Observation Report 2003-2004: Humacao University Observatory

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Abstract: We report on measurements of position angle and separation of binary stars obtained using a CCD camera coupled to a 31 inch telescope. The images where obtained in the fall of 2003 and the spring and fall of 2004.They where analyzed at the Humacao University Observatory afterwards as part of the ongoing research project on binary stars.

Introduction

This report includes measurements of separation and position angle of binary stars gathered from CCD images obtained using the National Undergraduate Research Observatory (NURO) 31 inch telescope in the fall of 2003 and the spring and fall of 2004. The Humacao Campus of the University of Puerto Rico is a member of NURO, a consortium of primarily undergraduate institutions (www.nuro.nau.edu) that share the 31 inch telescope, property of Lowell Observatory, for 120 nights per year. It is located roughly 20 miles east of Flagstaff, Arizona at Anderson Mesa, at an altitude of 7200 feet. We travel to the NURO telescope twice a year, usually during the spring and fall. The data presented in this report was acquired on 3 trips, one in the fall of 2003 and the others in spring and fall of 2004. At the time of these trips a TEK 512x512 CCD Camera was coupled to the NURO telescope. The camera had 27 micron pixels and was cooled to -110 ^{o}C to eliminate as much thermal electron noise as possible. A new CCD camera was installed recently; we will report data with this new camera in the future.

The data include 39 measurements obtained in October of 2003 and 87 measures for the year 2004. Some of the binaries where imaged both in the spring and the fall of 2004, so they show more than one measurement in the data tables.

The CCD images where analyzed by students pursuing undergraduate research projects at our observatory; they used two different methods to obtain the results on the table. First the students used the pixelization of the CCD images to obtain the separation and position angle (see Muller, Rafael et. all. , The Double Star Observer, **9**, 4-16, March/April 2003,for details). Then the CCD images where also analyzed 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. 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 coupled to the telescope. This error can be corrected by using well known binary systems and binary systems that "don't move". The 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 an-

gle. 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 by Dr Brian Mason at the JDSO: Mason, Brian: Spring 2006, Requested Double Star Data from the US Naval Observatory JDSO **2**, 21-35. By imaging a mix of well known binaries and binaries that "don't move" (we use around 20 of them total) and comparing the value of position angle given in the WDS with the one obtained from our images one can correct for the systematic error in the position angle. We call such error the offset error and is incorporated in the position angle values given in Table 1 and Table 2.

Both Table 1 and Table 2 display first the WDS Name of the binary system, then the coordinates from the WDS are shown in the second column (both RA and Dec). The tables further present the visual magnitudes for the primary and the secondary. These values where 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 we post the number of images obtained in that particular night for a particular binary. We must stress that although sometimes more than one image of a binary was obtained on a particular night, in the analysis and calculations of PA and separation only one image was used in all cases.

Acknowledgements

We would like to acknowledge support for this project from the Puerto Rico Space Grant Consortium and the L.S. Alliance for Minority Participation of the University of Puerto Rico. We also receive support from the MARC 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.

NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
HJ 3235	000346.5 +125121	11.2, 11.2	25	16.6	2003.802	1
STI3089	000352.3 +551757	12.6, 13.2	124	16.6	2003.802	1
LDS3117	000421.6 +282924	14.3, 14.4	9	62	2003.802	1
BU 9001AC	000509.7 +451344	6.69, 10.58	237	21.6	2003.802	1
STF3064	000737.9 +400852	7.0, 10.0	8	25.9	2003.802	2
ARN 28AD	000944.2 +520141	7.62, 9.44	59	83.9	2003.802	1
HJ 1947AB	001621.5 +433542	6.16, 9.83	76	9.5	2003.802	1
STF 23AB	001728.7 +001915	7.8, 10.28	220	9.2	2003.802	1
GRB 34AB	001822.8 +44012	8.07, 11.04	64	35.4	2003.802	1
STF 36Aa-B	003223.7 +065719	5.68, 9.52	84	27.2	2003.802	1
STF 46 (55Piscium)	003955.5 +212618	5.56, 8.49	196	6.6	2003.802	2
STF 88AB (ψ_1 Piscium)	010540.9 +212823	5.27, 5.45	159	29.8	2003.802	2
WAL 14AC	015240.7 +571717	8.15, 9.70	104	64	2003.802	1
HJ 1115	021857.0 +283834	5.0, 11.3	207	60.7	2003.802	1
STFA 43Aa-B (Albireo)	193043.2 +275734	3.37, 4.68	56	35	2003.802	2
HJ 1486	201112 +1111	11.0, 11.0	98	10.9	2003.802	1
ES 204	201413 +3521	7.6, 10.5	276	15.3	2003.802	2

Table 1: Double star measurements made in 2003 (*continued on next page*)

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NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
BAL2021	201457.7 +031446	10.6, 10.6	348	4.7	2003.802	1
SEI1422	210952.7 +365910	8.9, 11.0	335	21.4	2003.802	2
HJ 1619AB	211226. +143156	10.0, 11.0	171	6.8	2003.802	1
BU 270AB-C	211327.2 +071304	7.25, 14.01	28	30.7	2003.802	1
MLB 424	211530.2 +371919	9.3, 10.7	65	4.9	2003.802	2
STT 434AB	211900.0 +394457	6.67, 9.93	122	24.9	2003.802	S
BU 696AC	220430.1 +155128	7.95, 8.96	322	62	2003.802	1
HJ 1726	220651.5 +150501	11.0, 11.5	25	18.9	2003.802	1
LDS4955	221930. +151312	16.3, 17.0	7	68.1	2003.802	1
STI2720	222130.0 +583648	12.1, 12.1	162	14.3	2003.802	1
STI2722	222159.1 +561952	10.6, 13.0	72	14.4	2003.802	1
STI2728	222223.0 +551642	12.5, 13.1	38	14.3	2003.802	1
BU 172AB-C	222406.8 -045013	5.78, 10.1	342	54.4	2003.802	1
ARN 24AC	222548.0 -201413	6.7, 8.0	90.5	127.	2003.802	1
STF2922Aa-B (8 Lacerta)	223552.2 +393803	5.66, 6.29	186	22.7	2003.802	2
AG 423	223615.6 +294443	8.3, 9.7	156	23.5	2003.802	2
STT 475AB	223904.5 +372231	6.84, 10.8	72	15.6	2003.802	1
BU 1517	224911.1 +110652	11.0, 12.4	200	17.5	2003.802	1
HJ 1839	230023.9 +410729	8.8, 10.5	293	15.2	2003.802	2
STF2982	230931.5 +084038	5.12, 9.7	199	33.1	2003.802	1
STI2957	231339.4 +564748	11.9, 12.5	155	13.1	2003.802	1
HJ 307	231920.7 +132648	10.2, 11.7	314	25.8	2003.802	1

Table 1 (*cont. from previous page*): Double star measurements made in 2003.

NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
STI 738	120317.7 +592405	10.1, 11.0	38	7	2004.390	3
STF1622 (2 Canes Venatici)	121607.5 +403936	5.86, 8.71	258	11.8	2004.390	3
STF1636 (17 Virgo)	122232.1 +051820	6.5, 10.48	337	20.8	2004.390	3
KZA 36 AC	122857.5 +373541	8.9, 10.5	327	86.4	2004.390	1
SHJ 145 (Delta Corvi)	122952.0 -163054	2.95, 8.47	216	24.3	2004.393	3

Table 2: Double star measurements made in 2004. (*continued on next page*)

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NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
STF1673AB	124256.1 -021504	9.1, 10.6	92	51	2004.393	1
COU 59AB	140042.1 +175355	9.9, 12.2	172	8.4	2004.390	1
ARA 74	140126.4 -163600	13.3, 13.3	15	13.4	2004.393	1
LDS1402	140227.1 +152033	15.1, 15.5	314	7	2004.390	1
HJ 2699BC	140304.6 +115418	8.3, 13.3	237	14.7	2004.390	1
ARA 695	140329.2 -193220	12.6, 12.9	60	8	2004.393	1
LDS2702	140808.3 +615558	12.2, 19.5	199	15.1	2004.393	1
BAL1169	140819.3 -001119	10.9, 11.3	297	14.5	2004.390	1
ARA 231	141028.7 -181011	12.9, 13.6	243	6.5	2004.393	1
HJ 542	141221.2 +364612	12.0, 12.0	68	12.5	2004.390	1
POU3162	141323.9 +242412	6.11, 12.8	347	6.9	2004.390	1
LDS 953	141329.8 +213739	13.7, 15.2	173	10.8	2004.390	1
STF1821 (Kappa Bootis)	141327.7 +514716	4.53, 6.62	237	13.5	2004.390	3
STFA 26AB (Iota Bootis)	141610.0 +512201	4.76, 7.39	34	39.7	2004.390	1
ES 1085	141630.2 +463309	8.8, 11.8	177	6	2004.390	3
BU 1442AC	142543 +233701	9.72, 9.50	75	80.4	2004.390	2
HJ 1258AB	145037.1 +432618	9.9, 13.8	216	25.7	2004.390	1
STF1888AB (Xi Bootis)	145123.2+90602.3	4.76, 6.95	314	6.9	2004.390	1
POU3176	145243.4 +235347	14.4, 13.0	1	7.4	2004.390	1
HJ 560	145536.9 +345723	9.2, 10.6	298	40.2	2004.390	3
STFA 27 (Delta Bootis)	151530.1 +331854	3.56, 7.89	79	102.4	2004.390	1
KZA 80	152042.0 +313315	9.5, 10.0	55	26.6	2004.390	3
HJ 2777	152225.3 +253727	7.5, 10.4	343	42.5	2004.390	1
KZA 87	152448.6 +293428	12.0, 12.5	1	11.8	2004.390	1
KZA 90	152725.4 +310141	12.5, 13.0	298	20	2004.390	1
GIC 131	153230.27+083208	13.6, 14.7	313	16	2004.390	1
POU3193	153522 +240818	13.2, 13.7	293	7.6	2004.390	1
STF1999AB (Struve 1999)	160425.9 -112657	7.52, 8.05	101	12.1	2004.390	1
H 3 7AC (Beta Scorpii)	160526.2 -194819	2.59, 4.52	17	13.8	2004.393	2

Table 2 (*cont. from previous page)*: Double star measurements made in 2004. (*continued on next page*)

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NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
ARA 433	160635.8 -181911	11.6, 14.1	53	10	2004.393	1
ALI 370	160726.8 +354829	13.7, 14.1	147	14.3	2004.390	1
ALI 370	160726.8 +354829	13.7, 14.1	146.4	13.3	2004.762	1
POU3214	160748.8 +230529	11.1, 13.3	82	12.5	2004.390	1
POU3214	160748.8 +230529	11.1, 13.3	82	12.1	2004.762	1
STF2010AB (Kappa Herculis)	160804.5 +170249	5.10, 6.21	14	27.5	2004.390	3
STF2010AB (Kappa Herculis)	160804.5 +170249	5.10, 6.21	13.5	27	2004.762	1
HJ 1288	161240.8 -164518	11.0, 12.3	123	19	2004.393	1
STF2032AB (Sig. Cor. Bor.)	161440.8 +335131	5.62, 6.49	237	7.4	2004.390	3
STF2032AB (Sig.Cor. Bor.)	161440.8 +335131	5.62, 6.49	236	7.5	2004.762	1
ES 627	161835.7 +511951	9.6, 10.8	287	12	2004.390	1
ES 627	161835.7 +511951	9.6, 10.8	285.5	12	2004.762	2
STFA 35 (Nu Draconis)	173215.8 +551022	4.87, 4.90	310.8	63.6	2004.759	2
BU 1202AB-C	180132.3 +033127	8.43, 7.95	28	105.7	2004.390	1
BU 1202AB-E	180132.3 +033127	8.67, 10.20	139	86.7	2004.390	1
STF2293	180953.8 +482405	8.08, 10.34	83.2	12.9	2004.759	1
STF2330	183112.9 +131055	8.27, 9.69	167	17	2004.393	1
STF2330	183112.9 +131055	8.27, 9.69	166.2	16.7	2004.762	1
STF2337AB	183455.1 -144210	8.14, 9.05	297	16.6	2004.762	1
STF2337AB	183455.1 -144210	8.14, 9.05	296.5	16.8	2004.393	1
STF2346	183715.2 +073143	7.93, 10.0	299	29.8	2004.393	1
STF2346	183715.2 +073143	7.93, 10.0	297.2	29.9	2004.762	2
HJ 1349	184848.8 +331912	8.3, 10.7	91.1	29.5	2004.759	2
STFA 39AB (Beta Lyrae)	185004.7 +332145	3.63, 6.69	148.8	46.4	2004.759	1
STF2417AB (Theta Serpentis)	185613.18+041212	4.59, 4.93	104.5	23.1	2004.759	1
AG 375	191413.4 +262628	9.6, 10.5	295.5	18.8	2004.759	1
STFA 43Aa-B (Albireo)	193043.2 +275734	3.37, 4.68	55.5	34.5	2004.759	1

Table 2 (*cont. from previous page*): Double star measurements made in 2004. (*continued on next page*)

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NAME	RA + DEC	MAG A, B	PA (deg)	SEP (as)	DATE	NOTE
GYL 17	193144.6 +334801	7.5, 10.0	230.5	22.9	2004.759	1
STFA 44	193310.0 +600931	6.47, 8.19	286.5	75.6	2004.759	1
ARN 48	194057.6 +232918	8.20, 9.69	5.2	25.9	2004.759	1
HJ 603AB	195033.9 +384320	5.38, 10.54	113.8	56.5	2004.759	1
STFA 48AB	195322.6 +202013	7.14, 7.34	147.3	42.2	2004.759	1
HJ 1479	200550.3 +253603	8.4, 10.7	1.7	34	2004.759	1
HJ 1479	200550.3 +253603	8.4, 10.7	4.4	34	2004.762	1
ES 204	201413.9 +352142	7.6, 10.5	277.2	14.7	2004.759	1
BAL2021	201457.7 +031446	10.6, 10.6	343	4.5	2004.759	1
ENG 73AB	201654.5 +501643	8.24, 10.30	75.5	78.2	2004.759	1
STF2666Aa,C	201806.9 +404355	5.80, 11.11	208.1	34.1	2004.759	1
SEI1422	210952.7 +365910	8.9, 11.0	332.7	20.4	2004.759	1
HJ 1619AB	211226.5 +143156	10.0, 11.0	172.5	6.9	2004.759	1
BU 270AB-C	211327.2 +071304	7.25, 14.01	27.5	29.4	2004.759	1
MLB 424	211530.2 +371919	9.3, 10.7	62.2	4.9	2004.759	1
BU 696AC	220430.1 +155128	7.95, 8.96	322.3	63	2004.759	1
STI2720	222130.0 +583648	12.1, 12.1	159	14.2	2004.759	1
STI2722	222159.1 +561952	10.6, 13.0	73.1	14.8	2004.759	1
STI2728	222223.0 +551642	12.5, 13.1	38	14.3	2004.759	1
STF2922Aa-B (8 Lacerta)	223552.2 +393803	5.66, 6.29	186.1	21.9	2004.759	1
AG 423	223615.6 +294443	8.3, 9.7	154.8	24.4	2004.759	1
STT 475AB	223904.5 +372231	6.84, 10.8	72	15.8	2004.759	1
HJ 1839	230023.9 +410729	8.8, 10.5	294.5	14.7	2004.759	1
STF2982	230931.5 +084038	5.12, 9.7	197.5	32.6	2004.759	1
STI3007	233642.8 +581949	13.2, 13.2	119.5	8.9	2004.759	1
STI3012	233824.5 +580027	12.6, 12.6	98.2	7.8	2004.759	1
BAL1249	234102.7 +004307	9.2, 11.2	334.9	14.5	2004.759	1

Table 2 (*cont. from previous page*): Double star measurements made in 2004.