Lunar Occultation Observations of Double Stars – Report #7

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Abstract: Reports are presented of lunar occultations of close double stars observed using video techniques. Included are cases where a determination of the position angle and separation of the pair can be made as well as instances where no duplicity has been observed of known or reported double stars. Twenty-six double stars discovered as a result of a lunar occultation are also included together with the light curves for the discovery event.

This paper continues the series of reports of double star measurements made at lunar occultations of the star (see refs [2-7] for the previous reports). The majority of the observations date from early 2017 through 2018 to the end of March 2019. There are also a few observations made considerably earlier.

The principle and general method of calculation are explained in Herald (2009) and Loader (2010).

Occultations presented in this paper have been observed using video cameras, mostly at either 25 frames, 50 fields per second (Australasia and Europe) or 30 frames, 60 fields per second (USA, Brazil and Japan). A video time inserter has been used to time-stamp each video field to millisecond precision. The limit of tim-

ing accuracy is usually about ±0.02 seconds, where analysis has been carried out using video frame measures and ±0.01 seconds using field measures. An error of 0.01 seconds in time will typically translate to an angular error of 4 milliarcsecond.

Video records of double star occultations have been analyzed using the Limovie program developed by K. Miyashita. This program measures the light flux of the occulted star from the video record allowing a light curve for the event to be generated.

Occultations of double stars result in a stepped light curve, see e.g. Herald (2009). The duration of the step gives a measure of the separation of the pair in a direction perpendicular to the moon's limb at the point of occultation. The relative heights of the steps allow an estimate of the magnitude difference of the two stars to be made. Limovie has a facility to do this and to add the results to the light curve. Observations are normally made with an unfiltered CCD video camera.

Normally the separate occultations of the two stars of a pair will take place at slightly different points on the moon's limb. An angular separation of 1" at the mean distance of the moon is equivalent to about 1.86 km.

The heights of the moon's limb at the two points of occultation of the two stars may differ. Any difference will have an effect on the interval between the two events.

For each observation an estimate of the effective slope of the moon's limb between the two points of occultation is therefore needed for calculations of the position angle and separation angle of a pair of stars. For this paper, use has been made of the new limb data from the Lunar Reconnaissance Orbiter, Lunar Orbiter Laser Altimeter.

The Observations Reported

Table 1 continues the series of measures of known double stars for which a solution for the position angle and separation of the system has been calculated. In order to produce a solution, at least two observations are required with the occultations well separated on the moon's limb. A minimum separation of 10° round the moon's limb is needed to obtain a reliable result.

Ideally the observations would all be made on the same date but this is rarely possible. In most cases the occultation observations have been made on different dates, with an interval between them sufficiently short for any change in relative position of the pair of stars to be small. Besselian dates of each observation and the mean date of the combined observations are shown. An estimate of any change in the expected position angle and separation of the pair, as indicated by Washington Double Star (WDS) data, is given in the notes. The changes shown cover the period in which the observations were made. The observed magnitude differences, as calculated by Limovie, are also shown.

Table 2 shows a number of occultation observations of double stars listed in the WDS for which only one observation is available. For many of them, no further occultations will occur for some years.

With only one observation the actual position angle and separation of the pair of stars cannot be determined. Only a vector separation in the direction of the position angle of the moon's limb at the point of observation can be found.

From a single observation an apparent magnitude difference of the two stars can be determined. The cataloged difference and the observed difference are shown. The resulting magnitudes of the pairs are also listed, based on the published combined magnitude.

Tables 3A and 3B present details of previously unknown double stars discovered as a result of stepped lunar occultations.

Table 3A shows cases where more than one occultation of the new double has been made, enabling the position angle and separation of the pair to be established. Similar data to Table 1 is presented.

Table 3B shows the far more numerous cases where only one observation has been made of the new double, resulting in the determination of a vector separation of the pair. In some cases two or more observations were made, but the separation of the occultation events on the moon's limb was too small to generate a reliable solution.

Only cases where the resulting light curve shows a reasonably well defined step have been included. Discovery light curves are presented for the events at the end of this paper. The captions for the curves give some further details.

Table 4 presents observations of stars which have been reported as possibly double as a result of earlier visual occultation observations. More recent video observations of occultations for the stars listed have shown no sign of a stepped event, that is, no indication that it is double. Only cases with two or more observations with event position angles (the vector angle) separated by at least 10° have been included. The stars in Table 4 all have an entry in the Interferometric Catalog.

While the most likely reason for the failure to detect a companion star is simply that the star is in fact single, other possible reasons are:

i. The vector separation was small so that the interval between the two events was too short to detect. This possibility is largely eliminated by

(Text continues on page 510)

Lunar Occultation Observations of Double Stars – Report #7

Table 1 Known double stars: PA and separation measured

WDS name	XZ	Position RA Dec	Measured PA° & Sepn″	Mean Date	Mag. diff.	Observn. Date	Observers	Note
HDS 61	505	00266-0003	285.89±3.36° 0.498±0.016″	2017.04	2.46 n/a 2.21	2016.639 2016.864 2017.612	RS MI BL	1.
STF 291AB	3594	02411+1848	112.17±0.63° 2.240±0.026″	2006.10	-0.03 -0.11	2006.097	SM, RS	2.
BU 537	4891	03471+2449	222.6±2.4° 0.529±0.050″	2006.70	1.29 0.9	2005.727 2007.672	DG SM	3.
STF 449	4907	03474+2440	329.34±0.25° 6.600±0.025″	2008.38	n/a n/a	2007.672 2009.096	SM SM	4.
STF 572AB	5948	04385+2656	193.67±0.01° 3.133±0.016″	2007.64	0.18 0.17	2007.226 2008.049	SM RS	5.
BU 1044	5983	04399+1631	202.00±0.41° 0.637±0.014″	2016.18	n/a	2015.753 2016.127 2016.651	HA HA AA	6.
HO 226AB	6952	05270+2737	266.77±0.30° 0.700±0.007″	2006.07	0.04 0.45	2005.135 2007.005	RS SM	7.
STF 813	7838	05544+1854	139.55±0.72° 2.152±0.030″	2010.25	0.28 0.53 0.13	1999.225 2013.738 2017.777	RS MI JG	8.
HO 238	9774	06463+1812	120.65±13.29° 0.300±0.056″	2017.13	n/a	2016.882 2017.255	MI MI,HW	9.
STT 156	9812	06474+1812	135.98±2.48° 0.182±0.005″	2016.69	n/a 0.24,0.28 n/a n/a	2015.160 2016.806 2016.882 2017.256	DG SM,RS MI HA,WH	10.
BU 899AB	10199	06592+1843	268.21±4.30° 0.764±0.020″	2015.93	1.25 1.27 n/a	2014.115 2016.283 2017.406	BL DH YA	11.
HO 253	14778	09478+1004	294.36±2.19° 1.310±0.026″	2015.53	2.89 n/a ,2.07 n/a, n/a	2015.160 2015.469 2015.843	BL DG,DH AA,MI	12.
STF1670AB	18692	12417-0127	4.88±2.77° 2.278±0.183″	2017.18	0.61 n/a	2016.527 2017.348	GK YA,MI,AA,WH	13.
MCA 38AaAb	19147	13099-0532	352.81±0.80° 0.446±0.010″	2016.15	n/a 2.36	2016.005 2016.304	AA AP	14.
HU 141	20639	14492-1050	308.63±2.24° 0.461±0.016″	2017.98	0.73 1.94 1.64,1.5,2.3	2016.609 2017.431 2018.627	BL DH DG,JB,SK	15.
HDS2210	21550	15394-1355	164.48±0.37° 0.146±0.003″	2017.28	n/a,0.53 0.41	2016.612 2018.630	DH,DG BL	16.
BU 958	42128	17165-1920	204.40±0.60° 1.970±0.024″	2016.77	ca 1.7 0.61	2014.673 2018.860	BD DG	17.
BU 246AB	25003	18177-1940	111.82±2.55° 0.486±0.019″	2014.15	0.79, -, 0.28 0.73	2012.804 2018.190	DH,CC2,DG DG	18.
B 1887	25499	18340-1929	283.01±0.26° 2.236±0.009″	2015.24	n/a 0.55	2012.730 2017.743	DH DH	19.
KUI 88	25902	18488-1836	147.85±2.50° 0.398±0.012″	2014.64	n/a n/a	2013.554 2015.725	DH HY	20.
HU 262	45748	19167-1739	31.30±0.29° 3.999±0.038″	2016.77	0.31, 0.26	2016773	BL,SK	21.
FIN 336	28531	20311-1503	50.67°±1.34° 0.181±0.005″	2013.91	0.48 n/a, n/a	2010.865 2015.430	DH HA,MI	22.
4H 1 47	49923	21124-1500	308.75±2.44° 4.301±0.233″	2017.38	n/a, n/a 0.15, 0.13	2017.003 2017.751	MI, HW DG, DH	23.
HU 282	30282	22006+1345	49.08±1.07° 0.220±0.004″	2014.16	n/a 1.61, 1.85	2006.832 2017.829	BL AP,TH	24.
CHR 111	30765	22313-0633	356.28±0.30° 0.097±0.001″	2008.78	2.5,2.5,n/a	2008.779	DG,DH,BL	25.

Lunar Occultation Observations of Double Stars – Report #7

Table 1 Notes

1. HDS 60 (10 Ceti), any change in relative positions likely to be small in 1 year .
2. STF 291AB, very slow rate of change, observations on same date
3. BU 537, recently received report, little change in position expected in 2 years, separation change ca 0.01".
4. STF 449 little change in position expected over ca 19 months.
5. STF 572AB, little position change expected over 10 months.
6. BU 1044, little position change expected over 11 months.
7. HO 226 AB, known orbit period 374 years, expected PA change in 2 years less than 1 degree.
8. STF 813, observations wide spaced in time, little position change in period.
9. HO 238, little position change expected over 5 months.
10. STT 156, WDS orbital period 205.3 years, PA changing ca 10° per year, separation changing slowly.
11. BU 899 AB, position changing very slowly.
12. HO 253, Any change in position insignificant in 10 months.
13. STF1670 AB, WDS orbit period 169.1 years. Rate of change in 2017: ca 1.8° in PA, 0.14" in separation per year.
14. MCA 38 Aa,Ab, orbital period 695 years, change in PA in 2016 ca 0.9° in PA and < 0.01" in separation per year.
15. HU 141, Orbital period 173.9 year, change in PA 0.4° per year, separation near constant
16. HDS2210, WDS shows only 2 or 3 observations, with considerable variations in PA and separation.
17. BU 958, little change in PA and in separation expected in 4 years.
18. BU 246AB, changes expected during 5+ years very small
19. B 1887, little change expected during 5 years.
20. KUI 88, orbital period 909.7 years, expected rate of change in 2 years of PA ca 0.6°, separation < 0.01"
21. HU 262, observations on same date. SK observed a near graze.
22. Orbital period 50.66 year, change in PA between observations ca 10°, separation near constant. HA and MI observations very close in limb PA, result very dependent on DH's earlier observation.
23. Orbital period shown as 4890 years, so no significant position change in 9 months.
24. Only 5° separate observation by AP and TH, so result largely dependent on BL 11 years earlier.
25. Short orbital period, 1.7309 years, observations all on same date.

Lunar Occultation Observations of Double Stars – Report #7

Table 2. WDS: Single observation, Vector separation and magnitudes determined

WDS Star	XZ number	RA Dec	Observed Vector		Mag difference		Mags	Date	Obs
			Angle	Sepn	Catalog	Observed			
BU 777	376	00211-0015	297.6°	2.55″	1.19	1.27	9.78+11.05	2017.387	BL
CHR 200	3623	02425+1045	272.4°	0.336″	0.2	0.87	6.70+7.57	2018.592	DG
STF 412AB	4598	03344+2428	44.3°	0.436″	0.26	0.28	6.61+6.89	2008.047	RS
HO 324	4956	03490+1459	36.0	0.447″	0.19	n/a	n/a	2016.047	HA,AA
STT 64AB	4984	03500+2351	206.8°	2.94″	3.34	2.11	6.91+9.02	2006.550	RS
STF 559	5862	04335+1801	71.9°	8.81″	0.05	0.15	6.89+7.04	2018.074	BL
CHR 154	5998	04404+1631	299.4°	0.174″	1.75	n/a	n/a	2016.653	MI
STF 598	6174	04486+1748	334.4°	7.42″	1.86	n/a	n/a	2017.184	BL
BU 1047 BC	6595	05098+2802	221.4°	0.080″	0.60	0.03	9.36+9.39	2006.180	RS
COU 470	7257	05384+1808	108.7°	0.214″	1.40	n/a	n/a	2017.253	HA,YA
HU 39	7590	05472+2153	235.7°	0.180″	0.1	0.33	8.67+9.00	2019.125	BL
HDS 824	8190	06038+1816	88.9°	0.91″	1.10	1.19	8.04+9.23	2017.254	AP
STT 160	10040	06544+2110	110.5°	0.069″	2.26	3.39	6.65+10.04	2019.203	AP
STF1083	11061	07256+2030	100.9°	3.71″	0.91	0.67	7.37+8.04	2018.156	DH
HU 845	104753	07470+2045	212.6°	0.216″	0.47	0.99	1.49+10.48	2018.307	DH
COU 772	11679	07471+1847	86.5°	0.326″	0.19	0.24	8.96+9.20	2017.184	BL
COU 929	11911	07560+2342	238.9°	0.193″	0.67	1.36	7.70+9.06	2007.384	RS
COU 956	13372	08481+1836	66.5°	0.178″	0.3	0.33	10.19+10.52	2018.309	DH
COU 384	14098	09183+1847	34.8°	0.034″	0.1	0.04	8.62+8.66	2001.331	RS
HU 869	14273	09252+1449	287.4°	0.743	0.10	0.26	9.70+9.96	2017.413	BG
COU 936	14363	09290+1917	123.5°	0.154″	1.54	1.09	8.59+9.68	2005.819	RS
STT 220	15705	10292+1009	111.9°	0.462″	1.44	1.36	7.45+8.81	2017.267	DH
STF1450	15851	10350+0839	121.6°	1.78″	2.1	2.07	5.75+7.82	2017.342	AP
J 87	17572	11409+0457	80.5°	1.07″	4.58	2.8	8.36+11.16	2017.420	DH
AG 178	124037	12310+0207	309.6°	1.252″	0.1	0.43	9.64+10.07	2018.545	BL
BU 607	18685	12412-0127	265.9°	0.711″	2.2	n/a	n/a	2017.349	YA
HDS1881	19358	13244-0419	328.2°	0.243″	3.87	3.28	7.04+10.32	2017.351	DH
CHR 221	20105	14133-0827	161.9°	0.035″	1.1	0.37	7.18+7.55	2017.354	DH
RST3898	20687	14515-1033	238.1°	0.653″	0.54	n/a	n/a	2018.627	DG
HDS2167	39439	15245-1322	124.9°	0.125″	0.17	0.69	10.76+11.45	2018.704	DH
HLD 25	39817	15403-1432	300.1°	1.469″	0.19	n/a	n/a	2018.630	SK
RST3950	22363	16283-1613	89.7°	0.199″	1.08	1.12	7.61+8.73	2017.661	DH
A 2242	23446	17232-1807	17.8°	0.175″	2.5	2.32	9.55+11.87	2017.814	BL
HJ 2806	23593	17297-1748	84.8°	2.77″	0.64	0.75	8.77+9.52	2017.218	BL
CHR 235	25181	18228-1843	301.6°	0.152	0.9	n/a	n/a	2016.172	HA
HLD 144AB	43966	18257-2102	309.9°	0.187″	0.07	0.53	9.12+9.65	2019.162	DH
I 1030	160315	18462-2046	104.0°	4.27″	2.99	2.65		2018.715	DH
BU 154	29006	20528-1610	57.4°	2.99″	1.00	1.57	8.63+10.20	2017.825	SK
BU 1262	050164	21223-1455	62.9°	1.221″	1.05	0.82	8.72+9.54	2017.900	DG
RST4105	30710	22281-1153	227.5°	0.89″	0.41	0.4	9.0+9.4	2017.980	CE
RST4712	31173	23006-0704	288.5°	0.39″	1.90	2.09	9.85+11.94	2017.308	DG
STF2981	184816	23095-0850	57.3°	1.191″	0.05	0.43	9.80+10.23	2018.879	DH

Lunar Occultation Observations of Double Stars – Report #7

Table 3A: Occultation Discoveries: Separation and Position Angle Determined

Star name	OCC #	XZ	Position RA Dec	Measured PA° & Sepn.	Mean Date	Mag. diff.	Observn Dates	Observers
TYC 1387-00971-1	1672	12883	08317+1928	296.78±1.46° 0.189±0.016″	2009.41	0.3 0.24	2000.430 2018.383	RS DH
TYC 6171-00196-1	1789	21196	15210-1533	158 ± 20° 0.10±0.02″	2015.11	3.19 n/a	2014.742 2015.490	SK HW
TYC 6239-01058-1	1827	142496	17300-1755	232.59 ± 0.07° 0.423 ± 0.000″	2017.02	0.19 0.94 0.63	2016.768 2017.141 2017.141	BL DH BL
TYC 6348-01744-1	1847	28920	20484-1812	46.31±3.47° 0.630±0.027″	2018.87	3.37 3.98	2018.871 2018.871	DG DH

Table 3B: Occultation Discoveries: Vector separation only measured

Star name	OCC #	XZ	RA Dec	Vector Angle	Vector Sep.	Mag. diff.	Observn. Date	Obs.	Fig.
TYC 0604-01110-1	1850	1066	00496+0757	79.1°	0.061″	0.90	2007.664	SM	Fig 1
TYC 1215-00520-1	1832	3229	02235+1644	305.6°	0.028″	0.80	2012.083	RS	Fig 2
TYC 1253-00461-1	1864	5187	03589+1654	84.0°	0.035″	1.09	2019.120	DH	Fig 3
TYC 1320-01983-1	1838	79423	05536+1937	217.4°	0.201″	0.74	2017.179	DG	Fig 4
TYC 1342-01830-1	1861	92793	06464+2110	97.9°	0.035″	1.04	2018.4.21	DH	Fig 5
TYC 1902-00526-1	1860	95864	06578+2637	263.9°	0.545″	1.13	2007.571	SM	Fig 6
TYC 0283-00658-1	1842	122998	12070+0255	131.5°	0.042″	1.02	2017.496	DH	Fig 7
TYC 0290-00520-1	1844	124516	12341+0100	250.7°	0.204″	0.29	2017.573	BL	Fig 8
TYC 6217-00770+1	1836	137098	16426-1645	219.3°	0.158″	2.07	2017.138	DH	Fig 9
TYC 6256-01444-1	1862	42587	17363-1932	33.2°	0.021″	0.11	2018.758	BL	Fig 10
TYC 6269-03059-1	1837	155991	18232-1823	101.9°	0.100″	0.15	2017.144	DH	Fig 11
TYC 1320-01983-1	1838	79423	18262-1823	101.9°	0.100″	0.15	2017.180	DG	Fig 12
TYC 6270-00109-1	1857	44022	18273-1814	59.0°	0.371″	1.46	2016.771	SK	Fig 13
TYC 6274-01331-1	1853	157882	18318-1910	96.8°	0.027″	0.70	2017.743	BL	Fig 14
TYC 6275-00749-1	1851	44271	18359-1927	145.1°	0.039″	0.22	2017.825	DH	Fig 15
TYC 6289-02180-1	1859	161543	18529-1929	83.3°	0.255″	0.22	2017.893	DH	Fig 16
TYC 6294-00379-1	n/a	45164	18594-2123	301.3°	0.023″	0.40	2019.238	BL	Fig 17
TYC 6305-01605-1	1858	26920	19242-2018	269.0°	0.059″	0.09	2017.895	CE	Fig 18
TYC 6321-01088-1	1863	47100	19539-2023	292.9°	0.197″	0.86	2018.868	DG	Fig 19
TYC 6332-01468-1	1855	28346	20236-1813	265.4° 265.2° 265.1°	0.089″ 0.100″ 0.107″	0.24 -0.45 0.18	2017.749	YA MI HA	Fig 20 Fig 21 Fig 22
TYC 5784-00577-1	1839	49915	21121-1411	146.1°	0.023″	0.62	2017.303	BL	Fig 23
TYC 5784-00642-1	1852	29433	21137-1439	10.8° 8.7°	0.091″ 0.091″	0.89 0.61	2017.751	DH DG	Fig 24 Fig 25
TYC 5241-00846-1	1840	52763	22561-0715	297.0°	0.020″	0.21	2017.308	BL	Fig 26

Lunar Occultation Observations of Double Stars – Report #7

Table 4: Companion not observed (possible double star, entry in WDS &/or IF Catalog.)

Star name	OCC #	XZ	RA Dec	Vector angle	Resolution limit	Limiting Mag. diff.	Observn Date	Observer
HD 12281	429	2796	02008+1323	35.2° 75.2°	0.027″ 0.030″	n/a 2.7	2004.973 2004.973	DG BL
HD 16802	588	3612	02420+1033	244.5° 171.9°	0.037″ 0.011″	2.0 3.0	2018.592 2018.592	DG BL
HD 23288	1213	4813	03448+2417	278.1° 216.0°	0.032″ 0.028″	3.0 2.3	2006.774 2007.672	RS SM
HD 29150	888	5915	04362+2132	115.5° 216.0°	0.016″ 0.025″	2.7 1.7	2012.164 2012.613	RS JB
HD 38558	986	7602	05474+1744	245.2° 245.2° 77.5°	0.022″ 0.022″ 0.036″	2.3 3.0 2.1	2015.756 2015.756 2016..280	HW MI RS
HD 39357	206	7791	05533+2737	117.6° 220.5°	0.038″ 0.027″	2.5 2.7	2007.379 2007.678	RS SM
HD39393	882	7796	05533+2132	236.1° 324.8° 157.8° 149.2°	0.032″ 0.014″ 0.011″ .0.016″	2.9 2.0 2.5 2.8	2011.793 2018.751 2019.126 2019.126	JM BL DH DG
HD 49345	1130 (9127)	9863	06492+2711	50.1° 207.1°	0.019″ 0.035″	2.3 1.5	2004.242 2016.934	RS SM
HD 60820	1368	11417	07371+2009	140.2° 271.4°	0.031″ 0.035″	2.7 2.1	2010.303 2018.755	EI RS
BD +20 1912	815	11731	07492+2015	125.1° 99.0°	0.033″ 0.036″	2.5 1.5	2018.307 2018.307	DH JB
HD 153727	40	22959	17019-1853	64.8° 148.8° 120.6° 106.1°	0.043″ 0.017″ 0.024″ 0.024″	2.2 3.3 2.9 2.3	2013.699 2018.709 2018.709 2.018.709	BL DG JB SK
HD 164438	1523	24425	18019-1906	132.9° 126.8° 40.6°	0.019″ 0.021″ 0.027″	3.2 3.5 2.6	2017.666 2017.666 2017.866	DH DG DH
HD 168608	1542	25129	18214-1852	68.2° 65.4° 60.5°	0.033″ 0.033″ 0.024″	2.7 3.3 3.3	2013.628 2013.628 2017.592	DH DG BL
HD 174115	455	25924	18496-1909	24.9° 30.6° 80.5° 79.6° 233.2°	0.018″ 0.021″ 0.033″ 0.025″ 0.026″	3.3 3.3 2.5 2.5 1.8	2012.656 2012.656 2012.656 2016.622 2017.444	DG DH BL SM DH
HD 2196888	1639	31446	23179-0911	126.1° 72.3°	0.010″ 0.031″	n/a 1.8	2003.916 2018.730	BL AP

[The 'Resolution limit' is set at no less than two frame intervals [0.080s (PAL) or 0.067s (NTSC)] times the vector rate of motion.]

Table 5. Companion not observed (definite double star, listed in WDS)

Star name	XZ	RA Dec	Predicted-Mags	Predicted delta T	Limiting Mag. diff.	Observn Date	Observer
COU475AB	11356	07354+1950	9.2+11.5	0.48 s	3	2017.782	DG
RST49448	17224	11279-0142	6.2+8.2	0.24 s 0.35 s 0.30 s	2 2.7 1.5	2009.416 2010.014 2013.431	RS MI MI
TDS 8625	35595	12590-0146	10.9+11.1	1.00 s	2.4	2017.499	DH
TDS8701	35802	13078-0227	9.5+10.1	0.75 s	3 2.3	2017.650 2017.650	DG DH
JC 6	25260	18254-2033	5.0 + 7.4	3.85 s	3.5	2018.788	BL

(Continued from page 504)

having two or more observations of the star at different position angles round the moon.

ii. The magnitude difference of the two component stars is too large for the fainter star to be detected at the occultation.

Table 5 contains data similar to Table 4 for stars with entries in the Washington Double Star Catalog, but which have failed to show any double star nature during lunar occultations of the star. Those listed in the table have the predicted intervals between the two occultations shown and the component magnitudes showing it is likely the occultation would have separated the pair.

The names of all contributing observers are listed at the head of this paper and are referred to by the two letter code in the tables.

The XZ identifier refers to the XZ80Q catalog, available at VizieR as catalogue I/291. It includes all stars to magnitude 12.5 within 6° 40' of the ecliptic, that is, all stars which can be occulted by the moon.

OCC# is the number assigned to the possible double at the discovery.

This research has made use of the Washington Double Star Catalog (WDS) and the Interferometric Catalog, both maintained by the United States Naval Observatory, Washington.

Extensive use has been made of the Occult program written by D. Herald, including the solutions for the position angle (PA) and separation of pairs shown in Table 1 and Table 3A.

References

Herald, D. "SAO97883 – a new double star", *JDSO*, **5**, No 4, 2009.

Loader B. "Lunar Occultations of Known Double Stars – Report #1", *JDSO*, **6**, No 3, 2010.

Loader B. "Lunar Occultations of Double Stars – Report #2", *JDSO*, **7**, No 3, 2011.

Loader B. "Lunar Occultations of Double Stars – Report #3", *JDSO*, **8** No 4, 2012.

Loader B. "Lunar Occultations of Double Stars – Report #4", *JDSO*, **10** No 2, 2014.

Loader B. "Lunar Occultations of Double Stars – Report #5", *JDSO*, **12** No 2, 2016.

Loader B. "Lunar Occultations of Double Stars – Report #6, *JDSO*, **13** No 4, 2017.

Herald D. "Two New Double Stars from Lunar Occultations, SAO 117948 and TYC 1310-16-1", *JDSO*, **10**, No 2, 2014.

Loader B. "A Possible New Double Star from Lunar Occultation, SAO 163677", *JDSO*, **10**, No 1, 2014.

Gault D. "A New Double Star Observed During Lunar Occultation, HIP 18473", *JDSO*, **10**, No 1, 2014.

Dave Herald's "Occult" can be downloaded from: www.lunar-occultations.com/iota/occult4.htm.

The program "Limovie" by K. Miyashita can be downloaded from: http://astro-limovie.info/limovie/limovie_en.html.

The Figures

The following figures present the discovery light curves of stars found to be double at a lunar occultation. In most cases there is only one observation, although a few have more but no solution was possible. The curves have been generated using Kazuhisa Miyashita's Limovie program to analyze the video record.

The horizontal axes, effectively time, show the frame number of the video. The vertical axes show the light intensity of the star as measured by pixel brightness. In some cases measures have been made for each frame of the video recording, that is 30 frames per second for NTSC videos, 25 fps for PAL videos. Otherwise measures have been made for each field of the video, with two fields in a frame, giving 60 fields per second for NTSC or 50 for PAL. Which has been used is indicated at the top of the plot, usually following the name of the observer.

The step in the light curve occurs when only one of the pair of stars is visible, the other being hidden by the moon. In most cases the step is clear. The points on the step which are used to measure the light intensity are marked with a red cross. The points used to measure the light intensity when both stars are visible and those used to measure the background, both stars hidden, are colored green. Usually the results from the measures, including the calculated magnitudes of the two stars have been added to the diagram.

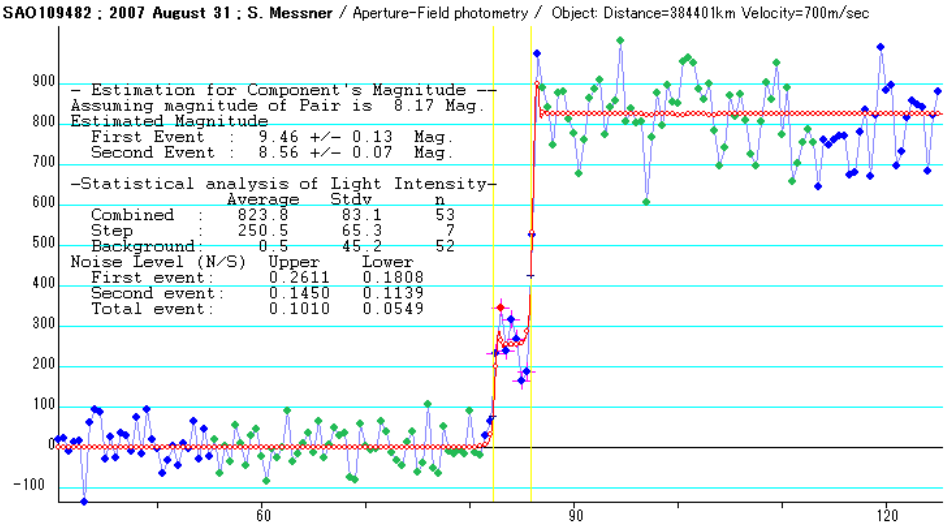


Figure 1. Occultation reappearance of TYC0604-01110-1 (SAO109482). The fainter star appeared first, 0.12 second before the brighter star.

Lunar Occultation Observations of Double Stars – Report #7

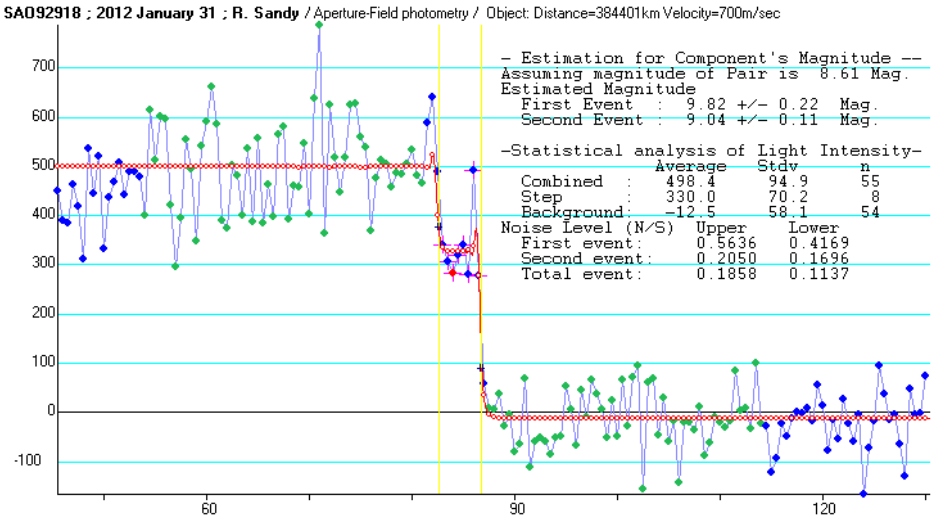


Figure 2: Occultation disappearance of TYC1215-00520-1 (SAO 92918). The fainter star disappeared first, 0.14 second before the brighter.

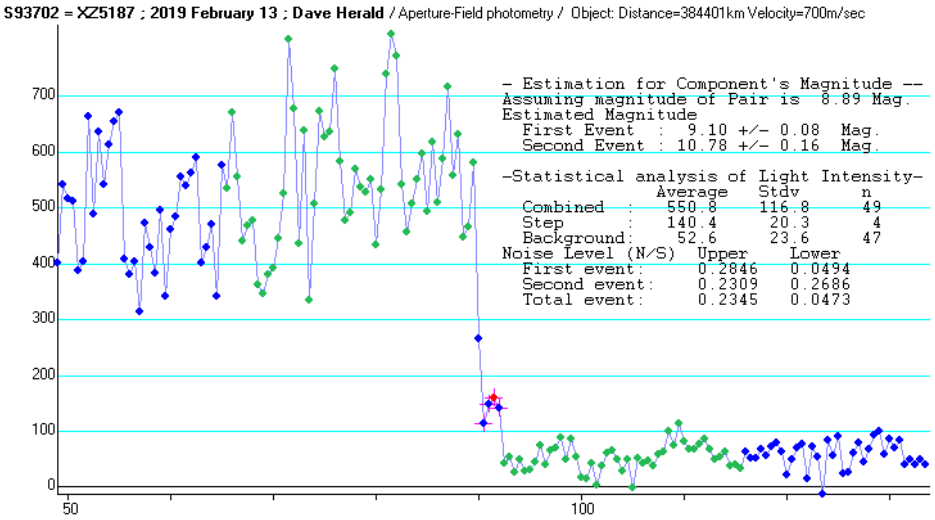


Figure 3: Occultation disappearance of TYC1253-00461-1 (SAO 93702). The brighter star was first to disappear with the step lasting for 0.08 second.

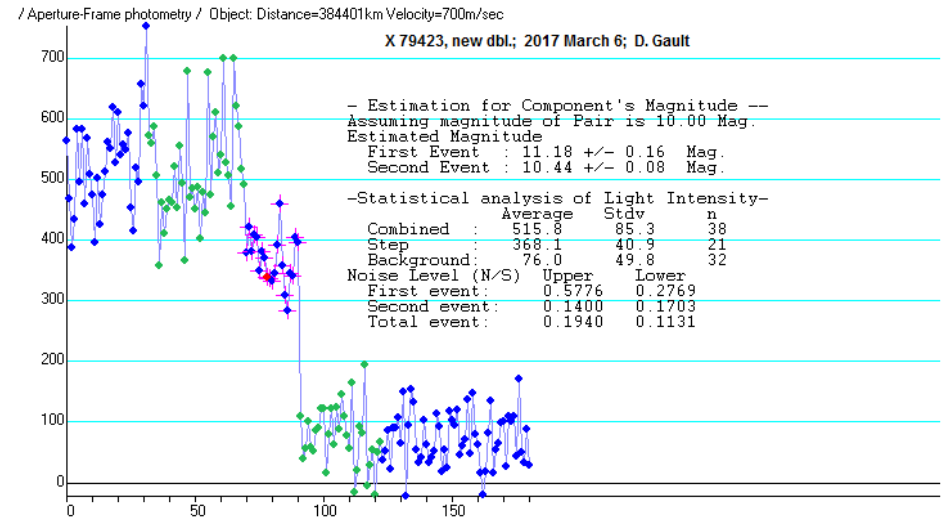


Figure 4. Occultation disappearance of TYC 1320-01983-1 (XZ 79423). The fainter star disappeared 0.84 second before the brighter.

Lunar Occultation Observations of Double Stars – Report #7

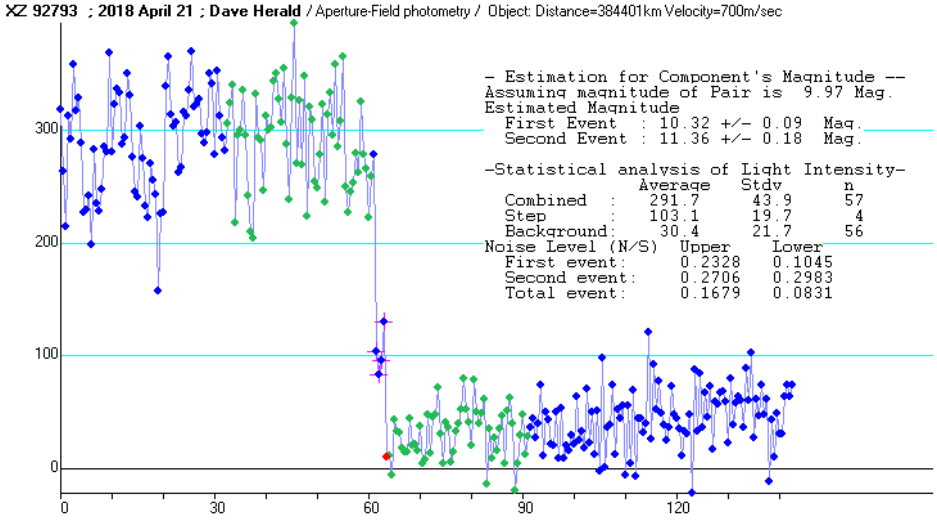


Figure 5. Occultation disappearance of TYC 1342-01830-1 (XZ 92793) with a 0.08 second step. The fainter star was the second to disappear.

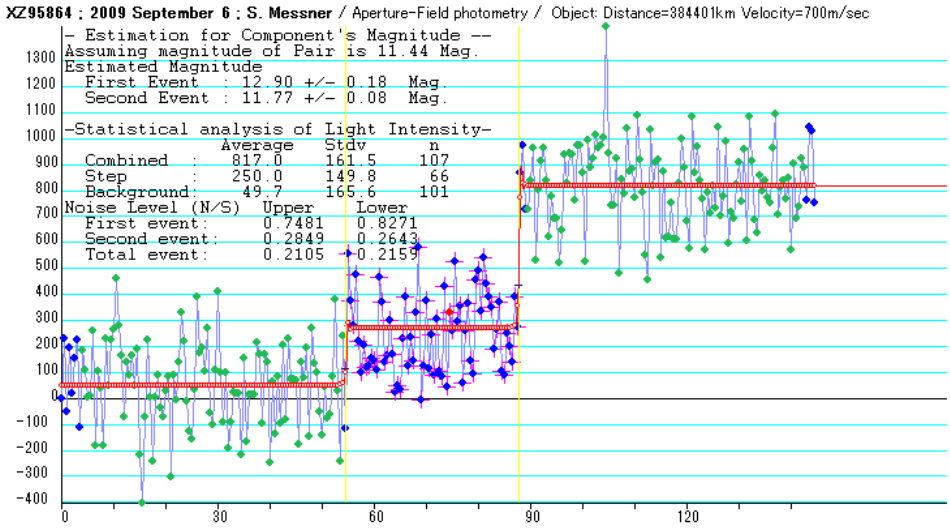


Figure 6. Occultation reappearance of TYC 1902-00526-1 (XZ 95864). The step lasts for 1.11 second with the fainter star being occulted first.

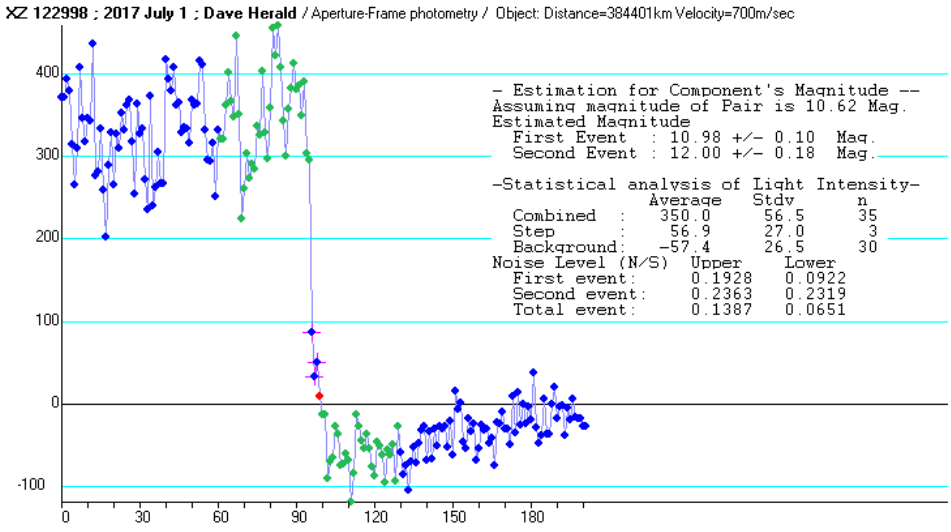


Figure 7. Occultation disappearance of TYC 0283-00658-1 (XZ122998) shows a step lasting for 0.12 second, measured at PAL frame rate. The brighter star was the first to disappear.

Lunar Occultation Observations of Double Stars – Report #7

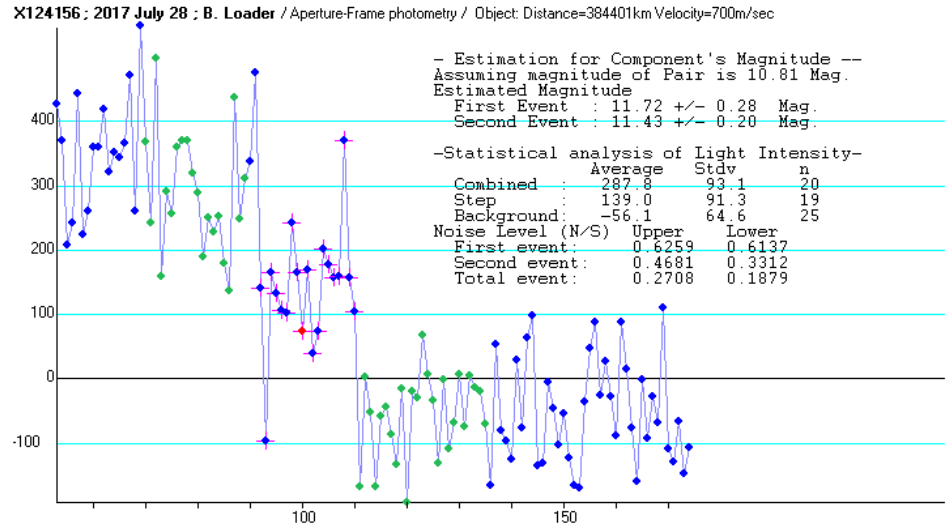


Figure 8. A noisy light curve of the occultation of TYC 0290-00520-1 (XZ124156). The step lasts for 0.76 second with the fainter star occulted first.

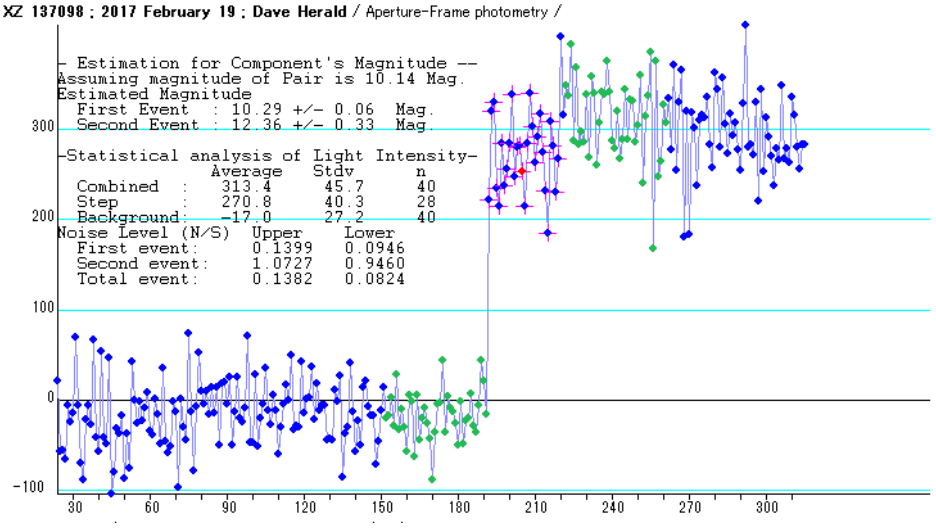


Figure 9. Light curve for the occultation reappearance of TYC 6217-00770-1 (XZ137098). The step lasts for 1.12 second, with the brighter star appearing first.

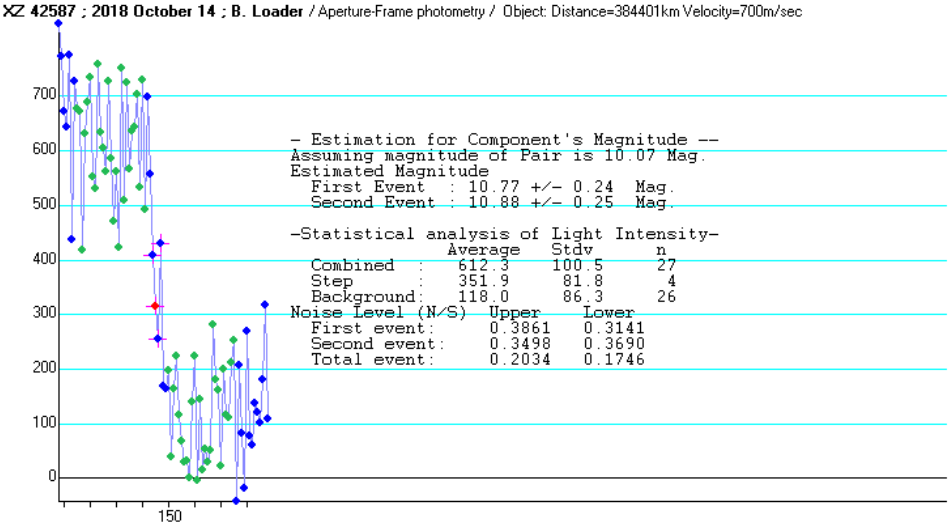


Figure 10. The light curve for the occultation disappearance TYC 6256-01444-1 (XZ42587) shows a likely brief step lasting 0.08 second. The slightly fainter star was the second to disappear.

Lunar Occultation Observations of Double Stars – Report #7

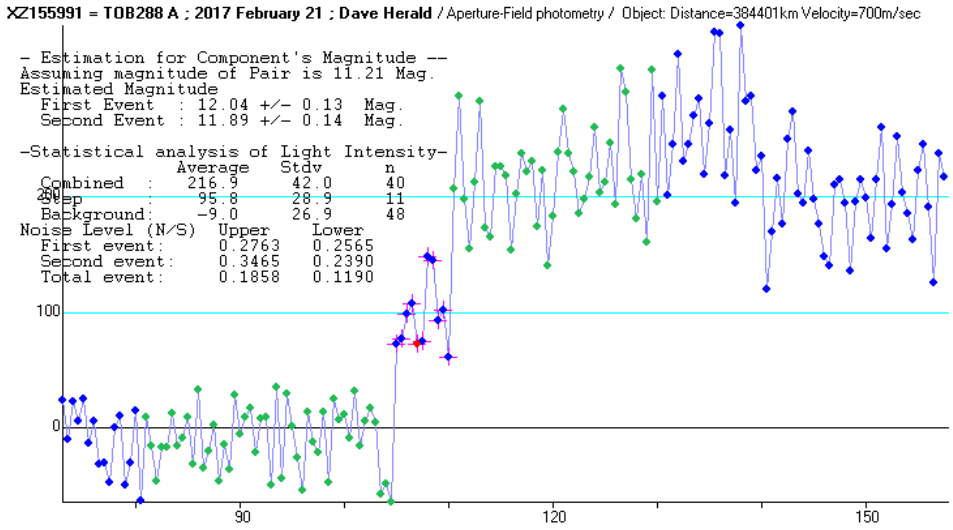


Figure 11. Light curve for the reappearance of TYC 6269-03059-1 (XZ155991) shows a step lasting for 0.22 second. The fainter star probably appeared first but the magnitude difference is small. The observations indicates TOB 288 A is itself double.

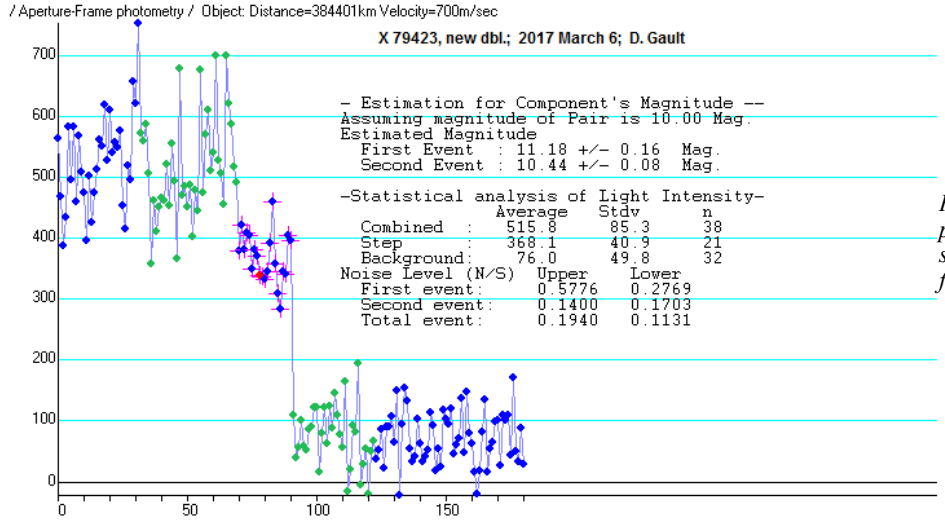


Figure 12. The light curve for the disappearance of TYC 1320-01983-1 (XZ 79423) shows a step lasting for 0.84 second. The fainter star disappeared first.

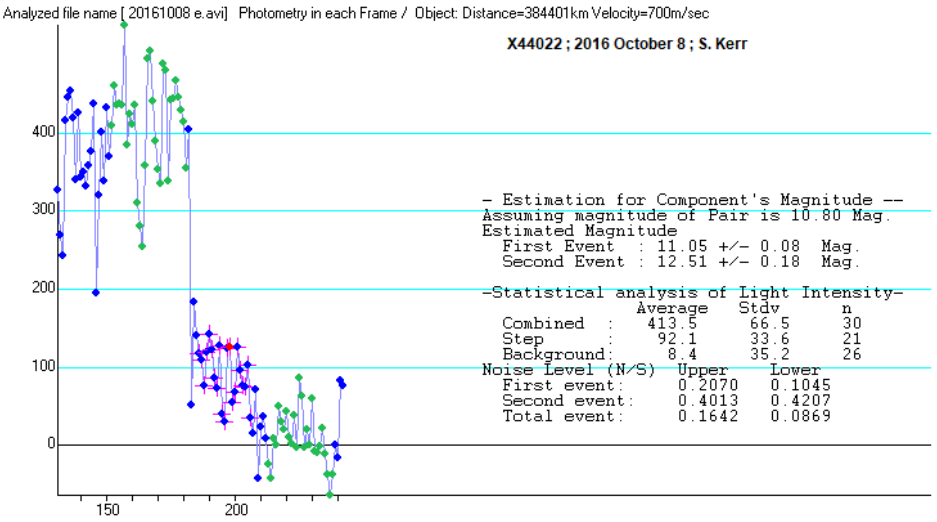


Figure 13. The light curve for the disappearance of TYC 6270-00109-1 (XZ 44022) shows a step lasting for 1.04 second. The brighter star was occulted first

Lunar Occultation Observations of Double Stars – Report #7

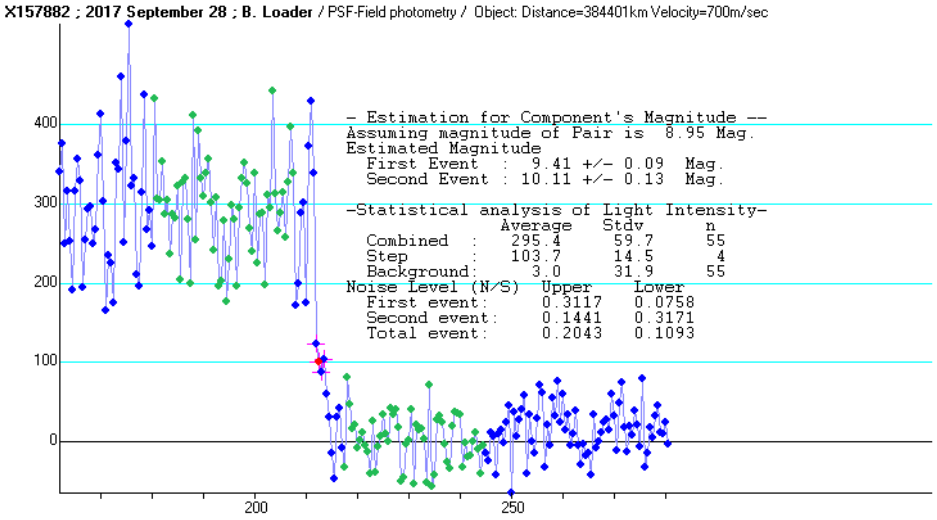


Figure 14. The light curve for the occultation of TYC 6274-01331-1 (XZ157882) shows a brief 4 field step lasting 0.08 seconds. The brighter star disappeared first.

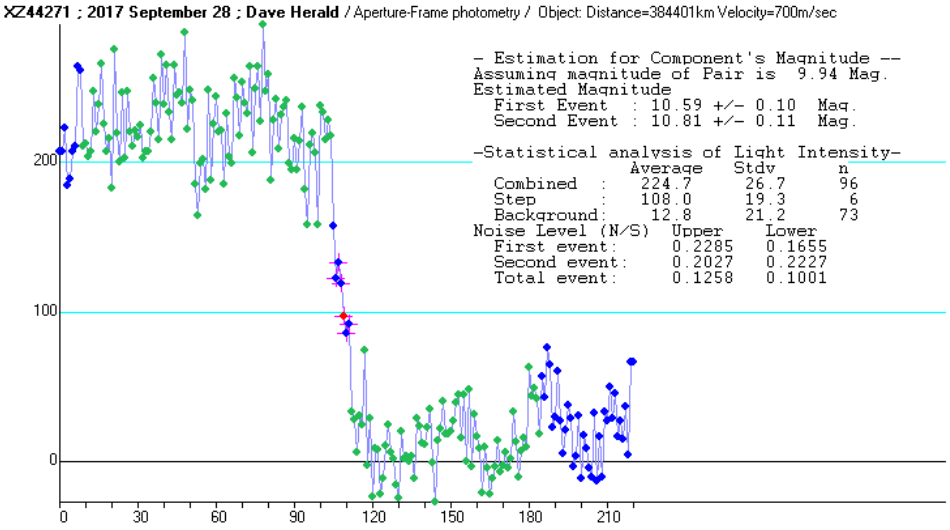


Figure 15. The light curve for occultation of TYC 6275-00749-1 (XZ 44271) shows a 6 frame, 0.24 second step. The fainter star was occulted first.

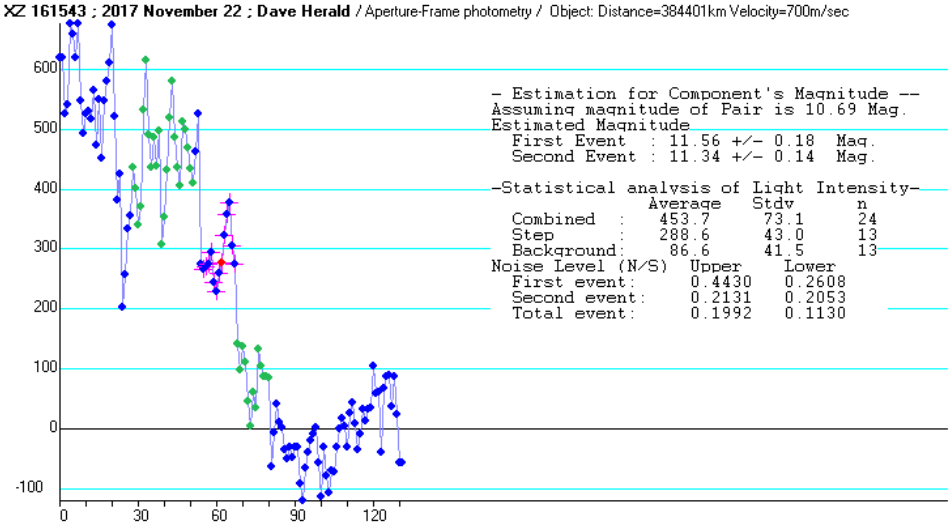


Figure 16. The light curve for the occultation of TYC 6289-01280-1 (XZ161543) shows a 0.56 second step. The fainter star disappeared first.

Lunar Occultation Observations of Double Stars – Report #7

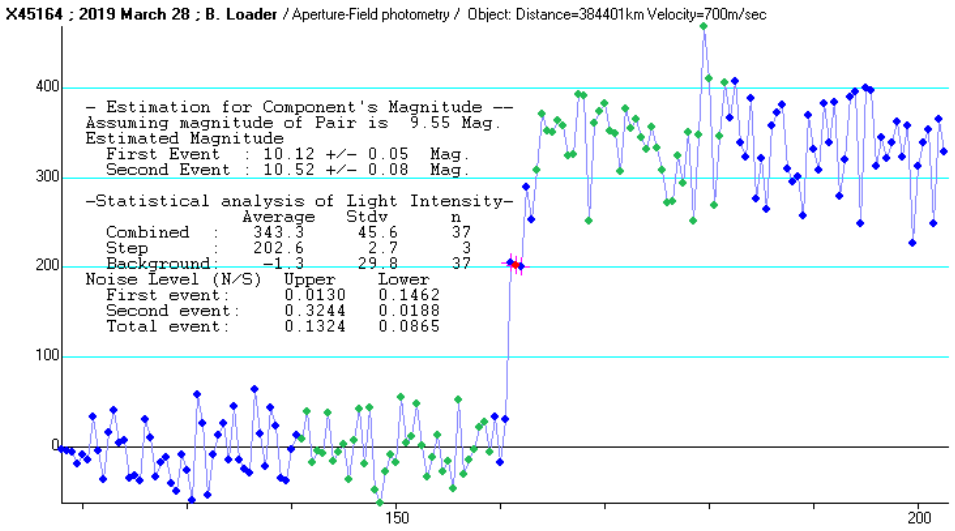


Figure 17. The light curve for the reappearance of TYC 6294-00379-1 (XZ 45164) shows a brief 3 field step lasting 0.06 second. The brighter star appeared first.

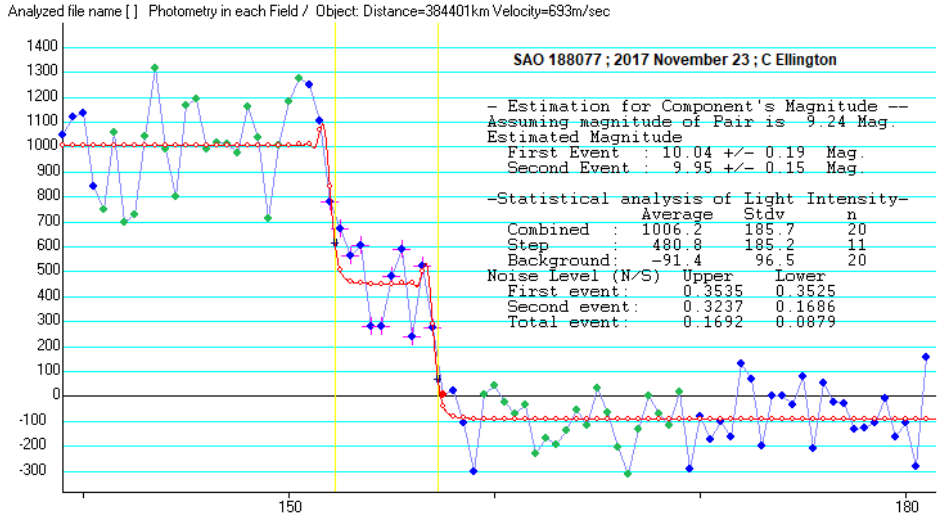


Figure 18. The light curve of the occultation of TYC 6305-01605-1 (SAO188077) shows a step lasting for 0.17 second. The fainter star was apparently occulted first but the apparent magnitude difference of the components is only 0.09.

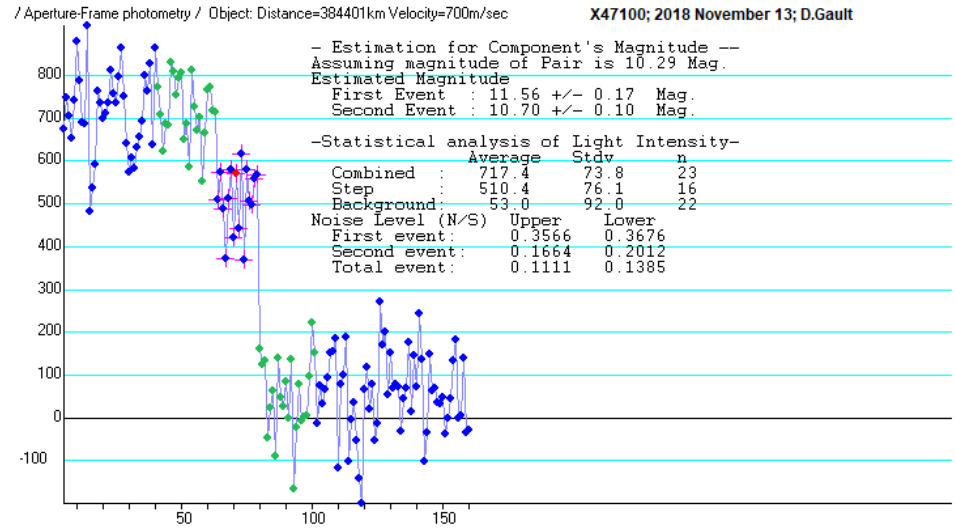
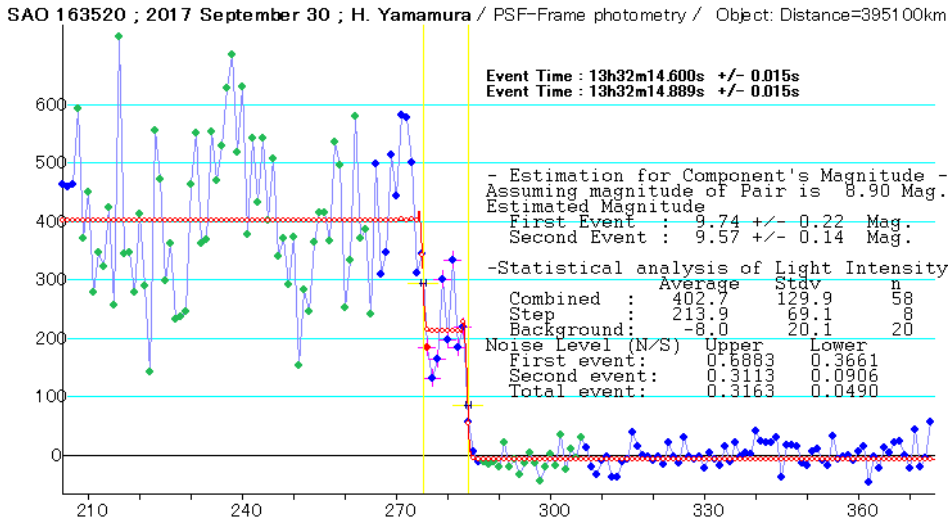
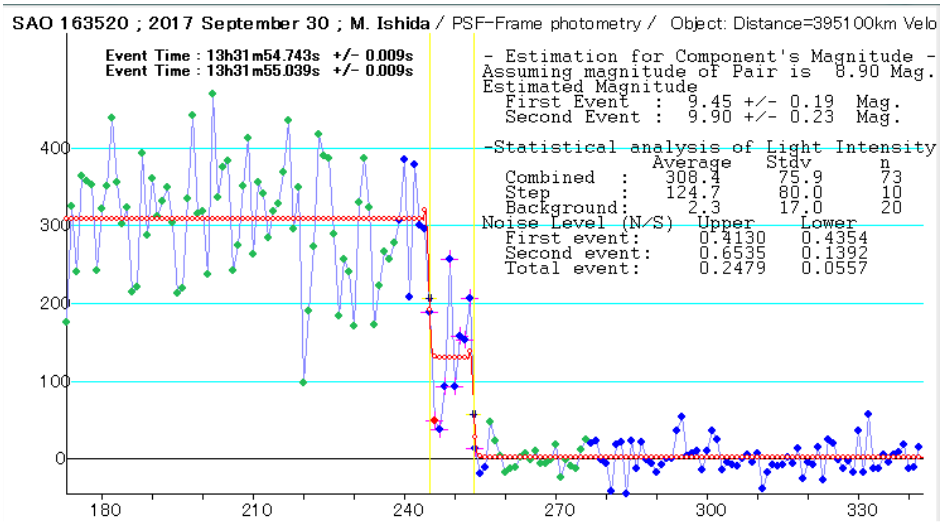
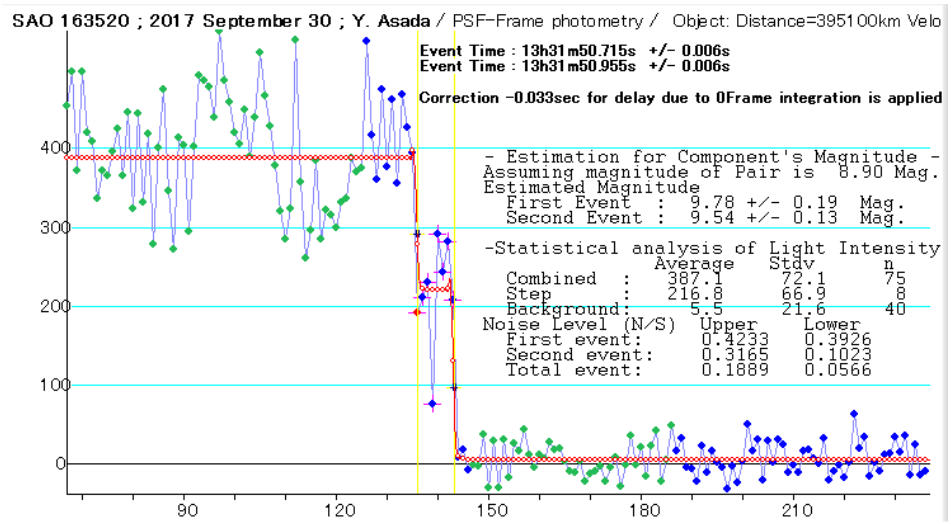


Figure 19. The light curve for the occultation of TYC 6321-01088-1 (XZ 47100) shows a 0.64 second step. The fainter star was clearly occulted first.

Lunar Occultation Observations of Double Stars – Report #7







Figures 20, 21, and 22. The occultation of TYC 6332-01468-1 (SAO 163520) was observed by three Japanese observers, H. Yamamura, M. Ishida and Y. Asada, on the same night. The three occultations were too close to each other on the moon's limb to obtain a solution of the double. The observed lengths of the step were all close to 0.25 second. The magnitude observed differences are more variable with M Ishida's curve showing the brighter star as occulted first.

Lunar Occultation Observations of Double Stars – Report #7

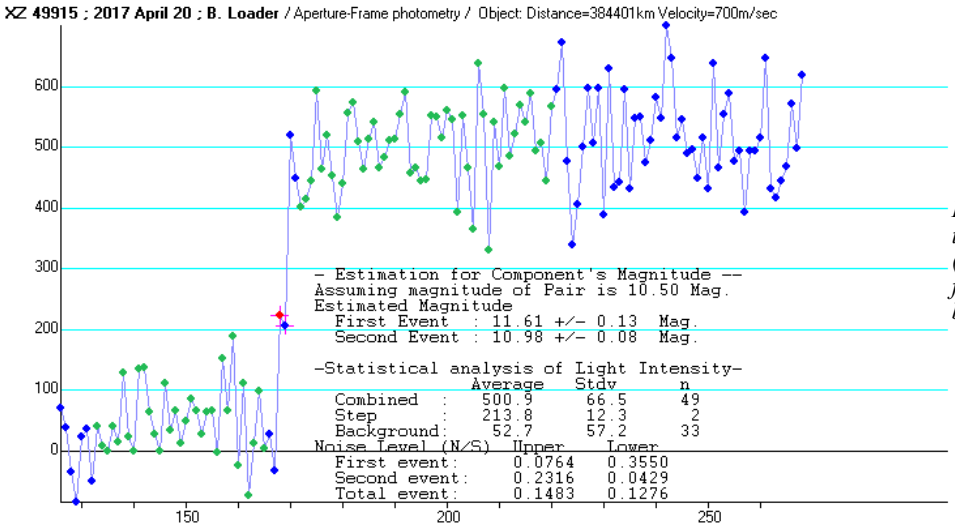
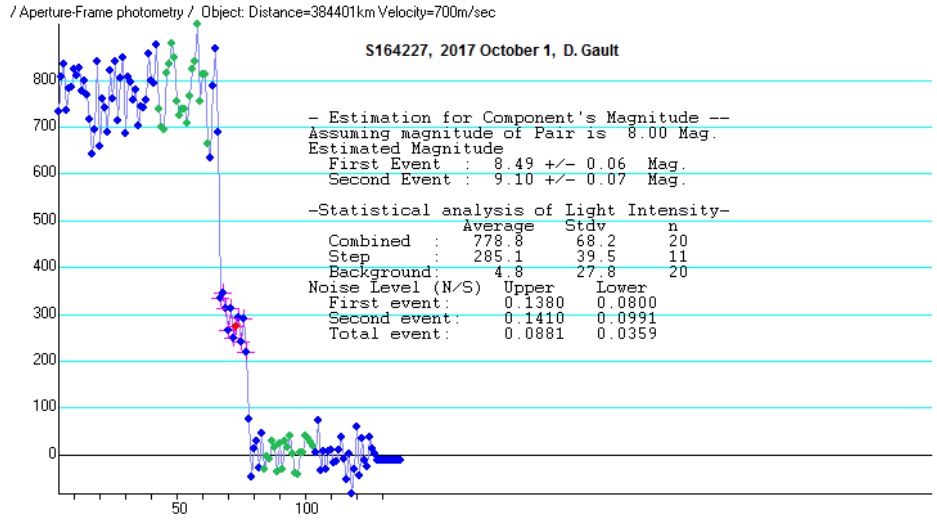
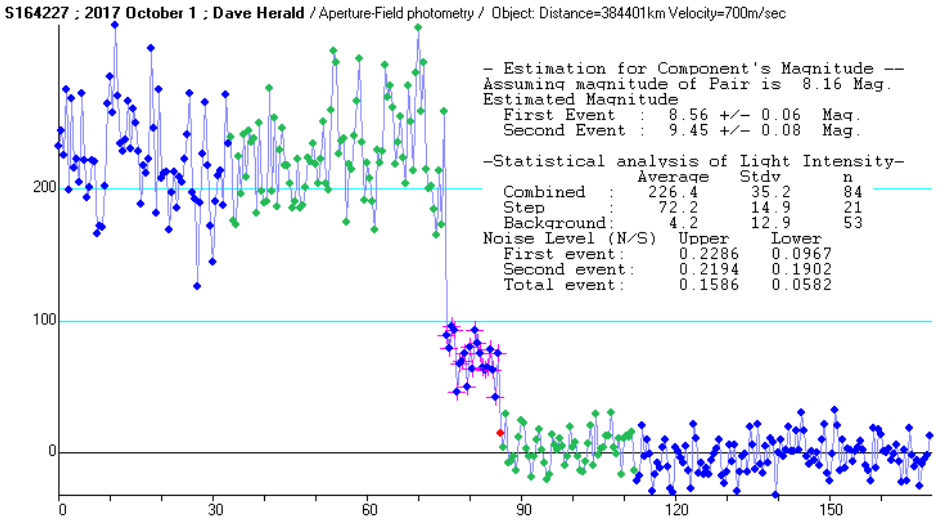


Figure 23. The light curve for the occultation reappearance of TYC 5784-00577-1 (XZ 49915) lasts only 0.08 second. The fainter star was the first to appear from behind the moon.





Figures 24 & 25. Both D. Gault and D. Herald observed this occultation of TYC 5784-00642-1 (SAO164277). The positions on the moon's limb of their two events differed by only 2.1°, too small to obtain a solution of the double. The lengths of the observed steps were similar, 0.42 second for Herald and 0.44 for Gault. The brighter star was occulted first.

Lunar Occultation Observations of Double Stars – Report #7

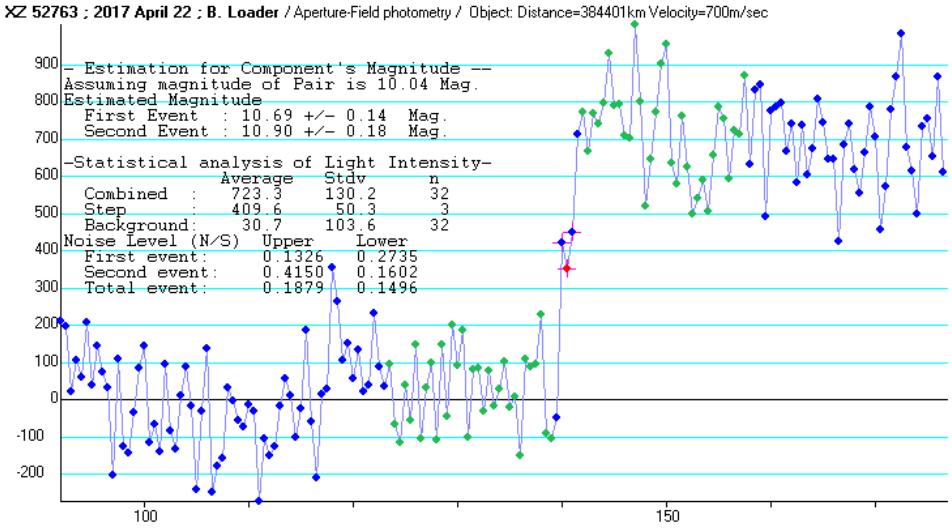


Figure 26. The light curve for the occultation reappearance of TYC 5241-00846-1 (XZ 52763) shows a very brief ca 0.06 second step with the brighter star being the first to appear.