Double Star Measures Using the Video Drift Method - VI

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

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

Abstract: Position angles and separations for 227 multiple star systems are presented using the video drift method. The drift method generates standard (*x*,*y*) coordinates for the primary and companion star for each video frame during the drift. Position angle and separation are derived from these coordinates. Systems fainter than *m* = +12 were measured and computed using a variation of the drift method using an integrating video camera. Most doubles had 1,000's of (*x*,*y*) pairs analyzed per system. Several systems lacked measurements since the late 1800's and early 1900's.

Introduction

In our first paper (Nugent and Iverson, 2011) we described a new video method that computes both the position angle (PA) and separation (Sep) for a double star. 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 and separation for each video frame. The position angles and separations are then averaged 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, and standard deviations for both position angle and separation for each drift. The offset of the pixel array alignment of the video camera's chip from the true east-west direction (drift angle) is calculated using the method of least squares to an accuracy of better than 0.02°.

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). Author Nugent uses a Collins I^3 image intensifier with his 14 inch SCT telescope and routinely reaches *m* = +14 to +15.

Methodology

Preference was given to multiple star systems where the WDS lacked measurements for a minimum of 10-15 yr and had less than 10 measurements. This criterion applies to nearly all 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. Twenty-seven doubles had more than 35 measurements. We routinely look at a few well measured doubles to support ongoing efforts to compare the video drift method with other measurement methods. Nineteen systems lacked measurement since 1893-1945. The faintest system measured in Table 2 had primary/secondary magnitudes of +10.0, +15.0. One dozen systems had WDS magnitudes in the +14.0

to +14.8 range.

With some doubles not measured since the late 1800's or early 1900's, significant deviations in PA and Sep 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 data points were obviously in error. These were rejected and not included in Table 2. An investigator comparing their new measurement to the latest WDS catalog value, and noting a large difference, might reject their measurement. However the new measurement might be a good one, since the WDS is known to have some values that have large errors, especially when there is just 1 or 2 measurements for a given double star system.

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 the 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, *JDSO*, **7**, 185-194.

Nugent, R. and Iverson, E. 2014, *JDSO*, **10**, 214-222.

VizieR catalog database, 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 an Watec 902H Ultimate camera with the Collins I^3 image intensifier.

Double Star Measures Using the Video Drift Method - VI

Table 2. Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
00194-0849	HJ 1953AC	190.5	0.1	106.4	0.23	2014.786	2912	3.67	10.40	4	1
00059-3020	SEE 1AB,C	327.2	2.1	5.0	0.20	2014.877	1687	9.30	10.8	2	1
00080-3139	BVD 46	328.2	0.9	20.1	0.31	2014.877	1632	10.90	11.59	2	1
00094-3321	TDS1322	277.5	1.9	9.3	0.31	2014.877	1668	10.89	10.92	2	1
00123-3128	PRO 1	177.7	0.9	16.4	0.26	2014.877	1727	9.70	11.54	2	1
00132-3021	HDS 31	221.0	1.6	11.6	0.27	2014.877	1702	10.60	13.65	2	1
00154-3219	LDS 7	143.7	1.8	12.8	0.36	2014.877	1711	12.9	14.4	2	1
00164+1950	LDS 863AB	59.0	0.8	25.1	0.30	2014.877	1509	11.86	13.3	2	1
00280-3051	UC 375	335.8	0.9	39.2	0.59	2014.874	1657	10.5	12.9	2	1
00282-1030	GAL 300AB	182.9	0.1	44.6	0.12	2014.786	6156	9.01	9.78	8	2
00292-3228	LDS 19	149.0	1.4	18.6	0.48	2014.874	2412	10.99	13.5	2	1
00311-3238	B 2553	356.5	0.8	10.2	0.13	2014.874	1683	10.36	13.54	2	1
00314-1113	GAL 302AB	232.1	0.1	84.0	0.12	2014.786	5076	8.14	11.16	8	2
00367-2725	HJ 3379	230.9	0.5	14.2	0.11	2014.874	1585	7.98	11.09	2	1
00374+2351	POU 44	316.0	2.5	13.4	0.52	2014.877	1599	10.46	11.8	2	1
00378+2431	POU 47	203.6	3.0	12.5	0.59	2014.877	1625	12.37	13.2	2	1
00388+3101	AG 430	117.3	0.0	254.8	0.11	2014.888	2996	9.12	10.03	8	2
00417-1433	GAL 27	78.5	2.8	7.9	0.44	2014.874	1218	10.	11.	2	1
00428-0955	HJ 1995	128.0	0.3	42.4	0.18	2014.784	2812	6.69	11.32	4	1
00450+2210	LDS 869	197.5	0.2	121.6	0.39	2014.877	2183	10.70	12.8	2	1
00487+1841	TOK 224AB	138.8	0.2	151.5	0.47	2014.877	1146	7.67	10.83	2	1
00550+2406	ENG 3	206.9	0.2	37.8	0.16	2014.795	3199	8.81	10.51	4	1
00555+2457	POU 76	194.1	1.5	17.7	0.45	2014.805	1617	11.83	12.2	2	1
01007-3112	HJ 3410	73.1	0.8	22.2	0.29	2014.805	1650	11.05	12.18	2	1
01020-2959	HJ 3411	2.5	0.7	25.0	0.30	2014.805	1696	9.43	11.46	2	1
01045-3024	PRO 3	277.7	2.3	6.9	0.31	2014.805	1688	9.9	10.2	2	1
01072+3839	STTA 11AB,C	164.2	0.2	59.3	0.18	2014.888	3716	7.62	8.77	4	1
01078+2452	POU 100	83.0	2.2	8.4	0.31	2014.877	1609	11.9	13.5	2	1
01097+3537	KUI 5BJ	94.3	0.6	45.4	0.48	2014.877	820	14.4	13.7	2	1
01107-2800	SWR 1	116.0	1.2	15.7	0.35	2014.805	1630	12.21	12.2	2	1
01116-2624	LDS 37	338.0	1.8	10.8	0.30	2014.805	1658	11.43	12.5	2	1
01137-3107	PRO 4	20.3	0.4	10.8	0.14	2014.805	1700	7.8	11.2	2	1
01141-3022	HDS 161	219.0	1.3	13.7	0.28	2014.805	1675	9.41	13.01	2	1
01147-3500	HDS 163	354.0	1.8	7.4	0.18	2014.805	1781	10.71	13.26	2	1
01171-3055	UC 535	125.7	0.8	18.0	0.17	2014.805	1653	9.4	13.4	2	1
01177-2812	B 16AB	276.1	0.4	34.6	0.19	2014.805	1487	9.3	12.0	2	1
01177-3018	LDS2181	176.9	1.7	7.7	0.32	2014.877	1498	13.7	14.2	2	1
01191-2729	HJ 3425	253.7	2.2	7.2	0.26	2014.877	1497	10.7	11.2	2	1
01228-3038	HJ 3432	221.1	1.2	8.3	0.21	2014.877	1531	8.97	10.95	2	1
01233-3329	RSS 48	99.3	0.9	18.5	0.31	2014.877	1613	9.17	12.0	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VI

Table 2 (continued). Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
01245+3902	STTA 17AB	101.5	0.3	35.8	0.14	2014.888	3581	7.96	9.80	4	1
01245+3902	STTA 17AC	347.4	0.1	134.9	0.21	2014.888	3644	7.96	8.47	4	1
01245+3902	STTA 17CD	279.0	0.2	68.5	0.18	2014.888	3195	8.47	9.79	4	1
01253-2743	UC 556	128.5	1.0	44.5	0.77	2014.805	1493	14.5	14.4	2	1
01261-2618	SWR 2	82.4	0.4	44.5	0.26	2014.805	1451	10.0	10.3	2	1
01270-3058	RSS 3	344.4	0.7	32.9	0.44	2014.877	1676	9.03	9.73	2	1
01291+2143	HO 9AB	41.8	0.2	51.4	0.18	2014.795	3032	7.84	10.35	4	1
01301-4024	BVD 17	176.0	1.5	20.0	0.57	2014.877	2373	12.03	12.07	3	1
01304-1903	ARA 518	310.9	1.7	12.0	0.32	2014.877	1407	10.7	12.5	2	1
01323-2633	ARG 4	72.8	0.7	17.8	0.24	2014.805	1588	7.99	9.14	2	1
01328-4115	HJ 3445	265.5	1.0	18.6	0.22	2014.877	1894	9.26	10.40	2	1
01350+2753	MLB 634	167.9	2.9	7.0	0.31	2014.871	1554	12.71	13.5	2	1
01355-3211	JKS 3	238.8	0.3	94.2	0.42	2014.871	1381	9.98	11.20	2	1
01361-3718	HJ 3448	57.3	0.6	28.7	0.25	2014.877	1761	9.23	9.88	2	1
01386-4113	CPO 110	74.9	0.4	73.1	0.40	2014.877	1610	11.52	12.26	2	1
01397-3728	HJ 3452	276.8	1.0	19.5	0.29	2014.871	1779	7.41	8.88	2	1
01405-2413	AHD 12	138.4	0.6	14.9	0.17	2014.871	1585	10.0	13.	2	1
01410-0524	TOK 228	31.6	0.1	125.1	0.30	2014.877	1236	8.56	12.10	2	1
01413-3404	UC 603	206.8	1.6	14.9	0.33	2014.871	1781	13.5	14.5	2	1
01415-2454	ENO 1	53.3	1.0	12.9	0.22	2014.871	1613	10.11	13.0	2	1
01469-2740	RSS 50	6.6	0.7	32.0	0.41	2014.871	1656	8.82	12.0	2	1
01487-2916	HJ 3466	52.6	0.8	31.0	0.39	2014.871	1586	9.52	11.24	2	1
01526-2636	BGH 8	170.6	0.4	92.3	0.69	2014.877	1580	9.90	9.96	2	1
01530-2805	HJ 3472	240.6	2.1	6.1	0.20	2014.877	1672	9.93	10.05	2	1
01560-3057	JSP 859	149.0	1.8	6.4	0.17	2014.877	1739	9.89	12.9	2	1
01574-2928	RSS 52	256.2	0.6	26.5	0.31	2014.877	1553	9.89	13.0	2	1
01590-2921	UC 652	163.2	1.2	33.5	0.59	2014.877	1645	12.9	14.5	2	1
02005-3107	UC 659	119.9	2.1	11.7	0.38	2014.877	1718	11.6	11.8	2	1
02022+1120	J 1080AC	318.4	1.6	15.1	0.41	2014.877	1439	11.40	14.13	2	1
02027-3019	HJ 3478	150.1	0.3	42.6	0.24	2014.877	1649	8.18	8.89	2	1
02039-2526	UC 678	94.5	0.9	29.5	0.47	2014.877	1556	12.5	13.6	2	1
02057-2423	I 454AB,C	257.6	0.4	56.9	0.40	2014.877	1399	8.68	8.99	2	1
02114+0936	LDS3353	334.2	1.4	25.3	0.63	2014.871	1363	9.99	14.4	2	1
02131+0404	BAL2098	231.6	2.9	10.7	0.53	2014.871	1472	12.71	12.71	2	1
02173-3108	PRO 5	171.2	2.0	14.7	0.50	2014.877	1708	10.7	11.5	2	1
02186-2940	B 34AC	99.0	0.5	38.4	0.33	2014.871	1536	9.01	10.41	2	1
02517+3854	ROE 67AB	129.3	0.5	27.3	0.20	2014.888	3704	8.92	10.57	4	1
03027+0414	BAL2110	226.6	1.3	9.1	0.21	2014.860	3012	9.6	9.9	4	1
03032-0215	J 1455	61.4	2.7	6.1	0.29	2014.860	2172	11.5	11.8	1	1
03142+1603	SLE 34	45.8	3.5	8.8	0.49	2015.052	1356	13.4	14.8	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VI

Table 2 (continued). Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
04259-0124	STF 547AB	121.1	1.2	7.7	0.18	2014.860	2995	9.42	12.4	4	1
04259-0124	STF 547AC	258.1	0.0	214.0	0.16	2014.860	1365	9.42	6.85	4	1
05047+3954	ALI1047	93.8	1.5	9.4	0.17	2014.888	4161	12.39	13.4	2	1
05342+2401	POU 728	46.5	2.4	14.6	0.56	2015.052	1558	14.8	14.8	2	1
05499+2316	POU 788	125.6	3.4	4.5	0.31	2015.052	1563	11.35	12.6	2	1
05511+2344	POU 794	268.0	1.3	10.1	0.28	2015.052	1571	10.79	12.8	2	1
06171-2243	HJ 3845	358.4	0.3	60.6	0.38	2015.049	1565	6.06	10.44	2	1
06179+0919	OPI 9	245.1	3.2	5.3	0.37	2015.049	1231	11.68	13.0	2	1
06272+1118	J 1945	275.1	2.0	7.2	0.48	2015.049	1470	11.29	11.3	2	1
06296-0215	BAL 62	174.0	1.9	9.0	0.32	2015.049	1489	10.99	11.05	2	1
06311-2244	ARA1649	183.5	1.5	10.9	0.34	2015.049	1596	11.85	12.1	2	1
06321+0300	BAL2176	290.9	2.2	12.5	0.53	2015.049	1445	12.3	12.6	2	1
06426+0000	BAL1013	285.0	2.2	14.0	0.63	2015.049	1423	10.86	11.2	2	1
06432-0245	BAL 71	355.7	0.0	11.8	0.05	2015.049	1470	8.6	11.3	2	1
06442-0117	BAL 333	6.5	1.7	12.2	0.37	2015.049	1490	9.54	11.8	2	1
17097+3021	STF2131AB	179.0	0.7	24.1	0.24	2014.477	3478	8.39	9.80	4	1
17178+2844	S 686	4.1	0.4	49.7	0.22	2014.477	3376	8.17	9.30	4	1
18496+3818	AG 226	53.9	0.5	25.9	0.16	2014.564	3690	10.12	10.23	4	1
18523+3926	WEI 33	329.2	0.1	99.3	0.14	2014.564	3462	8.96	8.99	4	1
18530+3621	HJ 1354	4.9	1.1	10.1	0.17	2014.564	3810	10.01	9.97	4	1
18581+3813	SP 2AE	350.0	0.1	160.2	0.15	2014.564	3549	9.61	5.87	4	1
18581+3813	SP 2BE	329.9	0.1	150.2	0.16	2014.564	3054	9.93	5.87	4	1
18581+3813	STF2427AB	59.5	0.2	55.0	0.15	2014.564	3417	9.61	9.93	4	1
18581+3813	STF2427AC	61.7	0.2	61.7	0.18	2014.564	3346	9.61	10.20	4	1
18581+3813	STF2427BC	78.7	1.8	7.1	0.17	2014.564	3789	9.93	10.20	4	1
19126+1651	STTA177AC	276.1	0.1	98.2	0.18	2014.562	2405	7.11	8.02	4	1
19133+1934	HO 573	127.9	1.9	7.9	0.26	2014.562	1496	9.75	10.2	4	1
19135+3902	SHJ 289	56.5	0.3	39.1	0.13	2014.564	3620	8.01	8.71	4	1
19153+1505	STTA178	266.8	0.1	89.8	0.18	2014.562	2442	5.69	7.64	4	1
19159+2018	J 2959AB	186.8	0.1	93.0	0.22	2014.562	3115	7.79	11.8	4	1
19188+1937	AG 432	317.2	0.1	91.8	0.19	2014.562	2725	6.50	9.68	4	1
19207+1425	STTA180	266.1	0.1	79.8	0.18	2014.562	2518	7.87	8.83	4	1
19426+4002	BUP 196	165.5	0.1	105.9	0.13	2014.564	3729	7.90	8.31	4	1
19429+0115	HJ 895AC	25.0	0.4	30.0	0.21	2014.726	2894	8.61	9.66	4	1
19479+1002	AG 391	295.7	0.2	52.1	0.19	2014.800	2684	7.72	9.19	4	1
19487+2048	KU 124	283.8	0.2	49.6	0.18	2014.562	2879	9.87	10.55	4	1
19534+2020	STFA 48AB	146.5	0.2	41.8	0.18	2014.562	3085	7.14	7.34	4	1
19550+0441	BAL2954AB	208.4	1.6	13.2	0.42	2014.786	1463	11.57	11.5	2	1
19557+4024	HJ 604	93.0	0.1	70.8	0.14	2014.564	3260	7.35	9.33	4	1
19572+4022	BU 1474AB	314.6	0.2	63.5	0.15	2014.564	3506	5.44	9.31	4	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VI

Table 2 (continued). Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
19578+1520	J 2294	162.9	1.4	9.4	0.25	2014.786	1527	11.87	13.1	2	1
20008+2949	BU 439AC	200.8	0.5	37.7	0.28	2014.786	1636	7.89	12.0	2	1
20015+0040	HDO 315	199.6	0.9	7.7	0.19	2014.786	1447	9.04	12.5	2	1
20068+3203	SEI 881	312.1	1.7	7.1	0.21	2014.789	1715	10.64	11.18	2	1
20076+1655	BRT1337AB	222.3	2.0	5.0	0.18	2014.786	1527	10.2	10.9	2	1
20077+0446	ARN 20AD	126.5	0.1	99.1	0.18	2014.726	2447	9.67	8.91	4	1
20077+0446	STF2627AC	260.5	0.1	82.2	0.19	2014.726	2418	9.67	7.70	4	1
20079+0836	J 1873	174.6	2.2	7.2	0.27	2014.786	1476	12.42	12.87	2	1
20092+3540	SEI 922	215.2	1.3	18.4	0.31	2014.786	1779	11.86	12.4	2	1
20101+3617	SEI 939	217.4	0.6	26.9	0.26	2014.786	1751	10.0	11.0	2	1
20104+3644	SEI 945AB	276.6	2.0	6.0	0.20	2014.786	1456	9.5	11.0	2	1
20110+3559	SEI 961	19.9	1.5	13.7	0.25	2014.786	1818	10.96	12.2	2	1
20117+0146	HJ 906AB	156.1	1.0	13.3	0.20	2014.726	2895	11.23	11.8	4	1
20125+3717	SEI1005	55.9	0.8	26.4	0.26	2014.789	1753	11.81	11.8	2	1
20128+3638	SEI1010	24.7	0.8	31.4	0.34	2014.789	1756	10.78	10.8	2	1
20142+0635	S 740	191.7	0.2	42.9	0.18	2014.800	3016	7.77	8.06	4	1
20183+2002	HJ 912AC	169.5	0.1	88.5	0.17	2014.562	3143	10.65	9.02	4	1
20244+1935	STF2679AB	78.2	0.4	24.4	0.16	2014.562	3061	7.88	9.69	4	1
20244+1935	STF2679AC	149.9	0.4	39.2	0.26	2014.562	2979	7.88	11.56	4	1
20321+1358	HJ 1527	270.0	1.2	10.6	0.27	2014.789	1467	12.05	12.44	2	1
20344-4221	DON 988AB,C	270.1	0.7	23.1	0.32	2014.789	1870	9.41	10.35	2	1
20355+3510	POP 6	218.4	3.4	6.4	0.32	2014.789	1756	11.98	12.2	2	1
20391-0942	J 1400AB	20.5	3.1	3.7	0.24	2014.789	1520	11.96	12.4	2	1
20391-0942	J 1400AC	230.9	1.5	12.2	0.36	2014.789	1443	11.96	13.3	2	1
20480-3523	B 2892	105.1	1.3	7.5	0.17	2014.792	1786	9.31	12.0	2	1
20500+0533	STTA210AB	127.1	0.1	78.2	0.19	2014.800	2575	6.30	9.18	4	1
20501+3714	CLL 15AC	20.5	0.3	48.1	0.23	2014.792	1807	10.71	10.93	2	1
20506-3645	B 2893	295.5	1.4	9.5	0.22	2014.792	1799	9.85	11.9	2	1
20527+0720	STF2733	144.4	0.2	39.7	0.17	2014.800	2889	8.39	8.58	4	1
20567-0600	J 2330AB	114.2	2.6	6.2	0.33	2014.789	1140	11.58	11.6	2	1
20596+3216	GYL 43	7.4	0.7	29.8	0.25	2014.789	1732	12.16	12.2	2	1
21005+1920	BU 1497	336.6	0.3	49.3	0.22	2014.800	3048	5.89	10.00	4	1
21026+2141	BU 69AC	240.9	0.2	74.3	0.19	2014.800	2423	8.35	8.02	4	1
21046+1201	BU 70AB	240.2	0.2	81.3	0.24	2014.786	2360	8.56	11.41	4	1
21046+1201	BU 70AC	236.0	0.2	74.5	0.25	2014.786	2557	7.6	10.0	4	1
21047+2446	POU5135	202.5	5.7	4.4	0.71	2014.792	1454	13.9	14.2	2	1
21054+3937	CRB 137	172.0	0.9	29.0	0.37	2014.792	1901	11.3	14.0	2	1
21069+3845	STF2758AD	267.8	0.0	336.5	0.17	2014.789	405	5.35	10.45	4	1
21079-1013	BU 473AC	15.5	0.4	39.0	0.26	2014.792	1416	8.86	12.6	2	1
21111-3041	HJ 5248	319.3	3.2	5.3	0.33	2014.792	1640	12.32	12.9	2	1

Table 2 continues on next page.

Double Star Measures Using the Video Drift Method - VI

Table 2 (continued). Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
21140+1106	TOB 316BC	87.7	0.6	21.5	0.31	2014.784	2914	10.62	12.32	4	1
21143+2522	POU5283AB	84.4	0.8	15.9	0.20	2014.789	2404	10.1	11.9	3	1
21156+3600	SEI1479	76.0	1.1	26.9	0.47	2014.805	1739	11.08	12.1	2	1
21181+1646	J 3238AC	210.1	0.5	31.0	0.31	2014.789	1455	12.0	11.98	2	1
21182-0224	J 1719	168.7	2.0	5.2	0.18	2014.805	2171	10.77	14.0	3	1
21251+0923	STF2793AB,C	241.4	0.2	26.4	0.12	2014.726	5753	7.44	8.98	8	2
21371+2503	POU5434AC	130.3	5.7	4.4	0.54	2014.805	1305	12.9	13.6	2	1
21385+0546	HJ 941	309.3	0.4	33.3	0.27	2014.792	1373	5.67	11.8	2	1
21442-3505	UC 4541	303.5	0.4	74.8	0.51	2014.805	1512	11.6	12.6	2	1
21484-0506	SCA 97	45.5	0.6	36.1	0.41	2014.805	1397	11.94	12.3	2	1
21486+1440	HJ 1693	313.4	1.0	11.5	0.20	2014.786	3019	10.52	10.54	4	1
21494+3045	STF2829	15.6	0.6	16.8	0.17	2014.800	3455	8.91	9.66	4	1
21496-0026	BAL 933	153.7	1.7	9.4	0.34	2014.805	1480	12.82	12.83	2	1
21497+3415	KU 133	180.0	0.2	48.7	0.17	2014.800	3592	9.44	9.89	4	1
21509+3240	ES 382AC	322.1	0.2	57.9	0.17	2014.800	3310	8.28	8.42	4	1
21543+1333	BU 1213AB	258.5	0.1	64.3	0.17	2014.786	2584	8.64	11.00	4	1
21559+2753	HJ 1704	316.5	2.6	5.2	0.27	2014.805	1644	12.93	13.01	2	1
21575+0409	STTA225	286.3	0.1	75.1	0.12	2014.726	4977	7.10	8.57	8	2
22019+0446	STTA228AB	23.1	0.1	85.7	0.13	2014.726	5521	8.79	9.83	8	2
22029-0054	BAL 627	205.3	0.9	8.6	0.15	2014.655	2954	9.91	11.0	4	1
22090-3604	RSS 567	175.9	0.4	49.1	0.29	2014.805	1812	7.56	10.45	2	1
22100+0757	STF2867AB	208.0	0.9	10.4	0.15	2014.784	3017	8.31	9.31	4	1
22145+0759	STF2878AC	119.1	0.2	69.0	0.29	2014.784	2563	6.94	10.68	4	1
22145+0759	STF2878AD	273.6	0.1	124.9	0.43	2014.784	2084	6.94	10.78	4	1
22151-1018	UC 4694	345.0	1.9	8.3	0.30	2014.805	1494	12.3	12.3	2	1
22152-4412	RSS 569	97.9	0.4	55.0	0.31	2014.805	1784	8.58	9.65	2	1
22173-4123	SKF1106	183.6	1.9	7.6	0.23	2014.805	1998	10.5	11.3	2	1
22183-3846	UC 4712	8.3	0.4	79.4	0.43	2014.805	1847	9.9	14.5	2	1
22199-3635	RSS 571	177.6	0.6	24.1	0.18	2014.805	1812	10.44	13.0	2	1
22199-3642	HJ 5326	300.6	2.0	6.5	0.22	2014.805	1803	10.51	10.66	2	1
22218-0150	SCA 126	331.0	0.1	82.9	0.17	2014.655	2707	9.84	10.78	4	1
22235+0351	STTA232AB	193.3	0.1	75.4	0.13	2014.726	5809	9.22	9.46	8	2
22237-3805	UC 4732	242.4	1.9	10.2	0.32	2014.805	1830	14.0	14.4	2	1
22258-3705	UC 4742	54.4	2.4	11.3	0.41	2014.805	1799	13.3	14.3	2	1
22263-1839	BHA 52	172.3	1.9	7.2	0.26	2014.805	1551	12.26	12.88	2	1
22279+0442	ENG 85AB	227.3	0.1	80.5	0.16	2014.726	5085	4.91	10.0	8	2
22279+0442	ENG 85AC	251.1	0.0	176.3	0.15	2014.726	3385	4.91	10.64	8	2
22279+0442	ENG 85BC	268.7	0.1	108.0	0.14	2014.726	4132	10.0	10.64	8	2
22416+2947	CHE 366	6.4	0.4	21.6	0.13	2014.795	3475	10.09	10.23	4	1
22435+3114	ES 393AB	297.0	0.1	81.0	0.15	2014.795	2934	8.90	9.01	4	1

Table 2 concludes on next page.

Double Star Measures Using the Video Drift Method - VI

Table 2 (conclusion). Results of 227 double stars using the video drift method.

WDS	Designation	PA°	σ-PA	Sep"	σ-Sep	Date	No.(x,y) pairs	Mag Pri	Mag Sec	Drifts	Nights
22476+3158	CHE 433	120.6	0.4	27.5	0.18	2014.795	3398	9.42	11.57	4	1
22478-0414	STF2944AC	86.4	0.1	61.4	0.16	2014.655	2538	7.30	8.58	4	1
22597-0422	STF2964	278.9	1.1	8.7	0.17	2014.655	2940	8.29	9.54	4	1
23026+2948	TOK 352	249.3	0.4	45.2	0.32	2014.879	1514	8.92	14.66	2	1
23045+3123	ES 396	303.0	0.3	34.8	0.15	2014.795	3321	10.84	10.91	4	1
23077+0636	STF2976AB	260.7	1.4	7.7	0.18	2014.726	3007	9.13	10.63	4	1
23077+0636	STF2976AC	208.8	0.3	21.0	0.11	2014.726	5925	9.13	9.46	8	2
23095+0841	STF2982AB	197.7	0.3	32.6	0.23	2014.721	2904	5.29	10.06	4	1
23103+3229	HJ 5532AB,C	77.3	0.2	57.9	0.15	2014.795	3067	7.10	9.43	4	1
23141-0855	S 826AC	130.8	0.1	79.7	0.17	2014.655	2610	7.55	9.10	4	1
23141-0855	S 826BC	115.1	0.2	64.4	0.17	2014.655	2634	8.17	9.10	4	1
23141-0855	STF2993AB	175.5	0.4	24.8	0.16	2014.655	3013	7.60	8.17	4	1
23159-0905	STFB 12A,BC	311.6	0.2	48.9	0.21	2014.655	2725	4.36	9.88	4	1
23171-1349	BU 182AB,D	101.8	0.2	87.3	0.34	2014.879	1193	8.16	11.0	2	1
23189+0524	BU 80AC	338.9	0.1	119.6	0.14	2014.784	5388	8.18	11.27	8	2
23189+0524	BU 80AD	321.2	0.0	225.4	0.18	2014.721	1938	8.18	9.99	5	2
23189+0524	BU 80AE	292.1	0.0	249.3	0.12	2014.784	2470	8.18	10.40	8	2
23189+0524	BU 80CE	264.5	0.0	188.1	0.13	2014.784	3019	11.27	10.40	8	2
23232+1226	HJ 3188AB	252.4	0.5	21.9	0.25	2014.784	2927	8.88	11.57	4	1
23269-3227	UC 4952	271.0	0.5	29.8	0.30	2014.879	1609	10.4	15.0	2	1
23305-2231	ARA2289AB	274.6	1.9	14.2	0.51	2014.805	1547	13.6	13.7	2	1
23305-2231	ARA2289AC	224.1	0.8	33.5	0.41	2014.805	1472	13.6	13.7	2	1
23305-2231	ARA2289BC	238.5	0.6	43.7	0.42	2014.805	1477	13.7	13.7	2	1
23386-3038	HJ 5412	51.2	1.3	16.2	0.34	2014.792	1676	9.92	11.35	2	1
23431-3101	LDS2996AB	79.5	1.8	8.8	0.29	2014.792	1658	10.63	12.6	2	1
23431-3101	LDS2996AC	195.1	0.7	28.9	0.32	2014.792	1704	10.63	12.4	2	1
23537-0140	HJ 3223	352.7	0.2	48.8	0.16	2014.786	3021	8.77	10.43	4	1

Table 2 Notes

All magnitudes were 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 successive nights drift runs were made for that system.

WDS 01304-1903. A single observation in the WDS catalog from 1916 is likely a measurement of a mirror image. WDS PA = 39°, our measurement is 310.2°. Proper motions for the components are insignificant. WDS reports this double with an "X" code, meaning dubious to its existence. The WDS RA, DEC of the primary (not the secondary) was a match for the system we measured and from the POSS image. See Figure 1.

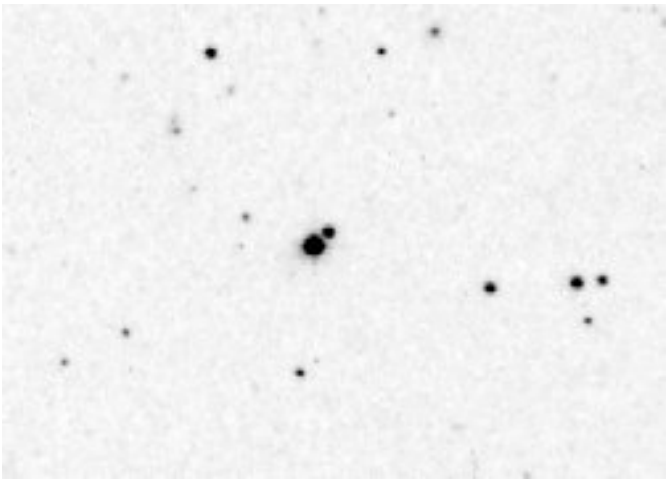

Figure 1. WDS 01304-1903. POSS image from 15-Sep-1954. North is up, FOV is 8 arc minutes. See Table 2 notes for discussion.