# Observation Report 2005: Humacao University Observatory

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**Abstract:** We report on measurements of position angle and separation of binary stars using a 512 X 512 CCD camera coupled to a 31 inch telescope. The images where captured in the fall of 2005 at the NURO telescope. They where analyzed at the Humacao University Observatory as part of the ongoing research project on binary stars.

## Introduction

We continue reporting measurements of separation and position angle of binary stars gathered from CCD images obtained at 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 the spring and fall. The data presented in this report was acquired on one trip in the fall of 2005, August 26 to 28. At the time of these trips the NURO telescope had a TEK 512 X 512 CCD camera with 27 micron pixels attached. The camera was cooled to -110 $^{o}$C. to eliminate as much thermal electron noise as possible. A new CCD camera was installed last spring; we plan to report data with this new camera soon.

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 (see Muller, 2003 for details). Then the CCD images where analyzed a second time using the software that is included in *The Handbook of Astronomical Image Processing for Windows*, by Richard Berry and James Burnell, Willman-Bell, Inc, Virginia (www.willbell.com) 2000. The Handbook includes the CD *AIP for Windows*, which has a feature that, with some care, allows for measurement of separation directly from the CCD image (there is a new edition of this handbook on the market at present). 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. 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. There are many of them in the catalog. One can get detailed information on such systems by requesting the information from the database of the Washington Double Star (WDS) catalog. The procedure for doing so is simple and is outlined in Mason, 2006. By imaging a mix of well known binaries and fixed binaries (we use around 20 of them

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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.

The table, with 76 entries, displays first the WDS name of the pair, then the coordinates from the WDS in the second column (both RA and Dec). After that, the table presents the visual magnitudes for the primary and the secondary. These magnitude values are also obtained from the WDS. Next we display our measurement of position angle (PA) and we further display the measured separation. Finally, in the NOTE column the number of images 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.

## Acknowledgements:

This research has made 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 and the L.S.AMP of the University of Puerto Rico. 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

Mason, Brian , 2006, "Requested Double Star Data from the US Naval Observatory", Journal of Double Star Observations, **2**, 21-35.

Muller, Rafael, *et al.*, 2003, "Precise Separation and Position Angle Measurements using a CCD Camera", The Double Star Observer, **9**, 4-16.

| NAME | RA | DEC | MAGS A | MAGS B | PA | SEP | DATE | NOTE |
|---|---|---|---|---|---|---|---|---|
| BAL1175 | 150023.7 | +000644 | 10.8 | 11.2 | 198 | 14.6 | 2005.652 | 1 |
| HJ 2758 | 150040.2 | -173034 | 11. | 13. | 344 | 19.5 | 2005.652 | 1 |
| STF1985 | 155554.63 | -20951.3 | 7.03 | 8.65 | 348.6 | 5.8 | 2005.657 | 1 |
| AG 348 | 160011.9 | +141112 | 9.5 | 10.0 | 172 | 41 | 2005.652 | 1 |
| HJ 1284 | 160036 | –0030 | 10. | 14. | 185.7 | 22.2 | 2005.652 | 1 |
| LDS4622 | 160147. | -044748 | 13.1 | 17.0 | 39.5 | 14.1 | 2005.652 | 1 |
| HJ 580 | 160250.6 | +370527 | 9.2 | 12.2 | 8.9 | 41 | 2005.652 | 1 |
| STF1999 AB (Struve 1999) | 160425.9 | -112657 | 7.52 | 8.05 | 100.5 | 12 | 2005.652 | 1 |
| H 3 7 AC (Beta Scorpii) | 160526.2 | -194819 | 2.59 | 4.52 | 24.3 | 13.1 | 2005.652 | 1 |
| ARA 433 | 160635.8 | -181911 | 11.6 | 14.1 | 55 | 10.2 | 2005.652 | 1 |
| ALI 370 | 160726.8 | +354829 | 13.7 | 14.1 | 148.2 | 13.2 | 2005.652 | 1 |
| HJ 259 | 160742 | +3549 | 12. | 13. | 156 | 35.7 | 2005.652 | 1 |
| POU3214 | 16 0748.8 | +230529 | 11.1 | 13.3 | 83.4 | 12.6 | 2005.652 | 1 |
| STF2010 AB (Kappa Herculis) | 160804.5 | +170249 | 5.10 | 6.21 | 14.8 | 27.3 | 2005.652 | 1 |

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| NAME | RA | DEC | MAGS A | MAGS B | PA | SEP | DATE | NOTE |
|---|---|---|---|---|---|---|---|---|
| H 5 6 Aa-C (Nu Scorpi) | 161159.7 | -192738. | 4.21 | 6.60 | 338 | 41.3 | 2005.652 | 2 |
| HJ 1288 | 161240.8 | -164518 | 11.0 | 12.3 | 123.5 | 17.8 | 2005.652 | 1 |
| STF 2032 AB (Sigma Corona Borealiss) | 161440.85 | +335131. | 5.62 | 6.49 | 237.8 | 7.2 | 2005.652 | 1 |
| ES 627 | 161835.7 | +511951 | 9.6 | 10.8 | 288 | 11.9 | 2005.652 | 1 |
| GRV 940 | 165136.98 | +002841.9 | 9.29 | 10.69 | 342.7 | 44.3 | 2005.652 | 1 |
| BAL2429 | 165451.2 | +031841 | 10.5 | 11.5 | 51.3 | 11.5 | 2005.652 | 1 |
| SLE 76 | 170015.7 | +331220 | 14.3 | 15.0 | 14 | 9 | 2005.652 | 1 |
| ES 1255 | 170100.5 | +461627. | 8.0 | 11.7 | 40.7 | 8.3 | 2005.652 | 1 |
| LDS4718 | 170251.4 | +091233 | 11.9 | 21.0 | 316.5 | 44.2 | 2005.652 | 1 |
| WFC 186 | 170605.5 | +432856. | 11.4 | 13.0 | 16 | 18.2 | 2005.652 | 1 |
| PTT 16 | 170642 | +3839 | 8.8 | 13.0 | 53.6 | 22.6 | 2005.652 | 1 |
| BEM 26 | 170836.7 | +502245. | 11.1 | 12.7 | 17 | 15.4 | 2005.652 | 1 |
| STFA 35 (Nu Draconis) | 173215.8 | +551022 | 4.87 | 4.90 | 312 | 62.6 | 2005.652 | 1 |
| STF2214 AB | 174320.8 | +434452. | 9.61 | 10.15 | 212.3 | 19.9 | 2005.652 | 1 |
| BU 1202 AB-C | 180132.3 | +033127 | 8.43 | 7.95 | 29.5 | 106.1 | 2005.652 | 1 |
| BU 1202 AB-E | 180132.3 | +033127 | 8.67 | 10.20 | 139 | 89.7 | 2005.652 | 1 |
| STF2293 | 180953.8 | +482405 | 8.08 | 10.34 | 85 | 13.3 | 2005.652 | 1 |
| SLE 343 AB | 182733.4 | +080342 | 8.8 | 12.8 | 345.7 | 12.8 | 2005.652 | 1 |
| STF2330 | 183112.9 | +131055 | 8.27 | 9.69 | 166.7 | 16.6 | 2005.652 | 1 |
| STF2337 | 183455.1 | -144210. | 8.14 | 9.05 | 298.9 | 17 | 2005.652 | 1 |
| STF2346 | 183715.2 | +03143 | 7.93 | 10.0 | 300 | 29.6 | 2005.652 | 1 |
| STF2398 AB | 184248 | +5933 | 9.11 | 9.96 | 177.6 | 12.3 | 2005.652 | 1 |
| HJ 1349 | 184848.8 | +331912 | 8.3 | 10.7 | 93.1 | 29.5 | 2005.652 | 1 |
| STFA 39 AB (Beta Lyrae) | 185004.7 | +332145 | 3.63 | 6.69 | 150.5 | 47.4 | 2005.652 | 1 |

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| NAME | RA | DEC | MAGS A | MAGS B | PA | SEP | DATE | NOTE |
|---|---|---|---|---|---|---|---|---|
| STF2417 AB (Theta Serpentis) | 185613.18 | +041212.9 | 4.59 | 4.93 | 105 | 22.6 | 2005.652 | 1 |
| POU3652 | 190122.4 | +250951 | 9.9 | 14.0 | 188.6 | 13.6 | 2005.652 | 1 |
| BEM 37 | 190125.48 | +532747.3 | 11.87 | 11.90 | 307 | 11 | 2005.652 | 1 |
| STF2486 AB | 191205.03 | +495120.7 | 6.54 | 6.67 | 204.3 | 8.7 | 2005.652 | 1 |
| AG 375 | 191413.4 | +262628 | 9.6 | 10.5 | 297 | 18.9 | 2005.652 | 1 |
| STE 1 | 192842 | +001718 | | | 256 | 6.9 | 2005.652 | 1 |
| STFA 43 Aa-B (Albireo) | 193043.2 | +275734 | 3.37 | 4.68 | 55.1 | 35 | 2005.652 | 1 |
| GYL 17 | 193144.6 | +334801 | 7.5 | 10.0 | 231 | 23 | 2005.652 | 1 |
| STFA 44 | 193310.0 | +600931 | 6.47 | 8.19 | 288 | 75.5 | 2005.652 | 1 |
| ARN 48 | 194057.6 | +232918 | 8.20 | 9.69 | 6.4 | 25.9 | 2005.652 | 1 |
| STFA 46 Aa-B | 194149.09 | +503131.6 | 6.00 | 6.23 | 135.5 | 39.3 | 2005.652 | 1 |
| HJ 603 AB | 195033.9 | +384320 | 5.38 | 10.54 | 115 | 56 | 2005.652 | 1 |
| STFA 48 AB | 195322.6 | +202013 | 7.14 | 7.34 | 148.1 | 42.9 | 2005.652 | 1 |
| ES 204 | 201413.9 | +352142 | 7.6 | 10.5 | 277 | 16 | 2005.652 | 1 |
| J 838 | 202056.77 | +102658.4 | 9.6 | 9.6 | 117.6 | 6.3 | 2005.657 | 1 |
| GRV 365 | 203759.39 | +095141.5 | 11.7 | 11.8 | 106.4 | 28.5 | 2005.657 | 1 |
| ES 89 | 203817.0 | +480412 | 6.58 | 11.5 | 209.5 | 21.4 | 2005.657 | 1 |
| STTA209 AC | 204500.2 | +124336 | 8.22 | 8.17 | 156.1 | 97 | 2005.657 | 1 |
| STF2725 | 204613.31 | +155426.4 | 7.54 | 8.20 | 13 | 6.2 | 2005.657 | 1 |
| STF2727 | 204639.50 | +160727.4 | 4.36 | 5.03 | 266 | 9.0 | 2005.657 | 1 |
| STF2758 AB | 210653.94 | +384457.8 | 5.35 | 6.10 | 152.6 | 31.6 | 2005.657 | 1 |
| SEI1422 | 210952.7 | +365910 | 8.9 | 11.0 | 334 | 20.8 | 2005.657 | 1 |
| HJ 1619 AB | 211226.5 | +143156 | 10.0 | 11.0 | 173.5 | 7.1 | 2005.657 | 1 |

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| NAME | RA | DEC | MAGS A | MAGS B | PA | SEP | DATE | NOTE |
|---|---|---|---|---|---|---|---|---|
| BU 270 AB-C | 211327.2 | +071304 | 7.25 | 14.01 | 28.7 | 31.9 | 2005.657 | 1 |
| MLB 424 | 211530.2 | +371919 | 9.3 | 10.7 | 65 | 5.1 | 2005.657 | 1 |
| STT 434 AB | 211900.0 | +394457 | 6.67 | 9.93 | 122 | 25 | 2005.657 | 1 |
| STFB 11 AB | 212205.1 | +194815 | 4.20 | 7.56 | 313 | 36.5 | 2005.657 | 1 |
| STFA 55 AR | 212348.3 | +372105 | 6.6 | 13.4 | 202.8 | 23.4 | 2005.657 | 1 |
| BU 696 AC | 220430.1 | +155128 | 7.95 | 8.96 | 323.7 | 63.5 | 2005.657 | 1 |
| HJ 1726 | 220651.5 | +150501 | 11.0 | 11.5 | 24 | 19.2 | 2005.657 | 1 |
| STI2720 | 222130.0 | +583648 | 12.1 | 12.1 | 160.9 | 14.3 | 2005.657 | 1 |
| STI2722 | 222159.1 | +561952 | 10.6 | 13.0 | 71 | 14.6 | 2005.657 | 1 |
| STI2728 | 222223.0 | +551642 | 12.5 | 13.1 | 38.1 | 13.7 | 2005.657 | 1 |
| BU 172 AB-C | 222406.8 | -045013 | 5.78 | 10.1 | 342.5 | 53.1 | 2005.657 | 1 |
| STF2922 Aa-B (8 Lacerta) | 223552.2 | +393803 | 5.66 | 6.29 | 185.6 | 22.4 | 2005.657 | 1 |
| AG 423 | 223615.6 | +294443 | 8.3 | 9.7 | 154 | 23 | 2005.657 | 1 |
| HJ 3189 | 232331.9 | +001729 | 6.31 | 10.5 | 148 | 39.2 | 2005.657 | 1 |