Double Star Measures of Neglected Systems Using the Video Drift Method

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Abstract: Position angles and separations are given for 64 neglected multiple star systems measured using the video drift method. Most of these systems have lacked measurements since the late 1800's and early to mid 1900's as shown in the WDS Catalog version from early 2012. Most had multiple drifts, resulting in thousands of video frames analyzed per system. The video drift method provides high systematic accuracy.

Introduction

In the first and subsequent papers describing a new video method to measure double stars (Nugent and Iverson, 2011, Nugent and Iverson, 2013), 1,000's of Cartesian (*x*,*y*) positions of the double star components weere obtained from a short video clip of the multiple star system drifting across the field of view. The freeware program *Limovie* (Miyashita, 2006), originally intended for analysis of occultation videos, was used to automatically convert the raw video into a table of Cartesian (*x*,*y*) positions for the component stars being measured. An Excel program written by this author reads the (*x*,*y*) coordinate data and computes a simultaneous solution for the position angle, separation and other statistical quantities from the entire data set per system. Typical probable errors for the data presented here in the Tables is 0.75° for PA and 0.28″ for separation.

Methodology

The telescope used and scale factor are summarized in Table 1. The systems targeted in this research in Table 2 lacked measurements from the late 1800's to the early to mid 1900's. Unknown to this author, some systems were updated in the WDS catalog during the course of this research by other investigators. For most systems, a Collins I^3 image intensifier (Collins 1998) was used to aid in reaching fainter doubles. This device is attached between the telescope and the video camera and adds approximately three (3) magnitudes to the faint limit of the video system. The faintest system measured from Table 2 had a secondary with a published magnitude of +14.0 (WDS 14284+0520/LDS 961). Table 2 presents results for 64 double star systems along with standard deviations, number of video

Table 1: Telescope used and scale factor.

TELESCOPE	APERTURE	FOCAL LENGTH	SCALE FACTOR
Meade LX-200	14" (35cm)	3550 mm f/10	0.6"/pixel

frames, number of drift runs, and other data.

Table 3 has the result for the unconfirmed system WDS 13109+2114 SIN 79AC whose only entry is from epoch 1989.

Discussion of Individual Systems

06072-2216/ARA 1638BC

See Figure 1. The Palomar Sky Survey (DSS) IR image shows only two stars at nearly 180° PA. The WDS catalog value for the AB component for year 1999 shows a PA=179°, sep=13.4". This is very close to the Table 2 values of PA= 182.1° and Sep=12.4". A "BC" component is listed from a 1920 entry at PA=147°, sep=8.8" however no such star is visible in any of the images at or near the reported magnitude of +10.9. Ignoring a flare star possibility in 1920, it is suggested that the C component doesn't exist and the BC entry should

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Table 2. Results of 64 neglected double stars using the video drift method.

WDS	Discoverer	PA	PA-σ	Sep	Sep-σ	Date	# video frames	mag pri	mag sec	N
02414+0426	A 2337AD	214	0.8	20.1	0.28	2013.044	1903	6.9	11.7	3
02578-2317	ARA1971	92.8	1.9	16.7	0.65	2013.036	759	9.89	12.7	1
02595+3753	HO 219AD	188.3	0.7	47.3	0.42	2013.044	822	8.2	11.6	1
03195-2145	JC 1AC	119.8	0.8	38.6	0.67	2013.036	623	3.91	10.8	1
04286+1911	BUP 61AB	268.8	0.2	191	0.55	2013.036	592	3.53	10.6	2
04467-0042	BAL 663	200.7	3.1	16.9	0.9	2013.036	683	10.82	11.2	1
04507-1713	ARA 155	24.3	4.7	10.8	0.88	2013.036	443	12.53	12.7	1
04514+0706	LDS3621	176.9	1.4	53.1	1.22	2013.036	717	11.92	12.0	1
04564+1331	BU 553AC	71.3	0.2	106	0.44	2013.197	1331	4.07	11.6	3
06072-2216	ARA1638AB	182.1	1.1	12.4	0.33	2013.255	2446	10.36	10.9	3
06089-1954	ARA 540	184.8	2.0	9.8	0.46	2013.255	2375	12.81	12.9	3
06136-1527	GAL 396AB	256.9	1.0	15.2	0.27	2013.255	2171	8.5	10.5	3
06290+0335	BAL2172	262.3	1.7	14.6	0.52	2013.255	2192	11.32	11.9	3
06312+2253	POU1390	322.1	2.2	13.2	0.44	2013.255	2377	11.43	12.2	3
06360-0047	BAL 701BC	200.3	2.3	15.7	0.58	2013.255	1473	11.2	11.4	3
06549-0224	BAL 95	21.2	1.3	17.2	0.38	2013.2	2161	12.14	12.1	3
07147+2453	HO 343	279.5	0.2	30.9	0.35	2013.2	759	6.0	12.7	1
07175-2239	ARA1683	145	2.6	14.8	0.68	2013.255	1608	11.74	11.8	2
07366-1429	STF1121AC	131.5	1.1	17.7	0.36	2013.255	1942	6.92	13.0	3
07535+0428	BAL2794	283.2	0.7	28.6	0.39	2013.2	2085	10.8	11.0	3
07550+0036	BAL1123	48.7	3.4	14.4	0.77	2013.255	2141	11.96	12.2	3
07585-0217	BAL 191	121.2	1.4	11.6	0.33	2013.197	2180	8.90	11.1	3
08000-0050	BAL 842	93	1.2	13.1	0.4	2013.197	2188	11.44	11.5	3
08022-0058	HJ 77AB	359.2	0.5	30.8	0.3	2013.197	2241	9.68	11.7	3
08022-0058	HJ 77AC	13.9	0.5	34.5	0.33	2013.197	2168	9.68	12.0	3
08022-0058	HJ 77BC	73.3	1.7	9.9	0.32	2013.197	2182	11.7	12.0	3
08029-0242	BAL 194	143.9	1.6	10.7	0.34	2013.197	2190	10.6	11.0	3
08165-1619	FOX 157AC	32.4	0.4	74.3	0.41	2013.197	2052	7.7	10.8	3
08236+2509	BUP 116	171.4	0.2	116	0.45	2013.252	1496	10.04	12.0	2
08468-0004	BAL1142	105.2	1.3	12.7	0.37	2013.2	2176	10.28	10.4	3

Table continues on next page.

Double Star Measures of Neglected Systems Using the Video Drift Method

Table 2 (conclusion). Results of 64 neglected double stars using the video drift method.

WDS	Discoverer	PA	PA-σ	Sep	Sep-σ	Date	#video frames	mag pri	mag sec	N
08491-1244	J 2064AB	29.4	0.4	68	0.45	2012.227	1799	8.40	10.8	3
08504+1123	HJ 2470	215	2.2	7	0.31	2013.197	2216	11.75	11.82	3
09006+4147	BUP 122AB-D	104.3	0.2	173	0.4	2013.258	853	4.03	10.8	2
09012+0245	STF1302AC	255.4	0.6	24	0.31	2013.252	1371	9.31	12.6	2
09047-0806	J 2895	5.1	2.1	7.5	0.3	2013.26	1522	12.02	12.0	2
09090-1411	HU 227AC	323.9	0.2	26.2	0.15	2013.197	2155	7.74	11.0	3
09142-2036	ARA1066	330.5	1.1	13.9	0.28	2013.2	2354	10.17	12.3	3
09168-2121	ARA1067	85.8	1.7	12	0.69	2013.26	1588	12.43	12.9	2
09230-2843	B 2680	314	0.7	15.7	0.23	2013.26	1568	8.87	13.0	2
09308-1623	LDS 272	6.5	1.0	23.8	0.35	2013.26	1561	10.65	12.9	2
09347-2509	B 2220	82.6	0.4	20.2	0.13	2013.26	1549	8.28	11.1	2
09357-2230	ARA1768	53.1	0.7	14.9	0.21	2013.2	2094	9.44	11.9	3
09419-3011	J 1556	21.5	2.7	9.2	0.35	2013.255	1706	10.5	11.0	2
10008-1809	ARA 220	5.8	1.9	7.7	0.36	2013.197	2317	11.8	11.9	3
10160+3034	BEW 6	21.5	1.8	10.3	0.3	2013.255	2586	13.6	13.4	3
10294+0346	SLE 494	38.8	1.6	21.7	0.55	2013.197	2141	11.8	12.5	3
10319+3223	HJ 482	248.4	0.4	56.8	0.29	2013.26	1453	5.90	11.8	2
10459-2025	ARA 672	269	1.3	7.6	0.27	2013.252	2341	11.83	12.2	3
10470-1241	GWP 1454	212.6	2.6	13.7	0.55	2013.26	1491	12.9	13.8	2
10522-2248	ARA1785	140.4	2.0	7.2	0.32	2011.107	3179	12.48	12.5	4
11330-3151	HJ 4449AB	133.9	0.4	73	0.53	2013.258	1307	3.54	10.7	2
11423-1544	LDS 357	256.7	0.2	66.5	0.3	2013.2	1919	9.11	11.5	3
11536-1607	A 2381AC	319.3	0.2	71.5	0.35	2013.2	2651	7.57	11.1	4
12301-1324	LV 19AC	302.8	0.2	71.3	0.27	2013.351	1904	6.49	10.6	3
12301-1324	LV 19AD	165.5	0.6	71.2	0.58	2013.351	724	6.49	11.6	1
12400+2955	LDS4243	44.3	0.2	87.7	0.32	2013.351	1431	11.54	12.6	2
13085+3106	LDS1363	288.2	0.1	198	0.34	2013.351	399	11.52	12.24	3
13343-0019	STF1757AD	75.7	0.2	144	0.51	2013.351	890	7.82	11.9	2
14158+1018	STF1823AB,D	253.3	0.3	65.4	0.46	2013.351	1247	9.19	12.4	2
14257+2338	BU 1442AF	283.1	0.1	246	0.37	2013.351	868	9.87	12.5	3
14284+0520	LDS 961	256.1	0.3	60.7	0.4	2013.351	1265	13.2	14.0	2
14313-1538	BU 117AC	330.8	0.3	142	0.62	2013.351	627	8.44	12.5	1
14336+3535	STF1858AC	322.1	0.1	36.6	0.1	2013.351	1650	8.13	13.9	2
14463+0939	STF1879AB,C	232.6	0.2	38.1	0.11	2013.351	1366	7.32	12.1	2

Table 2 Notes:

All magnitudes were taken from the WDS catalog.

All positions are for Equator and Equinox of date.

Column titled "# **video frames**" is the total combined no. of video frames from all drift runs. All video frames were used in the solution, none were discarded.

The last column "**N**" is the number of separate drift runs made for that system.

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Table 3. Measures of Unconfirmed Double Star system using Video Drift Method

WDS	Discoverer	PA	PA-σ	Sep	Sep-σ	Date	#video frames	mag pri	mag sec	N
13109+2114	SIN 79AC	25	0.25	94.9	0.79	2012.307	750	6.82	12.2	1

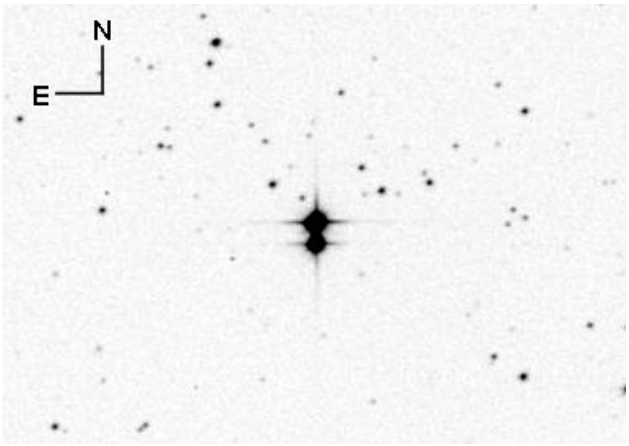

Figure 1. WDS 06072-2216, epoch 1991.

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be removed.

07535+0428/BAL 2794

Primary and secondary have nearly similar magnitudes. A recent addition to WDS using 2000 data shows PA at 284°. The value derived by the video method was 103.2°, 180.8° different from the WDS catalog value. Hence 180° was added to get 283.2° to make the value consistent with the catalog measure. Misidentification of the primary star occurs occasionally with video due to the spectral sensitivity of the chip in the video camera.

09047-0806/J 2895

See Figure 2. POSS images from 1953 and 1991 plus a single video frame from 2013 show the PA change of approximately 15°, indicating possible orbital motion. WDS has only two entries for years 1945 and 1955 showing only a 1° PA change. The video method derived a value of PA = 5.1° for epoch 2013 confirming relative motion of the pair.

14257+2338/BU 1442AF:

See Figure 3. The AB components of this system have a common proper motion of 1.4"/yr. in PA = 144° and as of 2013 they have moved a distance of 116" since the WDS catalog's 1930 entry. This physical pair's large proper motion is clearly responsible for the large change in PA and separation values for the AF components over the 83 year interval since last measured.

Unconfirmed Individual Systems

WDS 13109+2114 SIN 79AC

See Figure 4 and Table 3. Identification of the single observation from the WDS in 1989 of this pair is not

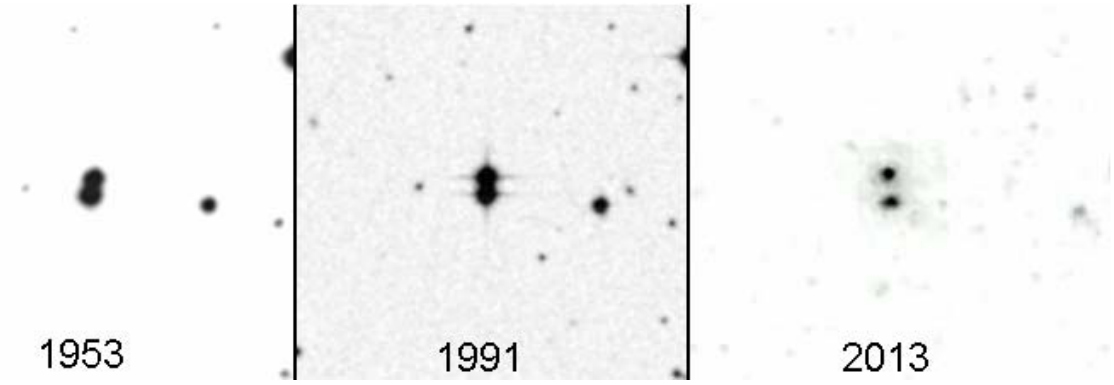

Figure 2. WDS 09047-0806. POSS images left to right epochs 1953, 1991 plus enlarged single video frame from 2013. From the images, the PA change over 60 years is approximately 15°, hence possible orbital motion is detected.

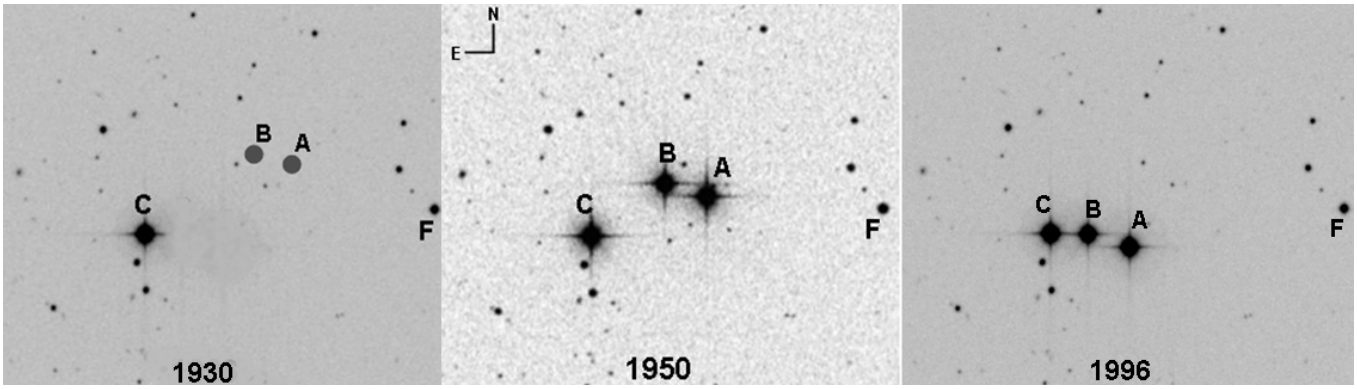

Figure 3. WDS 14257+2338. Left: calculated position of AB component in 1930 from proper motions. Center, right: POSS images from 1950, 1996. AB system has moved 92" in 66 years.

confirmed. The suspected C component is marked in Figure 4 at PA=25°, sep=95". Proper motion data does not support the 19° PA and 10" separation differences over the 23 year interval since the WDS 1989 entry. The B component is well known as 13109+2114 COU 96 AB.

Acknowledgements

This research makes use of the following catalogs/ surveys: Washington Double Star Catalog maintained at the US Naval Observatory. The National Geographic Society - Palomar Observatory Sky Atlas (POSS), made by the California Institute of Technology with grants from the National Geographic Society. Dr. Brian Mason of the USNO made helpful comments.

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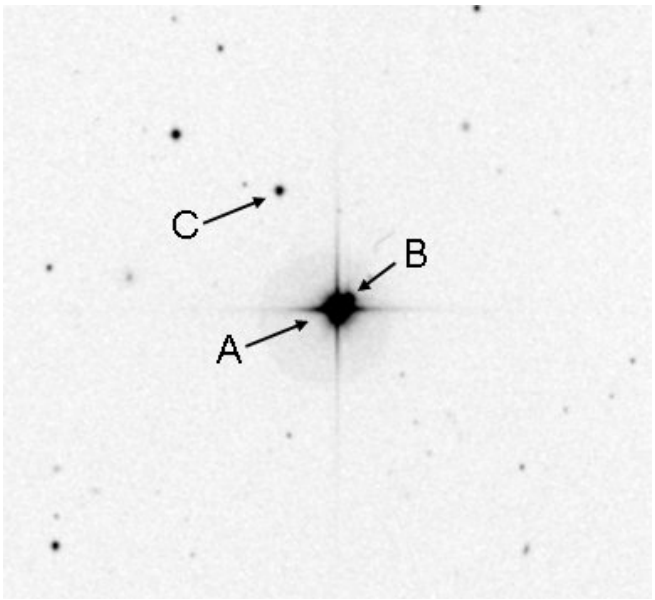

Figure 4. WDS 13109+2114 SIN 79. Arrows indicate components measured. POSS image epoch April 19, 1996. The AB components are known as 13109+2114 COU 96 AB.