LSO Double Star Measures for the Year 2012

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Abstract: Reported here are the position angle and separation of 39 pairs in 30 systems. Eleven pairs are difficult large Δm objects requiring a special coronagraphic technique and (in the case of Sirius AB) a shaped pupil mask was employed in combination with the stellar coronograph. This set-up may be of interest and is further discussed.

The Measures

This year's measurements were mostly routine with only the unusually bad weather preventing a larger output. Thus only one note is included which describes the technique used in the imaging of AGC 1AB. Each of the 39 results listed is the average of 12 or more adequately sharp CCD frames. The CCD is an SBIG ST-7 non anti-blooming camera located at the Barlow amplified focus of a 9-inch Schupmann medial telescope. The effective focal length is 278.82 inches for the measure of normal pairs and 166.48 inches in the coronograph mode (Daley 2007) used to measure large Δm doubles.

The results are listed in order of the discoverer designation, their WDS positions (in order of right ascension), WDS magnitudes sometimes rounded off, the position angle in degrees, the separation in seconds of arc, the decimal date (average date in the case of more than one night), N, or the number of nights observed, and finally brief notes.

A Note Describing the Imaging of AGC 1AB

Recent interest in optimizing telescopes for the detection of exoplanets has led to cleverly designed aperture or pupil masks. With perfect optics and no atmosphere, these "shaped pupil" masks mathematically predict high contrast, typically reaching values of 10^{-10} over relatively narrow position angles. These dark sectors are freed of the diffracted light of a circular aperture by redirecting it over a broad region away from the "discovery zones." Unlike a square pupil mask, where four relatively wide low background regions are observed, the newer masks provide only two dark regions or sectors. The dark zones typically form a sector angle of about 20° close to the primary, thus to survey the close-in region around a star one must take ≈9 images, rotating the mask between each exposure. A newer class of rotational symmetric masks (Vanderbei, Spergel & Kasdin 2003) provides full coverage surrounding a star, but has much poorer throughput (≈9%) and also presents insurmountable construction difficulties for the amateur astronomer wishing to explore its possibilities.

Clearly, a mask designed for exoplanet discovery and imaging should also be useful when working on high Δm double stars such as AGC 1AB. The mask I chose was pioneered by Princeton University scientists David Spergel and Jeremy Kasdin. This mask (Figure 1) and other more complex variations were described by Spergel and Kasdin in a technical talk given some years ago to the Amateur Astronomers Inc (AAI) of New Jersey. Scale drawings of the various mask designs were sent to me by AAI member Clif Ashcraft, who attended the talk. I chose the mask shape that was physically realizable in my workshop.

The mask was cut to the required shape from manila folder stock with a single-edge razor blade. The mask is stiffened with a thin plywood disc somewhat larger than the telescope objective cell, enough to glue on retaining buttons for easy centralized rotation.

The mask opening outline was then band saw cut about 1 inch oversize. Woodworker's white glue was used to attach the mask to the plywood. A few coats of

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Table 1. LSO Measurements of Double Stars

Discoverer	RA + DEC	Mags		PA	Sep	Date	nn	Notes
STT 547AB	00057+4549	8.20	8.26	187.2	6.15	2012.917	2	
GRB 34AB	00184+4401	8.07	11.0	65.3	34.81	2012.923	1	
BAR 1AB	01097+3537	2.06	14.4	234.0	29.91	2012.022	1	β And
DAL 39AK	01097+3537	2.06	13.6	89.4	59.70	2012.022	1	
DAL 39KL	01097+3537	13.6	13.7	180.7	5.97	2012.022	1	
ST 3HL	05167+4600	10.5	13.7	172.9	3.41	2012.161	1	Capella H
STF 919AB	06288-0702	4.6	5.0	132.7	7.13	2012.190	2	β Mon
STF 919AC	06288-0702	5.1	6.1	125.2	9.83	2012.190	2	
BU 570AD	06288-0702	4.7	12.2	55.0	26.61	2012.191	1	
STF 919BC	06288-0702	5.0	6.3	107.1	2.95	2012.190	2	
STF 924AB	06323+1747	6.31	6.88	211.2	20.09	2012.175	1	20 Gem
STT 154	06443+4037	7.06	9.68	85.0	23.41	2012.191	1	
AGC 1AB	06451-1643	-1.46	8.5	85.1	9.66	2012.156	1	Sirius
STF 948AB	06462+5927	5.4	6.0	68.3	1.87	2012.180	1	12 Lyn
STF 948AC	06462+5927	5.4	7.1	308.4	8.81	2012.180	1	
STF 948BC	06462+5927	6.2	7.2	299.0	9.85	2012.180	1	
STF 982AB	06546+1311	4.7	7.8	143.4	7.45	2012.178	1	38 Gem
STF1066	07201+2159	3.5	5.7	226.2	5.57	2012.195	1	δ Gem
STF1110AB	07346+3153	1.9	3.0	56.4	4.81	2012.210	1	Castor
STT 179	07444+2424	3.7	8.2	241.9	7.50	2012.219	1	κ Gem
STF1138	07455-1441	6.0	6.7	339.8	16.89	2012.219	1	2 Pup
STF1224A,BC	08267+2432	5.4	6.9	53.1	5.81	2012.265	1	24 Cnc
STF1223	08268+2656	6.1	6.2	218.9	5.22	2012.265	1	23 Cnc
STF1306AB	09104+6708	3.7	8.3	348.5	4.31	2012.284	1	σ2 UMa
STF1321AB	09144+5241	7.79	7.88	96.7	17.27	2012.271	2	
STF1424AB	10200+1950	2.4	3.6	126.7	4.73	2012.347	1	γ Leo
STF2093	16429+3855	3.58	12.5	265.6	115.87	2012.710	1	η Her
BU 1118AB,C	17104-1544	2.42	12.3	148.0	99.75	2012.707	1	η Oph
BU 1118AD	17104-1544	2.6	10.7	281.0	101.21	2012.707	1	
DAL 52AE	17104-1544	2.42	11.1	316.5	62.73	2012.707	1	
BU 1090AC	17304+5218	2.79	12.7	155.1	118.92	2012.693	1	β Dra
RST5090AB	17376-1524	3.54	13.0	78.2	24.85	2012.696	2	ξ Ser
BU 1459AB	17395+4600	3.76	11.8	48.9	116.66	2012.699	1	ι Her
STF2398AB	18428+5938	8.97	9.69	178.3	11.91	2012.713	1	Neat binary
STF2578AB	21069+3845	5.20	6.05	152.4	31.69	2012.803	1	61 Cyg
KR 60AB	22280+5742	9.93	11.4	344.6	1.47	2012.880	1	Near min sep
STF2910	22282+2332	9.05	9.67	332.8	5.57	2012.885	1	Slow binary
STF2909	22288-0001	4.34	4.49	168.0	2.25	2012.891	1	ζ Aqr
STF2922AB	22359+3938	5.73	6.50	185.5	22.42	2012.893	1	8 Lac

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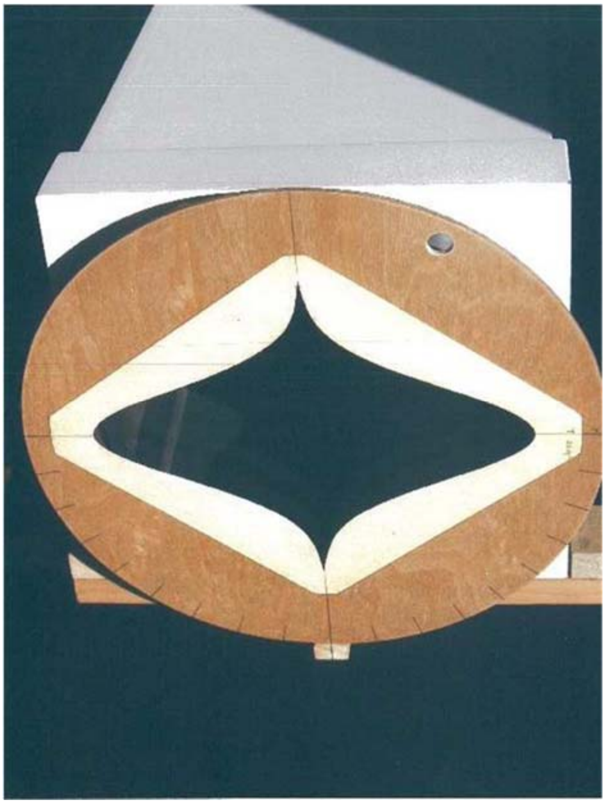

Figure 1. Shaped Pupil Mask mounted on 9 inch objective cell.

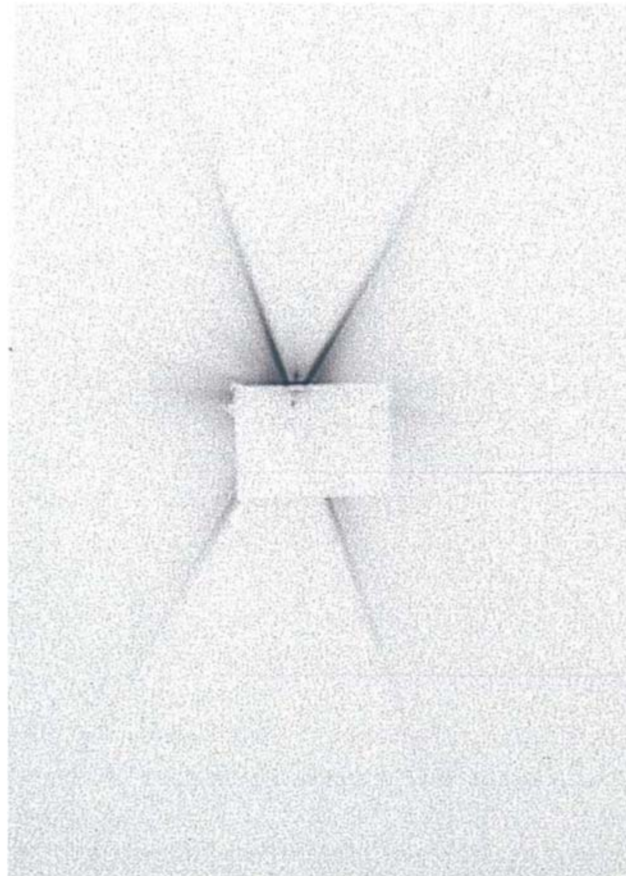

Figure 2. CCD image of AGC 1AB using shaped pupil mask and stellar coronagraph.

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clear shellac greatly improves the card stock durability. The mask is spray painted flat black on the inner face.

You will note in the mask photo that PA is ruled in 10° steps along its rim. An indicator bar is clamped to the square telescope tube. Setting (rotating) the mask to the predicted PA of Sirius "B" is easily done to 2° accuracy by eye. Note that the two discovery regions are symmetrical about and in line with the pointed ends of the mask.

One downside of all the proposed and realized pupil masks of this general class is their relatively poor throughput, with the one shown here the best at 41% of the available light through my 9 inch refractor (the mask's maximum dimension just fits within the telescope's clear aperture). This drawback must be compensated with longer and, unfortunately, more atmospherically disturbed exposures. I use the mask described in conjunction with my tailpiece stellar coronagraph to make full use of the mask's potential.

A typical image of Sirius and its faint companion, using the described mask, is shown in Figure 2, where "B" is clearly seen in the dark zone. The primary image is a bit weak but easily measured. The almost square (1.0×1.26 mm) coronagraph focal mask foil is seen covering and greatly attenuating "A". I am replacing this foil with one transmitting about 2× more light for blue-white stars such as Sirius. Cutting these tiny (≈1 mm) square foils from aluminized mylar sheet is a story in itself!

References

Daley, J.A. 2007, JDSO 3, 159

Vanderbei, R.J., Spergel, D.N. & Kasdin, N.J. 2003, AJ 599, 686