Ludwig Schupmann Observatory Double Star Measures for the Year 2016

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Abstract: Observations of large Δm pairs continues at LSO. Measurements in θ and ρ space for forty (40), mostly wide brightness difference objects are reported. The improved tailpiece stellar coronagraph (Daley 2016) attached to a 9-inch Schupmann medial was employed for all measures. Scarcity of measures and the challenging nature of these pairs provides a strong driving force.

1. Introduction

Measurements for 2016 were ended in April as the observatory's equatorial mount was needed for the testing and development of a new (scalable) solar telescope optimized for imaging photospheric granulation. The telescope was contructed in the LSO workshop. Design, construction and early test results of this instrument were detailed, by the author, in a talk delivered at the Hartness House Workshop. The theme this year was "Sub-Arc-Second Spatial Resolution Imaging" and was held Thursday, August 4, 2016 in Springfield, VT.

Briefly, the instrument is optimized for maximum contrast imaging of solar granulation. An 8-inch f/21.5 singlet objective operates in a narrow band (1 nm FWHM) centered on the TiO absorption band at 705.7 nm. This is a temperature sensitive band used by solar astronomers which effectively darkens the cooler intergranular lanes and sunspot umbra helping to bring-out warmer features (umbral dots, etc.). Gains in observations of photospheric faculae are clearly evident as well. A ZWO ASI 120 MM CMOS camera is employed for this work. Standard lucky imaging and stacking techniques are applied to the ~1 min. videos. Single frame exposures run about 0.33 ms, which freezes atmospheric seeing.

The solar work is exciting and challenging, however, a return to large Δm double star observing is not completely ruled out. In the author's opinion, this narrow observing notch is where we can compete for a while longer in the face of the massive, ultra-precise, star position data beginning to rain down from satellites such as Gaia.

2. The Measures

The measures presented here are conventionally listed left to right as follows: WDS identifier (epoch-2000 RA & Dec), discoverer designation, decimal date of observation, LSO position angle in degrees, LSO separation in seconds of arc, number of nights object was observed and a notes column with a number for detailed notes appearing at the end of the paper. Nearly all measures are the mean of 8-12 sharp images. Position angle corrections are determined by a full-field drift image for each pair. The doubles are measured (centroid to centroid) using LSO's ST7 CCD camera in its native astrometry mode.

3. LSO Notes to Measures

1. STF 93AC&AD (Polaris)

It was nice to use the new coronagraph (Daley 2016) on the star that inspired my large Δm work back in 2005. Fine seeing was experienced for the measure. I have installed a circular Lyot stop which currently sets the clear aperture to 6.25 inches. The Lyot stop is placed in the plane of the exit pupil which is located between the symmetrical elements of the transfer (relay) lens. This ⅛ inch diameter stop is made using a round punch and die set available from tool suppliers. I used .003 steel feeler stock for the stop material. A noticeable reduction in scattered light was observed compared to the old coronagraph which did not utilize a Lyot stop.

These measures employed a Baader solar film attenuator as the occulting bar. It is sliced ~0.7 mm wide and extends across the plano side (sky face) of the rotatable field lens. Other occulting masks are planned

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Table 1. LSO Measures for the Year 2016

RA+DEC J2000	Discoverer Designation	Date	PA (deg)	Sep(")	n	Brief Note
01097+3537	BAR 1 AB	2016.014	235.3	30.63	1	β And
01097+3537	BAR 1 AG	2016.014	214.6	206.36	1	
01097+3537	BAR 1 AH	2016.014	224.2	232.52	1	
01097+3537	DAL 39 AK	2016.014	88.4	59.07	1	
01097+3537	DAL 39 KL	2016.014	178.4	5.99	1	
01441-1556	BUP 25	2016.016	149.6	160.45	1	τ Cet
02318+8916	STF 93 AB	2016.019	235.7	18.39	1	1
02318+8916	STF 93 AC	2016.019	102.8	38.98	1	
02318+8916	STF 93 AD	2016.019	193.7	83.18	1	
03475+2406	STFA 8 AB	2016.074	290.6	117.63	1	Alcyone
03475+2406	STFA 8 AC	2016.074	313	181.96	1	
03475+2406	STFA 8 AD	2016.074	296.5	191.78	1	
03475+2406	HL 23 AE	2016.074	231.5	78.39	1	
03475+2406	HL 23 AF	2016.074	232.4	144.45	1	
03475+2406	HL 23 AG	2016.074	53.5	200.02	1	
03475+2406	HL 23 AH	2016.074	44.3	222.83	1	
03475+2406	STFA 8 CD	2016.074	224.8	54.67	1	
04153-0739	STF 518 AB	2016.090	101.91	83.87	1	2
04153-0739	STF 518 BC	2016.090	329.48	7.74	1	
04359+1631	BU 550 AB	2016.101	112.8	31.6	1	Aldebaran (physical)
04359+1631	STFA 2 AC	2016.101	31.1	136.49	1	optical
04498+0658	STT 560 AB	2016.076	170.6	73.22	1	π^3 Ori
04498+0658	DAL 50 AC	2016.076	357.3	22.9	1	3
05320-0018	BU 558 AB	2016.142	228.7	33.42	1	Mintaka
05320-0018	STFA 14 AC	2016.142	0.23	52.49	1	
07282+0856	LAM 4 AB	2016.18	232.1	26.9	1	γ CMi
07282+0856	LAM 4 AC	2016.18	261.2	114.02	1	
07282+0856	WAL 52 AD	2016.18			1	not found
07282+0856	DAL 54 AE	2008.176	358.5	31.74	1	
07282+0856	DAL 54 AE	2016.18	358.8	31.24	1	
07282+0856	DAL 54 AF	2008.178	292.4	153.7	9	1
07282+0856	DAL 54 AF	2016.199	292.2	153.10	3	4
07282+0856	DAL 54 AH	2016.224	198.3	171.57	1	
07282+0856	DAL 54 FG	2008.178	290.1	4.33	1	
07282+0856	DAL 54 FG	2016.199	287.8	4.28	3	
07282+0856	DAL 54 HI	2016.224	254.1	5.32	1	5
08165+0911	BU 1065 AB	2016.276	293.4	29.47	1	β Cnc, cpm
08165+0911	DAL 42 AC	2016.287	37.8	70.47	1	
08464-1333	BU 1065 AB	2016.284	265.6	26.80	1	12 Hyd
08468+0625	STF1273 AB,D	2016.306	200.5	18.57	1	ε Hyd, hyperbolic orbit

such as a 0.5 mm "dots" and various smoked-glass semi-field patterns to fit the particular measure at hand.

Measurements of position angle this close to the pole present some difficulty in determining the north point as its direction varies across the field. I used the following method. With the polar drive turned off I simply made short exposures of Polaris every 2 minutes setting the pole star near east frame edge and ending at the west frame edge. All the images were co-added to form a single PA calibration image. The path of Polaris and its "B" component trail in a slightly curved path, concave to the pole. A chord is established at equal distances from the field center (the track point for the primary). A PA reading across the chord is made to establish the instrumental east-west position angle which provides the north point direction from Polaris. Due to the strong effect of precession this near the pole, the pairs reported for Polaris will appear to increase in position angle about 45 degrees by the year 2100!

An unfiltered Δm measure of CD was made using 7 -flat fielded astrometry images. The "D" component is brighter by 0.24 magnitudes. CD could conceivably be a wide foreground binary!

2. o^2 Eri = STF 518AB

The WDS 2006.5 CD gives an A,BC designation. The separation of BC is highly resolved, so I elected to measure it as just AB. The white dwarf "B" component is much the higher mass of the "BC" pair and is the brighter, but not by much in my unfiltered CCD image. The visually faint "C" component is a dM4e object, thus rich in the red. Note that the PA is given to the second decimal place (the way it is reported in the astrometry program used) as the consistency of the values are high over the 12 frames measured. The "BC" measure shows the pair now closing, but somewhat inside the published (Heintz 1974) orbit ellipse†.

3. DAL 50AC

After four measures spanning seven years the observed motion of the pair appears to be rectilinear due to the high proper motion of the primary. The new stellar coronagraph made easy work of this otherwise difficult pair. The AB pair is also optical. Because the class F6V primary is only 26 ly distant it may be a good candidate for planet detection if truly a single star. A powerful speckle observation could help decide the matter.

4. DAL 54FG

A new pair found in the field of γ CMi. Looking at my 2008 images, I found the pair at the field edge and measured them and are also reported here. The new pair lies very close to a "bright" 10.75 mag field star, however I chose to associate the pair with γ itself. Gamma is a spectroscopic binary and a faint pair and this separation makes it a good candidate for a bound system similar to Capella "H" in its architecture.

5. DAL 54HI

This pair, as with FG above, is possibly physical with γ The magnitudes are nearly identical with H perhaps 0.05 magnitude brighter in unfiltered Δm measurements. The pair is in a "lonely place" among the many field stars.

† *Note that the orbit and mass determinations of these were recently improved in Mason et al. (2017).*

References

Daley, J.A., 2016, *JDSO*, **12**, 468.

Heintz, W.D., 1974, *AJ*, **79**, 819.

Mason, B.D., Hartkopf, W.I. & Miles, K.N., 2017, *AJ*, **154**, 200.