Double Star Measures Using the Video Drift Method - VII

Richard L. Nugent
International Occultation Timing Association
RNugent@wt.net

Ernest W. Iverson
International Occultation Timing Association
ewiverson@consolidated.net

Abstract: Position angles and separations for 226 multiple star systems are presented using the video drift method.

Introduction

This is paper seven in the continuing series in double star measurements using the video drift method first proposed by Nugent and Iverson 2011. A significant advantage of this method is that data collection and subsequent data analysis is almost completely automated with little human interaction. A short video clip of the multiple star system drifting across the field of view is evaluated by the freeware program *Limovie* (Miyashita, 2006) to capture 100's to 1,000's of (*x*,*y*) positions (aka "standard coordinates") for each component. Although *Limovie* was originally written to measure the change in light levels during an occultation, it also produces a table of standard (*x*,*y*) coordinates for both components along with their brightness levels for each video frame. *VidPro*, an Excel program written by co-author Nugent, reads the (*x*,*y*) coordinate data and computes the position angle, separation for each video frame. The position angles and separations are then averaged over all video frames to give a final result.

Each double star drift is self calibrating. The *VidPro* program computes a unique scale factor, an offset from the east-west direction compared to the camera's pixel array (drift angle), and standard deviations for both position angle and separation for each drift. Using the (*x*,*y*) positions of each star for each video frame across the field of view, the offset of the video camera's chip from the true east-west direction is calculated using the method of least squares to an accuracy of better than 0.02°.

Methodology

Preference was given to multiple star systems where the WDS lacked measurements for a minimum of 10 - 15 years and had less than 10 measurements. This criterion applies to most of the multiple star systems measured at the epoch of their measurement. In some cases where one component of a complex system meets this requirement, all of the other components within the reach of our telescopes were also measured for completeness even though they have been well measured in the past. We routinely look at a few well measured doubles to support ongoing efforts to compare the video drift method with other measurement methods. The faintest system measured in Table 2 had primary / secondary magnitudes of +13.2 / +16.9. Thirty-five systems had WDS magnitudes in the +14.0 to +15.6 range.

For systems in which either primary and/or secondary star magnitude exceeded *m* = +12, co-author Iverson used a variation of the drift method employing an integrating video camera (Iverson and Nugent 2015). Co-author Nugent uses a Collins I^3 image intensifier with his 14-inch SCT telescope and routinely reaches *m* = +14 to +15.

With some doubles not measured since the early 1900's, significant deviations in position angle and sep-

aration were sometimes observed. This is not surprising. These doubles were checked with the interactive *Aladin Sky Atlas* webpage (from the Centre de Données astronomiques de Strasbourg) to verify that the stars originally observed were identified and re-measured by us. Updated proper motions were taken into account from catalogs from the *VizieR* database to confirm the observed changes in PA and separation.

Other doubles showed a significant deviation from the WDS summary catalog value. The observational history was obtained from the U.S. Naval Observatory and both the position angle and separation were plotted against the year of observation. In most cases the data conformed to a general trend line. In a few cases the fit was very good and the least squares correlation coefficient was greater than 0.90. Graphing the data also showed which measurements were obviously in error. These were rejected and not included in Table 2. Just comparing a new measurement to the WDS summary catalog value and noting a large difference might cause an observer to incorrectly reject the new measurement when in fact it might be a very good measurement.

Calibration

In our previous paper (Nugent and Iverson, 2014), we discussed how to make a one-time calibration to set the correct aspect ratio for the hardware configuration used for the recording of the videos. This calibration makes a slight adjustment to the video aspect ratio (width vs. height) to overcome the unavoidable skewing of the image aspect ratio caused by modern digital video recorders. With this one-time video size adjustment (done automatically using an AviSynth script when *Limovie* opens the video file), our video aspect ratios closely matched the sky in the east-west and north-south directions. To confirm this, we measured long term stable doubles with no change in PA, Sep and also used RA, DEC coordinates from the *VizieR* online star catalogs to compute the angular displacement and separation of known stars.

The telescope equipment used and scale factors are summarized in Table 1.

Acknowledgements

This research makes use of the *Washington Double Star Catalog* maintained at the US Naval Observatory, the *Aladin Sky Atlas* Interactive webpage and the *VizieR* catalog database from the Center de Données Astronomiques in Strasbourg, France.

References

Aladin Interactive Sky Atlas, Centre de Données Astronomiques de Strasbourg, http://aladin.u-strasbg.fr/java/nph-aladin.pl.

Iverson, E. and Nugent, R., 2015, *Journal of Double Star Observations*, **11**, 91-97.

Miyashita, K. 2006, *Limovie, Light Measurement Tool for Occultation Observation Using Video Recorder,* http://www005.upp.so-net.ne.jp/k_miyash/occ02/limovie_en.html.

Nugent, R. and Iverson, E. 2011, *Journal of Double Star Observations*, **7**, 185-194.

VizieR catalogue data base: Centre de Données Astronomiques de Strasbourg, http://vizier.u-strasbg.fr/viz-bin/VizieR.

Table 1. Telescopes/cameras used in this research.

Telescope	Aperture	Focal Length	Scale Factor*	Video Camera**
Meade LX-200GPS ACF optics	14”(35 cm)	3556mm f/10	0.62”/pixel	Stella Cam 3
Meade LX-200GPS Classic	14”(35 cm)	3556mm f/10	0.6”/pixel	Watec 902H Ultimate

*Scale factors will vary slightly due to the declination of the target.

**To reach fainter doubles E. Iverson uses the Stella Cam 3 integrating camera; R. Nugent uses a Watec 902H Ultimate camera with the Collins I^3 image intensifier.

Double Star Measures Using the Video Drift Method - VII

Table 2. Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No. of (x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
00018-1912	HJ 3232	338.1	2.6	13.9	0.61	2015.860	1581	10.44	12.90	2	1
00049-1320	GAL 295	19.7	1.1	38.8	0.69	2015.860	1496	10.65	11.74	2	1
00059-1426	HJ 3238	239.8	1.1	33.6	0.62	2015.860	1423	9.65	11.75	2	1
00066-1101	GAL 3AB,C	14.7	3.7	6.8	0.56	2015.860	1540	10.56	10.80	2	1
00069-3036	HDS 10	193.9	1.7	19.8	0.47	2015.860	1719	10.31	12.00	2	1
00110-0627	J 1432	269.9	2.6	6.6	0.43	2015.860	1479	11.10	12.70	2	1
00111-2239	HJ 3351	134.9	2.1	11.5	0.46	2015.860	1600	11.33	11.28	2	1
00120-1600	ARA 8	132.3	2.2	10.5	0.42	2015.860	1556	11.50	12.10	2	1
00136-2202	ARA1599	119.3	2.2	5.5	0.24	2015.860	2408	10.92	12.50	2	1
00144-1424	GAL 296	100.6	0.9	24.0	0.34	2015.860	1444	6.5	11.00	2	1
00146-3604	HJ 3354	334.5	2.0	16.7	0.53	2015.860	1848	10.48	11.05	2	1
00147-1245	HDO 7	5.5	0.8	6.5	0.21	2015.860	1514	8.11	11.15	2	1
00148-2859	RSS 1	320.9	0.6	55.5	0.52	2015.860	1573	10.23	10.31	2	1
00158-1159	STF 14	235.8	2.3	14.4	0.59	2015.860	1501	8.90	10.85	2	1
00175+0019	STF 23AB	215.9	0.6	10.34	0.12	2015.945	6025	7.88	10.28	8	1
00594+0047	STF 80AB	338.3	0.2	29.40	0.13	2015.945	6024	7.82	9.05	8	1
01038+0122	STF 84AB	253.3	0.5	15.97	0.14	2015.945	5882	6.11	9.52	8	1
01488-0125	STF 171AB	164.5	0.2	34.07	0.13	2015.945	6021	9.61	9.74	8	1
02245-0145	STF 265	136.0	0.5	12.21	0.12	2015.945	6066	9.14	9.57	8	1
02249-0207	STF 266	266.6	0.5	7.72	0.10	2015.945	6109	9.10	9.25	8	1
02260+2324	POU 187AB	320.1	2.1	8.7	0.39	2015.858	1529	11.10	12.80	2	1
02260+2324	UC 738AC	215.9	0.4	54.5	0.31	2015.858	1424	11.10	11.65	2	1
02425-0119	BAL 279	41.4	1.0	6.06	0.11	2015.945	6063	10.07	10.24	8	1
02579+0025	STF 332	53.8	0.5	12.06	0.10	2015.945	5727	8.94	9.10	8	1
03598+1133	STF 478AB	137.4	0.7	9.62	0.13	2015.951	6158	8.83	10.22	8	1
04065+1422	S 443AB	103.9	0.2	40.15	0.12	2015.951	5763	8.99	9.53	8	1
04065+1422	S 443AC	309.4	0.0	187.78	0.12	2015.951	3836	9.00	7.36	8	1
04459+1911	AG 311AB	112.2	0.2	33.00	0.12	2015.951	6023	8.90	9.32	8	1
04472+2027	KU 85	32.6	0.2	33.52	0.10	2015.951	6291	9.64	10.45	8	1
04486+1748	STF 598	317.0	0.7	9.15	0.11	2015.951	6347	8.10	9.96	8	1
05192+2008	STF 680	201.9	0.8	9.43	0.13	2015.951	5797	6.22	9.66	8	1
05217+1854	KU 87AB	103.9	0.2	35.94	0.12	2015.951	5988	7.85	9.98	8	1
05223+3348	STF 687AB	69.0	0.9	17.1	0.24	2016.173	1750	8.69	9.77	2	1
05223+3348	ABH 29AF	174.9	0.5	69.3	0.48	2016.173	865	8.69	13.21	1	1
05223+3348	STF 687A,CD	154.6	0.3	48.2	0.25	2016.173	1745	8.69	10.22	2	1
05281+3519	SEI 268AB	221.4	2.5	8.6	0.33	2016.173	1655	10.8	11.0	2	1
05281+3519	SEI 267AC	217.3	1.5	15.7	0.34	2016.173	1679	10.8	11.0	2	1
05281+3519	SEI 269AD	147.0	1.3	19.9	0.39	2016.173	1664	10.8	11.0	2	1
05281+3519	SEI 265AF	301.0	1.3	27.4	0.46	2016.173	1599	10.8	11.0	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VII

Table 2(continued). Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
05281+3519	BKO 241AG	2.2	1.1	22.9	0.53	2016.173	1703	10.8	13.1	2	1
05281+3519	BKO 241DH	100.3	2.0	11.6	0.35	2016.173	1675	11.0	13.3	2	1
05281+3520	BKO 240AB	146.0	1.7	12.8	0.31	2016.173	1752	11.9	12.8	2	1
05281+3520	BKO 240AC	65.7	1.9	17.1	0.42	2016.173	1714	11.9	12.6	2	1
05281+3520	BKO 240AD	356.2	1.3	19.7	0.41	2016.173	1756	11.9	12.5	2	1
05281+3520	BKO 240CF	125.9	3.0	9.7	0.46	2016.173	1768	12.6	13.1	2	1
05298+1825	HJ 3275AC	21.4	0.1	56.10	0.11	2015.951	6184	7.65	8.22	8	1
05364+2111	STF 740	120.9	0.3	21.64	0.12	2015.951	6287	9.01	9.93	8	1
05381-0011	S 493AE	262.8	0.0	138.31	0.12	2015.052	3793	7.96	8.67	8	1
05381-0011	STF 758AC	87.3	0.1	51.34	0.11	2015.052	5210	7.96	8.69	8	1
05381-0011	STF 758AD	79.4	0.2	41.92	0.11	2015.052	5163	7.96	8.52	8	1
05381-0011	STF 758CD	297.9	0.5	11.35	0.10	2015.052	5678	8.69	8.52	8	1
05421+2135	STF 772AB,C	242.8	0.2	30.62	0.10	2015.951	6107	8.88	9.65	8	1
05456+2141	J 1905	264.0	1.9	5.83	0.21	2015.951	1014	10.55	10.9	3	1
05526-2328	ARA1995	93.9	1.4	11.7	0.33	2016.173	2294	12.9	13.4	3	1
05529+1609	SKF2493	270.0	1.4	10.2	0.41	2016.173	1537	11.0	11.5	2	1
05530+2400	POU 802AB	316.5	2.1	11.5	0.38	2016.173	1556	10.43	13.3	2	1
05530+2400	POU 803AC	78.8	1.5	16.0	0.40	2016.173	1528	10.43	13.98	2	1
06031+1248	BRT1193AB	110.0	1.2	5.41	0.06	2015.134	10214	10.6	11.0	6	1
06031+1248	BRT1193AC	201.3	1.4	7.74	0.15	2015.134	11512	10.6	11.2	3	1
06112+2313	POU1114	165.6	3.0	12.5	0.66	2016.170	1494	11.0	14.0	2	1
06112+2315	POU1117AC	357.5	1.0	12.5	0.23	2016.170	1527	12.8	12.6	2	1
06115+2314	POU1123	184.6	1.1	7.1	0.22	2016.170	834	11.31	14.1	2	1
06170+2342	POU1189	237.3	3.3	8.1	0.46	2016.173	1621	11.6	13.6	2	1
06220+2429	POU1260	241.5	2.0	17.2	0.55	2016.170	1612	13.0	14.3	2	1
06225-2003	ARA 542	115.5	1.8	10.8	0.36	2016.170	1587	12.6	13.5	2	1
06348+0819	BRT2120	82.8	3.8	3.3	0.43	2016.170	1465	11.0	10.3	2	1
06357+2258	POU1556AB	129.6	2.9	11.7	0.53	2016.170	1027	12.4	13.8	2	1
06357+2258	POU1557AC	154.7	1.4	21.8	0.50	2016.170	998	12.4	14.4	2	1
06359+2258	POU1574AB	167.5	1.4	16.6	0.39	2016.170	1607	13.31	15.27	2	1
06361+2257	POU1579	47.9	2.3	11.6	0.43	2016.173	2400	13.2	14.2	3	1
06363+2300	POU1592	145.6	2.7	16.4	0.71	2016.170	1575	13.7	14.1	2	1
06364+2257	POU1598	35.2	3.6	11.7	0.71	2016.170	1532	13.0	14.0	2	1
06365+2252	POU1604	186.3	2.1	9.7	0.38	2016.170	1625	11.4	14.3	2	1
06367+2259	POU1613	12.8	2.3	13.7	0.51	2016.170	1606	11.41	13.8	2	1
06368+2255	POU1619AB	30.0	2.8	6.9	0.36	2016.170	1555	11.9	13.1	2	1
06368+2255	POU1620AC	62.4	2.4	9.8	0.38	2016.170	1609	11.9	14.4	2	1
06375+2259	POU1670	260.7	2.3	14.3	0.63	2016.170	1558	11.37	14.0	2	1
06381+2305	POU1710	119.5	3.1	13.1	0.72	2016.170	1500	14.1	14.5	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VII

Table 2 (continued). Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
06382+2305	POU1714	139.8	2.4	15.0	0.60	2016.170	1574	13.0	14.3	2	1
06540-0207	BAL 91	357.1	1.8	11.4	0.50	2016.173	1521	11.68	12.2	2	1
07079+1053	SIN 121AB	305.5	0.5	42.0	0.43	2016.173	1392	8.89	12.51	2	1
07079+1053	SIN 121AG	257.9	0.2	112.9	0.41	2016.173	1074	8.89	9.14	2	1
07131-0141	ARG 65	185.4	2.3	8.1	0.38	2016.178	1499	10.86	11.7	2	1
07138+0536	XMI 51	173.0	0.8	20.8	0.30	2016.178	1526	10.93	11.36	2	1
07139+0809	XMI 52	335.8	1.0	20.8	0.36	2016.178	1494	11.38	11.40	2	1
07140-0101	BAL 781	188.3	2.0	11.6	0.40	2016.178	1498	12.15	12.22	2	1
07141-0053	BAL 782	243.4	1.4	16.6	0.40	2016.178	1472	12.17	13.0	2	1
07144-1519	ROE 26AB	120.5	1.5	8.7	0.26	2016.178	1279	9.71	13.1	2	1
07144-1519	ROE 26AC	50.5	0.4	52.0	0.28	2016.178	1869	9.71	12.69	2	1
07156+0024	BAL1090	221.8	1.6	15.6	0.49	2016.178	1474	11.26	11.7	2	1
07255-1914	ARA 581	94.0	1.8	11.1	0.42	2016.175	1449	11.7	12.8	2	1
07258+0107	BAL1402	6.3	1.2	16.3	0.34	2016.175	1513	11.19	11.27	2	1
07258-2020	ARA 925	337.6	3.5	6.1	0.41	2016.175	1517	10.69	11.5	2	1
07258-2228	ARA1687	83.2	2.4	6.4	0.30	2016.175	1541	10.44	12.7	2	1
07260-2041	ARA 927	123.7	2.4	11.0	0.51	2016.175	1466	11.6	11.49	2	1
07260-2142	ARA1338	191.0	2.2	10.1	0.37	2016.175	1595	12.3	12.4	2	1
07261-2146	ARA1339	64.6	1.8	9.1	0.37	2016.175	1586	10.48	12.3	2	1
07261-2409	ARA2048AB,C	338.0	1.6	11.8	0.31	2016.175	1409	9.2	11.7	2	1
07264-0111	BAL 810	297.3	2.5	12.6	0.66	2016.175	1456	11.0	11.1	2	1
07266-0016	BAL 812	128.8	1.5	11.3	0.40	2016.175	1438	12.15	11.02	2	1
07266-0033	BAL 811	176.4	1.7	11.1	0.48	2016.175	1501	11.3	11.4	2	1
07268-2213	ARA1688	241.2	0.6	12.1	0.12	2016.175	1516	10.9	11.7	2	1
07269-1937	ARA 583	137.3	1.4	13.7	0.36	2016.175	1559	10.53	10.7	2	1
07270-2109	ARA 929	197.0	1.4	14.8	0.34	2016.175	1591	11.40	11.72	2	1
07270-3046	B 1544AB	205.4	2.2	6.3	0.19	2016.175	1656	9.15	10.68	2	1
07270-3046	B 1544AC	148.9	0.1	145.1	0.23	2016.175	1005	9.15	11.79	3	1
07272-0535	J 2632AB	71.9	0.5	34.0	0.32	2016.175	1352	9.29	11.98	2	1
07272-0535	J 2632BC	143.9	3.0	5.1	0.28	2016.175	1449	12.5	13.0	2	1
07273-2355	ARA2050AB	42.7	2.0	12.5	0.41	2016.175	1616	10.99	12.21	2	1
07273-2355	ARA2050AC	193.7	0.8	9.4	0.17	2016.175	1631	10.99	12.80	2	1
07273-2355	ABH 67AD	249.0	0.5	40.1	0.38	2016.175	1471	10.99	9.48	2	1
07273-2355	ABH 67AE	244.8	0.2	54.9	0.23	2016.175	1445	10.99	14.2	2	1
07273-2355	ABH 67AF	246.8	0.4	92.2	0.59	2016.175	1264	10.99	13.72	2	1
07273-2355	ABH 67AG	275.3	0.2	125.2	0.50	2016.175	1132	10.99	12.99	2	1
07273-2355	ABH 67AH	204.4	0.4	80.8	0.52	2016.175	1483	10.99	13.61	2	1
07273-2355	ABH 67AI	38.1	0.5	69.8	0.56	2016.175	1429	10.99	13.53	2	1
07273-2355	ABH 67AJ	36.2	0.5	62.0	0.52	2016.175	1454	10.99	13.56	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VII

Table 2 (continued). Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
07273-2355	ABH 67AL	48.6	1.4	31.5	0.98	2016.175	2362	10.99	14.0	3	1
07273-2355	ABH 67AM	145.7	0.7	35.9	0.41	2016.175	1534	10.99	11.33	2	1
07273-2355	ABH 67AO	139.2	0.3	74.2	0.40	2016.175	1396	10.99	9.04	2	1
07273-2355	ABH 67AP	135.7	0.3	113.6	0.49	2016.175	1290	10.99	10.87	2	1
07273-2355	ABH 67AQ	186.8	0.4	63.3	0.37	2016.175	1536	10.99	14.9	2	1
07273-2355	ABH 67AR	172.3	0.3	57.2	0.29	2016.175	1591	10.99	14.5	2	1
07273-2355	ABH 67AS	179.0	0.3	41.8	0.27	2016.175	1621	10.99	14.3	2	1
07273-2355	ABH 67AT	189.8	0.4	31.7	0.29	2016.175	1574	10.99	14.4	2	1
07273-2355	ABH 67AV	294.8	0.6	53.3	0.56	2016.175	1401	10.99	14.86	2	1
07273-2355	ARA2052PX	50.6	1.6	13.5	0.38	2016.175	1614	10.87	11.6	2	1
07453-0026	HJ 767AB	163.3	0.8	20.8	0.33	2016.173	1481	7.99	10.64	2	1
07453-0026	SIN 31AE	27.2	1.6	28.4	2.19	2016.173	677	7.99	12.3	2	1
07459-0121	BAL 488	69.4	1.7	16.5	0.51	2016.173	1444	11.1	11.1	2	1
08088-1844	ARA 394	333.9	3.1	7.2	0.42	2016.178	1564	10.6	12.1	2	1
08091-2236	ARA1722	347.6	2.9	8.8	0.56	2016.178	1531	9.86	12.4	2	1
08104-2156	ARA1432	29.4	2.9	12.0	0.56	2016.170	1603	11.63	13.5	2	1
08105-2203	ARA1433	108.5	1.4	17.8	0.44	2016.170	1559	11.47	11.9	2	1
08108-1635	XMI 80	29.4	0.9	20.7	0.31	2016.178	1515	9.60	10.88	2	1
08113-1956	ARA 635AB	71.9	1.9	15.9	0.49	2016.178	1512	12.7	13.6	2	1
08113-1956	ARA 635BC	344.3	3.4	8.9	0.55	2016.178	1595	13.6	13.6	2	1
08115+1041	HJ 777AB	348.7	0.8	10.6	0.15	2016.178	1810	9.58	11.7	3	1
08115+1041	HJ 777AC	104.4	0.2	113.0	0.50	2016.178	1021	9.58	14.02	2	1
08123+0157	BAL1839	119.8	1.4	14.0	0.39	2016.178	1496	11.4	11.5	2	1
08127+0859	OSB 6	192.6	3.9	9.5	0.68	2016.178	1491	12.59	14.13	2	1
08129+1044	BPM 436	203.3	0.3	116.7	0.47	2016.178	1367	11.40	13.48	2	1
08133-2200	ARA1435	87.0	1.3	13.8	0.40	2016.178	1575	10.4	12.0	2	1
08135-0123	HJ 85	84.6	1.1	16.7	0.31	2016.178	1458	11.27	11.61	2	1
08135-3624	HJ 4060	178.7	0.6	21.7	0.33	2016.178	1872	8.11	10.00	2	1
08137-1407	HJ 779AB	301.8	1.0	20.1	0.37	2016.178	1488	11.16	12.3	2	1
08137-1407	HJ 779AC	130.1	1.0	21.4	0.39	2016.178	1491	11.16	12.4	2	1
08137-1407	DAM 63AD	78.2	1.8	10.6	0.34	2016.178	1508	11.16	13.6	2	1
08137-1407	DAM 63AE	177.2	1.3	12.6	0.37	2016.178	1470	11.16	13.68	2	1
08306-0247	BAL 198	67.1	1.2	17.4	0.38	2016.173	1416	11.76	12.64	2	1
08312-1100	GWP1029	325.2	0.6	57.4	0.67	2016.173	1354	11.21	14.76	2	1
08317+1924	LDS 905AB	348.6	2.6	9.7	0.44	2016.170	1564	11.90	14.01	2	1
08377+1946	STF1249	40.4	0.6	25.0	0.28	2016.170	1523	11.00	10.78	2	1
08491-1440	HJ 797	138.4	1.3	16.6	0.41	2016.175	1484	10.34	13.7	2	1
08500+1155	BPM 455	294.4	0.3	69.3	0.40	2016.175	1257	9.12	12.47	2	1
08508+1143	BPM 456	338.3	0.6	88.8	0.83	2016.175	1349	13.16	14.14	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VII

Table 2 (continued). Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
08596+0146	BAL1855	85.9	1.2	16.6	0.39	2016.175	1424	10.03	12.92	2	1
09007+1353	HJ 112	339.0	2.7	8.3	0.46	2016.175	1266	12.	13.	2	1
09009+0644	GWP1128AB	237.8	0.4	125.3	0.80	2016.170	1055	13.66	14.19	2	1
09009+0644	CLZ 47AC	198.3	1.1	45.3	0.83	2016.170	1256	13.66	16.0	2	1
09009+1035	UC 128	352.1	1.5	11.7	0.35	2016.170	1505	11.41	14.49	2	1
09015-2742	BRT2963	206.9	2.7	7.4	0.37	2016.170	1229	12.6	12.6	2	1
09593-2631	LDS3945	128.4	0.2	164.1	0.54	2014.871	972	12.41	13.26	2	1
11151+2120	WNO 36AC	58.4	1.3	19.6	0.44	2015.375	2270	14.6	14.5	3	1
11330-3151	HJ 4449AB	134.4	0.0	74.6	0.00	2015.375	730	3.54	10.7	1	1
11480-0838	STF3074	302.0	0.6	10.85	0.11	2015.238	6028	9.60	9.71	8	1
13064+3042	CRB 93	106.9	1.5	26.0	0.66	2015.375	1645	13.80	14.42	2	1
13115+4024	BVD 228	191.2	1.4	38.4	0.66	2015.375	1926	13.18	13.72	2	1
13254-0209	BAL 550	319.8	1.3	18.0	0.42	2015.375	1453	11.56	12.0	2	1
13288+2757	LDS1391	45.2	0.3	134.3	0.57	2015.375	1211	10.24	14.2	2	1
13444+2536	BUP 152AC	149.6	0.3	94.7	0.53	2015.466	1436	10.82	13.97	2	1
13577-2525	J 1610	283.4	1.2	11.0	0.25	2015.468	2377	11.3	11.6	3	1
14189-1752	LDS 486	8.6	1.1	34.2	0.57	2015.468	1548	13.2	14.8	2	1
14308-0839	BUP 158	96.4	0.1	162.4	0.47	2015.375	849	9.58	10.85	2	1
14438+2352	AZC 88	7.8	0.7	40.4	0.43	2015.375	2183	10.03	14.41	3	1
14475-3658	SEE 211	182.1	0.7	13.8	0.18	2015.468	1858	8.41	13.7	2	1
15125-3555	RSS 367AB	103.9	1.3	6.5	0.15	2015.466	1830	8.42	13.0	2	1
15160-0454	STF3091AB,E	46.4	0.4	41.3	0.30	2015.466	1386	7.30	12.0	2	1
15169-0817	STF1925AB	17.6	2.1	5.7	0.18	2015.466	1513	8.14	9.85	2	1
15169-0817	STF1925AC	291.5	0.4	62.3	0.61	2014.874	617	8.14	14.42	1	1
15407+2339	AZC 93	170.1	0.6	41.7	0.40	2015.375	1505	14.25	15.6	2	1
15434-1037	J 2663	52.9	2.4	6.9	0.32	2015.466	1513	12.4	12.3	2	1
16134-2758	AOT 64	145.6	1.1	13.6	0.23	2015.468	1679	10.3	11.23	2	1
17129+3451	CRB 119	34.4	0.5	25.5	0.14	2015.375	1054	13.2	16.9	3	1
18295+2959	KU 118	322.9	0.1	50.20	0.09	2015.521	7525	9.16	9.30	9	1
18554-0552	J 2241AB	214.7	0.3	29.53	0.15	2015.696	5897	10.52	11.82	8	1
18554-0552	J 2241BC	258.1	1.3	5.30	0.17	2015.696	8232	11.82	13.8	6	1
19371+0819	STF2544AC	238.7	0.4	13.64	0.11	2015.641	5558	8.62	9.87	8	1
19395+1012	HJ 893	190.0	0.6	7.71	0.09	2015.641	5970	9.48	10.09	8	1
19471+2701	OSB 8AB	9.9	0.5	13.96	0.10	2015.521	7814	10.76	11.83	9	1
19471+2701	TOB 160AC	212.1	0.3	29.96	0.13	2015.521	7505	10.76	12.32	9	1
19534-0600	STF2591	106.2	0.2	29.33	0.11	2015.696	5793	8.74	9.23	8	1
19579+2715	AC 16AC	135.5	0.1	92.89	0.10	2015.521	6590	7.81	7.97	9	1
20001+1111	HJ 1458	312.4	0.4	16.17	0.11	2015.668	6194	9.27	9.43	8	1
20029+1056	AG 397	113.8	0.2	29.13	0.12	2015.668	5968	8.86	9.68	8	1

Table 2 concludes on next page.

Double Star Measures Using the Video Drift Method - VII

Table 2 (conclusion). Results of 226 Double Stars Using the Video Drift Method

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
20054+2716	HJ 1473	138.0	0.5	10.48	0.08	2015.521	7707	10.47	10.67	9	1
20070+1035	HJ 904	308.2	0.2	30.00	0.12	2015.668	5975	8.49	10.90	8	1
20072+1037	HJ 905	176.9	0.5	12.08	0.11	2015.668	3647	8.85	10.82	8	1
20116-0609	BU 833AB	63.2	0.1	127.04	0.13	2015.696	4388	8.35	9.21	8	1
20116-0609	BU 833AD	351.6	0.3	43.57	0.24	2015.696	7527	8.35	13.89	2	1
20144-0603	STF2646AB	39.7	0.4	17.76	0.12	2015.696	5960	7.49	9.28	8	1
20144-0603	STF2646BC	105.5	0.4	26.92	0.22	2015.696	8018	9.28	12.96	2	1
20178+0612	AG 251AB	185.5	0.8	7.12	0.11	2015.641	5918	8.61	10.0	8	1
20210+1028	J 838	118.7	1.9	6.74	0.21	2015.668	9119	11.52	12.0	2	1
20392+1059	SCJ 27AB	262.3	1.0	6.14	0.12	2015.668	6319	8.67	10.03	8	1
20418-0430	HJ 921	219.7	0.6	9.32	0.11	2015.696	6084	9.47	9.71	8	1
20426+1244	STF2718AB	87.1	0.3	8.46	0.07	2015.773	12364	8.28	8.39	16	2
20499+1255	HJ 1577	245.5	0.5	9.28	0.08	2015.773	12278	8.91	9.4	16	2
20537+0336	BAL2548	257.7	0.9	7.49	0.11	2015.641	6180	9.90	10.85	8	1
20541+1306	STF2734	227.3	0.3	24.07	0.11	2015.668	6136	9.39	9.82	8	1
20591+0418	STF2737AB,C	68.7	0.6	10.39	0.11	2015.641	5998	5.30	7.05	8	1
21105+2452	POU5216	191.1	4.2	5.7	0.47	2015.767	1644	12.9	14.3	2	1
21108+2452	POU5219AB	144.5	2.4	8.0	0.33	2015.767	1680	12.0	12.9	2	1
21140+1106	AG 415AB	23.8	0.3	15.79	0.08	2015.668	12546	10.09	10.62	16	2
21546-0318	STF2838AB	182.5	0.4	15.98	0.11	2015.696	6073	6.29	9.52	8	1
21546-0318	TOK 349AC	102.1	0.1	143.80	0.35	2015.696	6252	6.28	15.16	2	1
22007-0448	SCA 113	279.2	0.3	16.22	0.11	2015.696	6030	10.71	10.88	8	1
22141-2308	FOX 45AC	86.1	0.8	28.5	0.33	2015.767	1526	10.57	11.67	2	1
22185-1751	ARA 507	196.7	3.0	5.7	0.32	2015.767	1592	11.8	12.0	2	1
22241-3944	HJ 5330	274.7	2.9	5.1	0.40	2015.767	1940	10.60	10.94	2	1
22306-1307	BRT2793	292.7	5.1	5.0	0.59	2015.767	1549	11.5	11.6	2	1
22379+0554	STF2925	3.9	0.9	7.04	0.11	2015.773	6061	9.66	10.35	8	1
22426-2057	HJ 3135	352.8	0.7	35.5	0.40	2015.767	1563	8.8	11.6	2	1
22469-0707	BRT 521	29.7	3.1	4.3	0.35	2015.767	1523	12.0	12.0	2	1
23243+0343	STF3009AB	228.4	0.9	7.26	0.13	2015.773	5815	6.87	8.76	8	1
23397+0331	BAL2069	287.2	0.8	7.68	0.11	2015.773	6394	9.95	11.22	10	1

Table 2 Notes:

All magnitudes taken from the WDS catalog. All position angle/separation measurements are for the Equator and Equinox of date.

Column titled "**No. of (*x*,*y*) pairs**" is the total combined no. of (*x*,*y*) pairs (video frames) from all drift runs. All video frames were used, none were discarded.

The column "**drifts**" is the number of separate drifts made. "**Nights**" is the number of nights drift runs were made for that system.