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Double Star Astrometry with a Simple CCD Camera

Wolfgang Vollmann

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Abstract: I show my image acquisition and measurement procedures with a simple CCD camera. The attainable accuracy with a focal length of 1 meter is discussed and a list of about 100 measures of stars is presented. It was found that precise measures are possible for separations larger than 5 or 6 arc seconds. Some useful projects can be tackled with this setup, e.g., measuring "Neglected Double Stars" or demonstrating proper motion in nearby stars in comparison with older measures.

A Simple CCD Camera

In March 2006 I acquired a used, relatively cheap CCD camera, an SBIG model ST237A. It is an older model (1999) with a small chip size (4.7 x 3.6 mm) and quite long readout times of around 10 seconds for a full frame over the computer’s parallel port. But it is a sensitive camera and well suited as a precise astrometry measuring device – e.g., see my work on 61 Cygni [1]. The camera pixel size of 7.4 micron is a good match for the 1040 mm focal length of my 130 mm refractor. A pixel subtends an angle of 1.47 arc seconds on the sky. Astrometry of minor planets and comets yielded good measurements with an accuracy of 0.3 arc seconds or better using Astrometrica software [2]. This accuracy is good enough to earn a MPC observatory code, A97 Stammersdorf, for my installation [4].

Double Star Astrometry with a CCD Camera

I used the camera to try some double star measures with it. At the telescope I take around 20 images with an exposure time of 10 seconds. This captures stars down to about magnitude 14 and the resulting images are almost always solvable with Astrometrica and the UCAC2 star catalog or USNO B1.0 for northern stars. Astrometrica writes the exact measured focal length and camera field orientation to its log file. I found that the measured focal length on different images has a standard deviation of only 0.2 ± 0.3 mm on average, so image scale is known to 0.02 % accuracy. The measured field orientation on different images has a standard deviation of usually 0.01 ± 0.02 degrees.

If the double stars are bright and close, I take additional images with 1 s, 0.1 s and, in some cases, a 0.01 s exposure time. These images are for measuring the double star and are taken immediately after the 10 s images so image scale and field orientation should be the same. They usually do not have enough reference stars on them to solve them with Astrometrica, except for richer regions near the Milky Way like that of 61 Cygni.

Measuring CCD Images with Astrometrica

If the components of the double star are well separated and not under or overexposed, they are directly measurable with Astrometrica. Underexposure with a signal-to-noise ratio (SNR) of lower than about 6 delivers increasingly notable position errors approaching an arc second.

Overexposure is shown by Astrometrica in an intensity profile which is cut off on the top when you click on the star. The software is able to deliver the desired 1/10 pixel (0.15 arc second) accuracy easily.
Double Star Astrometry with a Simple CCD Camera

and quickly for correctly exposed stars. From the astrometric positions PA and distance can be calculated directly (eg. see [7], formulae (16.1) and (16.2)).

**Measuring CCD images with AIP4WIN**

In many cases the components of the double star are close or overexposed on the 10s astrometry images. Then I measure them with the "Distance Tool" of AIP4WIN software [3]. For this I often use images with less exposure time when the components of the double star are sufficiently bright. AIP4WIN does centroid astrometry which is not as precise as the PSF fitting of Astrometrica but produces consistent results with better than ½ pixel accuracy for correctly exposed stars. For close stars I use AIP4WIN's "Resample" function to enlarge the image 10 times to 1000% and then measure distance and angle with the "Distance Tool" function. For the focal length I provide the averaged value taken from the 10 s astrometry images solved by Astrometrica, so distance is given by the software directly in arc seconds. The software calculates a "PA" which must be corrected by the image orientation from Astrometrica: real PA = 360° – "PA" + orientation_angle_from_astrometrica.

**Example: STF2486 in Cygnus**

A calibration double with a well known slow orbit is STF2486 (WDS 19121+4951). On September 5, 2006, I took 12 images with 10 s exposure time which were solved with Astrometrica and USNO B1.0 star catalog. This gave a focal length of 1039.24 mm with std. dev. 0.17 mm and image orientation of +3.38° with std. dev. 0.01°. For the closer AB components 24 images with 0.1 s exposure time were measured and a PA of 205.62° with a std.dev. 0.87° was found. The distance was measured to 7.34 arcsec std.dev. 0.20 arcsec. The wider and fainter AC and AD components

### Table 1: comparison of observed and calculated distances and PAs for pairs with well known orbits

<table>
<thead>
<tr>
<th>Epoch</th>
<th>Name</th>
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<th>WDS</th>
<th>Sep.</th>
<th>PA</th>
<th>Orbit</th>
<th>Sep.</th>
<th>PA</th>
<th>O–C Dist</th>
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<td>70 Oph</td>
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<td>0.11</td>
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were directly measured on the 10 s exposures. The CCD images are shown in figures one and two.

Accuracy of Measures

Of great interest to every observer is the accuracy of his/her measurement procedure. For 5 stars I measured I was able to find orbits in the WDS [5]. I compared the calculated position with my observed position aided by Brian Workman's spreadsheet ephemeris calculator [6].

The distances have a mean O-C of 0.13 arc seconds. One cannot expect better accuracy with this telescope. PAs have a mean O-C of 1.9 degrees. We must throw out the measure of STF2052AB which is at 1.91 arc seconds. This is really too close, the stars are separated by only 1.3 pixels (10 microns) on the image. The remaining O-C for the PAs is 0.51 degrees. Since this is for a mean separation of only 5.9 arc seconds (4 pixels, 30 microns) at my focal length of one meter the accuracy of the position angles is good. It should be much better for wider separations when components are separated by more pixels!

Measures of Double Stars 2006

Besides measuring some stars for checking accuracy a variety of interesting objects were measured. These are given in Table 2.

Proper motion in nearby stars

Some faint companions to bright and nearby stars show the proper motion of the bright primary clearly when compared to the first measures in the WDS. A good object is Vega (α Lyrae). Here the naked eye component A travels, due to proper motion, almost exactly towards component E (STFB 9AE) in PA 39°, which is apparently not physically related to A and has apparently no noticeable proper motion.

Comparing the values from the WDS 2006.5 with my own measures I find:

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<th>Source</th>
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<td>40°</td>
<td>150.0&quot;</td>
<td>WDS 2006.5</td>
</tr>
<tr>
<td>1999</td>
<td>39°</td>
<td>91.7&quot;</td>
<td>WDS 2006.5</td>
</tr>
<tr>
<td>2006.48</td>
<td>39.0°</td>
<td>89.1&quot;</td>
<td>Average of my measures, see table 2</td>
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</table>

In the 175.5 years since 1831 component A traveled 60.9 arc seconds towards E, which corresponds to 0.347 arc seconds per year. The ARI Catalog of Nearby Stars [9] gives for Vega a proper motion of 0.348" in PA 35.2°.

Neglected stars

Besides several well known stars I measured a few stars on the "Neglected Doubles List" from the WDS and tried to improve positions for the components where they were given to only 1 arc second accuracy in WDS or found to be off by more than one arc second. This is noted in Table 2.

Magnitudes and magnitude differences

Some effort was made to determine the magnitude of the stars if they were not over- or underexposed and well separated so Astrometrica [2] was able to determine a magnitude from the UCAC2 reference star catalog. Since this is not a precise photometric catalog and the images were taken unfiltered with the color sensitivity of the CCD camera they are only an approximation to the real visual or V magnitudes.

Conclusion

It was found that precise measures are possible for separations larger than 5 or 6 arc seconds. Some useful projects can be tackled with this setup, e.g. measuring "Neglected Double Stars" or demonstrating proper motion in nearby stars in comparison with older measures.

References

4. IAU Minor Planet Center (MPC): http://www.cfa.harvard.edu/iau/mpc.html
Double Star Astrometry with a Simple CCD Camera


9. ARI Catalog of Nearby Stars: http://www.ari.uni-heidelberg.de/datenbanken/aricns/ with the entry for Vega at http://www.ari.uni-heidelberg.de/datenbanken/aricns/cnspages/4c01497.htm

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Table 2: measures of double stars 2006. Table 2 continued on next page.
## Double Star Astrometry with a Simple CCD Camera

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*Table continued on next page.*
# Double Star Astrometry with a Simple CCD Camera

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**Table Notes**

1. A = 00 04 00.25 +12 08 44.7 (2000.0)
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3. C = 00 04 40.21 +34 16 19.6 (2000.0)
4. A = 00 07 37.89 +40 08 52.5 (2000.0)
5. 35 Psc. could not identify Che 2 at 0 15 06 +08 50 (2000.0)
6. A = 00 27 31.03 +16 01 31.7 (2000.0)
7. "B = 00 27 24.30 +16 00 34.6 (2000.0). In line with measure 1907, but not 1988 in WDS2006.5"  
8. Gamma CMi
9. Epsilon Cnc
10. Alpha Leo
11. Alpha Leo. Magnitude difference 4.00mag
12. Gamma Leo
13. Beta Leo
14. Eta Boo. Only 4 reference stars in poor field
15. Xi Boo
16. A = 15 07 50.14 +63 07 01.8 (2000.0)
17. A = 15 11 50.20 +61 51 26.0 (2000.0)
18. new component C
19. Eta CrB
20. Mu Boo
21. Zeta CrB
22. too close for f.l. 1040mm
23. Eta Her
24. "Eta Her. Faint companion, closer than B"
25. 56 Her
26. Delta Her
27. 70 Oph
28. Alpha Lyr (Vega)
29. 21 Aql. Scatter due to brightness of A

(Continued on page 135)
(Continued from page 134)

30. Delta Aql
31. "Delta Aql. New? star. Faint and close, large scatter"
32. Alpha Aql
33. 57 Aql
34. \( A = 20 \, 24 \, 39.15 \, +14 \, 38 \, 05.6 \) (2000.0)
35. \( A = 20 \, 24 \, 40.27 \, +14 \, 42 \, 52.5 \) (2000.0)
36. "pair in field of ES 2704. 21 03 58.43 +53 53 57.7" (2000.0)"
37. \( A = 21 \, 07 \, 33.95 \, +45 \, 14 \, 24.7 \) (2000.0) -- position in WDS 2006.5 is near
38. \( A = 21 \, 51 \, 16.30 \, +05 \, 44 \, 59.8 \) (2000.0)
Divinus Lux Observatory: Report #15

Dave Arnold
Program Manager for Double Star Research
2728 North Fox Fun Drive
Flagstaff, AZ 86004
E-Mail: dvdarnl@aol.com

Abstract: This report contains theta/rho measurements from 96 different double star systems. The time period spans from 2008.221 to 2008.402. 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.

While in the process of reviewing several papers over the past several months, in conjunction with my own research, it seems that a particular inference may be drawn regarding the neglected doubles list that comprises part of the Washington Double Star (WDS) Catalog data base. It appears that the majority of double stars that I have measured from this list are optical doubles, especially if the last published measurements are at least 50 years old. Perhaps since many of these pairs are widely separated, or have been discovered to have divergent proper motions, such double stars have become ignored because of only having a slight possibility of being physically connected. If these pairs happen to be faint, or have poorly known coordinates, this would also contribute to these double stars appearing on the neglected doubles list.

As a result of my experience with the neglected double star data base, it has occurred to me that it might be useful if a list of double stars could be generated from the WDS catalog that identified all known optical doubles, so that they could be eliminated from further study when one is attempting to conduct a binary star research project. It has since come to my attention that the Washington Multiplicity Catalog (WMC), which is currently being developed by the U. S. Naval Observatory, could fill this need. Not only could known optical systems be identified, but the WMC would combine the WDS catalog data with those of other existing catalogs, in order to formulate a complete listing of all known double and/or multiple stars. This could provide a list of pairs that would show theta/rho shifts that are more likely to be caused by orbital motion, rather than divergent proper motions. The existence of such a catalog could provide greater efficiency in identifying pairs that might merit an orbital motion study.

I simply mention the emergence of the WMC as an upcoming valuable tool for bringing efficiency to binary star research, especially when sifting through known optical pairs becomes burdensome. If more time could be devoted to common proper motion pairs, or pairs that are known to be physically related, it might become more likely that additional visual binaries could be identified in less time. My understanding is that the WMC will, hopefully, be completed in about two years. More information about this upcoming catalog can be obtained by visiting the website of the US Naval Observatory. I would also like to thank Bill Hartkopf for his input as I composed these above paragraphs.

As has been done in previous articles, the selected double star systems, which appear in this report, have been taken from the 2001.0 version of the Washington Double Star Catalog, with published measurements that are no more recent than ten years ago. Several systems are included from the 2006.5 version of the WDS Catalog as well. There are also some noteworthy items that are discussed pertaining to the following table.
As is often the case, proper motion by one or both of the components of a double star has caused some shifts in reported theta/rho values. In regards to STF 2120 AB, proper motion by the “B” component has caused a 3.5% increase in the rho value since 1998. A significant rho value increase is also being noted for AG 214. Since 1998, proper motion by the reference point star has caused a 10% shift to occur. Another rho value increase is being cited for HJ 4923. Since 1998, proper motions by both components have caused an increase of 4%. Additionally, proper motion by the reference point star, for HU 946, has resulted in a 5% increase in the rho value during the past 10 years. However, the most noteworthy rho value increase, which is being highlighted in this article, pertains to LV 20 AB. Since 1998, an increase of 36” has occurred because of a large proper motion by the “A” component.

A possible additional component is being submitted for A 281 (20106+3452). Labeled as ARN 100 AC, this star, with a magnitude of +9.7, appears to share a common proper motion with the (AB) components. This proposed “C” component does not appear to have been previously cataloged.

Regarding double stars that are currently listed in the WDS catalog, it is being noted that SEI 630 (19335+3611) appears to be a duplicate entry for HJ 1414 (19335+3610) because the coordinates and parameters for these two entries are very similar. It has been visually confirmed that only one double star appears in this part of the sky near the coordinates listed above.

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## Divinus Lux Observatory: Report #15

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* Not listed in the WDS Catalog.

Table Notes
15. In Serpens. Separation slightly increasing. Spect. G2.5III.
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25. In Hercules. AB = sep. increasing. AC = relfixed. Spect. AB = K0III, K1III.
35. In Hercules. Common proper motion; p.a. increasing. Spect. M0, M0.
40. In Hercules. Separation slightly decreasing. Spect. B3V.
51. Zeta or 7 Lyrae. Common proper motion; sep. inc.; p.a. dec. Spect. F0IV, F0IV.
53. 8 Lyrae. Sep. & p.a. slightly decreasing. Spect. B3IV.
63. Albireo, Beta, or 6 Cygni. Relatively fixed. Spect. K3III, B8V.
64. In Cygnus. Sep. increasing; p.a. decreasing. Spect. G0.
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70. In Cygnus. Sep. slightly increasing; p.a. slightly decreasing. Spect. B5V.
73. In Cygnus. Sep. slightly decreasing; p.a. slightly increasing; Spect. A0.
78. In NGC 6871 in Cygnus. AD & AF = relatively fixed. Spect. O9.5I, B2, B.
80. In Cygnus. (AB) = sep. inc.; common proper motion. AC = cpm. Spect. F7V.
83. In Cygnus. Position angle increasing. Spect. B0, G.
92. In Cygnus. Sep. increasing; p.a. decreasing.
93. In Cygnus. Common proper motion; sep. slightly increasing.
Double Star Measures Using a DSLR Camera

Ernő Berkó

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E-mail: berko@is.hu

Abstract: This publication presents double star measures made with a DSLR camera. The images used for the measures were taken in the period between 2007.197 - 2007.205. The result is 124 positive and 4 negative measures.

Instead of the earlier CCD camera, since 2007 I have been using a digital one (Canon EOS 350D) for photographing the images to be measured. I mounted the camera on my Newton telescope of 35.5 cm diameter and 2100 mm focal length. For the sake of precision, I enlarged the camera’s focus 2X with the help of a photographic teleconverter. The focus thus increased to 4200 mm gives a 0.3089’/pixel resolution.

For the later photo-processing and the measures, I took several dozen images of each sky area that I had previously chosen.

The exposure times are 10 - 60 seconds, depending on the brightness of the stars to be recorded. In the case of fainter stars, I added up more photos, while for closer doubles I took the average of the images. With this method, it has become possible to record a larger field of view, which is of great help in identifying the doubles.

I measured the pictures with Florent Losse’s program (Reduc), and I would like to express my gratitude to the developers. The photos had to be prepared for the measurements (Gray-scale, BMP, adding up, average). For the orientation of the pictures, I employed the Drift Analysis function of the program.

Cross-checking the system and the program has proved that they are capable of performing the planned measures. With thorough work, we can achieve a standard deviation under 0.1”, by measuring 6-10 images independently.

I used approximately 1157 photos for the present publication. It contains the data of 1165 independent measures of 128 pairs.

Regarding the measurement data, the identification of the doubles happened according to the Washington Double Star catalog (WDS) codes. I marked the pairs and components not appearing in WDS as Anon. Whenever possible, I wrote down the Guide Star Catalog (GSC) code of at least one of the components of the doubles measured by me. I described the brightness of the components on the basis of WDS, although it seems contradictory sometimes. When there is an Anon. component, I gave the GSC or USNO "R" brightness, if not available I provided the brightness that I estimated on the basis of the photo.

I found the greatest problem with the 10-character identification coordinates of WDS. In many cases it is different from the real position of the double. Although WDS contains more precise coordinates for most of the pairs, at times the double cannot be found at these locations. This certainly makes the identification of some (especially the neglected) doubles troublesome, mostly in sky areas rich in stars, pairs. This is true for computer imaging, as well. Several astronomical programs use the fixed identification coordinates of WDS, so it would be practical if these data were changed into the value closest to the precise position of the double.
Double Star Measures Using a DSLR Camera

For the doubles measured by me, I give suggestions regarding these closest coordinates in the form of (xxxxx+xxxxx!). In the RA and Dec columns of the table, the abbreviated coordinates of the doubles can be found, as used by WDS.

The table contains the position angle (PA) and separation (S) values that I measured, and the standard deviations values in (+/-) format. The time when the images were taken is also indicated, together with the number of photos used for the measures of the doubles (n), and finally - where it was needed - the reference to the separate notes. The last column of the table shows the number of the picture in which the double can be found.

I have made a picture for every measured pair with subtitles added, this way the double of a multiple system is readily apparent.

I would specially like to thank the work of Ágnes Kiricsi, who has helped a lot in this publication with the English translations and the correspondence.

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Table Notes
1. A=GSC 2397 765 (05138+35191).
2. A=GSC 2397 725
3. A=GSC 2398 384. The difference is significant compared to the previous measure/measures.
4. A=GSC 2398 894. The primary star according to WDS is AE Aur. In the photos that I took, and in the DSS image, no appropriate companions can be seen.
5. A=GSC 2398 26
6. A=GSC 2398 1076
7. A=GSC 2402 1436 (05217+3639!).
8. A=GSC 2402 394
9. AB=GSC 2402 554
Double Star Measures Using a DSLR Camera

10. Bx=GSC 2402 1041 non star.
11. A=GSC 2402 446 (05227+3627!).
12. A=GSC 2402 1033 (05228+3642!).
13. AB=GSC 2398 581 non star (05234+3445!).
15. A,B do appear in USNO.
16. x does not appear in USNO.
17. A=GSC 2411 1617
18. A=GSC 2411 985 (05252+3526!).
19. AB=GSC 2411 1940 non star.
20. A,B do appear in USNO (05258+3648!).
21. A=GSC 2411 911
22. A=GSC 2415 207 (05261+3647!), very different parameters.
23. A=GSC 2415 974. To the west of the specified location of SEI 258. Similar parameters but with 180' difference.
24. A=GSC 2415 417
25. A=GSC 2411 1303
26. A=GSC 2415 1076. The double to the north of the specified location of SEI 258, but the parameters are very different.
27. A=GSC 2415 996. The double closest to the specified location of SEI 258, but the parameters are very different.
28. A=GSC 2415 610. To the east of the specified location of SEI 258. Similar parameters but with 100' difference.
29. A=GSC 2415 1106.
30. A=GSC 2415 190.
31. AB=GSC 2909 1834 non star.
32. A=GSC 2909 1236.
33. AB=GSC 2909 1338.
34. B=GSC 2415 805, A does appear in USNO (05251+3628!).
35. AB=GSC 2411 1307 non star.
36. A=GSC 2411 1171
37. A=GSC 2411 925
38. A=GSC 2909 1732
39. Abx=GSC 2909 1672 non star (05300+3807!).
40. A=GSC 2411 1473
41. A=GSC 2411 89 1
42. A=GSC 2415 167
43. A=GSC 2415 609 (05312+3626!).
44. AB=GSC 2415 917 non star.
45. A=GSC 2415 605 non star.
46. A=GSC 2415 476 (05319+3604!).
47. Ax=GSC 2415 1001 (05320+3635!).
48. A=GSC 2910 259 (05324+3857!).
49. AB=GSC 2411 345
50. A=GSC 2415 795 (05324+3628!).
51. A=GSC 2415 1400
52. AB=GSC 2910 195 non star.
53. A=GSC 2415 670 (05329+3607!).
54. A=GSC 2416 8
55. AB=GSC 2416 433 non star.
56. A=GSC 2910 1278.
57. A=GSC 2416 167
58. (053424+365808), A,B do appear in USNO.
59. A=GSC 2416 885
60. B=GSC 2910 1398, A does appear in USNO.
61. A=GSC 2416 806.
62. AB=GSC 2416 1255 non star.
63. A=GSC 2416 1215.
64. A=GSC 2412 448
65. A=GSC 2416 1285.
66. A=GSC 2416 858.
67. A=GSC 2416 276.
68. (053459+365225), A,B do appear in USNO.
69. 150AB=GSC 2416 1034 blended object.
70. AB=GSC 2416 706 (05352+3653!).
71. AB=GSC 2416 832 non star.
72. A=GSC 2416 634.
73. A=GSC 2416 574.
74. Bx=GSC 2416 1219 non star.
75. y=GSC 2416 102.
76. A=GSC 2416 805
77. A=GSC 2416 509
78. A=GSC 2416 881
79. A=GSC 2416 1173 (05355+3650!).
80. Bx=GSC 2416 250 non star.
81. y=GSC 2416 700 non star.
82. A=GSC 2910 1024.
83. B=GSC 2416 1186
84. A=GSC 2416 523
85. A=GSC 2910 914.
86. A=GSC 2416 1239
87. A=GSC 2416 356.
88. A=GSC 2416 182.
89. A=GSC 2416 843
90. ABC=GSC 2416 1190 non star.
**Double Star Measures Using a DSLR Camera**

91. A=GSC 2416 494
92. A=GSC 2416 323
93. A=GSC 2416 134 (05389+3727!).
94. AB=GSC 2416 504 non star.
95. A=GSC 2910 814
96. (053925+373532), A,B do appear in USNO.
97. AB=GSC 2910 1354 non star.
98. A=GSC 791 1441 1
99. A=GSC 1363 2210
100.A=GSC 1380 1831
101.A=GSC 1380 1655
102.A=GSC 1381 916

103.A=GSC 1377 214
104.A=GSC 1377 301
105.ABC=GSC 1381 1638, AB are not separated.
106.A=GSC 1381 881
107.B is visible but cannot be measured.
108.Aa=GSC 1381 586
109.A=GSC 1386 1163
110.A=GSC 1386 1000
111.AB=GSC 2398 511 non star (05239+3451!). Far from the specified location.
Double Star Measures Using a DSLR Camera

Image 13

Image 14

Image 15

Image 16

Image 17

Image 18

Image 19

Image 20

Image 21

Image 22

Image 23

Image 24

Image 25

Image 26

Image 27

Image 28
Double Star Measures Using a DSLR Camera
Double Star Measures Using a DSLR Camera
Double Star Measures Using a DSLR Camera
A Mathematical Model to Predict the Resolution of Double Stars by Amateurs and Their Telescopes

Tim Napier-Munn
Astronomical Association of Queensland, Queensland, Australia

Abstract: This paper reports the development of a new statistical model for predicting whether a given double star will be resolved by a particular telescope. The model predicts the effect of the magnitudes of the pair, their separation, the telescope aperture and a quantitative estimate of seeing on the probability of resolving the pair. It is based on a database of observations made by members of the Astronomical Association of Queensland, Australia. The paper reviews the phenomenon of resolution, and summarises the literature on the development of criteria for predicting whether a given pair will be resolved, from the 19th century Dawes’ criterion to modern attempts to include factors other than just telescope aperture. The development of the new model is then described, including the collection of the data, a statement of the model equations, an assessment of model quality, and demonstrations of its use to show the effects of magnitude difference and seeing on the resolution limit of a range of telescope apertures. Some future work is suggested. The model has been implemented in an Excel spreadsheet which is available from the author at tgn-m@bigpond.net.au.

Introduction and Objectives

There are many reasons why you might want to split or separate close double stars in your telescope, for example:

1. To challenge the telescope and observer.
2. To establish, in a formal measurement, the capability of the telescope and observer.
3. To train the eye through regular observation of difficult doubles.
4. To measure the separation and position angle of close pairs.

However an observer new to the pleasures of observing double stars, or indeed new to amateur astronomy in general, has no real idea of what to expect when trying to separate or “resolve” a close or otherwise difficult double. There are several well-known theoretical and empirical resolution limits but these have generally been developed by and for expert observers with high quality instruments in good seeing conditions, and therefore may not apply to the average amateur. They are also based only on telescope aperture. Other more recent correlations have been reported which include additional factors, but none are based exclusively on amateur observations nor do they treat the problem as one in statistical probability which may offer a more practical and robust prediction for amateur observers.

Resolution

The ability to split a double star depends on the resolution which the combination of telescope, observer and conditions is capable of. Resolution is the capacity to see detail in an astronomical image, and the resolution of a telescope is generally formally defined as the angular separation of the closest pair of stars of equal magnitude which the instrument (and observer) can separate. Argyle (2004) and Mullaney (2005) give helpful discussions of the issue.

Resolution is dominated by the optical phenomenon of diffraction. When a point source of light such as a star is observed through a circular light collector such as a lens or mirror, the image is not a point of light but a diffraction pattern comprising a bright central disk surrounded by concentric fainter rings. The properties of this pattern were worked out by Sir
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Airy disk
First ring

Figure 1: The light intensities of the Airy diffraction pattern

George Airy in 1835. In particular he showed that the central disk (called the Airy disk in his honor) contained 84% of the light, the remaining 16% being distributed amongst the rings. The pattern and the intensities of the disk and rings are shown in Figure 1.

The pure diffraction pattern is rarely observed in practice. The “disk” of light which most of us view as a star is in fact a distorted image due to atmospheric seeing. Good seeing and high magnification are needed to observe the pure pattern, and small telescopes are better for this purpose than large because they are less susceptible to the seeing.

When a close double is observed the two diffraction patterns will overlap, making it difficult to distinguish the separate images of the two stars, and this is the main (though not only) factor which limits an observer’s ability to split a double. Lord Rayleigh suggested that the two images could just be distinguished if the peak of one Airy disk just fell on the center of the first dark ring of the other, as shown in Figure 2A. The drop in the light intensity between the two peaks is about 25% which is sufficient to distinguish the two centers and so “split” the pair. Figure 3 illustrates the notch effect seen at the Rayleigh Limit. Airy’s theory shows that at the Rayleigh Limit the resolution of a telescope is 1.22λ/D radians where λ is the wavelength of the light and D is the telescope aperture. Taking λ = 550 nm (usually regarded as the peak response of the eye), resolution in arc seconds is then given by 138/D where D is the aperture in mm. This suggests that a 200 mm telescope can resolve a pair separated by only 0.69".

In 1867 Rev. W.R. “Eagle Eye” Dawes reported a program of observation with a range of refractors from which he deduced that the separation of a pair of sixth magnitude stars which could just be separated in “moderately favorable seeing” was 116/D arc seconds, somewhat less than the Rayleigh Limit. Figure 2B shows that drop in the peak intensity for the Dawes Limit is only about 3%, but this is enough for an expert observer to deduce duplicity, and the literature has references to observations which exceed even this. A more modest limit is that of Markowitz = 152/D. (Mullaney, 2005).

The Rayleigh Limit is essentially an arbitrary though plausible definition of resolution based on Airy’s diffraction theory. The Dawes and Markowitz Limits are empirical, based on observation.
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In splitting difficult doubles, it is obvious to anyone who has attempted the task that although telescope aperture is important, as shown by the Rayleigh, Dawes and Markowitz Limits, it is not the only factor which determines whether a given double can be separated. Faint stars are more difficult to distinguish than bright ones, stars of differing magnitude are difficult to split because the glare of the primary can obscure the secondary, seeing can make all the difference between whether a particular double is easy or impossible, and there is evidence that different telescope types can have different resolving performance depending on conditions. And of course the skill, experience and visual acuity of the observer are also important. In predicting whether a particular double can be split by a particular telescope and observer, these factors must also be taken into account.

Several workers have reported methods of incorporating some of these elements into predictive tools. Fisher (2006) gives an excellent review of some of these. Lewis (1914) collected published data from 43 observers with a variety of telescopes, selected the “most difficult objects”, divided them into four groups based on the pairs’ magnitude differences, and reduced the number of stars in each group to about 5. He then deduced the following resolution limits in arc seconds for the four groups: Equal bright pairs (mean mags.5.7 & 6.4): 122/D. Equal faint pairs (means 8.5 & 9.1): 216/D. Unequal (means 6.2&9.5): 419/D. Very unequal (means 4.7 & 10.4): 914/D. (D in mm). Thus the resolution declines radically with the difference in magnitudes. For equal pairs the limit is very similar to Dawes, but for “very unequal” pairs it is more than 7 times greater.

Treanor (1946) used Lewis’ data to draw a continuous curve separating split and no-split regions as a function of magnitude difference. Others have followed. Perhaps the simplest graphical method is that developed by Harold Peterson in the 1950s (Mullaney, 2005), which defines by observation the splittable range for a given telescope in terms of the separation and the magnitude of the secondary (dimmer) star. Figure 4 shows a constant resolution of 3″ until a secondary magnitude of about 9, below which resolution declines. Arguelles (see website reference) took this a step further, plotting resolution against the magnitude difference between primary and secondary and suggesting a range of uncertainty between resolved and unresolved (Figure 5). It is well known that larger apertures become seeing-limited rather than diffraction-limited and this leads to different resolution limits for different ranges of aperture, the smaller instruments sometimes having an advantage (Fisher, 2006).

Some authors have developed numerical algorithms to predict double star splits. Arguelles used fuzzy logic to define a “Difficulty Index” based on the difference in the component magnitudes and the
A Mathematical Model to Predict the Resolution of Double Stars by Amateurs and Their Telescopes

A mathematical model to predict the resolution of double stars by amateurs and their telescopes is described. The model is based on observational data collected by a group of observers that meets an arbitrary definition of “amateur”, over a range of telescopes and conditions. The rest of this paper describes a project to collect and analyze just such an observational database.

The AAQ Model

The project

Predicting whether a double is resolvable can be thought of in terms of a statistical probability, defined by a cumulative distribution function (Figure 6). A probability close to one indicates that the double is very likely to be splittable, and a probability close to zero suggests the reverse. Intermediate probabilities suggest a corresponding uncertainty (which reflects reality!). Statistical modeling can be used to estimate the probability function in terms of measurable factors such as telescope aperture, magnitudes and seeing, using a database of real observations.

The Astronomical Association of Queensland embarked on a project to collect the observational data needed to fit such a model. 15 observers using 25 different telescopes observed 46 selected doubles over 10 months between February 2007 and January 2008. 315 valid observations were made in all. Observers were asked to inspect each pair with what they considered an appropriate magnification (they were encouraged to use higher magnifications than for regular observing). They reported the observation as one of four outcomes, illustrated in Figure 7. To reduce the outcomes to two possible conditions appropriate separation, which is available in a downloadable program called LADIC (see web reference.), and is also estimated in the AstroPlanner program when listing double stars from catalogues. The number in brackets for each pair in Figure 5 is Arguelles’ index. Barbour (web ref.) has put together an algorithm based on observations, which also attempts to show visually how the double will look in the eyepiece (though it is not described). Lord produced a mathematical analysis of the problem including a nomogram to help predict whether a given double can be split, based on aperture, obstruction (for reflectors), seeing and magnitude difference, though this is difficult to use (web ref.). Both Haas (2002) and Fisher (2006) have provided more accessible accounts of the use of the nomogram; Fisher also includes an on-line calculator. In a second paper, Lord (1979) provided another algorithm based on aperture and the contrast between primary and secondary.

All of these approaches are either simple criteria based on telescope aperture and observational data, or algorithms based on diffraction theory. They do provide useful benchmarks against which individual observations by amateurs can be judged. Arguably, however, none give an amateur the probability with which a pair of given separation and magnitudes can be split by amateurs and their telescopes on a night of given seeing. This is a statistical problem which can only be explored by an appropriate analysis of observational data. One approach is to use a program called LADIC, which is available in a downloadable program called LADIC (see web reference.). The number in brackets for each pair in Figure 5 is Arguelles’ index. Barbour (web ref.) has put together an algorithm based on observations, which also attempts to show visually how the double will look in the eyepiece (though it is not described). Lord produced a mathematical analysis of the problem including a nomogram to help predict whether a given double can be split, based on aperture, obstruction (for reflectors), seeing and magnitude difference, though this is difficult to use (web ref.). Both Haas (2002) and Fisher (2006) have provided more accessible accounts of the use of the nomogram; Fisher also includes an on-line calculator. In a second paper, Lord (1979) provided another algorithm based on aperture and the contrast between primary and secondary.

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The AAQ Model

The Project

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[1] The telescopes were: Newtonians – 2x508mm, 1x305mm, 3x254mm, 1x250mm, 1x203mm, 1x150mm. SCTs - 1x356mm, 1x235mm, 5x203mm. Refractors – 1x150mm, 2x128mm, 1x120mm, 4x80mm. Maksutov – 1x127mm.

[2] 334 observations were made originally, but 17 were “no-splits” of faint secondaries in small telescopes which were eliminated because the secondary was probably not observed due to its faintness in suburban skies rather than a real failure to resolve the pair. A further two observations were rejected as outliers in the development of the model.
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appropriate for applying the binary modeling procedure, “clear” and “notch” were defined as a split, and the other two as no-split.

Observers were also asked to report the seeing in terms of the Danjon scale which assesses the quality of the observed diffraction pattern, 5 being good and 1 bad (Figure 8).

The distribution of observations across observer/telescope combinations is obviously important in determining the scope and robustness of the resulting model. An even distribution is desirable but practicalities precluded this. The number of observations per observer varied widely, but the most prolific observer/telescope combination contributed no more than 14% of the total.

**The Model**

The purpose of the model is to predict whether or not a given pair can be split by a given observer and telescope under the prevailing seeing. Binary logistic regression (BLR) using a logit link function was used to develop the model from the observational data. (The term “binary” here means that there are only two possible outcomes of any prediction: split vs no-split. In this application the term is a happy coincidence!). The usual statistical criteria were used to evaluate the validity and efficacy of the model. BLR estimates the coefficients in the term X in the equation for the probability of a split, P:

\[
P = \frac{e^x}{1 + e^x}
\]

which describes the curve in Figure 6. 0 < P < 1, and x is a function of the observational variables such as the characteristics of the double, the telescope and the conditions. The variables available for inclusion in the model were: separation, magnitudes of the two components, telescope aperture and type, obstruction diameter (refractors and compound telescopes), magnification used, age of observer (a possible proxy for visual acuity), and seeing expressed in terms of the Danjon scale (Figure 8). Information was also available on the altitude of the pair at the time of observation, and the presence (or otherwise) and phase of the moon, though this was not used in modeling.

Because of the complexity of the system being studied, single variables often have less influence on prediction than appropriate combinations of variables. Accordingly many models were explored comprising both single (uncombined) variables and plausible combinations of variables. Two observations (both involving the failure to split pairs with large apertures) were eliminated from the database as various models consistently showed them to be outliers, ie they behaved quite differently from the rest of the dataset. Eliminating them improved slightly the predictive power of the model. The best model obtained was as follows:

\[
x = 1.6225 - 1.2026 \frac{(M_2 - M_1)}{S} - 0.5765 \frac{M_2}{S} + 1.9348 \frac{A^2 Z}{10^5}
\]

where \(M_1\) = magnitude of primary, \(M_2\) = magnitude of secondary, \(S\) = separation (arcseconds), \(A\) = telescope aperture (mm), and \(Z\) = seeing (Danjon scale, 1-5: see Figure 8).

Given the values of the variables, equation 2 is computed to give x which is then inserted into equation 1 to predict the probability with which the double can be split under those conditions. The model is easily implemented in a spreadsheet.

**How good is the model?**

The simplest interpretation of the probability P is to assume that the pair can be split when \(P>0.5\) and cannot be split when \(P<0.5\). On this basis the model correctly predicts the outcome in 84.1% of the cases in the database used in its development, and fails in 15.9% of cases. This does not necessarily imply that the model is 84% accurate all the time. It will depend for example on the conditions. Very difficult and very easy splits are more likely to be correctly predicted than intermediate ones. A more sophisticated interpretation of P can be obtained by dividing the predictions into 3 equal ranges, for which low probabilities (P<0.333) are defined as no-split, high probabilities (P>0.667) defined as split, and intermediate values (around P=0.5) defined as uncertain. On this basis 60 of the predictions (19%) fall into the “uncertain” category, and of the remaining 255 observations, 91.0% are correctly predicted as split or no-split.

The success of the simple “split – no split” interpretation can be illustrated in the histograms shown in Figure 9.

In order to validate the model, four of the original observers made a further 55 observations of 10 new close pairs with 6 telescopes: 80mm and 150mm refractors, a 203mm SCT, a 203mm reflector, a 356mm SCT and a 508mm reflector. In choosing the validation pairs it was realised that it would be easy to give a false impression of model efficacy by choosing
A Mathematical Model to Predict the Resolution of Double Stars by Amateurs and Their Telescopes

very wide and very close pairs because the model would nearly always correctly predict such splits. Accordingly the pairs were chosen to cover an intermediate range more difficult to predict. They varied in separation from 0.5\textquoteleft to 2.8\textquoteleft\ (with one pair at 5.3\textquoteleft), and magnitude differences from 0.8 to 3.7.

Based on the simple criterion of $P > 0.5$ indicating a split and $P < 0.5$ indicating no split, 47 of the 55 new observations were correctly predicted by the model, or 85.5\%, almost exactly the same as the original database. Interestingly, 7 of the 8 mistakes had $P$-values in the “uncertain” regime ($0.333 > P > 0.667$), as one might expect. In addition, two of these were no-splits on nights of a bright moon which may have made the detection of the secondary more difficult. Taking just the more certain values, for which $P < 0.333$ or $P > 0.667$, raised the success rate to 97.8\%, i.e. only one incorrect prediction in 45 observations. Interestingly this was a failure to resolve a 0.5\textquoteleft separation by the largest aperture (a 508 mm Newtonian); it will be recalled that the two outlier values in the original database, which were excluded during model development, were of a similar nature.

The model can therefore be accepted as useful. No model is perfect however. Imperfections are due both to inadequate model form and natural error or noise in the variables used to formulate the model. These may include the following:

- Several factors likely to influence prediction have not been included (yet) in the model, including reflector obstruction, observer experience and visual acuity, instrument type, and quality of optics. Reflector obstruction and observer age (as a possible proxy for visual acuity) were tried as variables in the model but were found to be not statistically significant. These factors need further investigation. As noted above, the moon may have interfered with the detection of faint secondaries.

- Larger telescopes are generally seeing-limited and smaller instruments diffraction-limited. This is not explicitly allowed for in the model.

- Observers themselves may have made observational errors such as incorrectly assigning the split/no-split, using inadequate magnification, incorrect estimate of seeing (which is somewhat subjective), and possible misidentification of the pair.

- The magnitudes and separations of the test pairs were taken from the WDS database. As far as possible pairs were chosen which had been recently observed and/or for which there was some evidence that changes in separation were slow. However it is possible that there are errors in these values, either due to real changes since the last observation, or mistakes.

- Assuming a large enough magnification is used (within the limits of the available focal length) then magnification should play no role \textit{per se} in whether a double is split or not. However it is a complex issue as there was no consistent protocol in choosing magnification, other than an exhortation to use higher values than usual, so some no-splits may be due to inadequate magni-
A Mathematical Model to Predict the Resolution of Double Stars by Amateurs and Their Telescopes

Figure 10: Effects of magnitude difference (left) and seeing (right) on 3 telescope apertures

<table>
<thead>
<tr>
<th>Scope aperture (mm)</th>
<th>AAQ predicted resolution (&quot;)</th>
<th>Dawes Limit</th>
<th>Rayleigh Limit</th>
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<td>Factor</td>
<td>Arcseconds</td>
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<td>356</td>
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<td>0.33</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Table 1: Resolution Limits: AAQ (seeing 4), Dawes, Rayleigh
A Mathematical Model to Predict the Resolution of Double Stars by Amateurs and Their Telescopes

less than both the Dawes and Rayleigh Limits. This is outside the range of separations in the database (the smallest was 0.5") and is likely to be optimistic. However it is interesting to note that the model predicts strong effects of seeing in the larger apertures (Figure 10); for the 356 mm aperture the predicted resolution declines from 0.25" at a seeing of 5 to 0.85" at a seeing of 1. At an “average” seeing of 3, the predicted resolution is 0.39", exactly the same as the Rayleigh Limit.

The model predictions have also been compared with the Lewis limits for “unequal” and “very unequal” pairs. With the exception of the 356 mm aperture, which is again probably over-optimistic, the model predictions for the unequal pairs are about the same as Lewis’ Limit. For the very unequal pairs however the model predicts a better resolution limit than Lewis. This may be due to the relative lack of close pairs of this extreme characteristic included in the AAQ database, and the model should therefore probably not be used to predict separation for close pairs with a magnitude difference greater than about 4.5. This could be remedied with further observations.

Future Work

The following enhancements to the model are worth considering:

1. More analysis could be done of the effects of magnification, obstruction and observer acuity, optics design, and the characteristics of the incorrect predictions.

2. Different models could be tried for different ranges of telescope aperture to account for the contrast between diffraction-limited and seeing-limited observations.

3. Ordinal logistic regression could be used to incorporate all four of the outcomes illustrated in Figure 7, rather than just two.

Statistical models of this kind always benefit from more data. A particular need is for records of non-splits, which are less well represented in the database and less well predicted by the model (Figure 9). If any reader would like to contribute observations, full details of how to do so with lists of the test doubles (many of which are southern pairs) can be found at the AAQ website at http://www.aaq.org.au/; follow the links to Sections > Double Stars > AAQ Resolution Survey.

Acknowledgements

This project would not have been possible without the dedicated band of AAQ observers who provided the data over a period of a year. Many thanks to Dave Allan, Roy Axelsen, Geoff Biggs, Jonathan Bradshaw, Rodney Burgess, Cheryl Capra, Allan Cooney, Peter Culshaw, Tony Dutton, Graeme Jenkinson, Steve Kerr, Max Kilmister, Bill Oliver, and John Salini. Des Janke and Tony Dutton assisted in placing material relating to the project on the AAQ website.

References


Lewis T, 1914. On the class of double stars which can be observed with refractors of various apertures. The Observatory, No.37, pp. 372-379.


Lord CJR. A report upon the analysis of the telescopic resolution of double stars of unequal brightness. http://www.brayebrookobservatory.org/BrayObsWebSite/HOMEPAGE/BRAYOBS%20PUBLICATIONS.html

Mullaney, James, 2005. Double and multiple stars. Springer.

HJ 1853: Old Companion Lost, New Companion Found

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Abstract: The double star HJ 1853 is a neglected double with only one measurement dated in 1905. The large proper motion of the A component allows checking that the pair registered in 1905 was optical. However, inspection of the photographic plates shows a new component which could constitute a physical pair with the A component of the old pair.

A Missing Old Companion

Located in Andromeda, the double star HJ 1853 should be an easy target for small telescopes: according to the Washington Double Star Catalog (WDS, Mason et al., 2003) it consists of two components of magnitudes 7 and 7.7 separated by 33".2. However, pointing the telescope to the corresponding coordinates (23108 +4531) shows only a seventh magnitude star, with no noticeable companion nearby. Checking the WDS again, we find that this is a pair with only one recorded measure in 1905. The plates of the 2MASS, POSSI and POSSII surveys confirm that the A star is surrounded only by a few faint stars (magnitude 12 and below). As an example, Figure 1 shows the corresponding J plate of the 2MASS survey.

Finding a missing component in the WDS is not always easy, but in this case the catalog provides additional information suggesting a solution: the proper motion of the A component is quite large (-81 mas in RA, -285 mas in DEC), and this could mean that the B component registered originally was an optical companion which is now far away.

Mystery (almost) Solved

Tracing back the position of the star to the year 1905, leads us to an area where, again, there is no star of magnitude 7.7. At this point I asked for help in the binary-stars-uncensored Yahoo group and W.I. Hartkopf kindly browsed the WDS data and found that the 1905 measurement was obtained by S.W. Burnham. The original observations from J. F. W. Herschel were dated in 1828 with PA 265.4°, sep. 15", and mags. 8.9 and 12.

The position of the A star in 1828 was such that there was a 12 magnitude star roughly at the position angle and separation recorded by Herschel. This star is now at PA 325.0 deg., sep. 40", mags. 7.07 and 12.3 (see Figure 1). The very small proper motion of the B component implies that it was an optical pair.

Burnham observed the star 77 years after Herschel and, due to the effect of the large proper motion, could not find the companion. Although he suspected that the Herschel measurement corresponded to the A and B star indicated above, he also thought that the double star could be another nearby pair (later designated BU 1528), and the data of this pair (PA: 191 deg, sep: 33".2) ended up as the WDS record for HJ 1835 (Hartkopf, 2008).

This explains most of the story, although some details are not completely clear, as the origin of the magnitude attributed to the B component, 7.7, which is mentioned neither by Herschel nor by Burnham.

The New Companion

Using the RGB facility of Aladin (Bonnarel, 2000) for color composition, I observed the large proper motion of the A star combining the plate of the POSSI
HJ 1853: Old Companion Lost, New Companion Found

survey (year 1953) in the red channel and one of the plates of the POSSII survey (year 1993) in the green channel. The result can be seen in Figure 2. The stars with small proper motion appear almost white, while the large proper motion stars as HJ 1853 A show two different images, one in red and another one in green.

Apart from the movement of the A component, the image shows that another star seems to be moving at the same pace as A. It is a new component not known before, which will be denoted by C in the rest of this paper. A rough measurement using the dist feature of Aladin shows that the C component is at about 90 degrees and about 50" from the primary.

Table 1 shows the proper motion data for both stars at the USNO-B1.0 catalog (Monet et al., 2003). The numbers after the ± symbol represent the mean error of the measure. Using these data we can check the Halbwachs (Halbwachs, 1983) selection criteria for distinguishing physical and optical pairs from its proper motion:

1. \((\mu_1 - \mu_2)^2 < \sigma_1^2 + \sigma_2^2 \ln (0.05)\)
2. \(\mu \geq 50 \times 10^{-3} \text{"/yr}\)
3. \(\rho/\mu < 1000 \text{ yr}\)

With \(\mu_1, \mu_2\) the two proper motion vectors, \(\sigma_i\) the mean error of the projections on the coordinate axes of \(\mu_i\), \(\mu\) the smaller proper motion vector module between \(\mu_1\) and \(\mu_2\), and \(\rho\) the angular separation of the two stars. In the A-C system the three criteria hold, indicating that the two stars are probably physically attached.

Old and New Measurements of the HJ 1853 A-C System

In order to obtain more precise data for the separation and position angle, it is convenient to look for the coordinates of both components in the available catalogs and also to obtain new images if possible. Unfortunately, the C component is not in the UCAC2 catalog (Zacharias et al., 2004), and the data for the two stars in the other catalogs such as the USNO-B1 correspond to different epochs. An exception is the 2MASS catalog, where both stars can be found with measurements corresponding to the same date (1999-10-05). The first row of Table 2 show the data obtained from the coordinates in this catalog.

This measurement was complemented by images taken by the author on July, 3, 6, and 7, 2008. The reduction phase relied on the program Astrometrica (Raab, 2008) using the catalog UCAC-2, following the

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<th>HJ 1853 C</th>
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<td>-322 ± 75</td>
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</table>

Table 1: Proper motion data for HJ 1853 A-C
next procedure:

• First every individual image was reduced using Astrometrica.
• All the images with residuals greater than 0.11" (either in Dec or in RA) were discarded.
• The rest of the images were stacked and reduced by Astrometrica to obtain the data.

The values of the second row of Table 2 show the result. However it must be mentioned that these results are unusually imprecise, with a standard deviation of 0.22 in the separation and of 0.37 in the PA w.r.t. the set of individual images. These deviations are the result of the large difference in stellar magnitude of the two components which can be observed in the image of Figure 3. In particular, the component C is too faint and this makes the reduction less reliable, while the relatively bright primary appears overexposed, which makes calculating the centroid an imprecise task.

Therefore, more reliable measurements of this pair would be useful, perhaps following specific techniques for high delta m doubles such as those described in (Daley, 2007). Also the photometry of C in Table 2 must be considered preliminary since C’s visual magnitude cannot be found in the catalogs, and no V filter was used in the author’s images. In order to improve the photometry, the images were calibrated with respect to other stars with known visual magnitude. After the calibration a test over another ten stars in the image with similar characteristics (visual mag. between 13 and 16, blue mag.- red mag. > 0) presented a maximum absolute error of 0.4 mags.

Physical Characteristics of the AC System

The A component has a mass of 0.9 solar masses (Allende Prieto, 1999) and with a MK spectral type of G8 V (Gray et al., 2003). Located at only 23.45 parsecs (76.5 light years) from the Sun, it is in the 25pc sample of sun-like stars catalog (Grether, 2006), but without indicating any known companion, confirming that C had not been noticed up to now. If we assume that C is also at 23.45 parsecs we have that both stars are separated by at least about 1172 AU, and hence probably the pair has a very long period. Finally, combining the distance $d=23.45$ with the estimated apparent magnitude $m=15.25$ by means of the formula $M = m + 5 – 5 \log d$, an absolute magnitude $M$ for C of approximately 13.40 is obtained. This visual magnitude corresponds in the HR-diagram either to a white or to a red dwarf, but the B, R magnitudes in the NOMAD catalog are 17.52 and 13.86 respectively and the strong predominance of the red magnitude indicates that C is likely a red dwarf.

Conclusions

The main contribution of this paper is the (serendipitous) discovery of a new possibly physical

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Table 2: Measures of the HJ 1853 A-C pair

Table Notes
1. Note 1: Obtained from the coordinates in the 2MASS catalog.
2. Note 2: Images taken with a DSI Pro camera and a refractor ED 100mm/900mm.
HJ 1853: Old Companion Lost, New Companion Found

binary star formed by HJ 1853 A and a new component C. Some initial measurements of the pair are given, although the high magnitude difference influences the reliability of the author’s measurements. From an amateur point of view this paper shows that even novice observers with modest equipment can obtain some results in this field, in particular thanks to the impressive set of resources (catalogs, plates) available on the internet.

Acknowledgements

My thanks to Dr. William I. Hartkopf, U. S. Naval Observatory, who taught me the basics of chasing missing doubles in the catalogs, and to Francisco Rica for his invaluable help. In this research I made use of the ALADIN Interactive Sky Atlas and of the VizieR database of astronomical catalogs, all maintained at the Centre de Données Astronomiques, Strasbourg, France. This publication makes use of data products from the Two Micron All Sky Survey, 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.

References

Hartkopf, W.I., 2008, personal communication on Binary Stars Uncensored Yahoo group.

When he was a child, Mr. Caballero wanted to be an astronomer. However, his parents thought that computers were more useful for his future so, instead of a telescope, he got a computer for Christmas. Now he works in the field of computer science during the day, but still dreams of being an astronomer while watching the stars at night.
Measurements of 16th Hour
Northern Neglected Double Stars

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Abstract: CCD images were taken of 16 neglected double stars from the United States Naval Observatory (USNO) northern list of neglected double stars. The star group's positional data were all measured using the software measurement utility, MPO Canopus. All CCD images were made at Stonegate Observatory Ann Arbor, Michigan, June 20, 2008 at 42:17:48N and 83:50:14W.

Introduction
The double stars were selected from the Washington Double Star (WDS) catalog listing of neglected double stars [1]. Stars were all chosen for low air mass positions during the early morning measurement period. All data were collected using a 14 inch, f/6.6 Schmidt-Cassegrain telescope mounted on a Software Bisque Paramount and imaged using a ST-10XME SBIG CCD camera. A minimum of four 30 second exposures were made of each star group.

Method
The resulting CCD images were processed and star positions measured using MPO Canopus Double Star Utility [2]. The software utility plate solved each image and determined the scale and coordinates of key stars. The primary and secondary stars were identified on each image and the position angle and separation determined. Canopus is capable of photometric reductions but all images were made with a clear filter only and are recorded as instrumental magnitudes. The position angle (PA) and separation measurements (SEP) were averaged and are shown in Table 1.

Conclusions
All data trends closely correlate with previous data collected with exception of KZA 116 taken in 1984. These data show significant change with PA increasing from 212 to 292.6 or 80.6 degrees. Considering a possible charting error, the primary and secondary positions were exchanged yielding a PA = 111.5 degrees which is 100.5 degrees decrease from 1984, an even greater movement. No explanation is apparent other than the system is fast moving or measurement errors. This system represents a good short term target to verify potential PA rotation at 17 seconds per month.

References

Table on next page.
### Measurements of 16th Hour Northern Neglected Double Stars

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**Table 1:** Measurement data of the 16th hour neglected double stars. All magnitudes are instrumental.

**Table Notes:**

1. Consistent change with 1911/1983 data of PA = 141, 148 and SEP = 2, 8. PA increased 2.4 degrees, SEP increased 3 seconds.
2. No change from 1911/1911 data of PA = 30, 30 and SEP = 32.6, 32.6.
3. Previous data 1983/84; PA increased 2 degrees from average.
4. Data consistent with 1983/84.
5. Previous data 1983/84; PA decreased 1 degree.
6. Correlates with 1983/84 data.
7. Previous data 1983/84; PA decreased 0.6 degrees.
8. Significant change from 1984; PA increased 80.6 degrees, SEP increased 2.6 seconds.
9. Previous data 1984; PA increased 5.4 degrees.
Observation Report 2006
Humacao University Observatory

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Abstract: Measurement of position angle and separation of 98 binary pairs are reported. The data was obtained using the NURO Telescope at the Anderson Mesa location of Lowell Observatory near Flagstaff, Arizona on May and August 2006. We gathered the data using the new 2K x 2K CCD camera, -NASACAM,- at the prime focus of the 31 inch telescope. The data was transferred and analyzed at the Humacao University Observatory by undergraduate students undertaking research projects.

Introduction

We report measurement of separation and position angle of binary stars gathered from CCD images obtained with the new NASA CAM CCD at the prime focus of the National Undergraduate Research Observatory (NURO) telescope. The Humacao Campus of the University of Puerto Rico is a member of NURO, a consortium of primarily undergraduate institutions (www.nuro.nau.edu) with access to a 31 inch telescope, property of Lowell Observatory. It is located roughly 20 miles east of Flagstaff, Arizona at Anderson Mesa, at an altitude of 7200 feet. We use the NURO telescope twice a year, usually during late spring and early fall.

The data presented in this report was acquired on two trips on 2006, May 27 to 29 and August 14 to 16. We were rained out August 14 and 15; all the data was acquired the 16.

The NASA cam is a 2K x 2K CCD camera with 15 micron pixels. The new camera does not need liquid nitrogen to cool down to -100, saving us a lot of time in the camera-telescope setup. The field of view of the old camera was 4 arc minutes by 4 arc minutes. The field of view of the new camera is 16 arc minutes by 16 arc minutes.

However, an optical reducer with ratio 2:1 lies in the optical path, so the separation of binaries in the images looks almost the same as before, in a much wider field.

Procedure

As in past reports, the CCD images where analyzed by students with undergraduate research projects at our department. The students used the pixelization of the CCD images to obtain the separation and position angle (Muller et al, 2003). Then the CCD images where analyzed a second time using the software Astronomical Image Processing for Windows (Berry et al, 2002). Since the software does not provide for introducing your telescope's plate scale in the computations you have to make your final number crunching with a hand calculator. The software in the program is also mirror reversed as far as position angle is concerned, so you must be very careful when you figure the correct angle from the one given by the software.

The design value for the plate scale with the new NASA cam is .515 arc seconds/pixel. We used 22 binaries with very long periods to obtain an experimental value for the plate scale. With this small sample it came to be .524 ± .009, in close agreement...
with the design value. We will use our value when calculating the separation of binaries.

There is a systematic error in position angle that occurs when the CCD camera is inserted into the telescope. This error can be corrected by using well known binary systems and binary systems that “don’t move”. Binary systems that “don’t move” can be found in the neglected section of the Washington Double Star catalog, as binary stars that have been measured for the last 100 years and show no change in position angle. By imaging a mix of well known binaries and fixed binaries (we use around 20 of them total) and comparing the value of position angle given in the WDS with the value obtained from our images, the systematic error in the position angle can be corrected. We call such error the offset error and is incorporated in the position angle values given in the accompanying table.

**Data**

The tables, with 98 entries, display first the WDS name of the pair, then the coordinates from the WDS in the second column (both RA and Dec). After that, the tables present the visual magnitudes for the primary and the secondary. These magnitude values are obtained from the WDS. Next we display our measurement of position angle (PA) and also display the measured separation. Finally, in the NOTE column the number of images of each binary obtained in that particular night. We must stress that although sometimes more than one image was obtained of a binary in a particular night, in the analysis and calculations of PA and separation only one image was used in all cases. Table I displays the data acquired in May. Table II presents the data obtained in August.

We have gathered data for many of these binaries in 2003, 2004 and 2005 (Muller et al, 2007) and we plan to analyze and compare the data obtained to eliminate spurious results.

**Acknowledgements:**

This research has made extensive use of the Washington Double Star Catalog maintained at the U. S. Naval Observatory and of the NURO telescope property of the Lowell Observatory.

We would like to acknowledge support from the Puerto Rico Space Grant Consortium. We would also like to acknowledge support from the M.A.R.C. Program at the Humacao Campus of the University of Puerto Rico. We also thank Ed Anderson of NURO for his efforts on behalf of our students.

**References**

Muller, Rafael, et al., 2003, The Double Star Observer, 9, 4-16.


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*Table 1: Double star measurements acquired in May 2006.*
Observation Report 2006 Humacao University Observatory

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Introduction

Difficulties attending CCD measurements of large ∆m pairs are described in an article by the author in a previous article (Daley, 2007). The specialized tail-piece optics used to make the measures reported here is also covered in that article and in a later article (Daley, 2008). Keen-eyed observers such as S. W. Burnham, Alvan Graham Clark and the Herschel’s, William and John, were dominant in the discovery of these contrasting component pairs. They usually employed the biggest reflectors and refractors of the time. It is only recently, with the introduction of the CCD, that amateurs with small telescopes have an opportunity to measure these systems.

The Measures

The following data is listed in the conventional way. From left to right: the discoverer’s designation, WDS identifier (Epoch 2000 RA & Dec), WDS mags rounded off to the first place (LSO unfiltered CCD "red" magnitudes in bold italics are ∆m inferred from known stars in the system), LSO position angle in degrees, LSO separation in seconds of arc, decimal date of observation, number of nights observed and a notes column. In the notes column entries such as 5m83 signifies 5 previous measures, the last being 83 years ago. Other self explanatory items, perhaps of interest, appear in this column.

There is no note section as all-in-all the work, although tedious, was without surprise; the optical components, for the most part, showing giant motions and the binaries displaying small but detectable position changes in most cases, the motions being reasonably consistent with previous measures—old and recent. Most measures are the mean of at least 12 CCD frames.

Among the few discoveries is an interesting red cpm pair in UMa (DAL 43, 12hr 05m 47.4988s +53° 54' 55.491"). Photometric measures (currently incomplete) of this wide pair will be presented in a future article.

Some CCD Images

Figure 1 shows STF 1110 (Castor), a popular fast moving pair. Both the A and B components are clearly resolved behind the foil. The slightly overexposed image of the eclipsing red pair YY Gem, which is physical with Castor, and the faint optical component "D" are well shown in this 10 second unfiltered exposure.

Figure 2 shows an image of BU 103 (upsilon Gem) with the primary highly attenuated behind the occulting foil strip. Relying on the one discovery measure 97-years ago, careful graphing demonstrates that the apparent motion of the secondary is precisely what is predicted by the proper motion of the primary, thus the companion is almost certainly optical.

Finally, Figure 3 is an image of Sirius utilizing a square aperture mask and no occulter. Although interesting, it would be a challenge to measure. However, the intersection of the diffraction spikes may give a reasonably good location of the primary as the mask is positioned very close to the objective's first
Ludwig Schupmann Observatory Measures of Large ∆m Pairs - Part Two

surface. A set of occulted images of Sirius were used for the included LSO measure and may be presented in a future article. As with the other images, North is up and East is left.

All images shown here are single frames (no stacking).

This ongoing measurement program is guided by an observation list generated by Brian Mason based on LSO's instrumentation capability and, in general, covers a ∆m range of 8 to 12 with the primary component no fainter than 4.5. Measurements are performed with a 9-inch aperture Schupmann medial telescope, a tailpiece stellar coronagraph and an unfiltered ST-7XE CCD.

References


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