LPI is something of an improvement over the run of the mill webcam too, if more an incremental than exponential one. As seen in Figure 2, the LPI is very small in size, which is a Good Thing if you use an alt-azimuth mounted SCT and a flip mirror (despite the LPI's larger chip, I still use a flip mirror to speed the object-centering process). When used with a flip mirror, some webcams extend so far out from the back of the scope that they will contact the drivebase of my Nexstar 11 SCT long before the scope is pointed to the zenith. This is not a problem with the

Figure 2: The LPI attached to an alt-az mounted SCT with a flip mirror.

LPI; I can concentrate on the computer monitor and allow the NS11 to track unattended without worrying about a "camera crash." The LPI is also considerably sturdier in build than the Quickcams and Toucams—my LPI has been dropped to the observing floor more than once with no ill effects.

Another plus for the LPI is that it includes a 1.25-inch adapter, an extra expense for the webcam user. While this 1.25-inch "nosepiece" is removable, the threads revealed by unscrewing it are non-standard. There are no T threads to allow easy use of the camera in the prime focus position. This is not a problem, though, since you'll almost always want to insert the LPI into a Barlow via the nosepiece in order to increase the focal ratio of your system when imaging doubles. Like many webcams, the LPI features a non-removable IR filter (glued in place). This helps the user achieve proper color balance (like all current webcams, the LPI is a "one shot color" camera), and keeps star "bloat" down and sharpness up. Since the LPI is mostly useful for relatively bright subjects—stars and Solar System objects—the presence of the filter doesn't create sensitivity issues.

Yes, the LPI hardware was an incremental if welcome advance over the webcam, but the Meade software, their "*Autostar Suite*" program, was and is a huge breakthrough for imagers of all types. *Autostar Suite*, seen in Figure 3, builds on some of the concepts pioneered in applications like *K3CCD Tools* and *Registax*, but also adds some significant advances of its own. This program is, frankly, nothing short of amazing. What makes it so revolutionary is that it can expose individual frames, evaluate their quality, and stack and process them *on the fly*. All the user must do is center the target of choice, focus using the program's "live" mode (while the software has a "magic eye" focus indicator, the fact that you can focus using live 1/30 second video means it's very easy to achieve a sharp image by merely observing the displayed stellar image), set the exposure, draw a "tracking" box around a medium bright star in the frame, and push the "start" button.

Once "start" is pressed, Autostar Suite takes over and does all the work. First, the program takes several frames in order to establish a baseline for image quality. The user is allowed to select how many

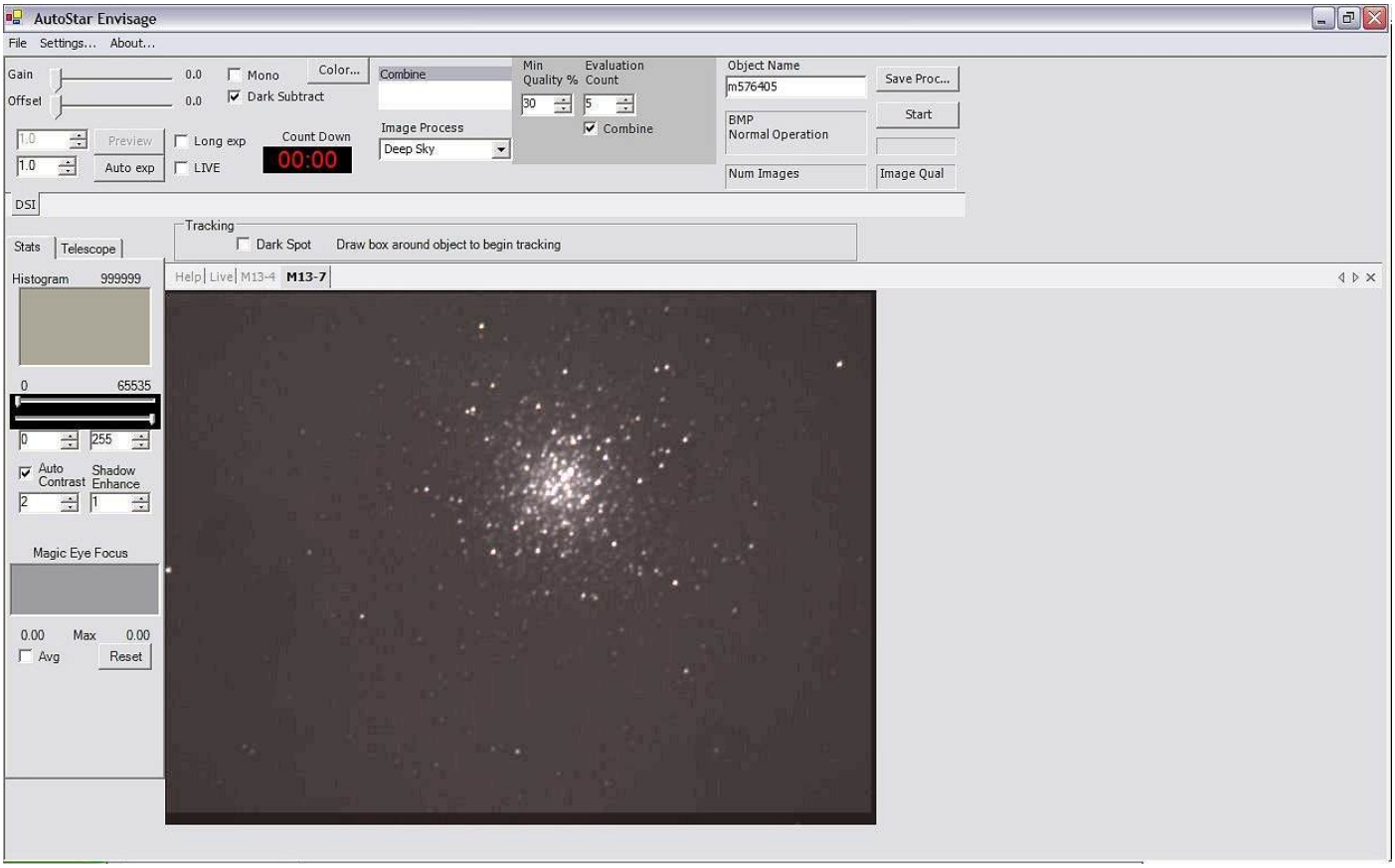


Figure 3: Screen shot from *Autostar Suite*.

frames will be used in this evaluation process, typically five, and what quality standard successive frames must meet to be used in the final image. The program examines the evaluation frames, picks the best one, and uses this to judge whether the frames that follow will be used. If, for example, the user selects "80%" as the quality standard, all exposures must have a quality "factor" of 80% of that of the reference frame to be used in the final composite image.

Once the reference frame is obtained, the program continues taking images. If a frame is of sufficient quality (the manual does not spell out how image quality is evaluated, but seems to do a pretty good job of it), it is added to the stack. As with Registax, stacking multiple short-exposure frames both reduces noise and tends to counteract the effects of poor seeing. As mentioned above, unlike Registax, the image frames are aligned on the fly as they are taken. The tracking box the user draws around a bright star in the live frame is used to align successive images during stacking. At the 10th frame, the program applies an image processing/sharpening filter if desired (user selectable) and continues to evaluate and stack frames into a composite image until the user presses "stop." I've found that a stack of about 50-60 frames will yield an excellent final image.

While the above "stack on the fly" method is the way the program is normally used, it can also be instructed to save each exposed frame rather than stack the exposures into a composite image, allowing the user to process the frames later using *Registax* or another program if desired. The file type of the final image is selectable by the user, with a large number of alternatives including .bmp, .jpg, and FITS being available. The program can also automatically expose and apply dark frames (for noise reduction), but this is seldom necessary with the LPI.

How well does the LPI work? It works very well on double stars, as can be seen in Figure 4. Is it perfect? No. At heart, this is still a webcam, and some electronic noise is evident. However, this camera is quite sufficient for imaging brighter double and multiple stars. Certainly it is more than usable on many pairs down to *at least* magnitude 8 with a C8. In fact, the only major complaint many binary-star-oriented users will have is the lack of astrometric facilities in *Autostar Suite*—tools for measuring separation and position angles. While the software does have some rudimentary photometry features, astrometry functions are conspicuously absent.

Autostar Suite is a "suite," by the way, because the program is actually composed of three separate applications. The camera control/image acquisition/stacking program, called Envisage, is accompanied by a fairly effective if less than feature-laden image processing application, Meade IP. While Meade IP pales beside something like Adobe Photoshop, it will perform most basic image processing tasks, and has the advantage of allowing the user to load FITS files without the use of the "plugins" required by Photoshop. Finally, there is Epoch 2000, a rudimentary planetarium program that will mainly be of interest to owners of Meade telescopes. If you're equipped with a Meade goto scope, you can control most of its functions (of Autostar scopes, anyway) with the program. It should also be noted that Autostar Suite will allow the LPI (or the DSI) to be used as an autoguider if desired, but only (easily) for Meade telescopes (a serial connection to the scope is required).

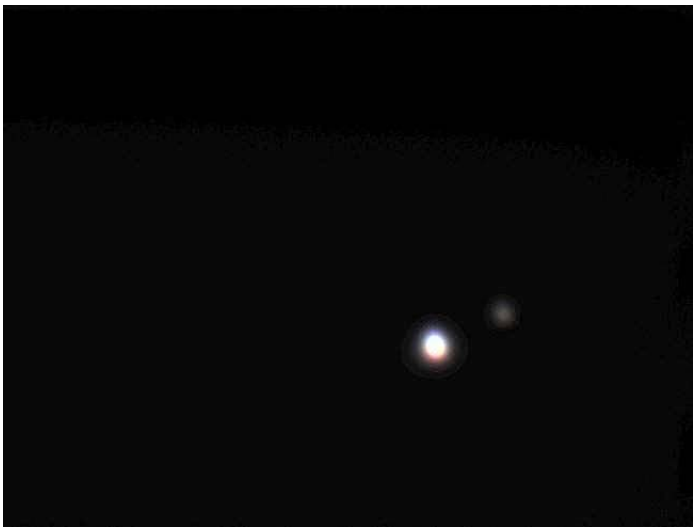


Figure 4: LPI image of a double star.

Are there any major criticisms to be leveled at the LPI? It's hard to think of any, as this 99 US$ camera and software can open the whole world of double star (and Lunar and planetary) imaging to the amateur almost painlessly. "Almost" painlessly. Problems for beginning LPI users have been twofold: difficulty getting the software installed, and difficulty understanding the program's operation once it's running. Meade had some problems with the software early on, but they have continued to update *Autostar Suite*, and real problems—bugs, that is--are now few. The current reason for most failed installations, those where the camera is not recognized by the software, is usually that the user has plugged-in the LPI before the

software is ready for it. Doing so prevents camera drivers from being loaded properly. Luckily, the installation instructions are pretty clear, and, if followed to the letter, the camera should install without difficulty.

As far as complaints about Autostar Suite's user friendliness, well, some of that is justified. The user interface could be better, but remember, this is a program that is required to do a lot; it must be able to do anything from applying image filters to exposing dark frames. There is a limit to just how "simple" it can be. At least Meade has provided some fairly understandable manuals for the programs: one for Envisage, one for Meade IP (a thick one), and one for Epoch 2000 (all on the included CD). Print 'em out and read 'em a couple of times if you want to be completely ready for the LPI experience. If, like me, you hate reading manuals, though, be prepared for at least a night or two of frustration. One noteworthy feature of the documentation is that the Envisage manual includes a "quick-start" guide to taking images. If these pages are read and their instructions followed carefully, the new user may be able to start getting pretty good images the very first night (as Meade gushes in its ads).

Just don't like the Envisage software? Can't get friendly with it? The LPI is now supported by K3CCD Tools, so you do have an alternative. In my experience, however, the camera still works better with the Meade program.

Final caveats? Autostar Suite needs at least a 566mhz (Windows) computer to work well. It may function with slower processors, but you really won't be happy with it. This USB camera works with either USB 1.x or 2, and I don't, in fact, notice any improvement with USB 2. As is the case with webcams and other CCD cameras, don't expect quality pictures unless your scope has a smooth drive with manageable periodic error.

The release of the Meade LPI caused some initial excitement amongst astrophotographers, but it quickly subsided. While the Meade camera was the first webcam-type device to be tailored especially for astronomy by a major manufacturer (Celestron would soon release a competing camera, the NexImage, but, unlike the LPI, it really was just a repackaged webcam), but it was still basically very similar to the Toucams and Quickcams. No one expected Meade to stop with the LPI, however. They had discontinued their cooled Pictor CCD cameras, and it seemed likely that a replacement would be forthcoming. In 2004 we found out what that replacement would be: the Meade DSI, the "Deep Sky Imager."

If amateur imagers were excited by the full-color DSI ads that appeared in *Sky and Telescope* and on the Internet, it was not because the DSI *looked* exciting. Despite being a little larger than the LPI, the DSI still looked like, yes, *another* webcam. There was a tip-off that something was different, however. Eagle-eyed Internet surfers quickly noticed the large heat-sink at the camera's rear (see Figure 5).

What made the DSI special? Meade's advertisements claimed this inexpensive, uncooled, one-shot-color camera didn't need a Peltier to keep thermal noise down. The heat sink and some other tricks (like turning off power to camera electronics during exposures) made active cooling completely unnecessary. Uh-huh. Most amateurs have tended to take a wait-and-see attitude toward Meade's advertising claims. While the company has produced and continues to produce some excellent products, Meade is well known for the dollops of hyperbole their advertising department heaps on everything.

This was one time, however, when we had to put aside our initial skepticism. Given its 299 US$ price tag, the Meade DSI turned out to be incredible. No, it wasn't completely noise free, but its frames were very comparable to those produced by cooled CCD cameras.

Figure 5: The Meade Deep Sky Imager with heat sink at the camera's rear.

Double Star Imaging and Measurement with Unconventional Imagers, Part II...

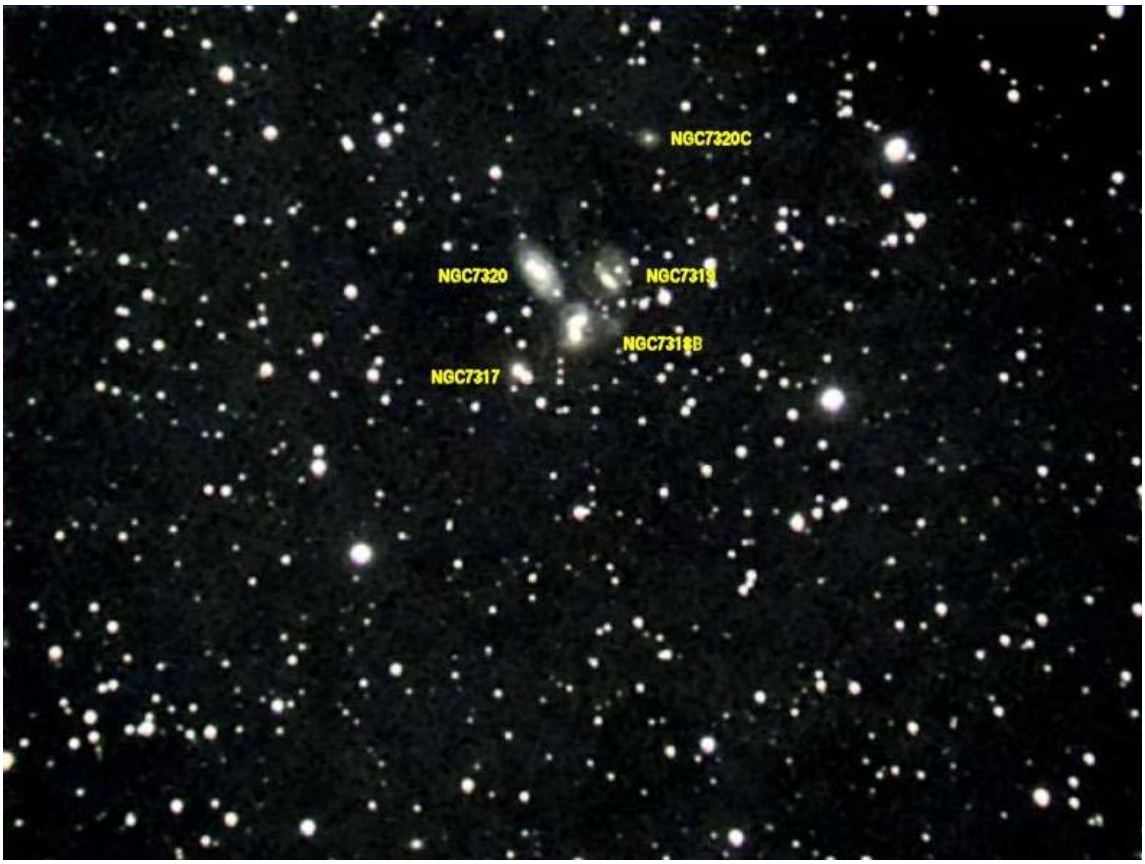


Figure 6: Stephan's Quintet imaged by a Meade DSI attached to an 8" SCT.

This is possible both because of the passive cooling techniques mentioned above, and because of the way the camera is usually operated.

While it's possible to take very long exposures with the DSI—up to one hour—the fact that it uses a small chip, a ¼ inch detector just like many webcams (a genuine CCD chip, a Sony ICX254AL interline device), means that mount-tracking problems will be exaggerated. For this reason, most users operate the DSI in the same manner as the LPI, taking multiple short exposures (30 second – 1 minute for deep sky objects, usually), allowing Autostar Suite to stack them into a final image. The use of these short exposures helps keep thermal noise down, just as with the LPI. Despite our initial skepticism, this camera has proved that it is capable of going very deep (see the image of Stephan's Quintet in Figure 6) and producing very attractive images even in the hands of novices.

The DSI's hardware is relatively simple. The camera (seen attached to a scope in Figure 7) is delivered with a 1.25 inch nosepiece that can be unscrewed to reveal standard T threads. A removable 2-inch IR blocking filter is also found in the box along with a few other items (a parfocal ring to help center objects using an eyepiece, and cables to allow *Autostar Suite* to control Meade telescopes).

Like the LPI, and, indeed, almost all other amateur CCD cameras today, the DSI is a USB device. While Meade assures users that the camera will work with USB 1.x, early adopters found that, unlike the LPI, it does not work very well at all without USB 2.0. The program display is sluggish, and images poorer in quality with the older USB port standard. Luckily, reasonably priced add-on USB 2.0 cards are readily available for older computers.

As with the LPI, the *Autostar Suite* software is the key to the DSI's success. With the release of the DSI, Meade updated the software to operate the new camera, but continued support for the LPI with the same program. This means that *Autostar Suite* can guide a Meade telescope with an LPI camera and image with the DSI at the same time. Program operation for the DSI is almost identical to that for the LPI: the user sets the exposure time, focuses, draws a tracking box around a bright star, and begins stacking short exposures by pressing "start." A couple of additional steps are required if longer exposures are needed (30 seconds and above): acquiring dark frames and combining them with images. Don't worry if you don't know a dark frame from a light frame; *Autostar Suite* handily automates this process, even reminding the user to "please uncover the telescope aperture" after the DSI finishes taking a series of darks. Image calibration with dark frames is automatic; simply check the,

Double Star Imaging and Measurement with Unconventional Imagers, Part II...

Figure 7: The Meade DSI attached to an SCT.

"subtract dark frames" box.

The Meade DSI has proven itself quite capable as a deep sky camera, but what does it have to offer the double star imager? Why pay nearly 300 US$ for the DSI when the 99 US$ LPI works just fine? In part, because of the DSI's lower noise profile. At both shorter and longer exposures, DSI images look "smoother" and less noisy than LPI pictures. But the main reasons to choose the DSI are its greater sensitivity and versatility. The DSI's high sensitivity, amazing for a color camera, means it can be used for just about any project you can dream up. How sensitive? When imaging the galaxy NGC 7331 in Pegasus with the DSI and a C8, I found that the camera easily revealed 15th and 16th magnitude PGC field galaxies in a 20-minute (total time) exposure. Versatility? Not only is it capable of bringing home nice images of galaxies and nebulae, it does a credible job on the Moon and planets—though it doesn't do as well on them, frankly, as a Toucam does.

When it comes to double star imaging, this little thing is, I'm not hesitant to say, *just right*. Once I'm set up in the field, I can quickly image any double I desire with the DSI. It's not unusual for me to come home with 20 different stars "in the bag." While my procedure is identical to that I used with the LPI (Barlow lens for image scale, flip-mirror for star locating, 50 – 60 short exposure frames stacked per image), my results (see Figure 8) look better, and, because they are cleaner, measurements are easier to make.

The catches? The problems with the DSI are essentially the same as those with the LPI: installation difficulty and a fairly steep learning curve for *Autostar* Suite. Also, many of us were surprised that Meade's new deep sky camera didn't feature a larger chip. The LPI had been at least a small step up from ¼ inch world, but with the DSI we were right back down in webcam territory. Finally, as was the case with LPI users, some DSI owners simply can't stand *Autostar Suite/Envi*sage.

Unfortunately, the DSI hardware is even more "different" than that of the LPI, and third party imaging program vendors have been slow to support the camera. *Maxim DL*, *Astroart*, and *K3CCD* are now DSI compatible, but I've seen few examples of DSI images taken with these programs. I suspect that most users of an expensive piece of software like *Maxim DL* are more interested in using the DSI as a guide camera than in taking pictures with our humble camera. You can, of course, load your images into non-Meade image processing programs once capture is complete.

Figure 8: Beta Monocerotis imaged with a Meade DSI.

This is required, in fact, in order to do measurements of your stars, as the updated *Autostar Sui*te still does not offer astrometry tools.

I've been very happy with the DSI, and find it both effective and easy to set-up and operate (though it didn't *become* easy until I'd had about three evenings with the camera under my belt). Though I also have an SBIG ST2000 at my disposal, it's nice to be able to get out and shoot a few doubles without worrying about power supplies, camera cooling, and hanging counterweights on the scope because of the massive SBIG on its rear. I just plug-in the DSI and snapshoot my doubles to my heart's content.

Addendum

Meade, driven by the success of the DSI, released a more sensitive monochrome version of the camera, the *DSI Pro*, a few months after the original one-shot color camera debuted. For about 100 US$ more than the original, the Pro offers considerably better sensitivity. For the double star imager, however, giving up the easy color of the original DSI for monochrome (or color-shooting via tricolor imaging) for usually unneeded sensitivity may not be a very attractive prospect. Also, the camera tends to "bloom" on bright stars (they look more like footballs than stars even with fairly short exposures), and this may be problematical when making measurements of brighter pairs.

Meade being Meade, they haven't stopped with just two cameras. In the last month, they've announced *two more*: the DSI II cameras. The new camera line currently includes both a one-shot DSI II color camera and a DSI II monochrome camera (the "Pro II"). In addition to still *more* sensitivity and a further reduction in noise, this pair offers larger chips, 1/3 inch rather than the ¼ inch detectors used in the original DSIs. Despite its better sensitivity, I'm told the Pro II does not suffer from star-blooming problems to the extent the original Pro does. I have not yet been able to try either of these new DSIs, but when I can, I'll report on them here.

In my opinion, however, the original color camera is still the most cost-effective DSI for us. Alas, though, unless you rush out and buy the original DSI *immediately*, you may not be able to get one. It appears Meade is discontinuing the camera, and I believe the original monochrome Pro won't be far behind. Sadly, double star imagers will probably soon wind up paying 300 dollars more for sensitivity they really don't need (the one shot color DSI II goes for 599 US$). There's always Astromart of course. The Original DSI is simple, effective, and just the thing to get your binary imaging-measuring program off the ground for a *pittance*.

Next Time: Measuring Double with Unconventional Imagers

Mr. Mollise spends his days working at Northrup Grumman Ship Systems in Pascagoula, Mississippi. His second book, The Urban Astronomer's Guide*, has just been published by Springer.*

Measurements of Double and Multiple Stars in the Southern Sky in 2002 Using an 8-Inch Schmidt-Cassegrain and a CCD Video Camera.

R. Anton

Altenholz/Kiel
Germany
E-mail: rainer.anton@ki.comcity.de

Abstract: Measurements of 69 double and multiple star systems at the southern sky made in fall 2002 are presented. The telescope was a C8 Schmidt-Cassegrain equipped with a CCD video camera. The best frames from video recordings were digitized and stacked in a computer. With this method, error limits of ± 0.1 arcsec for separations and less than ± 0.5 degrees for the position angles, depending on the separation, were obtained. The image scale was calibrated with selected reference systems.

Introduction

Among various methods for measuring double stars, video imaging and digital processing offers the possibility to significantly reduce seeing effects, and push the accuracy towards the limits of the telescope. I have already described this technique in detail in earlier papers [1,2]. As a result, using modest amateur telescopes with focal lengths greater than about 2 m, and after careful calibration, the accuracy of separation measurements can be better than ± 0.1 arcsec even under only mediocre seeing conditions. In the following, measurements of double star systems at the southern sky are presented, which were obtained with an 8 inch/f10 telescope at a guest farm in Namibia in September 2002.

Equipment and image processing

A CCD video camera (STV, Santa Barbara Instruments Group) was attached to an 8-inch Schmidt-Cassegrain (C8) telescope via a 2x-Barlow lens and a filter wheel. Filters were of additive, dichroic type (Edmund Scientific Co.) with infrared transmitting above wavelength 700 nm, red above 600 nm, green between 500 and 575 nm, and blue below 500 nm. Exposure times were in the range from 1 ms to 2.2 s per frame, depending on the star brightness and on the seeing. For each setting, i.e. filter and exposure time, image sequences of up to several minutes were stored on tape with a compact digital recorder (Sony GVD 900). Back home, the video sequences were loaded into a computer, and the best frames were selected, registered and stacked. Care was taken in selecting appropriate frames, as seeing effects often make it difficult to judge the quality of individual frames. When images had been recorded under fair seeing conditions and at lower magnifications, 16 good frames were usually found to sufficiently reduce the background noise and to yield reasonably well defined star images. This number was increased to 64 or even 128, when high magnifications were used for close pairs, and/or the seeing less than optimum.

The STV camera is equipped with a CCD chip with 656x480 pixels of size 7.6 µm square, which can be used unbinned ("zoom mode"), or binned 2x2 ("normal"), or 3x3 ("wide field"). Without binning, at a focal length of about 2000 mm and the Barlow lens inserted, the resolution is 0.38 arcsec/pixel per chip. I used the PAL standard video output of the STV camera, which provides a nominal resolution of 720 pixels/line and 576 visible lines. Digitization with 768x576 pixels results in a resolution of 0.189 arcsec/pixel in zoom mode in the final images (see below in sec. III). This figure is multiplied by 2 or 3 in normal and wide field mode, respectively. In most cases, the digital images were re-sampled during stacking by multiplying the number of pixels by 2x2 or sometimes even by 4x4. This resulted in a substantial improvement of the image definition, e.g. the intensity profile of the star images. A number of representative greyscale images are shown in plates 1a and 1b, which are all obtained with a red filter. A few color images are collected in plate 2. These are produced by composition of individual b/w images taken with red, green, and blue filters. In order to take into account the uneven spectral sensitivity of the camera, exposure times were set to about 1.5 times for green, and 2 times for blue, as referred to

red. This generally resulted in a fair rendition of the expected colors. Problems arise for systems with large differences in magnitudes. Either the brighter member is overexposed, or the color of the dimmer one is shifted. See also the remarks following table 2 below.

Star positions and separations were measured from the pixel coordinates of the central peaks of the star images. However, the vertical scale in the images was found to be contracted by about 8% in zoom and normal modes, and by about 11% in wide field mode. This is apparently an artifact of the digital-to-video conversion and requires corresponding corrections in the calculations. Position angles were measured by referring to the east-west direction, which was determined from superpositions of star images recorded while the telesope drive was switched off.

Calibration

Calibration of the image scale was done using 19 selected reference systems, which are contained in table 1 below and marked by shaded lines. These are all known as relatively fixed ("relfix" in Burnham´s Celestial Handbook [3]). However, some systems have nevertheless shown slight variations of separation (ρ) and position angle (PA) in the past. In such cases, data from the literature have been extrapolated to the epoch 2002. Main sources of literature data were the Washington Double Star catalog (WDS) [4], the 4th Catalog of Interferometric Measurements of Binary Stars (INT4) [5], the 6th Catalog of Orbits of Visual Binary Stars (ORB6) [6] and the Sky Catalogue 2000.0 [7].

The image scale was adjusted with an iterative method such that the average of the differences between measured and published/extrapolated separations (residuals) became virtually zero. This resulted in a calibration constant of 0.189 arcsec/pixel for zoom mode with Barlow, as was already mentioned above. The scatter of this data, as well as of all other measured systems, is shown in fig. 1 a) below. For only the reference systems, the standard deviation of ρ is ± 0.4". Individual error margins are about ± 0.1".

The residuals of the position angles are plotted in fig. 1 b. While for most of the reference systems deviations are less than ± 1 °, some are much larger for unknown reasons, e.g. for nos. 8 (HJ 3750), 13 (γ2 Volantis), and 62 (α1 Capricorni). However, this is not important for the image scale. On the basis of the thus determined calibration constant, the separations of the reference systems as well as of all other systems were calculated. The results, together with the measured position angles, are listed in table 1.

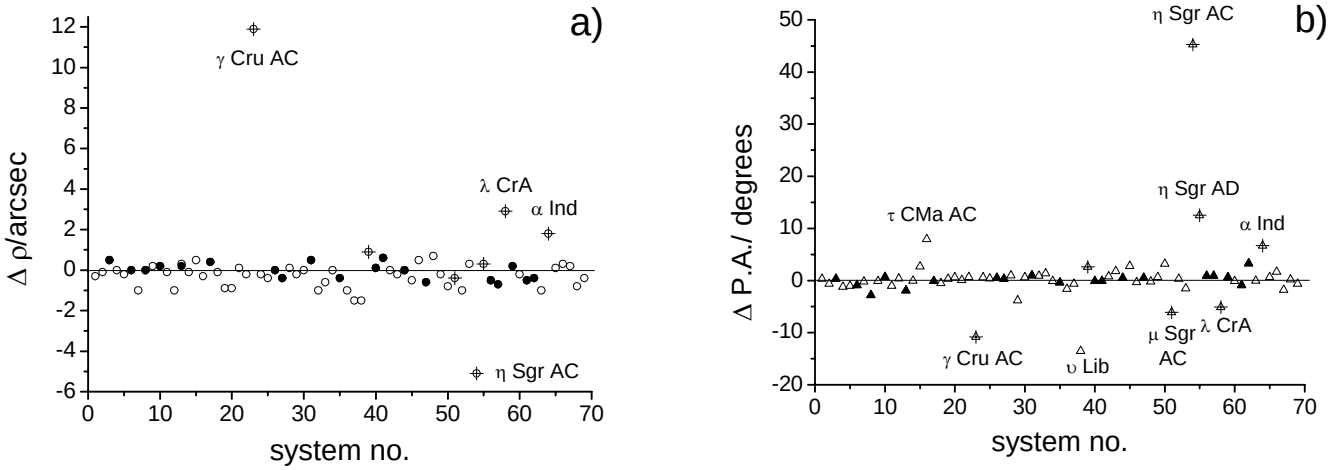


Figure 1. a): Plot of the residuals of the separations of all measured systems. Solid circles refer to relfix systems used for calibration, open circles refer to all other systems, circles with crosses mark systems with old reference data from between 1879 and 1965 (see below in notes to table 1).

b): Plot of the residuals of the position angles of all measured systems. Solid triangles refer to relfix systems used for calibration, open triangles refer to all other systems, triangles with crosses mark systems with old reference data as in a).

Systems exhibiting exceptionally large deviations are marked with their common names.

Measurement of Double and Multiple Stars in the Southern Sky...

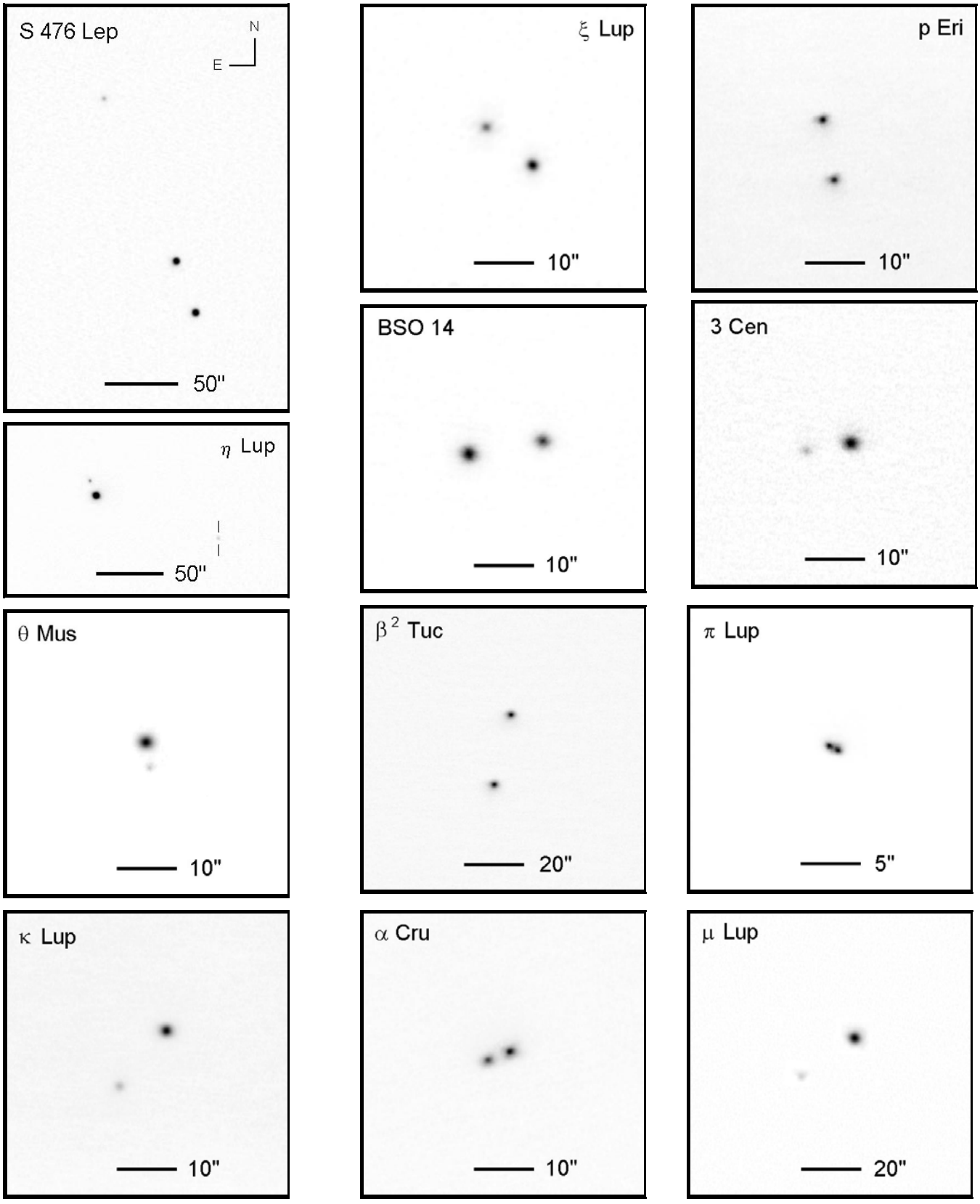


Plate 1A: Selected images of double and multiples stars in the Southern sky.

Measurement of Double and Multiple Stars in the Southern Sky...

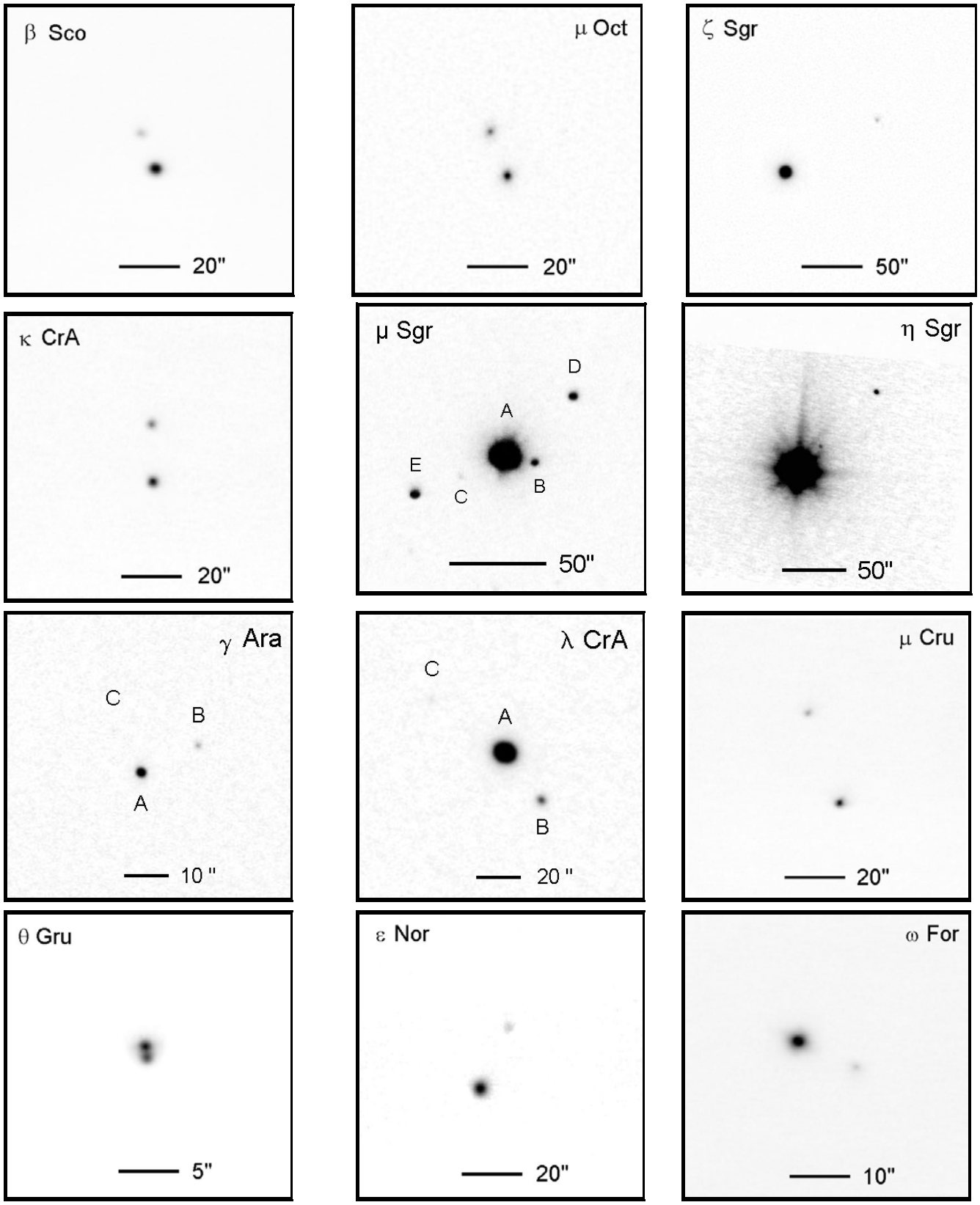


Plate 1B More images of double and multiples stars in the Southern sky. In all images North is up and East is left (chart view).

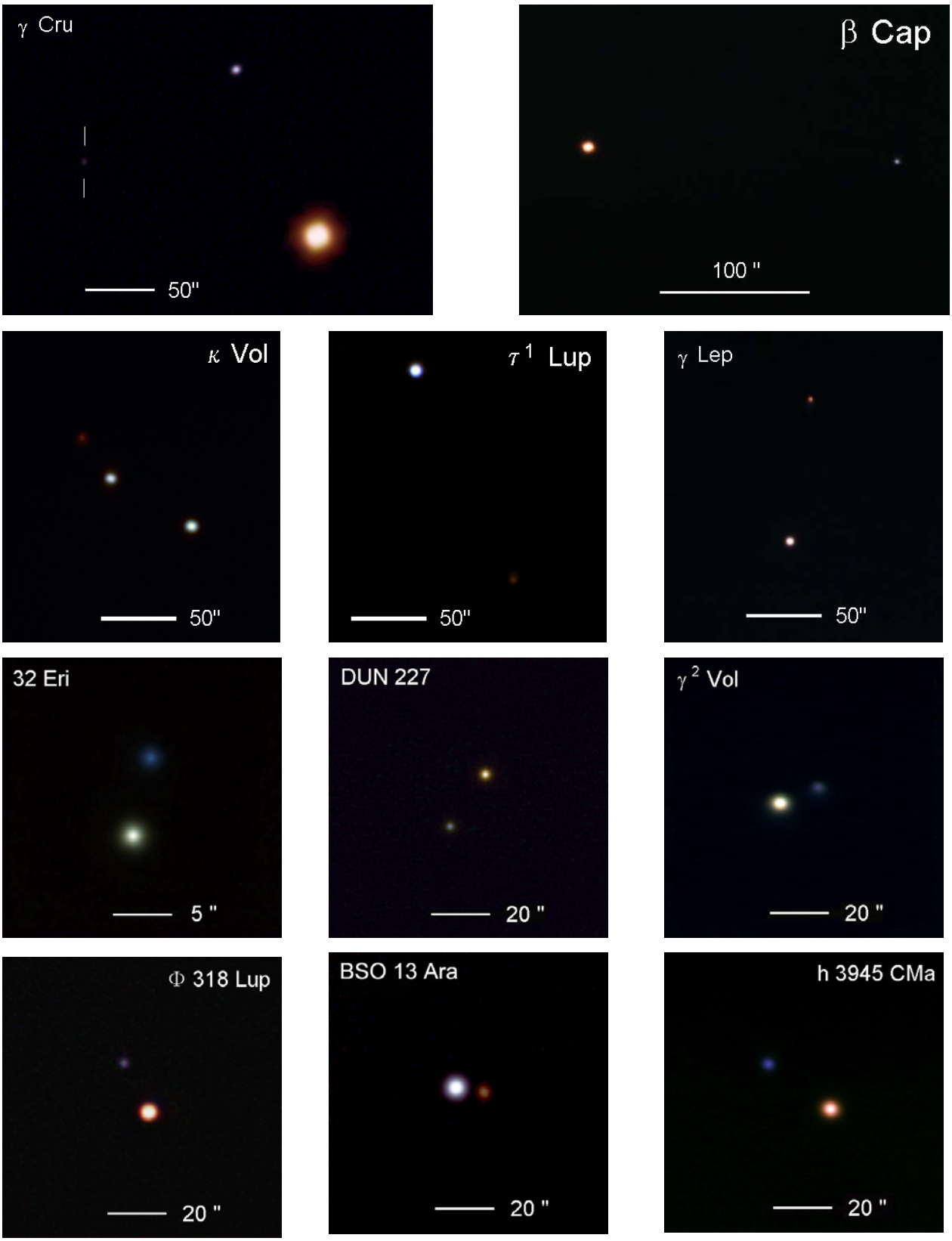


Plate 2: RGB images of double and multiple stars in the southern sky. Orientation as in Plate 1B.

Remarks on color images

For selected systems, differences Δm of the magnitudes of companions A and B in these spectral regions were calculated from the ratios of the integrated pixel values I of the individual star images (after subtraction of the background), using the relation $\Delta m = -2.5\log(I_A/I_B)$. As an example, the results for the system 32 Eridani (see plate 2) were –2.37 for infrared, -2.07 for red, -1.42 for green, and –0.76 for blue. The value for green compares reasonably well with the difference of –1.1 in the visual magnitudes of the pair of 4.8 and 5.9, respectively, as given in the WDS, and even better with the value –1.3, resulting from magnitudes 4.8 and 6.1, as given in the Sky Catalogue 2000.0 [7].

Table 1: List of measured double and multiple star systems. Systems used as reference for calibration of the image scale are marked by shaded lines. Position data are for epoch 2000.0, as listed in the WDS. Magnitudes are also adopted from the WDS. Own measurements of the separations are the result of an iterative procedure, as is explained in the text. Position angles (PA) are given in degrees, separations (ρ, rho) in arcsec. Columns PA ref. and ρ ref. contain reference data taken from the literature (see text). PA values given with one decimal digit are adopted from the INT4. Figure n means the number of measurements with different camera settings or with different filters (R, G, B, and sometimes IR). In the two columns before the last, differences Δ of own measurements minus the respective reference values are given. All measurements and reference data are rounded to one decimal digit.

NAME	RA+DEC	MAGS	PA meas.	ρ meas.	DATE	N	PA ref.	ρ ref.	Δ PA	Δ SEP	NOTES
LCL 119 AC	00315-6257	4.28,4.51	168.3	26.6	2002.688	2	168	26.9	0.3	-0.3	1
DUN 5	01398-5612	5.78,5.90	189.7	11.4	2002.693	1	190.3	11.5	-0.6	-0.1	2
HJ 3506	02338-2814	4.95,7.71	245.3	11.1	2002.693	1	245	10.6	0.3	0.5	3
HJ 3555	03121-2859	3.98,7.19	297.8	4.96	2002.693	1	299.0	4.9	-1.2	0	4
STF 470 AB	03543-0257	4.80,5.89	347.3	6.7	2002.693	4	348.3	6.9	-1.0	-0.2	5
S 476 AB	05193-1831	6.31,6.48	18.1	39.5	2002.693	1	19	39.5	-0.9	0	6
STU 20 AC	05193-1831	6.31,9.57	20.8	166.1	2002.693	1	21	167.1	-0.2	-1.0	7
HJ 3750	05204-2114	4.7,8.5	277.2	4.1	2002.693	4	280	4.1	-2.8	0	8
H 6 40 AB	05445-2227	3.64,6.28	349.9	97.1	2002.693	3	350	96.9	-0.1	0.2	9
STF 997 AB	06561-1403	5.27,7.14	343.7	3.0	2002.688	2	343.0	2.8	0.7	0.2	10
STF 997 AC	06561-1403	5.27,10.32	287.0	86.5	2002.688	1	288	86.6	-1.0	-0.1	11
STF 997 AD	06561-1403	5.27,10.64	63.4	103.8	2002.688	1	63	104.8	0.4	-1.0	12
DUN 42	07087-7030	3.86,5.43	296.1	14.4	2002.699	3	298.0	14.1	-1.9	0.3	13
HJ 3945	07166-2319	5.00,5.84	52.0	26.7	2002.699	4	52	26.8	0	-0.1	14
H 3948 AB	07187-2457	4.42,10.2	92.7	8.6	2002.699	1	90	8.1	2.7	0.5	15
H 3948 AC	07187-2457	4.42,11.2	86.9	14.2	2002.699	1	79	14.5	7.9	-0.3	16
H 3948 AD	07187-2457	4.42,8.22	76.9	84.8	2002.699	1	77	84.4	-0.1	0.4	17
BRSO 17 AB	08198-7131	5.31,5.59	57.5	64.7	2002.699	4	58	64.8	-0.5	-0.1	18
BRSO 17 AC	08198-7131	5.31,9.5?	48.3	98.8	2002.699	4	48	99.7	0.3	-0.9	19
BRSO 17 BC	08198-7131	5.59,7.67	31.6	36.7	2002.699	4	31	37.6	0.6	-0.9	20

Measurement of Double and Multiple Stars in the Southern Sky...

NAME	RA+DEC	MAGS	PA meas.	ρ meas.	DATE	N	PA ref.	ρ ref.	Δ PA	Δ SEP	NOTES
DUN 252 AB	12266-6306	1.25,1.55	114.1	4.0	2002.685	1	114	3.9	0.1	0.1	21
DUN 124 AB	12312-5707	1.83,6.45	26.7	125.2	2002.688	1	26	125.4	0.7	-0.2	22
DUN 124 AC	12312-5707	1.83,9.5	71.2	167.0	2002.688	1	82	155.1	-10.8	11.9	23
R 207	12463-6806	3.52,3.98	44.1	1.1	2002.686	1	43.5	1.3	0.6	-0.2	24
I 362 AB	12477-5941	1.25,11.4	326.4	42.2	2002.688	1	326	42.6	0.4	-0.4	25
DUN 126 AB	12546-5711	3.94,4.95	17.7	34.8	2002.688	3	17.2	34.8	0.5	0	26
RMK 16 AB	13081-6518	5.56,7.55	187.2	4.9	2002.686	1	186.9	5.3	0.3	-0.4	27
DUN 131 AC	13152-6754	4.76,7.24	332.0	58.4	2002.695	1	331	58.3	1.0	0.1	28
DUN 148	13518-3300	4.50,5.97	102.0	7.7	2002.688	1	105.8	7.9	-3.8	-0.2	29
DUN 160	14261-4513	4.53,8.92	204.6	157.0	2002.688	4	204.0	157.0	0.6	0	30
HJ 4690 AB	14373-4608	5.55,7.65	26.0	19.6	2002.685	3	25	19.1	1.0	0.5	31
RHD 1 AB	14396-6050	0.14,1.24	224.3	12.5	2002.688	1	223.4	13.5	0.9	-1.0	32
DUN 166	14425-6459	3.18,8.47	227.4	15.1	2002.688	1	226.0	15.7	1.4	-0.6	33
HJ 4728	15051-4703	4.56,4.60	65.5	1.7	2002.689	1	65.6	1.70	-0.1	0	34
DUN 177	15119-4844	3.83,5.52	142.6	26.1	2002.695	1	143	26.5	-0.4	-0.4	35
DUN 180 AC	15185-4753	4.99,6.34	127.4	22.7	2002.688	1	129	23.7	-1.6	-1.0	36
DUN 182 AC	15227-4441	3.6,9.1	167.8	24.9	2002.686	1	168.4	26.3	-0.6	-1.5	37
I 1271	15370-2808	3.58,10.8	150.5	2.0	2002.695	1	164	3.5	-13.5	-1.5	38
HDO 250	15381-4234	4.33,11.2	30.6	12.7	2002.686	1	28	11.8	2.6	0.9	39
DUN 196	15569-3358	5.09,5.56	48.9	10.4	2002.686	1	49	10.3	-0.1	0.1	40
RMK 21 AB	16001-3824	3.37,7.50	18.9	15.5	2002.688	1	19	14.9	-0.1	0.6	41
RMK 21 AC	16001-3824	3.37,9.27	248.8	115.0	2002.688	1	248 ?	115.0	0.8	0	42
H 3 7 AC	16054-1948	2.59,4.52	21.0	13.8	2002.695	1	20	13.6	1.0	0.2	43
HJ 4853	16272-4733	4.51,6.12	334.7	22.8	2002.688	1	334.2	22.8	0.5	0	44
BSO 13 AB	17191-4638	5.61,8.88	255.8	9.2	2002.688	3	253	9.7	2.8	-0.5	45
HDO 271	17233-4728	5.5,10.8	59.7	45.4	2002.695	1	60.0	44.9	-0.3	0.5	46
HJ 4942 AB	17254-5623	3.32,10.2	327.5	17.8	2002.686	1	327	18.4	0.5	-0.6	47
HJ 4942 AC	17254-5623	3.32,12.2	64.8	42.9	2002.686	1	65	42.2	-0.2	0.7	48
HJ 4951	17311-6041	3.64,10.96	322.7	49.7	2002.686	1	322	49.9	0.7	-0.2	49
H5 7 AB	18138-2104	3.85,10.48	261.2	16.0	2002.688	4	258	16.8	3.2	-0.8	50
BU 292 AC	18138-2104	3.85,13.5	111.9	25.2	2002.688	4	118	25.6	-6.1	-0.4	51
HJ 2822 AD	18138-2104	3.85,9.96	312.3	47.7	2002.688	4	312	48.7	0.3	-1.0	52
HJ 2822 AE	18138-2104	3.85,9.22	113.5	50.4	2002.688	4	115	50.1	-1.5	0.3	53

Measurement of Double and Multiple Stars in the Southern Sky...

NAME	RA+DEC	MAGS	PA meas.	ρ meas.	DATE	N	PA ref.	ρ ref.	Δ PA	Δ SEP	NOTES
BU 760 AC	18176-3646	3.2,13.0	321.3	28.2	2002.688	4	276	33.3	45.3	-5.1	54
BU 760 AD	18176-3646	3.2,10.0	318.5	92.9	2002.688	4	306	92.6	12.5	0.3	55
DUN 222	18334-3844	5.58,6.16	358.9	20.8	2002.688	1	358	21.3	0.9	-0.5	56
COO 227 AB	18438-3819	5.12,10.0	214.9	28.5	2002.688	1	214	29.2	0.9	-0.7	57
COO 227 AC	18438-3819	5.12, ?	51.9	42.9	2002.688	1	57	40.0	-5.1	2.9	58
BSO 14	19011-3704	6.33,6.58	280.9	13.0	2002.688	1	280.3	12.8	0.6	0.2	59
H5 78 AB-C	19026-2953	2.60,10.63	301.9	72.0	2002.688	1	302	72.2	-0.1	-0.2	60
DUN 227	19526-5458	5.80,6.39	147.1	22.5	2002.688	4	148	23.0	-0.9	-0.5	61
HJ 607 AC	20176-1230	4.24,9.6	224.3	45.6	2002.694	4	221	46.0	3.3	-0.4	62
STFA 52 AB	20210-1447	3.15,6.08	267.0	206.0	2002.694	4	267	207.0	0	-1.0	63
HJ 5209 AB	20376-4717	3.11,12.0	205.7	69.2	2002.700	1	199	67.4	6.7	1.8	64
DUN 232	20417-7521	6.51,7.07	19.7	16.8	2002.688	1	19	16.7	0.7	0.1	65
HJ 5258	21199-5327	4.50,6.93	273.3	7.0	2002.688	4	271.6	6.7	1.7	0.3	66
HJ 5278	21509-8243	5.56,7.26	62.9	3.5	2002.688	3	62.4	3.30	-1.8	0.2	67
PZ 7	22315-3221	4.28,7.12	172.3	29.6	2002.688	1	173	30.4	0.2	-0.8	68
Jc 20 AC	23069-4331	4.45,7.77	291.5	158.9	2002.686	1	292.1	159.3	-0.6	-0.4	69

Notes

In the following, common names of the systems are given, as well as other characteristics, like "cpm" (common proper motion), or "relfix" (relatively fixed) (both designations are adopted from Burnham´s Celestial Handbook [8]). Also, some remarks on reference data, on colors, as well as references to the image plates, if applicable, are added.

1: β^2 Tucanae, see plate 1a.
2: p Eridani; own measures fit rather well to published orbit.
3: ω Fornacis, relfix, see plate 1b.
4: α Fornacis, reference data taken from published orbit, which, however, is based on not too many data with significant scatter.
5: 32 Eridani, cpm, color contrast yellow-blue, see plate 2 and remarks on color imaging above.
6, 7: in Lepus, triple system, AB relfix, see plate 1a.
8: in Lepus, relfix.
9: γ Leporis, nice color contrast, see plate 2.
10, 11, 12: μ Canis Majoris, multiple system, AB reflix.
13: γ^2 Volantis, relfix, see plate 2.
14: in Canis Major, nice color contrast, see plate 2.
15, 16, 1 7: τ Canis Majoris, multiple system, AD relfix.
18, 19, 20: κ Volantis, multiple system, color contrast, see plate 2.
21: α Crucis, see plate 1a.
22, 23: γ Crucis, possibly optical, AC reference from 1879, C has markedly changed position, color contrast,

(Continued on page 116)

Measurement of Double and Multiple Stars in the Southern Sky...

(Continued from page 115)

see Plate 2.

24: β Muscae, orbit, own measure of rho is somewhat smaller than expected from calculated orbit, but seems to better fit to extrapolation from interferometric data from 1991.
25: β Crucis, optical ?
26: μ Crucis, relfix, see plate 1b.
27: θ Muscae, relfix.
28: η Muscae.
29: κ or 3 Centauri, cpm, see plate 1a.
30: τ^1 Lupi, color contrast, see plate 2.
31: in Lupus, also known as Φ 318, color contrast, relfix, see plate 2.
32: α Centauri, orbit. I have already measured this system in 2000 with the same equipment at the same location, resulting in PA = 224 o, and rho = 13.3 ". Both measures fit reasonably well to published orbit. A decrease of rho is expected.
33: α Circini, PA slowly decreasing.
34: π Lupi, cpm, PA decreasing, rho increasing, own measures fit well to extrapolation from last published data as from 1991 to 1996 in INT4. See plate 1a.
35: κ Lupi. Although designated as relfix, PA and rho seem to slowly decrease. See plate 1a.
36: μ Lupi, cpm, see plate 1a.
37: ε Lupi.
38: υ Librae, last published measurement from 1965.
39: ω Lupi, cpm, last published measurement from 1933.
40: ξ Lupi, relfix, see plate 1a.
41, 42: η Lupi; triple system, AB relfix, AC reference from 1935. PA for C given in WDS as 148 o probably is a printing error. See plate 1a.
43: β Scorpii, see plate 1b.
44: ε Normae, relfix.
45: in Ara, L7194. Published orbital data is based on only a small section of the suspected orbit. This system is reported in the Guide 8.0 program as problematic, as the position possibly is imprecise. Color contrast, see plate 2.
46: ι Arae.
47, 48: γ Arae, AB relfix, see plate 1b.
49: δ Arae.
50 – 53: μ Sagittarii, multiple system, AC reference from 1901, see plate 1b.
54, 55: η Sagittarii, multiple system, cpm, AC reference from 1896, AD reference from 1913, see plate 1b. (The close pair AB (rho = 3.1") is overexposed and not resolved in this wide field image. The diffraction spikes of the main star A were used for determining its exact position).
56: κ Coronae Australis, relfix, see plate 1b.
57, 58: λ Coronae Australis; AB relfix, AC reference from 1900, magnitude of component C has no entry in WDS, own estimate is roughly 12th mag in the red spectral region, see plate 1b.
59: in Corona Australis.
60: ζ Sagittarii, AB close binary, see plate 1b.
61: in Telescopium, relfix, color contrast, see plate 2.
62: α^1 Capricorni, multiple system, AC relfix.
63: β Capricorni, cpm, color contrast, see plate 2.
64: α Indi; reference from 1914.
65: μ^2 Octantis, cpm, PA increasing, rho decreasing, see plate 1b.
66: θ Indi, cpm, PA decreasing (?), rho increasing, color contrast.
67: λ Octantis; PA slowly decreasing.
68: θ Gruis, cpm, see plate 1b.
69: β Piscis Austrini.

Summary

An attempt was made to assess the accuracy of double star measurements from digitized video images by comparison with reference data. Provided that the image quality is sufficient, values for rho and PA can be calculated with errors less than 0.1 " and 1 °, respectively, with the equipment used here. However, the standard deviation of +/- 0.4 " obtained on the basis of 19 reference systems includes both possible systematic errors of the actual measurements and of the data from the literature. For the latter, error margins are difficult to estimate, with the exception perhaps of interferometric data. Nevertheless, it appears that the accuracy of digital image analysis of suitably processed video recordings is at least comparable to visual methods, and provides the additional feature of non-volatile documentation.

For a number of cases, differences between own measurements and reference data are significant. For some systems, these are probably due to rather long time intervals of several decades since last published measurements. For other systems, the reason for deviations is less clear. In any case, it would be worthwhile to independently check the questionable systems in the near future.

References

[1] Anton, Rainer, 2002, *Sky and Telescope*, July issue, 117-120.

[2] Anton, Rainer, 2004, *The Double Star Observer*, **10** (1), 2-10.

[3] *Burnham´s Celestial Handbook,* R. Burnham, Dover Publications, New York 1978.

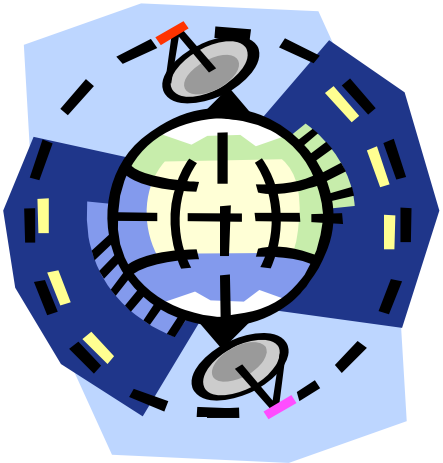
[4] Mason, B. D. et al., *The Washington Double Star Catalog* (WDS), U. S. Naval Observatory, version used here downloaded from the web in December 2005.

[5] Hartkopf, W. I. et al., *Fourth Catalog of Interferometric Measurements of Binary Stars* (INT4), 2002, U. S. Naval Observatory.

[6] Hartkopf, W. I. et al., *Sixth Catalog of Orbits of Visual Binary Stars* (ORB6), 2002, U. S. Naval Observatory.

[7] *Sky Catalogue 2000.0,* vol. 2, A. Hirshfeld and R. W. Sinnott, eds., Sky Publishing Corp. 1985.

The author is a physicist at Hamburg University, Germany, and started with video astronomy in 1995. Since then, he has been concentrating on double star measurements at home as well as in Namibia for exploring the southern sky.



Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars: Results of LIADA's Double Star Section for 2003

Francisco Rica Romero

Astronomical Society of Merida - Spain
Coordinator of LIADA's Double Star Section - Argentina

E-mail: frica0@terra.es

Abstract: LIADA's Double Star Section presents angular separations, position angles as well as V magnitudes for 103 neglected visual double stars obtained in 2003. A total of 701 measures were averaged into 311 mean positions that range in separation from 2.6" to 225.7". Our observations were made by means of several techniques (CCD detectors, astrometric eyepieces and photographic and digital surveys). About 45% of double stars were unconfirmed pairs discovered by John Herschel which remained neglected since before 1850. BVIJHK photometry, astrometric and kinematical data were used/obtained to determine astrophysical parameters (spectral types and luminosity classes, photometric distances, etc). Their nature was determined using several professional criteria, classifying them as optical, physical or common origin pairs. Only 6% were physical double stars. New companions were added to six known systems.

Introduction

As you probably know a large number of systems in the WDS are neglected or very neglected pairs and others in addition to this are unconfirmed double stars. A pair is unconfirmed if only the discovery measure was performed. While neglected pairs need more relative astrometry to allow us to characterize them, unconfirmed pairs need one more measurement to confirm their existence. There are several reasons for the neglect: poor coordinates or large proper motion, erroneous magnitude or delta-m estimates or true neglect (it is nearly impossible to measure the large amount of neglected double stars due to the lack of observers).

The Astrometry Department of the United State Naval Observatory (USNO) has published the Washington Double Star Catalog (Mason B.D., Wycoff G., & Hartkopf W. I., 2003, hereafter WDS) and has included on the web several lists of neglected and unconfirmed pairs. The USNO considers as neglected those double stars that have not been observed in twenty years. There are many thousands of pairs in these lists and amateurs play an important role not only in performing angular separation and position angle measures but studying the astrophysical parameters for their components and systems.

LIADA's Double Star Section has as its main goals to perform measurements of relative astrometry of these neglected and unconfirmed pairs, determine the astrophysical parameters for their members, and classify them, according to their nature, as physical, common origin, common proper motion or optical pairs.

The results of 701 individual relative measures for 103 visual double stars, performed with different techniques during 2003, are presented. Of these, 54 double stars have been confirmed.

We determined 150 spectral types and luminosity classes for their members. A study of the measured doubles determined that 5 double stars are physical pairs and another 5 pairs were classified as common origin pairs. New companions were added to six known systems.

Confirmation of visual double stars

In the period between January and December

2003 LIADA has confirmed the existence of 54 visual double stars. Of those confirmed, 48 of them were discovered by John Herschel and have remained unconfirmed since 1820 and 1830! Among all programmed unconfirmed double stars, four were not identified. These pairs are shown in Table I. In the first and second columns, the WDS identifier and discover code with their sequential number are listed; in the following columns, from left to right, are listed the magnitude for primary and secondary; in column 5 the epoch of the only measurement; and in the last two columns, the relative astrometry ρ and θ.

(1) WDS no.	(2) Designation	(3) Mg. A	(4) Mg. B	(5) Epoch	(6) ρ(")	(7) θ(deg)
21149+3240	HJ 1627	13	14	1828	2	182
21090+0410	HJ 5515	10	10	1823		15
21377+5728	HJ 1672	10	11	1828	12	261
21402+4422	HJ 1679	10	11	1828	3	86

Table 1: Unconfirmed Double Stars

Relative Astrometry

The results of 701 individual relative measurements, averaged into 311 mean positions, for 103 visual double stars were made with different techniques. The angular separation ranges from 2"59 to 225"69.

Several techniques were used to obtain astrometry and photometry. A Microguide eyepiece was used by Rafael Benavides -- Astronomical Society of Córdoba (Spain) – using a refractor telescope of 0.12 meter. Several 0.2-0.3 meter telescopes with a CCD were used by John Ryan -- "Spirit of 33", Salamanca (Spain/ USA) – and Francisco Rica – Astronomical Society of Mérida (Spain) -- . Jim Jones (from U.S.A.), Alejandro Russo (from Argentina), Lahuerta brothers (from Spain) and Daniel Osanai (from Argentina) were new members reporting their results.

Internet resources were also used for astrometry. The digitized images of Two Micron All Sky Survey (Cutri R.N. et al. 2000, hereafter 2MASS) project, enabled us to make measurements of great accuracy. Digitized Sky Survey (DSS) was also used for astrometry. Guide 6.0/7.0, Astrometrica, and FitsView software were used for documentation and astrometry.

Table 2 lists relative astrometry for 103 double stars. In the first and second columns, the WDS identifier and discoverer code with their sequential numbers are listed; in the following columns, from left to right, the Besselian epoch of the astrometry; the number of measurements; the position angle and the angular separation; the V magnitude of primary and secondary. If the magnitude listed has two decimal numbers these came from Tycho-2 (Hog E. et al. 2000) or else they came from calibrated GSC 1.2 (Morrison 2001), GSC-II, USNO-B1.0 (Monet 2003) photometry or inferred by spectral distribution using JHK photometry. The spectral type and luminosity class estimated using photometric and kinematic data.

Column (11) lists the observer code as follows: **FMR** (Francisco Rica, Astronomical Society of Mérida (Spain)), **ARU** (Alejandro Russo, amateur from Argentina), **JRY** (John Ryan, "Spirit of 33" group, amateur from Spain/USA.); **BVD** (Rafael Benavides, Astronomical Society of Córdoba –Spain-); **JJO (**Jim Jones, amateur from USA); **DOS** (Daniel Osanai, amateur from Argentina); **OMG** (Lahuerta's Brothers, Observatory of Manises –Valencia, Spain).

The observation methods are listed in the next column (**CCD:** CCD camera, **MCG:** MicroGuide eyepiece, **2MASS:** 2MASS project images; **DSS:** Digitized Sky Survey; **AC2000:** Astrographics Catalogue 2000).

In column (12) the nature of the double star code is as follow: **PHY**= Physical; **OPT**=Optical; **CO** = Common Origin; "**¿?"** = unknown; "--"=nature not studied. A "?" character means that the nature listed is not confirmed. In the last column the confirmed double stars show a "C" letter; a number indicates the years since the last measure. "#" character followed by a number refers to a note number.

This year four observers have reported their results for the first time:

Jim Jones, is an amateur from USA and member of "Spirit of 33" group. Jim used a 0.2 meter telescope, with SkyWalker GoTo system. A SBIG ST7ei CCD camera was used to obtain the images which were reduced by AIP4WIN software.

Daniel Osanai, an amateur from Argentina.

Luis and Salvador Lahuerta Zamora from Manises' Observatory (MPC-IAU Code J98). The Lahuerta brothers are members of *Grupo de Estudio, Observación y Divulgación de la Astronomía* (G.E.O.D.

A.) in Valencia (Spain). They used an 0.25 meter S/C Meade LX200 telescope (2500 mm of focal length). A Starlight Xpress MX516 CCD camera was used to obtain the images. The pixel size used is of 1.37 x 1.76 arcsec. The field of view was of 11.39 x 8.50 arcmin. Charon software was used to perform astrometric and photometric reduction.

New companions to known systems

New companions were added to the systems HJ 3100, HJ 1637, HJ 1368, HJ 780, HJ 84, HJ 438. For HJ 84 two new companions were added. The new companions were found by Rafael Benavides (BVD 1 to BVD 5) and John Ryan (JRY 1). The relation of the new companions to the members of the known systems were studied. Five of them were not bound to any member of the known system. The nature of the other two new companions remain undetermined due to missing or inaccurate data. Although LIADA's Double Star Section doesn't usually propose that optical companions to be listed in the WDS catalog, we suggest including these in order to avoid future erroneous faulty observer reports.

Spectral Types and luminosity classes

The process to estimate spectral types and luminosity classes using BVJHK photometry and kinematical data were explained in detail in Rica (2005).

Table 2 lists 150 spectral types estimated by the LIADA group; only 15 of these stars had spectral types previously published in the literature.

Table 3 compares spectral types determined by LIADA with those listed in the literature. For most of the stars, the difference is less than or equal to 2 spectral subclasses. In Table 2 there are many spectral types that were estimated using only JHK photometry due to the star component not being listed in Tycho-2, so their results were of lower accuracy than those obtained using BVJHK photometry.

Studying the Nature of Visual Double Stars

To study the nature of visual double stars and classify them as optical, physical, common proper motion or common origin pairs, BVJHK photometric and astrometric (proper motion and relative astrometry) data were used. The historical relative astrometry (θ corrected for precession and proper motion) in addition to our own measures were plotted in X (= ρ*cos(θ)) against epoch and Y(=ρ*sin (θ)) against epoch diagrams. A linear fit shows the relative proper motion of B with respect to A. This data is very important because nearly all the methods that allow us to determine their nature use these data. If a double star is physical then these data will give us the projected relative orbital motion and velocity.

The Tycho-2 optical BV photometry and the 2MASS infrared JHK photometry in addition to the individual proper motions allow us to obtain the spectral type and luminosity class. Finally the photometric and astrometric data were analyzed using up to 6 professional methods that allow us to classify visual double stars according to their nature. We analyzed individual proper motions using the method of Halbwachs (1986).

Figure 1 shows a summary of this study. Of the 103 visual double stars measured, LIADA studied the nature of 83 of them. About 75 % (62 visual double stars) were optical or suspected optical, while only 6% (5 doubles) were physical or suspected physical. Of the double stars studied there were pairs with photometric and astrometric data consistent with pairs located

(Continued on page 130)

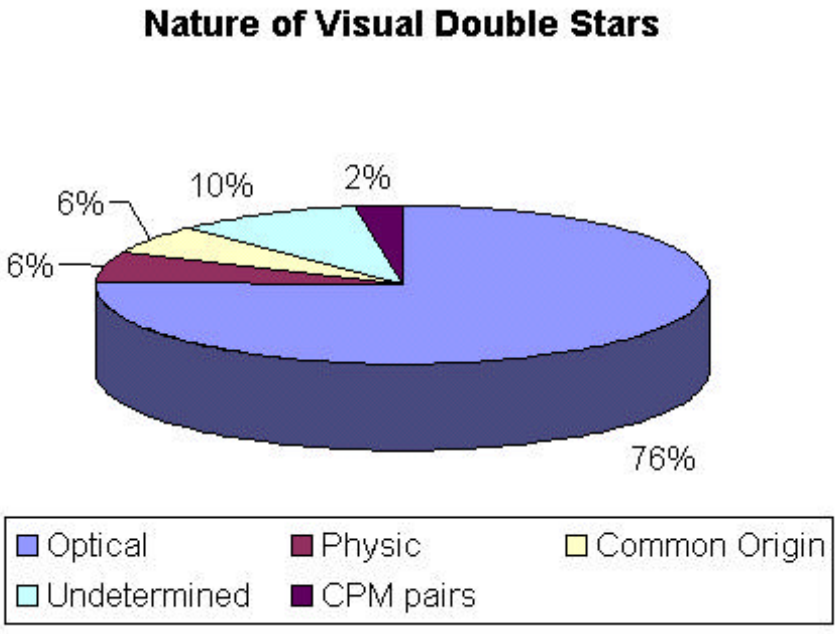


Figure 1: Study of the visual double stars' nature. Most of the neglected and unconfirmed visual double stars are optical pairs with no astrophysical interest.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
00023+0732	LDS6084	1955.861	1	127.1	15.33	17.8	18.0		JJO	DSS	CPM	C
		1991.697	1	127.8	14.89				JJO	DSS		
		1991.699	1	127.9	15.25				JJO	DSS		
00027+5958	ARG 47	1999.713	3	290.0	10.09	9.29	10.07		FMR	2MASS	--	
		2003.066	4	290.2	9.84				JRY	CCD		
01487+7528	HJ 2075 AB	1999.825	3	231.1	30.80	9.98	11.29	G8V+K6V	FMR	2MASS	CPM	
		2003.074	4	230.7	30.67				JRY	CCD		
01487+7528	HJ 2075 AC	1999.825	3	238.5	36.98	9.98	11.29	G8V	FMR	2MASS	OPT	C. 173
		2003.074	4	238.6	36.91				JRY	CCD		
01151+3125	WFC 248	1998.889	3	8.4	10.74	12.0	12.0		FMR	2MASS	--	
		2003.066	4	8.6	10.66				JRY	CCD		
03083+3101	HJ 331	1993.798	1	307.7	19.76	11.06	12.5	K7+K9	RBE	DSS	OPT	C. 173
		1998.031	3	308.0	18.01				FMR	2MASS		
		2003.074	4	308.7	18.03				JRY	CCD		
03278+5627	STI1984	1998.981	3	73.6	10.83	10.81	11.8		FMR	2MASS	--	
		2003.066	4	74.4	10.81				JRY	CCD		
03314+0131	HJ 2194	1951.686	1	122.2	30.83	11.30	11.63	F8+K1	JJO	DSS	OPT	
		1995.953	1	121.7	33.81				JJO	DSS		
		1995.953	1	121.6	30.64				RBE	DSS		
		2000.049	3	120.8	33.70				FMR	2MASS		
		2003.074	4	120.8	33.81				JRY	CCD		
03378+4943	WFC 250	1999.140	3	68.4	11.17	10.88	12.2		FMR	2MASS	--	
		2003.066	4	68.0	11.07				JRY	CCD		
03428+0015	HJ 2202	1995.953	1	80.4	33.68	10.18	12.0	K9	RBE	DSS	OPT?	C. 173
		2000.055	3	79.1	33.85				FMR	2MASS		
		2003.074	4	78.7	33.68				JRY	CCD		
03540+0316	HJ 2213 AB	1953.998	1	9.4	12.73	11.27	14.6		JJO	DSS	¿?	C. 173
		1991.787	1	8.3	13.12				RBE	DSS		
		1992.733	1	7.6	12.99				RBE	DSS		
		2000.058	3	7.7	13.47				FMR	2MASS		
		2003.074	4	7.6	13.31				JRY	CCD		
03540+0316	HJ 2213 AC	1953.998	1	95.6	20.99	11.27	14.8		JJO	DSS	¿?	C. 173
		1991.787	1	94.4	21.06				RBE	DSS		
		1992.733	1	93.4	21.08				JJO	DSS		
		2000.058	2	93.0	21.38				FMR	2MASS		
		2003.074	4	93.1	21.23				JRY	CCD		
04017+4905	WFC 251	1999.782	3	305.7	13.83	10.8	11.8		FMR	2MASS	--	

Table 2: Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		2003.066	4	305.6	13.89				JRY	CCD		
04067+0324	HJ 2221	1992.066	1	256.2	16.74	11.77	13.52	K2+G7	FMR	DSS	OPT	
		1999.859	3	257.6	16.88				FMR	DSS		
		2000.061	3	257.6	17.16				FMR	DSS		
		2003.074	4	257.3	17.14				RBE	DSS		
04074+0521	HJ 2222	1992.066	1	144.8	21.08	10.95	12.8	M0(K4V)	RBE	DSS	OPT?	C.173.#1
		2000.061	3	144.1	21.00				FMR	2MASS		
		2003.074	4	144.3	21.00				JRY	CCD		
04154+1641	HJ 3254	1991.932	1	228.2	25.82	10.88	12.5	G1+G5	RBE	DSS	OPT	C. 173
		1997.760	3	228.6	25.64				FMR	2MASS		
		2003.074	4	228.8	25.77				JRY	CCD		
04196+3355	HJ 674	1955.812	1	21.5	15.74	12.14	12.98	K8+F2	JJO	DSS	OPT	
		1982.806	1	20.2	16.43				JJO	DSS		
		1989.826	1	21.2	16.67				JJO	DSS		
		1993.798	1	20.7	16.53				FMR	DSS		
		1998.891	3	20.9	16.84	12.12	12.7		FMR	2MASS		
		2000.936	7	21.5	16.69				FMR	2MASS		
		2003.074	4	20.6	16.81				JRY	CCD		
04258+2855	HJ 343 AB	1992.753	1	124.8	24.86	10.32	12.8	F3+F9	RBE	DSS	OPT?	
		1997.910	3	125.2	24.70				FMR	2MASS		
		2003.074	4	125.0	24.77				JRY	CCD		
04258+2855	HJ 343 AC	1992.753	1	127.2	38.84	10.32	13.3	F3	RBE	DSS	OPT?	
		1997.910	3	127.7	38.78				FMR	2MASS		
		2003.074	2	127.5	38.92				JRY	CCD		
04258+2855	HJ 343 AD	1992.753	1	91.7	62.02	10.32	13.7	F3+G9	RBE	DSS	OPT?	
		1997.910	3	91.8	61.69				FMR	2MASS		
		2003.078	2	91.9	61.82				JRY	CCD		
04514-0613	HJ 28	1985.052	1	201.7	17.76	12.2	12.5	K2+K5	RBE	DSS	¿?	C. 183
		1998.779	3	203.4	17.90				FMR	2MASS		
04537-0618	HJ 29	1985.052	1	298.5	29.77	10.67	11.50		ARU	DSS	OPT	97
		1998.779	3	299.1	30.34				FMR	2MASS		
04553-0352	HJ 352 AC	1985.052	1	344.3	48.15	9.40	11.82	G1+K0	ARU	DSS	OPT	C. 183
		1985.052	1	344.7	47.62				RBE	DSS		
		1998.705	3	344.4	49.80				FMR	2MASS		
08002+0128	HJ 3306	2003.364	4	186.4	14.38	9.90	13.3		JRY	CCD	--	
		2003.399	1	186.1	15.00				OMG	CCD		
08005-0837	HJ 2425	1984.179	1	246.2	12.15	10.56	12.90	G4+F3	DOS	DSS	--	C

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1985.052	1	244.1	13.52				DOS	DSS		
08020+2532	HJ 435	1996.121	1	104.6	12.65	10.84	11.23	F4+F4	RBE	DSS	CO	
		2003.364	4	284.5	12.86				JRY	CCD		
		2003.399	1	285.4	12.70				OMG	CCD		
08023+0220	GSH 1	2003.364	4	315.0	225.69	4.39	10.45		JRY	CCD	--	
08023+1039	HJ 76	1951.236	1	85.4	9.44	10.60	11.4	F5+F7	RBE	DSS	OPT	
		1997.851	1	85.1	9.83				RBE	DSS		
		1999.960	3	84.6	10.12				FMR	2MASS		
		2003.364	4	85.1	10.07				JRY	CCD		
08039-3133	LDS 201 AB	1987.245	1	236.2	47.83	8.73	9.64	G4V+G6V	DOS	DSS	CO	#2
		1992.025	1	236.4	48.47				DOS	DSS		
		2000.236	3	236.9	47.89				FMR	2MASS		
08039-3133	LDS 201 AC	1992.025	1	258.1	75.12	8.73	10.96	G4V	DOS	DSS	OPT	C
		2000.236	3	258.1	73.24				FMR	2MASS		
08039-3133	B 2164 CD	1992.025	1	56.0	3.40	10.9	11.5	B9+A4V	DOS	DSS	CO?	
		2000.236	3	58.9	4.01				FMR	2MASS		
08042+3136	HJ 438 AB	1955.195	1	128.9	24.63	10.28	11.7		FMR	DSS	OPT	C.173.#3
		1998.214	3	128.7	24.65				FMR	2MASS		
		1998.217	1	128.7	24.67				RBE	DSS		
		2003.364	4	128.3	24.61				JRY	CCD		
		2003.399	1	128.7	25.10				OMG	CCD		
08042+3136	BVD 1 AC	1955.195	1	5.0	14.75	10.22	15.0		RBE	DSS	OPT	**new com.**
		1998.214	2	5.3	15.07				FMR	2MASS		
		1998.217	1	4.7	15.01				RBE	DSS		
08113+1045	HJ 82	1951.236	1	245.3	20.41	11.20	11.3	K4+K6	RBE	DSS	OPT	C. 183
		1997.851	1	243.7	21.60				RBE	DSS		
		2000.171	3	243.1	21.87				FMR	2MASS		
		2003.364	4	243.1	21.84				JRY	CCD		
08126+0431	HJ 84 AB	1949.914	1	250.1	8.11	12.3	13.1	K7V:+M0V	RBE	DSS	OPT	C. 183
		1997.165	1	245.0	8.38				RBE	DSS		
		2000.072	3	246.0	8.61				FMR	2MASS		
		2003.364	4	246.2	8.58				JRY	CCD		
08126+0431	BVD 2 AC	1949.914	1	186.2	13.48	12.3	14.6	K7V:+G5	RBE	DSS	OPT	**new com.**
		1997.165	1	189.3	14.95				RBE	DSS		
		2000.072	3	189.7	15.1				FMR	2MASS		
		2003.364	4	188.7	14.92				JRY	CCD		
08126+0431	BVD 2 AD	1949.914	1	234.9	24.37	12.3	12.5	K7V:+K4	RBE	DSS	OPT	**new com.**

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1997.165	1	189.3	14.95				RBE	DSS		
		2000.072	3	189.7	15.1				FMR	2MASS		
		2003.364	4	188.7	14.92				JRY	CCD		
08126+0431	BVD 2 AD	1949.914	1	234.9	24.37	12.3	12.5	K7V:+K4	RBE	DSS	OPT	new com.
		1997.165	1	232.8	25.22				RBE	DSS		
		2000.072	3	232.7	25.73				FMR	2MASS		
		2003.364	4	232.5	25.59				JRY	CCD		
08127+0428	HJ 83	1949.914	1	115.9	28.93	13.1	13.3	G4V:+K0	RBE	DSS	OPT	C. 183
		1996.881	1	111.5	29.90				RBE	DSS		
		2000.072	3	111.7	29.82				FMR	2MASS		
		2003.364	4	111.5	29.82				JRY	CCD		
08171+3348	HJ 780 AB	1954.154	1	203.7	14.79	11.7	12.6	K4+K0	RBE	DSS	OPT	C. 183
		1989.859	1	206.0	14.61				RBE	DSS		
		1998.214	3	206.7	14.76				FMR	2MASS		
		2003.364	4	207.6	14.63				JRY	CCD		
		2003.399	1	207.3	14.70				OMG	CCD		
08171+3348	BVD 3 AC	1954.154	1	190.9	24.72	11.7	13.8	K4+K0	RBE	DSS	OPT	new com.
		1989.859	1	191.7	25.06				RBE	DSS		
		1998.214	3	191.4	25.73				FMR	2MASS		
		2003.364	4	191.7	25.65				JRY	CCD		
08171+3348	BVD 3 BC	1954.154	1	173.7	11.38	12.60	13.8		RBE	DSS	¿?	new entry
		1989.859	1	173.3	11.65				RBE	DSS		
		1998.214	3	172.5	12.16				FMR	2MASS		
		2003.364	4	172.7	12.25				JRY	CCD		
		2003.399	1	173	12.3				OMG	CCD		
08195-0045	HJ 88	1954.971	1	129.6	24.15	7.84	11.6	K0III+ M1III	DOS	DSS	OPT	C.183.#4
		1983.040	1	128.2	25.38				DOS	DSS		
		1991.053	1	128.0	25.68				DOS	DSS		
		1998.943	3	128.0	25.35				FMR	2MASS		
08209-3613	HJ 4083	1988.035	1	118.7	28.97	10.24	11.7	K2III	DOS	DSS	--	#7
08231+1205	HJ 91	1951.987	1	244.7	19.82	11.9	11.8	F4+F4	RBE	DSS	CO	C.183.#5
		1988.189	1	244.6	20.10				RBE	DSS		
		1989.178	1	244.6	19.85				RBE	DSS		
		2000.178	3	244.3	20.31				FMR	2MASS		
08242+4722	HJ 2442	1953.121	1	93.5	15.47	10.61	12.6	F5+F8	RBE	DSS	OPT	C. 173
		1989.157	1	95.8	14.80				RBE	DSS		
		1998.296	3	96.0	15.25				FMR	2MASS		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		2003.364	4	96.3	14.93				JRY	CCD		
		2003.399	1	96.3	14.60				OMG	CCD		
08268+0226	STF1229	2003.364	4	115.7	21.67	9.59	11.7		JRY	CCD	--	
08287+0539	HJ 5473	1953.023	1	222.3	11.96	13.4	13.4	G4V:+G0:	RBE	DSS	OPT	#6
		1996.881	1	240.3	13.63				RBE	DSS		
		2000.080	3	241.4	13.77				FMR	2MASS		
08292+1343	HJ 2450	1951.987	1	175.0	27.45	10.24	10.94	K4+K3	RBE	DSS	OPT	C. 173
		1989.850	1	173.0	28.01				RBE	DSS		
		1997.851	3	172.8	28.22				FMR	2MASS		
		2003.364	4	172.7	28.08				JRY	CCD		
08361+3233	HJ 791	1953.026	1	237.3	7.99	12.8	13.1	K1+K2	RBE	DSS	OPT	C. 183
		1989.858	1	235.7	8.12				RBE	DSS		
		1998.217	3	236.6	8.52				FMR	2MASS		
		2003.364	4	236.0	8.42				JRY	CCD		
08364+1841	HJ 2456	1954.974	1	136.0	13.06	11.46	13.8	F0+F6	RBE	DSS	OPT	C. 173
		1990.077	1	134.1	13.16				RBE	DSS		
		1998.834	3	134.7	13.37				FMR	2MASS		
		2003.364	4	135.3	13.37				JRY	CCD		
08377+1931	HJ 454	2003.364	4	271.2	36.86	8.24	11.7		JRY	CCD	--	
		2003.399	1	270.5	37.40				OMG	CCD		
08391+1941	S 570 AC	2003.364	4	344.9	178.20	7.45	9.34		JRY	CCD	--	
		2003.399	1	83.7	57.10				OMG	CCD		
11037-2941	HDS1577	1978.111	1	8.5	11.53	9.90	13.00	G8.5III:+G4	ARU	DSS	OPT	C.13.#8
		1978.113	1	4.5	11.09				ARU	DSS		
		1999.518	1	5.3	10.83				FMR	2MASS		
11119-5312	HDS1595	1979.310	1	345.0	23.91	8.87	10.72	K2III+F5	ARU	DSS	OPT	C.13.#9
		1987.080	1	345.3	23.68				ARU	DSS		
11521-0259	HJ 192	1952.090	1	55.2	21.17	11.4	13.4	G6+F6:	ARU	DSS	OPT	
		1983.360	1	52	22.07				ARU	DSS		
		1998.300	1	50.4	22.57				ARU	DSS		
12089-0317	HJ 1211	1955.300	1	147.8	11.81	10.61	13.4	F5:+K3	DOS	DSS	OPT?	
		1984.420	1	149	11.32				DOS	DSS		
		1988.300	1	149.5	11.49				DOS	DSS		
		1996.290	1	152.8	10.79				DOS	DSS		
12437-0448	HJ 215	1992.410	1	294.3	12.14	12.07			DOS	DSS	--	C. 184
18028-2705	HLD 32	1998.212	3	101.2	5.05	8.37	9.2	F8V+F9V	FMR	2MASS	PHY	
18091-6154	LDS 624	1975.450	1	90.3	19.03	15.3	15.7	K7VI:+K8IV:	FMR	DSS	CO	

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1975.660	1	89.5	18.95				FMR	DSS		
		1990.470	1	90.3	19.02				FMR	DSS		
		1995.650	1	90.6	19.19				FMR	DSS		
		2000.510	3	89.7	19.3				FMR	2MASS		
18107+3903	ES 2569	1950.603	1	272.7	10.12	11.04	12.6	F6+F8	FMR	DSS	PHY?	
		1951.647	1	276.2	9.79				FMR	DSS		
		1982.393	1	274.3	9.66				FMR	DSS		
		1989.505	1	274.0	9.77				FMR	DSS		
		1992.484	1	279.1	9.74				FMR	DSS		
18422+8818	HJ 2971 AC	2003.540	4	61.7	28.42	9.72	11.50	K8	JRY	CCD	--	
18425+0439	HJ 866 AB	1950.442	1	87.5	16.21	11.54	11.80	G5.5+K3.5III	RBE	DSS	OPT	C. 184
		1990.467	1	83.1	17.14				RBE	DSS		
		1999.598	3	83.2	17.11				FMR	2MASS		
		2003.540	4	83.8	17.47				JRY	CCD		
18425+0439	HJ 866 AC	1950.442	1	313.2	11.74	11.54	12.50	G5.5+G8.5	RBE	DSS	OPT	C. 184
		1990.467	1	318.4	12.3				RBE	DSS		
		1999.598	3	320.5	12.73				FMR	2MASS		
		2003.540	4	321.1	12.65				JRY	CCD		
18464+3116	HJ 1345	1951.508	1	171.5	11.41	12.30	13.40	K8.5III+G0	RBE	DSS	OPT	C.176.#10
		1989.508	1	171.8	11.51				RBE	DSS		
		1998.303	3	169.5	11.79				FMR	2MASS		
		2003.540	4	169.4	11.75				JRY	CCD		
		2003.712	3	167.4	12.15				OMG	CCD		
18470-1912	HJ 2837	1987.465	1	88.4	10.49	11.29	12.60		DOS	DSS	--	C. 174
		1992.571	1	88.4	10.77				DOS	DSS		
18476+2335	HJ 2841	1997.437	3	254.1	10.57	11.73	13.30	G8III:+G0	FMR	2MASS	OPT	C.174.#11
		2003.540	4	254.1	10.51				JRY	CCD		
18498+0801	HJ 869	2003.622	3	271	10.07	11.20	10.90		OMG	CCD	--	
19097+1221	HJ 1368 AB	1952.397	1	34.1	19.43	10.76	13.40	G3III:+G7.5	RBE	DSS	OPT?	C. 176
		1990.628	1	30.2	19.54				RBE	DSS		
		1997.530	3	46.3	22.04				FMR	2MASS		
		2003.540	4	31.3	19.52				JRY	CCD		
		2003.622	3	30.5	19.31				OMG	CCD		
19097+1221	HJ 1368 AC	2003.540	3	270.7	17.92	10.76	13.70	G3III:+G0	JRY	CCD	--	C. 176
		2003.622	3	270.9	17.87				OMG	CCD		
19097+1221	BVD 4 AD	1952.397	1	230.8	4.77	10.76	12.30	G3III:+G1	RBE	DSS	OPT?	new com.
		1990.628	1	220.6	6.77				RBE	DSS		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1997.530	3	224.9	6.51				FMR	2MASS		
		2003.540	4	226.7	5.73				JRY	CCD		
19135-1632	HJ 2856	1986.640	1	151.4	3.3	11.00	12.00		DOS	DSS	--	C.174.#12
		1987.573	1	133.9	2.59				DOS	DSS		
19163+0438	HJ 880	2003.540	4	116.2	10.5	11.70	12.20	F3.5+K7	JRY	CCD	--	C. 184
		2003.622	3	117.2	10.55				OMG	CCD		
19165+0712	HJ 2861	1950.612	1	54.5	11.65	10.82	13.40	A0+F6	RBE	DSS	OPT	C.174.#13
		1995.622	1	54.4	11.76				RBE	DSS		
		1999.590	3	53.5	11.89				FMR	2MASS		
		2003.622	3	55.1	12				OMG	CCD		
19192+0401	HJ 2864	1950.617	1	216.2	21.92	9.96	12.90	G9III:+K9.5V:	RBE	DSS	OPT	C.174.#14
		1992.585	1	215.5	20.8				RBE	DSS		
		1999.609	3	216.5	20.48				FMR	2MASS		
		2003.540	4	216	20.52				JRY	CCD		
		2003.622	3	214.8	20.44				OMG	CCD		
19198+1036	HJ 882	1952.397	1	109.9	9.43	9.70	11.72	M5III+G7V:	RBE	DSS	OPT	15. #15
		1987.576	1	109.4	9.66				RBE	DSS		
		1999.603	3	110.7	9.84				FMR	2MASS		
		2003.540	4	110.4	9.64				JRY	CCD		
19215+0412	HJ 883	2003.712	3	302.4	8.99	11.80	13.40		OMG	CCD	--	C. 184
19221+3050	HJ 1389	2000.311	1	93	13.03	12.00	12.50	K1III+F4V	FMR	2MASS	OPT	C. 176
19251+3511	HJ 1394	2003.519	6	28.9	17.24	10.77	11.52	K2III:+K5III	JJO	CCD	OPT	
		2003.540	4	29	17.38				JRY	CCD		
		2003.712	3	28	17.26				OMG	CCD		
19287+4905	HJ 1408	1998.483	3	236.3	7.42	10.36	12.70	G1III:+G5V	FMR	2MASS	OPT	C.176.#15
		2003.540	4	236.1	7.23				JRY	CCD		
21021+1016	J 158 AB	2000.330	1	166	4.91	10.77	13.00	G9III+F5V	FMR	2MASS	OPT?	52. #16
21033+1259	HJ 272	1952.635	1	257.7	10.77	9.58	13.00	K5III+sdF?	FMR	DSS	OPT	#17
		1987.716	1	253.5	11.23				FMR	DSS		
		1991.541	1	256.3	11.29				FMR	DSS		
		1999.759	2	253.8	11.11				FMR	2MASS		
		2000.531	2	253.8	11.42				PMA	CCD		
		2003.882	6	254.7	11.29				JRY	CCD		
21043+3608	HJ 1610	1951.519	1	249.4	10.02	9.11	12.20	B9V:+K6V:	BVD	DSS	OPT	C.176.#18
		1991.702	1	246.3	10.87				BVD	DSS		
		2003.882	6	245	11.01				JRY	CCD		
		2003.993	3	252.9	10.9				OMG	CCD		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
21071+4134	HJ 1613	1989.680	1	4.4	15.87	10.01	12.80	F3V+F7V	BVD	DSS	OPT	C.176.#19
		2003.882	5	4.4	16.23				JRY	CCD		
		2003.953	3	3.6	16.13				OMG	CCD		
21126+0437	HJ 3013	2003.802	5	118.3	11.21	11.00	13.30	G7V+K0	JRY	CCD	OPT?	
		2003.996	3	119.3	10.91				OMG	CCD		
21141-5428	LDS 735	1975.451	1	61.7	15.42	12.30	13.20	K9V+M0.5V	FMR	DSS	PHY	C. 46
		1977.528	1	60.6	15.13				FMR	DSS		
		1991.679	1	59.4	15.44				FMR	DSS		
		1992.563	1	61.4	15.38				FMR	DSS		
		1992.567	1	60.8	15.25				RBE	DSS		
		1999.852	3	61.2	15.3				FMR	2MASS		
21202+1018	HJ 933	1917.148	1	239	16.85	10.11	11.60	F+F3.5	FMR	AC2000	OPT	C.185#20
		1951.579	1	240	16.36				BVD	DSS		
		1990.570	1	239.6	16.84				BVD	DSS		
		2000.333	3	238.7	17.01				FMR	2MASS		
		2003.996	3	239.6	16.94				OMG	CCD		
21226+3158	HJ 1637 AB	1987.797	1	104.6	13.19	8.63	12.00	F6V:+K3V	BVD	DSS	PHY?	C.176.#21
		1998.461	3	104	13.55				FMR	2MASS		
		2003.882	6	103.7	13.42				JRY	CCD		
		2003.996	3	102.8	12.22				OMG	CCD		
21226+3158	JRY 1 AC	2003.882	3	142.7	8.44	8.63	14.0		JRY	CCD	¿?	new com.
21270+4315	HJ 1646	1895.658	1	118.6	21.6	7.62	11.40	A0+G8:III	FMR	AC2000	OPT	C.176.#22
		1953.679	1	116.9	21.76				BVD	DSS		
		1989.679	1	115.5	22.61				BVD	DSS		
		2003.882	6	115.6	22.52				JRY	CCD		
		2003.996	3	114.3	21.9				OMG	CCD		
21278-1049	HJ 283	1987.712	1	71.2	9.47	12.60	13.10	A9+K1	BVD	DSS	¿?	C. 184
		1999.366	3	70.8	9.86				FMR	2MASS		
21327+0751	HJ 937	2003.882	5	162.3	10.87	11.80	11.50	G6V:+K7	JRY	CCD	OPT	#23
		2003.996	3	160.7	10.81				OMG	CCD		
21337-1444	HJ 3036	1987.798	1	96.9	5.83	12.10	12.10	K3V+K3V	BVD	DSS	PHY	
		1999.412	3	91.7	6.04				FMR	2MASS		
21341-1716	HJ 3037	1977.550	1	352.2	25.66	8.75	13.30	K1III+G9	BVD	CCD	¿?	C.174.#24
		1987.798	1	352.8	26.46				BVD	CCD		
		1999.412	3	352.5	26.5				FMR	2MASS		
21361-1023	HJ 5518	1988.774	1	159.9	49.27	11.55	11.44	K2III+K3V	BVD	DSS	OPT	C.180.#25
21377+1312	HJ 1667	1953.630	1	200.3	15.5	12.00	12.70	K2.5III: +K4III	BVD	DSS	OPT	

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1990.805	1	201.4	16.23				BVD	DSS		
		2003.882	5	202.2	16.44				JRY	CCD		
21399+3931	HJ 1675 AC	1951.510	1	262.7	35.13	6.98	13.10	A9+G6V	BVD	DSS	OPT	C. 176. #26
		1987.567	1	264.2	36.41				BVD	DSS		
		2003.882	6	263.7	37.41				JRY	CCD		
		2003.996	3	263.4	37.39				OMG	CCD		
21403+0848	HJ 3047	2003.885	6	37.6	17.5	11.05	13.20	K3+G9	JRY	CCD	OPT	#27
21418+0145	HJ 3049	1909.713	1	14	29.94	10.21	11.26	K2III+G1V	FMR	AC2000	OPT	C. 174
		2003.882	6	26.2	34.9				JRY	CCD		
21431+1338	HJ 1682	1953.630	1	75.3	18.66	10.15	12.0	G9+K2III	BVD	DSS	OPT	C. 176
		1990.806	1	77.5	20.28				BVD	DSS		
		2003.882	6	77.3	20.8				JRY	CCD		
21437+0230	HJ 3052	2003.882	6	292.5	14.2	10.26	13.3	K2III+G6V	JRY	CCD	OPT	C.174.#28
21462+0536	HJ 3057	1953.781	1	7.8	19.8	11.42	12.6		BVD	DSS	OPT	C. 174
		1995.568	1	7.4	20.76				BVD	DSS		
		2003.885	6	7.5	20.84				JRY	CCD		
22167-1112	BVD 5 BC	1989.733	1	304.1	5.08	11.13	15.7	F8III:+K5	BVD	DSS	¿?	new com.
		1998.795	3	305.1	5.01				BVD	DSS		
22167-1112	HJ 3100 AB	1989.733	1	75.7	38.31	9.22	12.60	G0V+F8III:	BVD	DSS	OPT	#29

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Notes:

(# 1): HJ 2222: Stephenson (1986) lists A as a K4 star.

(# 2): LDS 201 AB: Primary is a G3 V star according to the literature in agree with LIADA's estimate. Distance for the components inferred by Hipparcos' trigonometric parallax are 79 and 75 pc. Estimate of LIADA (71 pc) is in excellent agreement with Hipparcos data. Our result shows that A component could be an unresolved close binary.

(# 3): HJ 438: A weak companion of V = 15.0 located at 15.0 arcsec in direction 5 degrees is not bound to the system.

(# 4) HJ 88: Primary is a K0III giant star according to the literature (LIADA estimated K0III).

(# 5) HJ 91: It is located at 08h 22m 40s387 and +12d 04' 24"19, 6 arcminutes West of the WDS coordinate.

(# 6) HJ 5473: There are an optical companion at 11.3 arcsec in direction 333 degrees

(# 7): HJ 4083: it is located in NGC 2579 open cluster which according to literature is located at a distance of 3000 light-years, on the Milky Way. According to Lindoff (1974) NGC 2579 could be a false open cluster. Primary component could be located at 2000-2500 light-years. The proper motion of the main component is nearly the same at this of suspected open cluster. The secondary component is the planetaria nebulae PK 254.6+00.2. If both components are members of the open cluster remain unknowns.

(# 8) HDS 1577: According to literature primary is a K0 suspected variable star classified as NSV18596. CCDM catalog lists a double star with RSU observer code with a measure performed in 1976. Was HIPPARCOS not the first in resolved it?.

(Continued on page 130)

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(Continued from page 129)

(# 9) HDS 1595: Primary is a K2III star according to the literature in excellent agreement with LIADA's result.

(#10) HJ 1345 = SLE 121. Is the main component a variable star?

(#11) HJ 2841 = POU 3552

(#12) HJ 2856 = J 1667

(#13) The star at 14" in direction 168 degrees of HJ 2861 A likely is not gravitationally bounded at any component of HJ 2861 system.

(#14) The star located at 28”9 and 237 degrees of HJ 2864 A is likely not bound at any component. The spectral type listed in the table is corrected by reddening.

(#15) Spectral type of A is corrected by interestellar absorption.

(#16) J 158 AB: it was discovered by J. Jonckheere in 1910 (167 degrees and 3"8 with magnitudes of 10.7 and 12.9]. Later it was measured in 1952 (164 degrees and 4”7).

(#17) HJ 272: Secondary component is located in the H-K and J-H diagram in a region occupied by subdwarfs. However the reduced proper motion is typical for dwarfs stars. Primary is a K2 star according to Henry Draper catalog.

(#18) HJ 1610: Primary is an A0 star according to the literature with a radial velocity of –22 Km/s (Malaroda 2001).

(#19) HJ 1613: Primary is a F2 star according to the literature.

(#20) HJ 933: Primary is a A0 star according to the literature.

(#21) HJ 1637: Primary is a F5 star according to the literature.

(#22) HJ 1646: Primary is a A0 star according to the literature located at 184 pc (LIADA estimated a photometric distance of 199 pc).

(#23) HJ 937: The last WDS measure was performed in 2000. LIADA observed the secondary component as the brighter star.

(#24) HJ 3037: Primary is a K1III star according to the literature in excellent agreement with LIADA result .

(#25) HJ 5518: Secondary is a K3V high proper motion star located at 275 light-years. LIADA performed a search for unknown companions within 5 arc minutes. No companion candidate was founded.

(#26) HJ 1675 AC: Primary is a A2 star according to the literature.

(#27) HJ 3047: A new proper motion star was discovered while LIADA searched for unknown companions around HJ 3047 A. The proper motion of this star is μ(α)=-0”014 and μ(δ)=-0”086 and the star has V magnitude of 15.7 (inferred by B and R GSC-II photometry). It is located at a=21h 40m 17s36 y d=+08º 49’ 23”2. The reduced proper motions is typical for subdwarfs.

(#28) HJ 3052: Primary is a K2 star according to the literature.

(#29) HJ 3100: Primary is a F8 star according to the literature. HIPPARCOS determined a distance of 138 pc (LIADA estimated a photometric distance of 92 pc).

(Continued from page 120)

at the same distance with the same kinematics, but not gravitationally bound: they are called *‘common origin’* pairs and were 6% of all double stars studied. The common proper motion (CMP) pairs are composed of two stars with similar or very similar proper motion but with no physical relationship suspected.

About 10% of the visual double stars have an undetermined nature due to insufficient or inaccurate data, and thus more astrometric and photometric data are needed. The results have been very similar to those of the last year. As in previous surveys, the very low percentage of physical pairs has not surprised us. Most of the neglected and unconfirmed visual double stars are bona-fide or candidate optical pairs, hence their low astrophysical interest.

Acknowledgments

This report makes use of data from the Two Micron All Sky Survey (MASS), which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

Name #1	Name #2	MgV	Sp_Lit	Ref.	Sp_LIADA	Diff.
GSC 0079-1186	HJ 2222 A	11.0	K4V	1	M0	+6
HD 66791	LDS 201 A	8.7	G3V	2	G4V	+1
PPM 177392	HJ 88 A	7.8	K0III	3	K0III	0
PPM 258457	HDS1577 A	9.9	K0	4	G9III:	-1
HD 97395	HDS1595 A	8.9	K2III	5	K2III	0
SAO 106801	HJ 272 A	9.6	K2	6	K5III	+3
HD 200755	HJ 1610 A	9.1	A0	6	B9V:	-1
PPM 60978	HJ 1613 A	10.0	F2	6	F3V	+1
PPM 139963	HJ 933 A	10.1	A0	6	F	
HD 203613	HJ 1637 A	8.6	F5	6	F6V:	+1
HD 204402	HJ 1646 A	7.6	A0	6	A0	0
HD 205205	HJ 3037 A	8.8	K1III	7	K1III	0
HD 206261	HJ 1675 A	7.0	A2	6	A9	+7
GSC 0547-0776	HJ 3052 A	10.3	K2	8	K2III	0
HD 211359	HJ 3100 A	9.2	F8	3	G0V	+2

Table 3: Comparison between LIADA's and spectral types from the literature.
Reference: 1. Stepheson 1986, 2. Houk 1982 3. Houk, Swift 1999 4. Bastian, Roeser 1993, 5. Houk 1978, 6. Bastian, Roeser 1988, 7. Houk 1988, 8. Wenger, et al. 2003

The Guide Star Catalog-I was produced at the Space Telescope Science Institute under a U.S. Government grant. These data are based on photographic data obtained using the Oschin Schmidt Telescope on Palomar Mountain and the UK Schmidt Telescope.

The Guide Star Catalogue-II is a joint project of the Space Telescope Science Institute and the Osservatorio Astronomico di Torino. Space Telescope Science Institute and is operated by the Association of Universities for Research in Astronomy, for the National Aeronautics and Space Administration under contract NAS5-26555. The participation of the Osservatorio Astronomico di Torino is supported by the Italian Council for Research in Astronomy. Additional support is provided by European Southern Observatory, Space Telescope European Coordinating Facility, the International GEMINI project and the European Space Agency Astrophysics Division.

The data mining required for this work has been made possible with the use of the SIMBAD astronomical database and VIZIER astronomical catalogs service, both maintained and operated by the Center de Données Astronomiques de Strasbourg (http://cdsweb.u-strasbg.fr/)

References

Bastian U., Roeser S., 1988, A&AS, 74, 449R

Bastian U., Roeser S., 1993, Catalogue of Position and Proper Motions- South, Astronomisches Rechen-Institut, Heidelberg.

Cutri R.N. et al., 2000, Explanatory to the 2MASS Second Incremental Data Release, http://www.ipac.caltech.edu/2mass/releases/second/index.html

Halbwachs J.L., 1986, A&AS, **66**, 131B

Hog E. et al., 2000, A&A, **355,** 27L

Houk N., 1978, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 2: Declinations –53 to – 40 degrees (Ann. Arbol: Univ. Michigan)

Houk N., 1982, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 3: Declinations –40 to – 26 degrees (Ann. Arbol: Univ. Michigan)

Houk N., 1988, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 4: Declinations –26 to – 12 degrees (Ann. Arbol. Univ. Michigan)

Houk N., Swift C., 1999, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 5 (Ann. Arbol: Univ. Michigan).

Lasker, B.M., et al., 1992, Guide Star Catalogue Version 1.1

Lindoff U., 1974, Arkiv För Astronomia, vol 5, no. 4

Malaroda S., Levato H., Galliani S., 2001, Complejo Astronomico El Leoncito (CASLEO), San Juan, Argentina

Mason B.D., Wycoff G., & Hartkopf W. I., 2003, The Washington Double Star Catalog, http://ad.usno.navy.mil/proj/WDS/wds.html

Monet D.G., Levine S.E., Casian B., et al., 2003, AJ, **125**, 984M

Morrison J.E., Roeser S., McLean B., Bucciarelli B., Lasker B., 2001, AJ, **121**, 1752M

Rica F., 2005, JDSO vol. 1, No 1

Stephenson C.B., 1986, AJ, **91**, 144S

Wenger M., Ochsenbein, F., Egret, D., et al. 2003, SIMBAD astronomical databa base, http://simbad.u-strasbg.fr/

Journal of Double Star Observations

Winter 2006
Volume 2, Number 1

Editors
R. Kent Clark
Rod Mollise

Editorial Board
Justin Sanders
William J. Burling
Daniel LaBrier

Advisory Editor
Brian D. Mason

The *Journal of Double Star Observations* is an electronic journal published quarterly by the University of South Alabama. Copies can be freely downloaded from http://www.jdso.org.

No part of this issue may be sold or used in commercial products without written permission of the University of South Alabama.

©2006 University of South Alabama

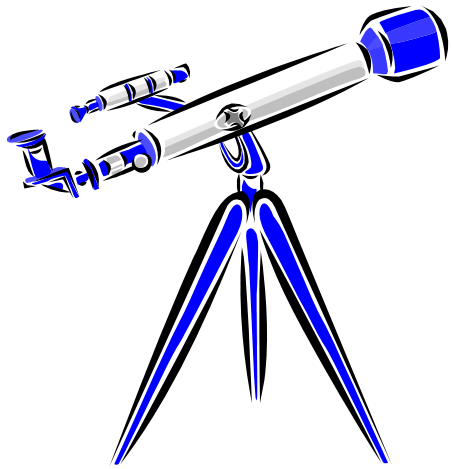
Questions, comments, or submissions may be directed to rkentclark@jaguar1.usouthal.edu or to rmollise@hotmail.com

The *Journal of Double Star Observations* (*JDSO*) publishes articles on any and all aspects of astronomy involving double and binary stars. The *JDSO* is especially interested in observations made by amateur astronomers. Submitted articles announcing measurements, discoveries, or conclusions about double or binary stars may undergo a peer review. This means that a paper submitted by an amateur astronomer will be reviewed by other amateur astronomers doing similar work.

Not all articles will undergo a peer-review. Articles that are of more general interest but that have little new scientific content such as articles generally describing double stars, observing sessions, star parties, etc. will not be refereed.

Submitted manuscripts must be original, unpublished material and written in English. They should contain an abstract and a short description or biography (2 or 3 sentences) of the author(s). For more information about format of submitted articles, please see our web site at www.jdso.org

Submissions should be made electronically via e-mail to rclark@jaguar1.usouthal.edu or to rmollise@aol.com. Articles should be attached to the email in Microsoft Word, Word Perfect, Open Office, or text format. All images should be in jpg or fits format.



We're on the web!

http://www.jdso.org