

# 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](http://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 were 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 were 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  $.524 \pm .009$ , in close agreement

## Observation Report 2006 Humacao University Observatory

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.

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### References

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NAME	RA	DEC	MAGS	PA	SEP	DATE	NOTE
HJ 816	09 34 25.6	+10 09 05	10.3 12.5	19	17.0	2006.405	1
AG 342	10 59 38.31	+2526 15.4	8.57 9.22	110	5.2	2006.408	1
HJ 2553	11 02 11.1	+07 24 59	10.6 12.78	267.8	16.5	2006.408	1
BAL1443	11 08 30.9	+01 17 44	10.8 11	175.8	6.5	2006.408	1
STT 231AB	11 11 01.87	+3026 44.4	10.9 9.12	262.8	35.3	2006.405	1
STI 738	12 03 17.7	+59 24 05	10.1 11	38	7.1	2006.405	1
HJ 2605	12 15 04.4	+55 00 55	10.8 11.8	320	18.0	2006.405	1
STF1622	12 16 07.5	+40 39 36	5.8 8.71	260	11.7	2006.408	1
STF1636 17 Vir	12 22 32.1	+05 18 20	6.5 10.48	337	21.2	2006.408	1
KZA 36AC	12 28 57.5	+37 35 41	8.9 10.5	327	87.9	2006.405	1

**Table 1:** Double star measurements acquired in May 2006.

*Table 1 continued on next page.*

## Observation Report 2006 Humacao University Observatory

NAME	RA	DEC	MAGS	PA	SEP	DATE	NOTE
SHJ 145 δ Crv	12 29 54	+16 30 54	2.95 8.47	216	24.7	2006.408	1
STF1657	12 35 07.7	+18 22 37	5.11 6.33	270	20.5	2006.405	1
STF1673AB	12 42 56.1	-02 15 04	9.09 10.6	92	51.9	2006.408	1
STF1744AB ζ UMa	13 23 55.4	+54 55 31	2.23 3.88	153	14.5	2006.408	1
BAL 552	13 52 36	-02 12	11.2 11.2	94	17.0	2006.408	1
SKI 15AC	13 52 37.3	-16 10 13	8.8 -	266	16.1	2006.408	1
KU 47AE	13 54 00.4	+32 09 04	10.7 -	321	29.0	2006.408	1
HJ 4637	13 57 10.7	-12 32 47	9.8 10.5	137	13.2	2006.408	1
LDS4421	13 57 32	-09 17 18	13.1 13.69	15	46.8	2006.408	1
LDS 951	13 57 37	+17 41 18	13.5 14.7	269	20.3	2006.408	1
COU 59AB	14 00 42.18	+1753 55.2	9.9 12.2	172	8.5	2006.402	2
				167	8.0	2006.408	
ARA 74	14 01 26.4	-16 36 00	13.3 13.3	15	13.6	2006.402	1
LDS1402	14 02 27.1	+15 20 33	15.1 15.5	314	7.1	2006.402	1
ARA 695	14 03 29.2	-19 32 20	12.6 12.9	60	8.1	2006.402	2
				59	7.4	2006.408	
BAL1169	14 08 19.3	-00 11 19	10.9 11.3	297	14.8	2006.402	1
ARA 231	14 10 28.7	-18 10 11	12.9 13.6	243	6.6	2006.402	1
HJ 542	14 12 21.2	+36 46 12	12 12	68	12.7	2006.402	2
				68	12.3	2006.408	
POU3162	14 13 23.9	+24 24 12	11 12.8	347	7.0	2006.402	1
STF1821 κ Boo	14 13 27.7	+51 47 16	4.53 6.62	237	13.7	2006.402	1
LDS 953	14 13 29.8	+21 37 39	13.7 15.2	173	11.0	2006.402	2
				172.5	10.8	2006.408	
LDS 954	14 15 11	+22 15 54	11.4 12.49	191	26.6	2006.402	2
				198	21.8	2006.408	
STFA 26AB ι Boo	14 16 10	+51 22 01	4.76 7.39	34	40.4	2006.402	2
				35	38.8	2006.408	
ES 1085	14 16 30.2	+46 33 09	8.8 11.8	177	6.1	2006.402	1

Table 1 continued on next page.

### Observation Report 2006 Humacao University Observatory

NAME	RA	DEC	MAGS	PA	SEP	DATE	NOTE
BU 1442AC	14 25 43.48	+23 37 01.5	9.87 9.66	75	81.8	2006.402	1
POU3176	14 52 43.4	+23 53 47	11.4 13.0	1	7.5	2006.402	1
BAL1175	15 00 23.7	+00 06 44	10.8 11.2	198	14.9	2006.402	1
STFA 27 $\delta$ Boo	15 15 30.1	+33 18 54	3.56 7.89	78	108.4	2006.402	1
KZA 80	15 20 42	+31 33 15	9.5 10.0	54	26.1	2006.402	1
HJ 2777	15 22 25.3	+25 37 27	7.5 10.4	343	42.6	2006.402	1
STFA 28a-BC $\mu$ Boo	15 24 48.6	+29 34 28	4.33 7.09	170	109.0	2006.402	1

NAME	RA	DEC	MAGS	PA	SEP	DATE	NOTE
AG 348	16 00 11.9	+14 11 12	9.5 10.0	170	41.7	2006.624	1
HJ 1284	16 00 36	-00 30	10 14	184	22.7	2006.624	1
ARA 243	16 01 04.1	-17 40 59	13.1 13.3	297	13.4	2006.624	1
HJ 580	16 02 50.6	+37 05 27	9.2 12.2	7	41.3	2006.624	1
STF1999AB Struve (1999)	16 04 25.9	-11 26 57	7.52 8.05	97	12.1	2006.624	1
ARA 433	16 06 35.8	-18 19 11	11.6 14.1	54	10.9	2006.624	1
HJ 582	16 07 06	+35 07	9.7 12.0	232	22.7	2006.624	1
ALI 370	16 07 26.8	+35 48 29	13.7 14.1	147	13.0	2006.624	1
POU3214	16 07 48.8	+23 05 29	11.1 13.3	82	12.3	2006.624	1
STF2010AB $\kappa$ Her	16 08 04.5	+17 02 49	5.10 6.21	14	27.7	2006.624	1
H 5 6Aa-C $\nu$ Sco	16 11 59.7	-19 27 38	4.21 6.60	335	41.7	2006.624	1
HJ 1288	16 12 40.8	-16 45 18	11.0 12.3	120	19.0	2006.624	1
ES 627	16 18 35.7	+51 19 51	9.6 10.8	288	12.2	2006.624	1
GRV 940	16 51 36.98	+00 28 41.9	9.29 10.69	341	46.1	2006.624	1
BAL2429	16 54 51.2	+03 18 41	10.5 11.5	52	11.8	2006.624	1
SLE 76	17 00 15.7	+33 12 20	14.3 15.0	14	8.6	2006.624	1
ES 1255	17 01 00.5	+46 16 27	8.0 11.7	48	7.8	2006.624	1
BU 1088AC	17 05 20.3	+54 28 15	5.8 13.7	175	12.6	2006.624	1

Table 2: Double star measurements acquired in August 2006.

*Table 2 continued on next page.*

### Observation Report 2006 Humacao University Observatory

NAME	RA	DEC	MAGS	PA	SEP	DATE	NOTE
WFC 186	17 06 05.5	+43 28 56	11.4 13.0	15	18.0	2006.624	1
PTT 16	17 06 42	+38 39	8.8 13.0	52	22.6	2006.624	1
STFA 35 v Dra	17 32 15.8	+55 10 22	4.87 4.90	311	63.5	2006.624	1
STF2214AB	17 43 20.8	+43 44 52	9.61 10.15	211	18.8	2006.624	1
STF2293	18 09 53.8	+48 24 05	8.08 10.34	83	13.2	2006.624	1
SLE 343AB	18 27 33.4	+08 03 42	8.8 12.8	345	12.9	2006.624	1
STF2330	18 31 12.9	+13 10 55	8.27 9.69	167	16.5	2006.624	1
STF2337AB	18 34 55.1	-14 42 10	8.14 9.05	297	17.0	2006.624	1
STF2346	18 37 15.2	+03 14 3	7.93 10.0	298	30.0	2006.624	1
HJ 1349	18 48 48.8	+33 19 12	8.3 10.7	92	29.8	2006.624	1
STFA 39AB $\beta$ Lyr	18 50 04.7	+33 21 45	3.63 6.69	148	46.7	2006.624	1
STF2417AB $\theta$ Ser	18 56 13.18	+04 12 12.9	4.59 4.93	104	22.8	2006.624	1
POU3652	19 01 22.4	+25 09 51	9.9 14.0	186	13.9	2006.624	1
BEM 37	19 01 25.48	+53 27 47.3	11.87 11.90	309	11.5	2006.624	1
AG 375	19 14 13.4	+26 26 28	9.6 10.5	296	18.9	2006.624	1
STFA 43Aa-B (Albireo)	19 30 43.2	+27 57 34	3.37 4.68	54	35.2	2006.624	1
HJ 603AB	19 50 33.9	+38 43 20	5.38 10.54	114	57.3	2006.624	1
ES 204	20 14 13.9	+35 21 42	7.6 10.5	281	14.3	2006.624	1
HJ 1619AB	21 12 26.5	+14 31 56	10.0 11.0	173	7.4	2006.624	1
MLB 424	21 15 30.2	+37 19 19	9.3 10.7	58	4.9	2006.624	1
STI2722	22 21 59.1	+56 19 52	10.6 13.0	71	14.7	2006.624	1
STF2922Aa-B 8 Lac	22 35 52.2	+39 38 03	5.66 6.29	185	22.4	2006.624	1
AG 423	22 36 15.6	+29 44 43	8.3 9.7	154	23.7	2006.624	1
STI2872	22 50 16.7	+57 36 20	12.6 12.6	52	11.2	2006.624	1
STI2876	22 51 26.3	+56 19 32	12.6 12.6	60	12.8	2006.624	1

