

CCD MEASUREMENTS OF DOUBLE AND MULTIPLE STARS AT NAO ROZHEN

ZORICA CVETKOVIĆ¹, RADE PAVLOVIĆ¹, ANTON STRIGACHEV²
and BOJAN NOVAKOVIĆ¹

¹*Astronomical Observatory, Volgina 7, 11060 Belgrade 38, Serbia*
e-mail: zcvetkovic@aob.bg.ac.yu, rpavlovic@aob.bg.ac.yu,
bnovakovic@aob.bg.ac.yu

²*Institute of Astronomy, Bulgarian Academy of Sciences, 72 Tsarigradsko Chausse
Blvd., 1784 Sofia, Bulgaria*
e-mail: anton@astro.bas.bg

Abstract. The Belgrade team performed three series of observations of double and multiple stars at the Bulgarian NAO Rozhen in the period from 2004 to 2006. We presented the results of measurements for the position angle and separation for 70 double or multiple stars (129 pairs) in the three papers published in Serbian Astronomical Journal. In this paper we present a review of the results obtained from the Rozhen observations and also the orbits of two binaries calculated for the first time.

1. INTRODUCTION

The Belgrade team performed three series of observations of double and multiple stars at the Bulgarian NAO Rozhen in the period from 2004 to 2006.

The first series of observations of double and multiple stars performed with a CCD camera attached to the 2-m telescope took place in the middle of October 2004. The telescope is of the Ritchey-Chretien-Coude type with a focal length of 16 m. The frames were obtained by using the Photometrics AT200 CCD camera. The chip dimensions are 1024x1024 pixels, the pixel size is 24x24 micrometers. The angle corresponding to one pixel is 0.31 arcsec. The results were published in (Pavlović et al. 2005).

The second series took place in the end of October 2005. The results were published in (Cvetković et al. 2006). The third series took place on December 16/17, 2006. The results were published in (Cvetković et al. 2007). In the second and third series the frames were obtained by using the CCD camera VersArray:1300B. The chip dimensions are 1300x1300 pixels, the pixel size is 20x20 micrometers. The angle corresponding to one pixel is 0.258 arcsec.

2. RESULTS

In the case of the first observation series of 2004 the observational team at the NAO Rozhen that collected the frames for the measurements consisted of D. Olević, R. Pavlović and Z. Cvetković from the Belgrade Astronomical Observatory and A. Strigachev from the Institute of Astronomy of Bulgarian Academy of Sciences. A total of 150 CCD frames concerning 15 observed systems was obtained, whereas the position angle θ and separation ρ were measured for 10 double or multiple stars (a total of 27 pairs).

In the case of the second observation series of 2005 the observational team consisted of Z. Cvetković and B. Novaković from the Belgrade Astronomical Observatory and A. Strigachev from the Institute of Astronomy of Bulgarian Academy of Sciences. A total of 400 CCD frames concerning 20 observed systems was obtained, whereas the position angle θ and separation ρ were measured for 11 double or multiple stars (a total of 35 pairs).

In the case of the third observation series of 2006 the observational team consisted of Z. Cvetković and R. Pavlović from the Belgrade Astronomical Observatory and A. Strigachev from the Institute of Astronomy of Bulgarian Academy of Sciences. More than 600 CCD frames concerning 55 observed systems were obtained, whereas the position angle θ and separation ρ were measured for 48 double or multiple stars (a total of 67 pairs).

All CCD frames obtained at NAO Rozhen were measured at the Astronomical Observatory in Belgrade by using AIP4WIN programme (version 1.4.21).

In the case of 21 systems the star images were not visually separated and the measurements could not be carried out. The reasons are the proximity of the components, the limiting capabilities of the CCD camera, the exposure duration and seeing.

Table 1 presents the example of measurements for several pairs, i. e. published data offering a complete information on every measurement. The designations used are: WDS - identification in WDS Catalogue (Mason et al. 2006); Disc. - double-star name after the discoverer; Mult. - designation for pair components; HIP - identification in Hipparcos Catalogue (ESA 1997); Epoch - observational epoch; θ - position-angle in degrees; ρ - separation in seconds of arc; Notes - means that there is a comment (N), or the pair has an orbit (O).

In Figs. 2 and 3 we see selected CCD frames of double or multiple stars obtained at Rozhen, among which is the CCD frame of multiple star WDS 00057+4549 = STT 547 = ADS 48 where the components P and Q were discovered at the Belgrade Observatory by G. Popović: POP 217AP and POP 217AQ in WDS (Fig. 3 - right). For pair AB of multiple star ADS 48 two orbits, given in Sixth Orbit Catalogue Pop1996b (Popović and Pavlović 1996) and Kiy2001 (Kiyaeva et al. 2001), have been calculated, presented in Fig. 4. For six more pairs observed by us, whereas in the case of the other pairs either short orbital arcs are covered by observations or the number of measurements is small being the reason why astronomers have failed to calculate the first preliminary orbital elements.

Table 1: An example of published data concerning measurements of double stars.

WDS	Disc.	Mult.	HIP	Epoch 2006+	θ ["]	ρ ["]	Notes
06443+4414	ES 1383			0.9582	335.56	2.300	
07023+1030	J 21			0.9582	274.99	3.020	
07106+1543	J 703			0.9583	294.00	9.730	N
07111+2452	POU 2525			0.9583	193.63	2.735	
07142+0533	J 2039			0.9583	201.72	1.896	
07153+0754	J 42			0.9583	109.30	1.455	
07476+0122	J 418			0.9584	136.15	1.978	N
08190+4927	HU 1124	AB	40744	0.9584	37.34	5.539	
08507+0752	VDK 3		43422	0.9584	159.57	1.377	O
09002+1550	ALD 115		44197	0.9584	268.35	1.660	
09057+2354	POU 3026			0.9584	310.59	3.141	
09357+3549	HU 1128		47080	0.9585	60.53	5.620	O
09365+2820	ES 428			0.9585	202.80	13.166	
09368+5755	ES 1783	BC	47174	0.9585	16.58	1.545	
09413+6214	STI 693			0.9585	219.44	4.363	
10015+6843	STF 1398		49121	0.9585	105.14	3.551	N
10099+5420	MLB 126			0.9586	250.34	4.769	
10110+7508	KUI 47		49868	0.9586	119.06	1.530	O
10281+4847	KUI 50		51248	0.9586	20.18	3.466	O
10334+0705	A 2767		51671	0.9587	51.23	5.124	N
10596+2527	AG 342			0.9587	112.03	5.183	O

In Fig. 1 the new CCD camera obtained by NAO Rozhen as sponsorship by UNESCO-ROSTE.

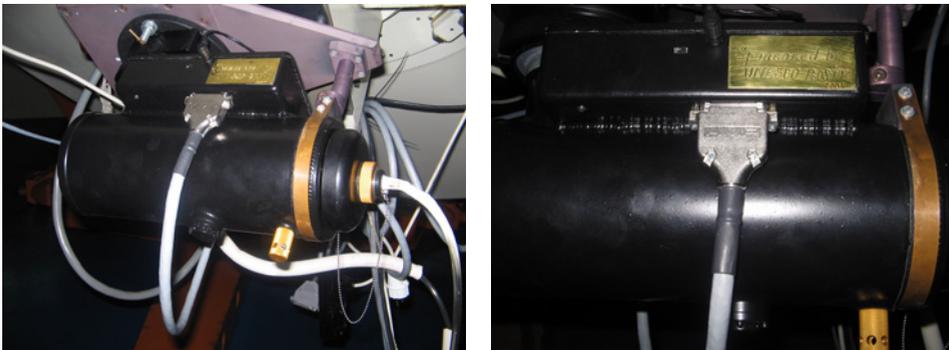


Figure 1: CCD camera VersArray:1300B – sponsored by UNESCO-ROSTE.

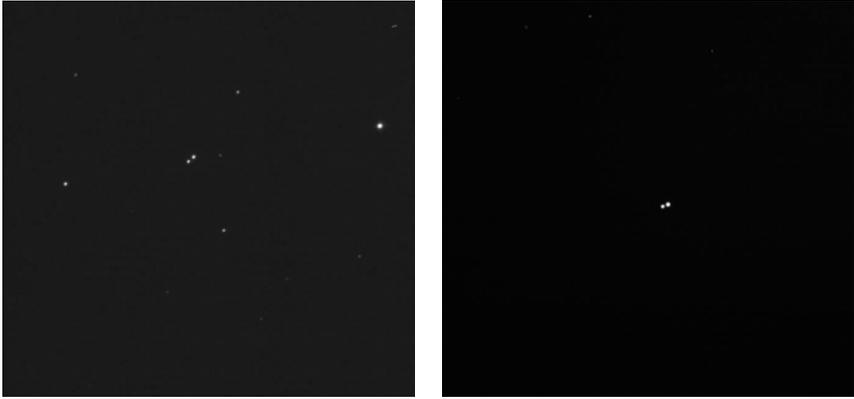


Figure 2: CCD frames of double or multiple stars obtained at Rozhen.

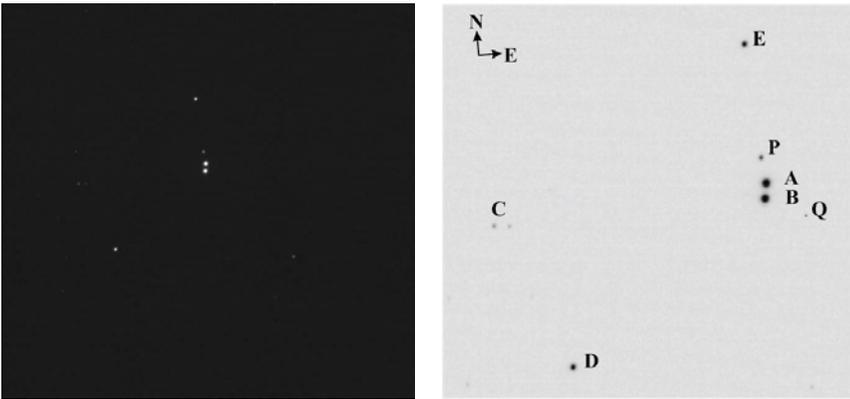


Figure 3: CCD frame of multiple star WDS 00057+4549 = STT 547 = ADS 48 (left); the components P and Q were discovered by G. Popović: POP 217AP and POP 217AQ in WDS (right).

Using the measurements obtained by us from CCD observations at NAO Rozhen we have calculated the first orbits for two binaries. The orbit of WDS 00152+2722 = J 868 was calculated by Novaković (2007), that of WDS 07106+1543 = J 703 by Cvetković (2007). Both orbits have been included in the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf and Mason 2006) and they are presented in Fig. 5, and the orbital elements are given in Table 2. The designations used: WDS – identification in WDS Catalogue; name – double-star name after the discoverer; P – orbital period; a – semi-major axis; e – eccentricity; i – inclination; T – epoch of periastron passage in fractional Besselian year; Ω – longitude of node for equinox 2000 and ω – longitude of periastron.

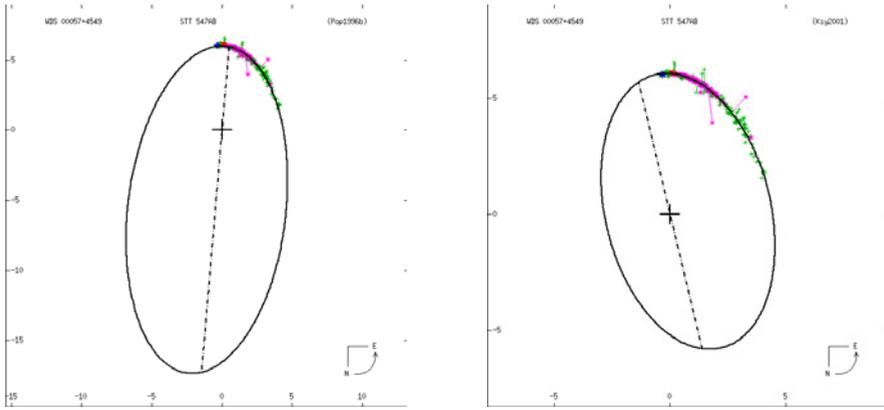


Figure 4: Orbits calculated for binary STT 547 AB given in Sixth Orbit Catalogue Pop1996b (Popović and Pavlović 1996)–left; Kiy2001 (Kiyaeva et al. 2001)–right.

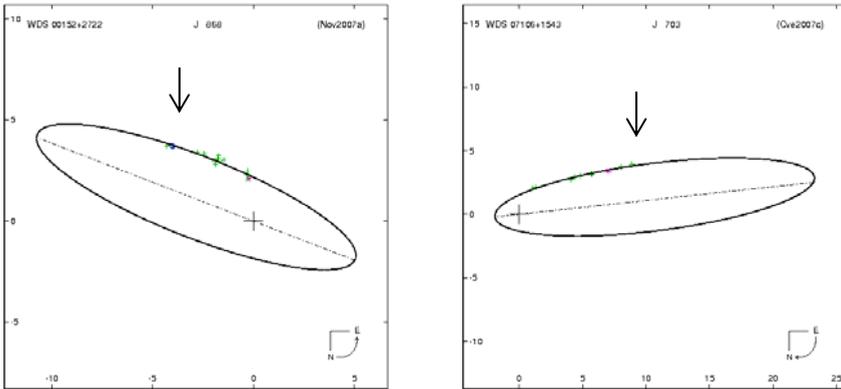


Figure 5: First orbits calculated by authors from Belgrade Observatory based on the Rozhen measurements; the arrows indicate our measurements.

Table 2: First orbital elements of two binaries.

WDS	Name	P [year]	a ["]	e	i [°]	T	Ω [°]	ω [°]
00152+2722	J 868	1089.17	8.477	0.367	75.2	1725.11	68.9	352.8
07106+1543	J 703	1360.20	12.699	0.850	113.4	3235.39	96.2	177.1

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