

CCD OBSERVATIONS OF VISUAL DOUBLE AND MULTIPLE STARS AT THE BELGRADE OBSERVATORY

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(Received: February 22, 1999)

SUMMARY: The author presents her CCD measurements of 105 double and multiple stars performed with a ST-6 camera on the Belgrade Large Refractor (Zeiss 65/1055 cm).

1. INTRODUCTION

The CCD observations of double and multiple stars at the Belgrade Observatory have been performed since 1994 at the Zeiss Large Refractor (65/1055 cm). The earlier observations were visual by using eyepiece-micrometer attached to the same instrument.

The presented series results from geometric and photometric CCD measurements (their mean value) of 105 double and multiple systems. These measurements were performed in the following way. In geometric CCD measurements the centre of each pair component is set on for given image parameters, whereas in photometric CCD measurements one takes the values of illumination of the points on the pair image having the highest relative intensity. Such geometric and photometric CCD measurements for a given exposure are mutually different and because of this the author presents as the measuring result their mean value, unlike other authors who choose either of the two ways of measuring.

Three observers (Popović G. M., Pavlović R. and the author) have effected more than 500 exposures. On the average each pair has been measured

4.5 times and every image has been measured by the author which contributed to the accuracy to be enhanced.

The camera pixel has a rectangular form with dimensions along the axes (x, y) as follows:

$$m_x = (0.4525 \pm 0.0021)''/\text{pixel}$$

$$m_y = (0.5312 \pm 0.0025)''/\text{pixel}$$

Before the pixel dimensions were derived, the focal length of the instrument had been established (Pavlović et al., 1996). The focal length is found to be

$$F = (1048.5 \pm 4.5)\text{cm}$$

The measurement accuracy is also determined (Popović et al., 1996) and its values are approximately $\pm 1^\circ 0$ in position angle and about $\pm 1'' 00$ in separation respectively in case of the pairs with $\rho > 2''$.

The results of these measurements are given in Table 1.

The analysis of the measurements presented here will be given in another paper.

2. EXPLANATIONS TO TABLE 1.

The columns contain the following data respectively:

- Column 1: WDS number
- Column 2: Designation of the pair's discoverer
- Column 3: Multiplicity
- Column 4: Observation date
- Column 5: Position angle in degrees
- Column 6: Separation of the components in arc seconds
- Column 7: Number of measurements
- Column 8: Indication of the author of the image
- Column 9: Number in ADS Catalogue
- Column 10: Indication of the notes appearing in Table 2

The designations in Column 8 mean: POP

= Popović G.M., PAV = Pavlović R., TRA = Trajkovska V.

The pairs denoted TRA1 = BD+34° 3267 (8^m 5)⁺, PAV1 = BD+72° 901(9^m 5), POP216 = BD+41° 2896(9^m 3), POP217 = ADS48 AP and POP218 = BD+34° 2947(9^m 0), have not been registered as yet so that here their very first measurements are communicated. The pair PAV1 was registered in IAU Cir., Commission 26, No.127.

REFERENCES

- Pavlović, R., Popović, G.M., Živkov V.: 1996, *Publ. Astron. Obs. Belgrade*, **54**, 101.
- Popović, G.M., Pavlović, R., Živkov, V.: 1996, *Publ. Astron. Obs. Belgrade*, **54**, 95.

Table 1. Double and multiple star measurements with ST-6 camera

1	2	3	4	5	6	7	8	9	10
WDS	Name	Mult.	Date	Θ	ρ	n	Obs.	ADS	Notes
00054N4549	STT 547	AB	1994.796	181.28	6.06	5	Pop-Pav	48	*
00054N4549	POP 217	AP	1994.796	44.57	11.62	3	Pop-Pav	48	*
00054N4549	STT 547	AC	1994.796	2.26	53.14	1	Pop-Pav	48	
00057N1750	STF 3061		1994.784	150.47	7.50	4	Pop-Pav	56	*
00059N1765	STF 3060	AB	1994.784	133.32	3.44	4	Pop-Pav	60	
00059N1765	STF 3060	AC	1994.786	264.43	67.64	2	Pop-Pav	60	
00422N4025	POP 124		1994.796	30.01	3.56	2	Pop-Pav		*
00423N3975	A 1507	AC	1994.796	51.58	16.87	1	Pop-Pav	585	
01198S0029	STF 113	A-BC	1994.796	14.33	1.23	1	Pop-Pav	1081	
01620N0246	STF 202		1994.738	276.95	1.83	5	Pop-Pav	1615	*
13165N3433	POP 72		1995.453	317.16	.95	2	Pop-Pav-Tra		
13625N4620	SWI -		1995.552	24.00	3.74	8	Pop-Pav	9090	
14362N1925	STF 3087		1995.434	41.33	2.53	3	Pop-Pav	9321	
14407N1626	STF 1864	AB	1995.434	109.27	5.54	6	Pop-Pav	9338	
15075N0914	STF 1910		1995.434	209.37	4.11	3	Pop-Pav	9507	
15154N4153	POP 118		1995.454	342.97	2.68	3	Pop-Pav-Tra		
15122N3420	POP 209		1995.452	166.60	3.98	5	Pop-Pav-Tra		
15207N3500	HO 62		1995.434	279.22	1.11	5	Pop-Pav	9599	
15300N2531	STF 1950		1995.508	89.77	3.18	6	Pop	9675	
16147N3352	STF 2032		1995.549	234.85	7.09	2	Pop-Pav-Tra	9979	*
16140N3510	POP 103		1995.522	51.05	3.92	8	Pop-Pav		
16273N3418	POP 1	AB	1995.464	179.99	2.44	7	Pop-Pav-Tra		
16273N3418	POP 1	AC	1995.464	202.01	40.28	2	Pop-Pav-Tra		
16333N3536	POP 89		1995.470	168.28	3.47	4	Pop-Pav-Tra		
16371N3351	POP 2		1995.464	133.75	3.80	1	Pop-Pav-Tra		
17034N5934	STF 2128		1995.552	44.12	12.28	8	Pop-Pav-Tra	10329	*
17096N4040	POP 166	AB	1955.514	284.21	6.37	5	Pop-Pav		
17097N4039	POP 166	AC	1995.514	309.88	71.07	6	Pop-Pav		
17147N3448	POP 76		1995.520	110.55	1.95	4	Pop-Pav		

⁺ This is the first new double star registered by using a CCD camera at Belgrade Observatory.

Table 1. (continued)

1	2	3	4	5	6	7	8	9	10
WDS	Name	Mult.	Date	Θ	ρ	n	Obs.	ADS	Notes
17150N2450	STF 3127	AB	1995.541	276.75	10.85	5	Pop-Pav	10424	*
17152N4440	POP 131	AB	1995.517	137.17	3.73	12	Pop-Pav		
17152N4440	POP 131	AC	1995.517	322.25	27.93	12	Pop-Pav		
17152N4440	POP 131	AP	1995.517	102.84	20.56	10	Pop-Pav		
17180S2417	H 25		1995.549	355.23	10.12	5	Pop-Pav-Tra	10442	
17180N4919	STF 2153		1995.549	251.92	1.49	4	Pop-Pav-Tra	10460	
17205N3440	POP 218		1995.522	89.38	30.92	3	Pop-Pav		*
17202N3439	POP 203		1995.522	209.22	3.76	4	Pop-Pav		
17294N3456	STF 2178		1995.522	127.82	10.58	6	Pop-Pav	10594	
17386N5546	STF 2199		1995.549	58.03	1.93	5	Pop-Pav-Tra	10699	*
17146N1423	STF 2140	AB	1995.541	105.26	4.67	13	Pop-Pav	10418	
17146N1423	AGC	AC	1995.541	305.96	20.36	4	Pop-Pav	10418	
17146N1423	STF 2140	AD	1995.541	38.12	79.16	2	Pop-Pav	10418	
17165N3448	POP 77	AB	1995.519	321.32	5.49	9	Pop-Pav		
17165N3448	POP 77	AC	1995.519	342.45	63.73	10	Pop-Pav		
17165N3448	POP 77	CD	1995.519	74.38	10.46	5	Pop-Pav		
17297N4447	POP 132		1995.525	154.53	15.41	4	Pop-Pav-Tra		
17316N3533	POP 175		1995.522	29.19	7.11	4	Pop-Pav		
17413N4127	A 696	AB	1995.552	175.31	8.30	7	Pop-Pav-Tra	10725	
17413N4127	A 696	BC	1995.552	305.77	1.95	6	Pop-Pav		
17457N4132	POP 216		1995.552	88.72	8.15	2	Pop-Pav		*
17573N3540	STF 2257		1995.434	151.74	22.67	2	Pop-Pav	10932	
17572N3542	POP 10	AB	1995.434	208.40	1.87	6	Pop-Pav		
17572N3542	POP 10	AC	1995.434	344.92	8.55	5	Pop-Pav		
17586N4231	POP 123		1995.555	227.02	3.37	5	Pop-Pav		
18011N3558	POP 210	AB	1995.555	267.34	80.16	1	Pop-Pav-Tra		*
18011N3558	POP 210	BC	1995.555	128.99	2.93	1	Pop-Pav-Tra		
18065N4021	STF 2282		1995.552	84.30	2.64	6	Pop-Pav-Tra	11074	
18273N4354	POP 134	AB	1995.555	58.02	7.60	4	Pop-Pav-Tra		
18273N4354	POP 134	AC	1995.555	284.87	66.84	3	Pop-Pav-Tra		
18273N4354	POP 134	CD	1995.555	252.32	6.18	3	Pop-Pav-Tra		
18310N0123	STF 2324		1995.541	151.47	2.86	1	Pop-Pav-Tra	11410	
18359N1654	STT 358	AB	1995.590	160.76	1.64	3	Pav	11483	*
18379N3506	TRA 1		1995.468	164.03	9.60	14	Pop-Pav-Tra		*
18379N3505	POP 16	AB	1995.469	309.06	9.07	11	Pop-Pav-Tra		
18379N3505	POP 16	AC	1995.469	279.14	53.67	11	Pop-Pav-Tra		
18388N3503	POP 17		1995.470	15.48	8.78	1	Pop-Pav-Tra		
18425N3432	POP 45		1995.525	276.75	6.79	9	Pop-Pav-Tra		
18484N3432	POP 43		1995.525	269.63	2.75	2	Pop-Pav-Tra		
18495N3512	POP 44		1995.525	228.10	9.79	8	Pop-Pav		
18535N3303	POP 192		1995.465	55.40	2.56	3	Pop-Pav-Tra		*
18538N3653	ES 2028	AB	1995.552	349.31	88.52	5	Pop-Pav-Tra	11825	
18538N3653	ES 2028	BC	1995.552	134.09	2.41	4	Pop-Pav-Tra	11825	
19155N1961	STF 2488		1995.549	348.43	1.70	4	Pop-Pav-Tra	12228	
19269N7322	STF 2550	AB	1995.550	253.50	1.92	9	Pop-Pav-Tra	12524	
19269N7322	STF 2550	AC	1995.551	167.13	79.13	5	Pop-Pav-Tra	12524	
19296N7311	PAV 1	AB	1995.551	72.28	4.49	11	Pop-Pav-Tra		*
19296N7311	PAV 1	AC	1995.552	9.25	76.73	4	Pop-Pav-Tra		
19297N3342	POP 154		1995.514	227.50	4.42	7	Pop-Pav		

Table 1. (continued)

1	2	3	4	5	6	7	8	9	10
WDS	Name	Mult.	Date	Θ	ρ	n	Obs.	ADS	Notes
19289N3515	POP 34	AB	1995.454	18.10	4.48	3	Pop-Pav-Tra		
19289N3515	POP 34	AC	1995.454	1.74	36.08	4	Pop-Pav-Tra		*
19384N2541	ES 492		1995.549	207.01	4.80	13	Pop-Pav-Tra	12727	*
19454N3656	POP 121		1995.517	324.54	1.62	7	Pop-Pav		
19455N3708	POP 122	AB	1995.517	284.28	49.10	7	Pop-Pav		
19455N3708	POP 122	BC	1995.517	89.18	2.39	3	Pop-Pav		
19478N3738	POP 127	AB	1995.517	155.17	33.03	5	Pop-Pav		*
19478N3738	POP 127	AC	1995.517	285.70	44.46	5	Pop-Pav		
19478N3738	POP 127	AD	1995.517	297.34	42.34	5	Pop-Pav		
19478N3738	POP 127	EF	1995.517	296.07	57.54	5	Pop-Pav		
19478N3738	POP 127	AE	1995.517	6.81	3.49	3	Pop-Pav		
19496N3545	POP 101		1995.520	136.79	6.56	3	Pop-Pav		
19497N3546	POP 102	AB	1995.520	141.98	4.73	3	Pop-Pav		
19497N3546	POP 102	AC	1995.520	77.89	14.11	3	Pop-Pav		
19498N3558	POP 104		1995.520	66.80	2.98	2	Pop-Pav		
20064N3455	POP 66	AB	1995.522	1.81	6.77	5	Pop-Pav		
20064N3455	POP 66	AC	1995.522	116.99	25.92	5	Pop-Pav		
20064N3455	POP 66	AD	1995.522	347.83	44.35	4	Pop-Pav		
21066N3436	POP 22	AB	1994.743	101.14	6.67	3	Pop-Pav		
21066N3436	POP 22	AC	1994.743	16.51	31.50	2	Pop-Pav		
21313N4454	POP 137	BC	1995.555	109.80	1.44	3	Pop-Pav-Tra		
21318N4519	POP 150	AB	1995.555	218.10	4.40	1	Pop-Pav-Tra		
21369N8255	STF 2837		1995.552	271.84	3.11	10	Pop-Pav-Tra	15229	*
21580N0556	STF 2848		1995.525	56.77	10.70	3	Pop-Pav	15493	
23165S0136	STF 2995		1994.747	32.35	5.49	4	Pop-Pav	16642	
23176S0131	BU 79	AB	1994.747	10.76	1.50	2	Pop-Pav	16649	*
23213N3486	STF 3006	AB	1995.550	152.66	6.94	10	Pop-Pav	16693	*

Table 2. Notes

48 AB	: Popović, Pavlović, 1996: +1 ° 4, +0 ″ 08.
48 AP	: P component not registered as yet.
56	: Popović, Pavlović, 1996: +2 ° 9, -0 ″ 23.
1615	: Popović, Pavlović, 1996: +2 ° 4, -0 ″ 02.
9979	: Rabe, 1958: -0 ° 7, +0 ″ 06 (Tra).
10329	: Popović, Pavlović, 1996: +0 ° 1, -0 ″ 15 – (rect. trajectory)
10424	: Popović, Pavlović, 1996: +0 ° 5, +0 ″ 32 – (rect. trajectory)
POP 218	: POP 218 = BD +34° 2947 (9 ^m 0) not measured as yet.
10699	: Popović, Pavlović, 1996: -0 ° 1, +0 ″ 04.
POP 216	: POP 216 = BD +41° 2896 (9 ^m 3) not measured as yet.
POP 210 BC	: In ser. No 47 (Bull.Astron.Belgrade, No.147,45-62) erroneously denoted as POP 110.
11483	: Heintz, 1954: +10 ° 2, +0 ″ 26.
TRA 1	: TRA 1 = BD+34° 3267 (8 ^m 5); newly registered pair.
POP 192	: Direct motion. Pair position with respect to NGC 6720 is: -16s, +1′.
PAV 1	: PAV 1 = BD+72° 901 (9 ^m 5); new pair.
POP 34 AB	: Popović, Trajkovska, 1988: -9 ° 4, +0 ″ 58 – (rect. trajectory).
12727	: Popović, Pavlović, 1996: -0 ° 6, +0 ″ 04 – (rect. trajectory).
POP 127	: POP 127 A = BD+37° 3610 (9 ^m 5). Earlier as POP 127 measured only the pair : denoted here as EF.
15229	: Popović, Pavlović, 1996: +0 ° 2, -0 ″ 04 – (rect. trajectory).
16649	: Heintz, 1962: -7 ° 0, -0 ″ 03.
16693	: Popović, Pavlović, 1996: -1 ° 0, -0 ″ 08 – (rect. trajectory).

**CCD ПОСМАТРАЊА ДВОЈНИХ И ВИШЕСТРУКИХ ЗВЕЗДА
НА БЕОГРАДСКОЈ ОПСЕРВАТОРИЈИ**

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УДК 520.8:524.38
Претходно саопштење

Аутор даје своја CCD мерења 105 двојних и вишеструких звезда посматраних са ST – 6 камером на Београдском рефрактору (Zeiss 65/11055 cm).