Double Star Measures Using the Video Drift Method - V

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Abstract: Position angles and separations for 189 multiple star systems are presented using the video drift method. The drift method generates a Cartesian (*x*,*y*) coordinate pair for the primary and companion star for each video frame during the drift. Position angle and separation are calculated from these coordinates. 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. The video drift method provides high systematic accuracy.

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 for each component. Although *Limovie* was originally written to measure the change in light levels during an occultation, it also produces a table of Cartesian (*x*,*y*) coordinates for both components along with the 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 to give a final result.

Unlike other video/CCD methods, calibration doubles are not needed to determine plate scale or orientation. An east-west line does not need to be drawn, a star catalog is not needed since there is no "plate adjustment" performed for each double star system, and no video frames are discarded. Each double star drift is self calibrating (see Nugent and Iverson 2014 for a discussion of a onetime equipment calibration). 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°.

Methodology

Preference was given to multiple star systems where the WDS lacked measurements for at least the past 10 years 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. Twelve 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

(see discussion below). Fifteen systems lacked measurement since 1894-1945. The faintest system measured had primary/secondary magnitudes of +12.4, +15.4. These magnitudes were reached by author Nugent using a Collins I^3 Image Intensifier.

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 software (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 directional changes in PA and Sep.

Other doubles showed a significant deviation from the WDS summary catalogue 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. Just comparing a new measurement to the WDS summary catalogue value and noting a large difference might cause an observer to incorrectly reject the new measurement when in fact it might to be a very good measurement.

Figure 1 is an example where the measurement reported in the WDS summary catalogue is very suspicious because it significantly deviates from the trend line. This illustrates the problem of putting too much trust in any single measurement. In many cases, comparison to the measurement history trend line gives a reasonable estimation of the relative position of the companion star. Although we have found this method useful for checking our results, it should be pointed out that the method does not always work. For reasons beyond the scope of this paper, a high correlation is not always found. In these cases it is best to reserve judgment and use other means to decide whether or not to publish the measurement.

It is easy to identify doubles which need checking by noting the offset from the WDS summary catalogue value, but it is much harder to identify suspect doubles where the WDS and measured value are close but widely separated from the trend line. Unfortunately the observational history is not available online and

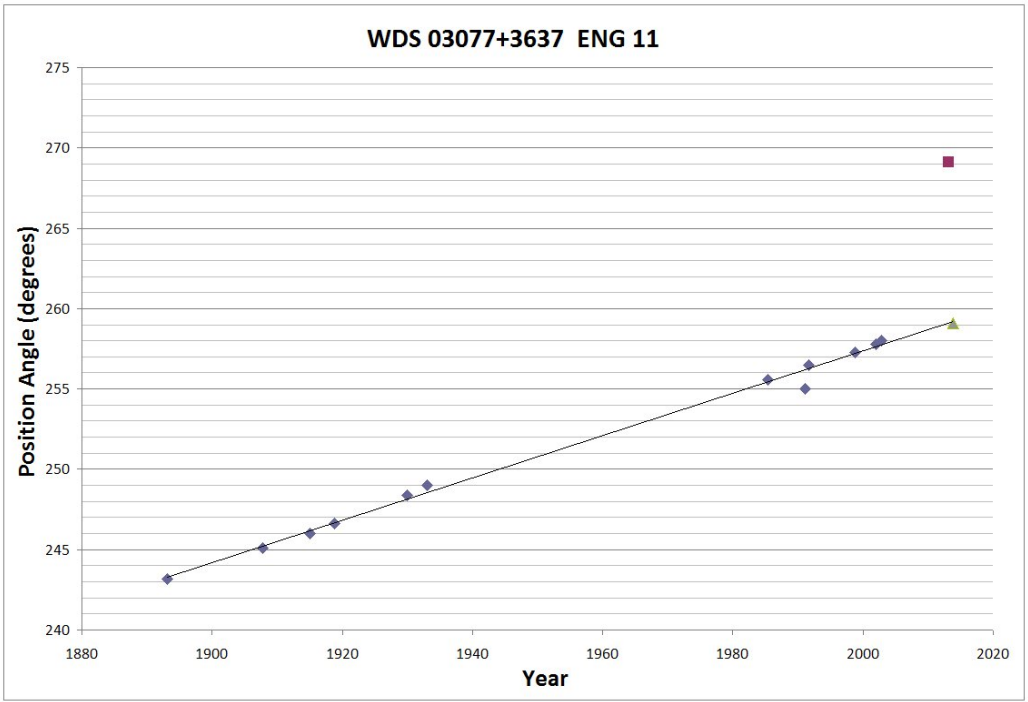

Figure 1. The diamonds represent historical position angle measurements for the double star 03077+3637 ENG 11 found in the WDS Observational Catalogue. The square represents the last measurement and current WDS Summary catalogue entry. Clearly this measurement is in error and illustrates a need for caution. The triangle represents our position angle measurement given in Table 2. After removing the wild data point (i.e., square) the Least Squares correlation coefficient is 0.9945.

Table 1. Telescopes used in this research. Scale factors will vary slightly due to the declination of the doubles.

Telescope	Aperture	Focal Length	Scale Factor
Meade LX-200	14″ (35 cm)	3556mm f/10	0.6″/pixel
Celestron refractor	6" (15.2 cm)	2400mm f/12	1.4"/pixel (barlow)

must be requested from the U.S. Naval Observatory. The staff at the US Naval Observatory kindly responds to reasonable numbers of requests for double star observations from the WDS historical database."

Calibration

In our paper (Nugent and Iverson, 2014), we discuss 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 VisieR star catalogs to compute the angular displacement and separation of known stars.

The telescope equipment used and scale factors are summarized in Table 1. The 189 double star measures are given in Table 2 beginning on the next page.

Acknowledgements

This research makes use of the Washington Double Star Catalog maintained at the US Naval Observatory, the Aladin Sky Atlas Interactive software program and the VisieR 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

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, No. 3, 185-194

Nugent, R. and Iverson, E. 2014, *Journal of Double Star Observations*, 10, No. 3 214-222

VisieR catalog database: Centre de Données Astronomiques de Strasbourg, http://vizier.u-strasbg.fr/viz-bin/VizieR

Double Star Measures Using the Video Drift Method - V

Table 2. Results of 189 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
00022+2705	BU 733AC	323.9	0.1	177.5	0.25	2013.830	1682	5.83	9.88	3	1
00066+2901	ENG 1A,CD	199.7	0.1	141.9	0.28	2013.830	1939	6.14	10.70	3	1
00066+2901	STT 549AB	259.6	0.1	192.9	0.17	2013.830	1185	6.15	10.34	3	1
00080+3123	STTA256AB	112.9	0.1	110.7	0.16	2013.830	1742	7.13	7.28	3	1
00239+2930	STF 28AB	224.2	0.3	32.8	0.16	2013.830	2267	8.32	8.55	3	1
00307+3208	STT 11	317.3	0.1	196.6	0.19	2013.808	1496	7.57	7.70	3	1
00499+3027	STTA 9AB	244.2	0.1	117.1	0.16	2013.830	1713	7.75	8.81	3	1
00552+3814	KU 71	248.9	0.5	22.5	0.16	2013.808	2474	9.95	10.61	3	1
01002+3818	GRV 58	188.2	0.3	32.9	0.15	2013.808	2580	8.92	9.23	3	1
01060+4447	HJ 2013	239.5	0.6	23.7	0.18	2013.808	2718	8.26	11.30	3	1
01477+2829	STF 161	211.6	0.7	24.1	0.24	2013.860	2252	8.57	10.24	3	1
02015+3319	BU 872AC	319.9	0.1	100.7	0.17	2013.808	1986	8.74	11.17	3	1
02217+3441	PTT 4A,BC	294.6	0.6	15.4	0.13	2013.808	2378	10.53	11.52	3	1
02267+3207	HJL1018AB	78.4	0.1	73.2	0.16	2013.808	1904	9.62	9.56	3	1
02536+3618	ALI 41	331.0	0.8	14.2	0.16	2013.808	2482	11.26	11.54	3	1
03036+3627	BUP 37AB	268.4	0.1	99.2	0.20	2013.860	1809	7.75	9.95	3	1
03077+3637	ENG 11	259.1	0.1	135.8	0.23	2013.860	1540	7.44	9.15	3	1
03136+3909	STF 364	310.8	1.0	11.7	0.18	2013.860	2559	8.73	8.92	3	1
03232+2412	KU 80	181.5	0.4	27.2	0.21	2013.860	2238	10.30	10.56	3	1
03266+2843	TOK 13AB	129.4	0.1	96.4	0.19	2013.808	1809	6.59	10.00	3	1
03322+1133	AG 68	247.9	0.6	16.8	0.19	2014.011	1985	6.79	9.87	3	1
03334+2322	STT 57AC	3.93	0.1	69.0	0.16	2013.852	2024	7.17	7.67	3	1
03347+3848	HJL1022	214.6	0.1	136.0	0.20	2013.860	1989	7.96	9.80	3	1
03446+2754	STTA 38AB	52.1	0.1	135.1	0.17	2013.852	1648	6.78	6.91	3	1
03510+2939	STF 459AB	340.6	0.5	24.7	0.19	2013.860	2248	8.01	10.87	3	1
04384+3927	STF 568	199.7	0.7	21.3	0.18	2013.860	2563	8.49	11.78	3	1
04590+1433	SHJ 49AB	305.1	0.3	38.7	0.18	2014.011	1927	6.06	7.43	3	1
04590+1433	SHJ 49AC	89.6	0.2	54.9	0.20	2014.011	1825	6.06	9.60	3	1
05102+1400	S 468	166.1	0.3	26.2	0.16	2014.011	2127	8.62	8.86	3	1
05261+2250	HDS 713	129.3	0.4	24.0	0.15	2013.860	2096	10.00	10.19	3	1
05282-0156	HJ 702	148.6	0.5	24.0	0.22	2013.827	2037	8.46	9.35	3	1
05297-0106	STF 725	87.6	0.8	13.0	0.23	2013.827	1958	4.69	9.70	3	1
05320-0018	STFA 14AC	0.7	0.2	51.5	0.28	2013.827	2013	2.41	6.83	3	1
05331-0143	STF 734AC	243.2	0.4	29.6	0.24	2013.827	1904	6.67	8.35	3	1
05358-0059	STF 751	123.1	0.7	15.5	0.20	2014.074	2240	8.02	8.96	3	1
05382+1251	AG 315	159.4	0.3	29.7	0.18	2014.011	2058	9.76	10.62	3	1
05403+1521	STF 766AB	274.1	0.9	10.0	0.17	2014.011	2074	7.00	8.36	3	1
05429+0001	STF 782AB	305.1	0.3	47.0	0.26	2013.827	1828	8.60	8.83	3	1
05467+1103	AG 317	237.2	0.5	21.9	0.19	2014.011	1996	7.73	10.18	3	1
05571+1014	ARG 63AB	67.6	0.3	32.5	0.14	2014.011	1895	8.69	9.09	3	1
06065+1045	STF 840A,BC	247.7	0.5	21.4	0.17	2014.011	1969	7.17	8.95	3	1
06092+1139	STF 853	7.6	0.2	37.3	0.14	2014.011	2043	8.49	8.98	3	1
06599-0003	HJ 3287	79.1	0.5	22.3	0.20	2014.074	1972	8.94	9.10	3	1
07005-0031	BAL 749	134.3	0.6	17.5	0.19	2014.074	2059	8.91	9.44	3	1

Table continues on next page.

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Table 2 (continued). Results of 189 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
07043+0129	STTA 82	318.9	0.1	89.9	0.26	2014.074	1735	6.54	7.62	3	1
07161+0202	BAL1783	30.0	0.5	20.3	0.18	2014.074	2037	10.53	10.48	3	1
07188+0252	STF1067	266.4	0.4	25.8	0.20	2014.074	1917	8.51	10.15	3	1
07201+0146	AG 138	320.9	0.4	24.5	0.19	2014.074	1992	9.64	10.65	3	1
07470+0001	ARN 45AD	46.5	0.2	63.4	0.23	2014.074	1862	8.41	9.64	3	1
07470+0001	ARN 45AE	276.8	0.2	61.7	0.25	2014.074	1787	8.41	9.97	3	1
07470+0001	STF1141AB	10.2	0.6	17.2	0.18	2014.074	2058	8.41	9.37	3	1
09127-2115	LDS3865	236.8	2.7	7.5	0.36	2014.329	1530	13.1	13.3	2	1
09133-0219	HJ 123AB	71.1	1.0	38.3	0.71	2014.329	1337	11.6	14.8	2	1
09133-0219	HJ 123AC	38.4	0.7	30.4	0.47	2014.329	1421	11.6	11.7	2	1
09140-2052	ARA1065	221.8	2.5	13.1	0.65	2014.329	1551	11.85	13.1	2	1
09536+2141	HJ 2511	122.1	1.4	13.3	0.33	2014.326	1490	11.7	12.7	2	1
09545-1255	HJ 4262AC	135.1	0.1	152.1	0.16	2014.219	2959	8.69	6.92	6	2
09593-2631	LDS3945	251.1	0.4	69.3	0.45	2014.326	1374	11.72	12.3	2	1
10205+0626	STF1426AB,C	10.1	1.4	7.3	0.20	2014.318	1097	7.30	9.43	2	1
10299-0457	J 1565	10.5	2.2	19.7	0.76	2014.326	1459	13.0	13.0	2	1
10459-2025	ARA 672	269.9	1.7	7.4	0.38	2014.326	1500	11.83	12.2	2	1
10507-1353	J 2657	162.0	2.2	8.0	0.36	2014.326	1527	12.60	12.9	2	1
10522-2248	ARA1785	142.9	2.0	7.7	0.30	2014.326	1609	12.48	12.5	2	1
10536-0742	J 90BC	193.9	1.6	11.6	0.36	2014.326	1451	10.94	12.4	2	1
10567-0542	GWP1501	84.8	3.9	9.5	0.94	2014.326	696	11.6	12.4	2	1
10576-1945	ARA 677	32.1	1.9	15.0	0.51	2014.329	1543	12.6	13.1	2	1
10577+1031	BPM 578	172.4	0.3	114.8	0.65	2014.329	1348	13.08	13.73	2	1
10585-1816	GWP1512	338.3	0.7	45.5	0.49	2014.329	1468	10.6	13.7	2	1
10589-0823	UC 2044	62.8	0.9	53.3	0.93	2014.329	1302	10.7	12.9	2	1
10590-1717	LDS 323	64.1	2.1	21.7	0.76	2014.329	1479	13.0	15.0	2	1
10594+1154	HDS1567	9.2	0.9	7.2	0.16	2014.329	1497	8.96	11.54	2	1
10598-0200	BAL 530	253.7	0.8	11.0	0.26	2014.329	1415	9.14	11.78	2	1
11011+0003	HJ 1182	106.8	0.8	32.7	0.54	2014.329	1313	7.29	12.3	2	1
11038-2100	UC 2066	326.4	0.7	44.9	0.57	2014.329	1475	10.7	12.5	2	1
11045-1940	HDS1580	284.9	1.2	17.3	0.38	2014.329	1522	9.76	11.07	2	1
11062-2028	UC 2079	32.0	1.0	42.6	0.74	2014.329	1493	13.4	14.8	2	1
11062-2723	LDS 334	122.1	0.3	132.3	0.64	2014.329	1182	11.7	13.8	2	1
11123-2117	ARA1091	263.4	2.1	6.7	0.26	2014.326	1313	11.04	12.1	2	1
11444-1641	J 1601	252.0	2.6	10.4	0.52	2014.326	1501	11.0	11.7	2	1
11533+0214	BAL1881	187.7	2.5	6.2	0.35	2014.326	1470	10.5	11.9	2	1
11582+0543	CBL 364AB	82.3	0.6	70.2	0.69	2014.329	1139	12.4	15.4	2	1
11582+0543	GWP1717AC	298.7	0.2	149.8	0.66	2014.329	988	12.4	13.3	2	1
11589-0147	GWP1722	340.0	0.4	79.0	0.76	2014.329	1378	12.3	14.5	2	1
12066-1701	HJ 1209	250.2	1.3	18.6	0.44	2014.329	1505	11.52	12.7	2	1
12106-1748	ARA 226	280.4	2.2	12.2	0.48	2014.329	1525	11.80	12.4	2	1
12133-0714	LDS 393	81.0	0.4	96.6	0.70	2014.329	1124	14.14	14.29	2	1
12151-0715	STF1619AB	266.0	1.7	6.9	0.21	2014.403	1323	8.06	8.30	2	1

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Table 2 (continued). Results of 189 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
12151-0715	STF1619AC	162.8	0.2	98.3	0.38	2014.403	1228	8.06	10.46	2	1
12163-2706	HJ 4509AC	111.5	0.4	27.7	0.18	2014.329	1505	8.20	12.6	2	1
12191-2726	HJ 4514	138.0	1.3	15.3	0.35	2014.326	1623	12.35	12.4	2	1
12222-1815	UC 2325	272.2	0.7	43.0	0.62	2014.329	1405	11.7	13.1	2	1
12226-1639	UC 2326	158.1	1.9	10.1	0.38	2014.329	1549	11.4	14.1	2	1
12314-3205	PRO 101	304.1	2.5	6.1	0.24	2014.326	1703	12.08	12.4	2	1
12357-1650	HJ 1218AB	259.3	0.5	11.1	0.19	2014.326	1457	6.6	11.0	2	1
12384-2236	ARA1795	63.7	1.9	10.8	0.34	2014.326	1552	11.8	12.6	2	1
12426-2437	HJ 4542	62.6	0.6	37.9	0.44	2014.326	1472	8.95	12.4	2	1
12459-2425	HJ 4549	86.5	1.6	11.9	0.36	2014.326	1576	11.01	11.03	2	1
12468-3319	HDO 219	219.8	0.4	77.1	0.43	2014.403	1337	5.86	12.0	2	1
12494-2639	LDS4277	79.7	0.4	84.5	0.56	2014.329	1309	10.77	12.91	2	1
12529-1732	UC 2421	257.0	1.6	19.8	0.64	2014.329	1505	12.2	13.7	2	1
13015-2134	ARA1482	60.9	1.5	12.5	0.33	2014.329	1396	11.46	13.2	2	1
13378+2819	HJ 3341AC	75.7	0.1	120.0	0.30	2014.403	1170	10.84	13.0	2	1
13451+1747	BUP 153AB	333.9	0.2	108.6	0.39	2014.411	1354	10.01	12.28	2	1
13569-2740	SEE 193	164.2	0.8	6.7	0.13	2014.411	1670	7.81	11.92	2	1
13577-2525	J 1610	283.5	1.7	11.1	0.34	2014.411	1598	12.77	12.71	2	1
14089-4328	SIN 88BC	270.7	0.3	50.2	0.37	2014.318	852	10.2	13.3	1	1
14216-1615	FOX 182	171.1	0.9	20.6	0.36	2014.411	1542	9.77	13.58	2	1
14475-3658	SEE 211	181.5	1.1	13.8	0.37	2014.411	1839	8.41	13.7	2	1
14489+2404	HJ 2747	47.8	1.7	12.8	0.32	2014.411	1597	11.60	12.6	2	1
14525+1844	BU 31AC	167.4	0.3	8.2	0.17	2014.411	1523	8.53	12.5	2	1
15019+1547	STF1902	191.5	0.4	25.9	0.18	2014.422	2120	8.99	9.61	3	1
15086+2507	HJ 2766	330.2	0.3	56.4	0.23	2014.441	2101	5.81	10.0	3	1
15125-3555	RSS 367AB	106.1	1.1	6.4	0.19	2014.493	1803	8.3	13.0	2	1
15131+1808	TOK 299	353.6	0.8	33.9	0.42	2014.411	1512	10.27	14.63	2	1
15169-0817	STF1925AB	17.8	2.2	5.5	0.22	2014.479	1411	8.14	9.85	2	1
15169-0817	STF1925AC	292.0	0.3	62.5	0.32	2014.479	1216	8.14	13.5	2	1
15169-0817	STF1925AD	287.3	0.2	118.8	0.50	2014.479	984	8.14	13.1	2	1
15169-0817	STF1925AE	276.4	0.1	208.6	0.49	2014.479	660	8.14	12.3	2	1
15282-3722	RST3920	284.8	0.2	11.8	0.13	2014.411	901	7.0	12.9	1	1
15288+3101	A 1369AC	258.4	0.2	73.1	0.16	2014.441	1902	10.66	10.48	3	1
15319+0940	STF1952AB,C	221.2	0.6	16.4	0.19	2014.422	2044	8.70	10.12	3	1
15325+0835	STTA140AB	179.5	0.1	113.7	0.20	2014.422	1875	8.30	8.74	3	1
15370-3137	RST1850AB	280.6	2.7	4.8	0.19	2014.411	1711	9.4	12.8	2	1
15434-1037	J 2663	51.9	2.4	7.1	0.30	2014.411	1436	11.95	12.1	2	1
16048+2514	HDS2270	7.7	0.3	27.3	0.17	2014.441	2268	9.47	9.61	3	1
16134-2758	AOT 64	145.3	1.7	13.5	0.39	2014.493	1641	11.23	12.6	2	1
16401+3038	LAU 3	262.7	0.1	80.1	0.17	2014.441	1865	9.86	10.52	3	1
16448-3144	BRT3031AC	197.7	2.1	7.7	0.25	2014.493	1710	11.55	12.72	2	1
16457+3000	STF2098AB	144.8	0.7	14.2	0.15	2014.441	2106	8.77	9.61	3	1
16457+3000	STF2098AC	128.2	0.1	65.7	0.14	2014.441	2157	8.77	8.81	3	1

Table continues on next page.

Double Star Measures Using the Video Drift Method - V

Table 2 (continued). Results of 189 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
16457+3000	STF2098AD	17.8	0.3	66.8	0.22	2014.441	2259	8.77	11.00	3	1
16458+0835	SHJ 239AB	228.2	0.1	84.7	0.20	2014.422	1646	5.33	9.29	3	1
16479-4058	SIN 98BC	71.1	0.5	89.9	0.68	2014.493	1526	11.0	13.9	2	1
16479-4058	SIN 98BD	288.4	0.4	103.2	0.59	2014.493	1475	11.0	12.7	2	1
16563-3123	SEE 312	51.5	0.4	21.1	0.13	2014.485	1649	9.0	13.6	2	1
16595+0942	STTA150AB,C	164.3	0.1	75.7	0.17	2014.422	1991	8.25	8.74	3	1
16599-2412	HJ 4907AB	35.2	2.3	6.3	0.27	2014.411	1599	9.67	10.16	2	1
17039+1941	BU 822AC	196.5	0.1	114.0	0.20	2014.441	1946	6.58	10.99	3	1
17153-3939	I 229	232.5	1.6	5.0	0.14	2014.485	1874	9.13	11.5	2	1
17311+3533	POP 20	25.3	1.9	8.5	0.25	2014.479	1788	13.4	14.5	2	1
17418-2032	ARA1129	272.7	1.8	6.6	0.31	2014.479	1462	11.57	12.1	2	1
17535-2231	ARA1828	101.0	3.0	7.2	0.37	2014.485	778	11.31	12.3	1	1
18073-3517	BRT1756AB	95.7	1.9	6.3	0.22	2014.485	1668	10.62	12.4	2	1
18134-2302	ARA2217AB	36.9	1.4	12.4	0.28	2014.485	1598	10.71	11.09	2	1
18134-2302	ABH 97AD	276.6	0.5	49.8	0.46	2014.485	1363	10.71	11.7	2	1
18134-2302	ARA2217BC	123.7	1.5	12.3	0.32	2014.485	1555	11.09	12.2	2	1
18134-2302	ABH 97BE	67.7	1.0	31.8	0.50	2014.485	1443	11.09	13.2	2	1
18143-1902	ARA 740	51.8	2.4	9.1	0.37	2014.485	1484	12.02	12.0	2	1
18174+2456	POU3380	73.9	2.1	12.9	0.44	2014.485	1583	12.20	13.03	2	1
19151-0428	LDS5873	99.6	0.2	85.2	0.24	2013.603	1601	10.03	10.44	3	1
19201+5334	A 1394AC	358.3	0.2	56.2	0.13	2013.732	3444	9.51	10.17	3	1
19264+0149	H 6 48	172.9	0.1	151.1	0.24	2013.592	2007	8.33	10.67	3	1
19411+1041	STF2558	307.8	0.5	27.5	0.23	2013.721	1979	8.11	11.89	3	1
19428+3741	STTA188AB	120.9	0.2	60.5	0.17	2013.603	2199	7.71	7.98	3	1
19428+3741	STU 11AC	228.0	0.1	146.0	0.19	2013.603	1790	7.71	8.14	3	1
19428+3741	STU 11AE	195.7	0.2	101.7	0.23	2013.603	1818	7.71	11.39	3	1
19581+5355	ARG 35	226.5	1.4	7.3	0.12	2013.732	3233	9.00	9.92	3	1
20058+3556	ABH 129AF	92.6	0.1	89.3	0.17	2013.603	1791	10.75	10.13	3	1
20058+3556	ABH 129AG	166.5	0.2	67.1	0.22	2013.603	2393	10.75	11.24	3	1
20105+3323	TOB 50	268.6	0.3	31.9	0.15	2013.721	2253	8.98	10.14	3	1
20264+5402	FRK 9	238.0	0.2	59.8	0.12	2013.732	2980	8.44	9.04	3	1
20312+1116	STF2690A,BC	255.2	0.8	17.6	0.22	2013.827	2032	7.12	7.39	3	1
20322-2209	HJ 2973AB	127.0	0.8	38.5	0.47	2013.803	6109	7.77	8.10	3	1
20482-0601	TOK 341	262.8	0.1	392.0	0.79	2013.803	3533	8.53	9.74	3	1
20515+5403	ARG 41AB	193.3	0.9	11.1	0.11	2013.732	3466	9.60	9.53	3	1
20527-0859	TOK 342AB	113.9	0.1	503.2	1.09	2013.803	2653	4.76	9.86	3	1
21036+5358	ES 2704AB	96.7	0.2	54.4	0.11	2013.732	2941	8.56	8.91	3	1
21143+3418	STTA216	47.1	0.1	101.9	0.16	2013.592	1977	7.35	8.09	3	1
21194+5219	ES 98BC	106.6	0.2	51.9	0.12	2013.732	2937	10.16	10.19	3	1
21224+5218	ES 2708	40.2	0.3	29.7	0.12	2013.732	3169	8.68	8.97	3	1
21268+3731	HEI9004AD	334.7	0.1	109.0	0.17	2013.603	2186	7.91	9.73	3	1
21308+4827	A 770AB,D	14.4	0.1	97.5	0.14	2013.732	2859	8.74	10.59	3	1
21424+0027	STF2817AB	154.9	0.5	25.8	0.25	2013.721	1989	8.88	9.20	3	1

Table concludes on next page.

Double Star Measures Using the Video Drift Method - V

Table 2 (conclusion). Results of 189 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
21432+3801	BLL 55AB	117.2	0.1	143.2	0.22	2013.603	1609	8.43	10.92	3	1
21443+2500	POU5472	202.2	1.2	23.4	0.30	2013.811	1162	11.47	13.05	3	1
21470+2930	GRV 503	330.7	0.5	20.2	0.16	2013.811	2345	11.29	11.30	3	1
21506+4017	SEI1539	259.8	0.4	26.9	0.16	2013.803	2480	11.46	11.85	3	1
22020+2651	HO 610AC	330.8	0.5	32.9	0.20	2013.811	2190	10.07	12.60	3	1
22020+2651	HO 610AE	239.0	0.2	57.2	0.22	2013.811	2094	10.07	12.13	3	1
22041+4437	LYS 18AB	85.0	0.5	28.4	0.18	2013.803	2520	10.45	12.23	3	1
22044+7013	STF2865	199.5	0.5	29.2	0.09	2013.721	5927	8.69	9.48	3	1
22083+6959	ARY 45	206.7	0.2	66.3	0.10	2013.721	5463	7.86	8.11	3	1
22363+2945	AG 423	154.4	0.6	23.6	0.22	2013.811	2354	8.48	11.27	3	1
22415+3003	STF2932AB	282.3	0.6	22.0	0.17	2013.827	2203	9.32	9.44	3	1
23066+4153	LYS 30	279.6	0.4	30.8	0.19	2013.803	2295	9.30	12.82	3	1
23267+4317	CHE 465	313.4	0.6	30.7	0.21	2013.803	1543	10.50	10.70	3	1
23268+4157	CHE 466	124.4	0.7	18.8	0.18	2013.803	2561	9.73	10.30	3	1
23549+2929	STTA252	144.4	0.1	110.7	0.12	2013.830	4056	6.77	8.37	6	2
23592+4112	HJL1113AC	192.5	0.1	114.3	0.15	2013.803	2487	7.78	8.22	3	1