Measurement comparison between CCD frames obtained at RNAO and ASV

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Abstract. During the night of March 31, 2019 we performed CCD framing for 24 double or multiple stars with the 2m telescope at the Rozhen National Astronomical Observatory. CCD frames for the same stars have been also obtained with the 1.4 m telescope at the Astronomical Station Vidojevica, during two nights, April 1 and 2, 2019. The CCD cameras possessed by both observatories are of the same type, ANDOR iKon-L. A comparison of the measurement results of the CCD frames obtained at the two observatories, concerning separations and position angles, is presented in this paper. We also present precise focal lengths for the 2m and 1.4m telescopes with the attached ANDOR iKon-L cameras.

Key words: visual double stars, CCD technique, focal length

Introduction

We started classical CCD observations of double and multiple stars in 2004 in the framework of a cooperation between Serbian and Bulgarian astronomers (see more details in the paper Cvetković et al. 2014). Since then observations have been performed with the 2 m telescope at the Bulgarian National Astronomical Observatory at Rozhen (RNAO), and from 2011 also at the Serbian Astronomical Station on the mountain of Vidojevica (ASV). Until mid-2016, there was only a 0.6 m telescope in use at ASV, then a 1.4 m telescope was mounted [3]. More details can be found at http://belissima.aob.rs/. Till now, we have published five papers with results from both observatories (see, Cvetković et al. 2015, 2016 2017, 2018, Pavlović et al. 2013). Also, we have determined the orbital elements and the linear solutions for double stars (Pavlović et al. 2018).

Recently, our two observatories obtained the CCD cameras of the same type, ANDOR iKon-L, with which we observed visual double or multiple stars at the beginning 2019. First, during the night of March 31, 2019 we performed CCD framing for 25 double or multiple stars with the 2m telescope at RNAO. Then, CCD frames for the same stars have been obtained with the 1.4 m telescope at ASV, during two nights, April 1 and 2, 2019. A comparison of the measurement results of the CCD frames obtained at the two observatories concerning separations and position angles is presented in this paper.

The telescope focal length is an important parameter in determining the angular pixel size. It is used for the purpose of determining the relative coordinates (angular separation and position angle) of double and multiple stars. The result of determining the focal length for the 2 m RNAO telescope more precisely for the attached VersArray 1300B CCD camera is

[3] http://belissima.aob.rs/

given in Cvetković et al. (2013). Here we present the first results of determining the effective focal length of 2 m telescope of the RNAO for the CCD camera ANDOR iKon-L. Also, we present the first results of determining the effective focal length of 1.4 m telescope of the ASV and the same type detector the CCD camera ANDOR iKon-L.

1. Results

CCD frames for the six selected double or multiple stars obtained at the two observatories are given in Figs.1-3. The north– east orientation is the same in all frames, as given in the lower right corner in first CCD frame in Fig.1. The weather conditions during the observations at the ASV were satisfactory, the humidity under 70%, i.e. seeing was good. During the observation night at the RNAO the humidity was between 80% and 90%, i.e. seeing was worse than at the ASV which can be noted from the CCD frames. Because of such conditions we observed pairs with larger separations (over 3 arcsec).

The focal length was determined for each CCD frame using software package Astrometry (www.astrometry.net) and the mean value was found. The number of CCD frames was 2210 at RNAO and 156 at ASV. The focal lengths (F) and the pixel scale (ps) for the 2m and 1.4m telescopes with the attached ANDOR iKon-L cameras are presented in Table 1.

Table 1. The focal lengths (F) and the pixel scale (ps) for the 2m and 1.4m telescopes with the attached ANDOR iKon-L cameras.

Telescope	F	ps
	(mm)	arcsec pixel^{-1}
2m	15818 ± 26	0.16604 ± 0.00029
1.4m	11399 ± 35	0.24427 ± 0.00073

The results for separation and position angle for 24 double or multiple stars observed at the two observatories are presented in Table 2. The calibration of position angles is performed in the same way and by using the same software as described in Cvetković et al. (2017). From this table it can be seen that the obtained values for the same pairs in both observatories are in good agreement.

Conclusion

There is a good agreement between the relative coordinates (separations and position angles) obtained at RNAO and ASV using CCD cameras of the same type - ANDOR iKon-L. Since the separation depends on the angle corresponding to one pixel, i.e., the focal length of the telescope, this means that the focal lengths of both telescopes has been well determined when CCD camera ANDOR iKon-L was attached.

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Table 2. The results of separation and position angle for 24 double or multiple stars

WDS Designation	Discoverer Designation	Epoch 2000+	ρ ($''$)	σ_ρ ($''$)	θ ($^\circ$)	σ_θ ($^\circ$)	Telescope
11039+1604	J427	19.24612	4.06	0.05	103.25	0.22	NAOR 2m
11039+1604	J427	19.24903	4.16	0.01	102.98	0.11	ASV 1.4m
11154+2734	STF1521	19.24613	3.51	0.06	97.47	0.50	NAOR 2m
11154+2734	STF1521	19.24906	3.66	0.03	96.94	0.44	ASV 1.4m
11193+0117	BAL1445	19.24620	4.46	0.04	344.48	0.10	NAOR 2m
11193+0117	BAL1445	19.24907	4.53	0.01	344.07	0.11	ASV 1.4m
11211+3134	MLB849	19.24615	5.10	0.02	174.15	0.16	NAOR 2m
11211+3134	MLB849	19.24908	5.11	0.01	173.75	0.16	ASV 1.4m
11272+1908	KU38	19.24611	6.21	0.03	53.73	0.10	NAOR 2m
11272+1908	KU38	19.24903	6.19	0.01	53.46	0.08	ASV 1.4m
11280+0827	J1014	19.24617	4.32	0.08	14.56	0.16	NAOR 2m
11280+0827	J1014	19.24909	4.53	0.01	14.16	0.11	ASV 1.4m
12152+0151	BAL1884	19.24623	4.31	0.04	323.01	0.16	NAOR 2m
12152+0151	BAL1884	19.24911	4.42	0.01	322.55	0.16	ASV 1.4m
12353+3634	ES2166	19.24630	4.66	0.03	357.59	0.11	NAOR 2m
12353+3634	ES2166	19.24912	4.72	0.01	357.17	0.08	ASV 1.4m
12563+5406	STF1695AB	19.24633	3.64	0.15	280.28	0.54	NAOR 2m
12563+5406	STF1695AB	19.24913	3.91	0.20	280.06	0.69	ASV 1.4m
13081+2325	COU2708	19.24627	3.53	0.16	78.05	0.48	NAOR 2m
13081+2325	COU2708	19.24915	3.89	0.01	78.03	0.13	ASV 1.4m
13298+5905	ES1790	19.24634	4.93	0.01	250.59	0.09	NAOR 2m
13298+5905	ES1790	19.24916	4.95	0.01	250.08	0.09	ASV 1.4m
13341+6746	STF1767	19.24636	4.07	0.04	343.69	0.31	NAOR 2m
13341+6746	STF1767	19.24920	4.15	0.03	343.01	0.36	ASV 1.4m
13529+4744	ES960AB	19.24638	4.49	0.07	270.04	0.16	NAOR 2m
13529+4744	ES960AB	19.24921	4.60	0.01	269.63	0.10	ASV 1.4m
14041+5716	STI2305	19.24640	4.99	0.03	188.85	0.12	NAOR 2m
14041+5716	STI2305	19.24923	5.03	0.01	188.32	0.07	ASV 1.4m
14172+6136	STI763	19.24647	4.02	0.05	319.59	0.21	NAOR 2m
14172+6136	STI763	19.24924	4.15	0.03	319.11	0.13	ASV 1.4m
14433+6015	PTT24	19.24650	4.26	0.03	352.67	0.14	NAOR 2m
14433+6015	PTT24	19.25163	4.32	0.01	352.34	0.07	ASV 1.4m
14541+5218	A1625AB	19.24651	3.11	0.11	117.47	0.43	NAOR 2m
14541+5218	A1625AB	19.25164	3.40	0.02	117.19	0.14	ASV 1.4m
14541+5218	A1625CD	19.24651	6.22	0.07	142.97	0.28	NAOR 2m
14541+5218	A1625CD	19.25164	6.26	0.01	142.62	0.12	ASV 1.4m
15200+4603	ES75AB,C	19.24653	4.38	0.05	34.90	0.16	NAOR 2m
15200+4603	ES75AB,C	19.25188	4.45	0.01	34.41	0.12	ASV 1.4m
15301+4618	ROE2	19.24655	4.41	0.05	82.96	0.12	NAOR 2m
15301+4618	ROE2	19.25189	4.49	0.01	82.74	0.16	ASV 1.4m
15498+4349	ES1554	19.24658	4.92	0.02	2.43	0.13	NAOR 2m
15498+4349	ES1554	19.25190	4.94	0.01	2.21	0.12	ASV 1.4m
15499+4247	STF1982	19.24659	4.85	0.01	298.98	0.08	NAOR 2m
15499+4247	STF1982	19.25190	4.87	0.01	298.87	0.10	ASV 1.4m
16316+1917	STF2057AB	19.24671	4.88	0.03	267.82	0.10	NAOR 2m
16316+1917	STF2057AB	19.25191	4.91	0.01	267.60	0.11	ASV 1.4m
17048+1816	BRT2428	19.24673	3.80	0.09	127.26	0.45	NAOR 2m
17048+1816	BRT2428	19.25193	3.92	0.05	126.97	0.25	ASV 1.4m
17297+1815	BRT2433	19.24674	4.44	0.04	307.82	0.13	NAOR 2m
17297+1815	BRT2433	19.25194	4.52	0.01	307.53	0.16	ASV 1.4m

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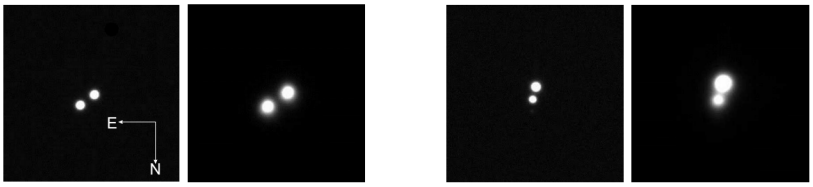

Fig. 1. CCD frames: the first two on the left are the pair **KU38** at ASV (left) and at NAOR (right); the other two to the right are the pair J1014 at ASV (left) and at NAOR (right).

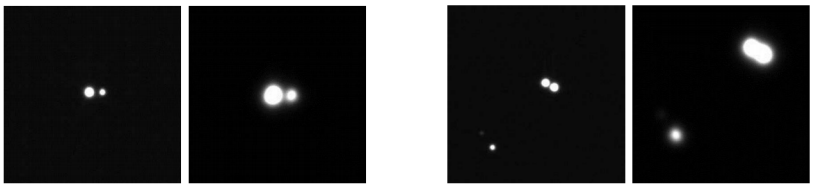

Fig. 2. CCD frames: the first two on the left are the pair ES960AB at ASV (left) and at NAOR (right); the other two to the right are the pair A1625AB at ASV (left) and at NAOR (right).

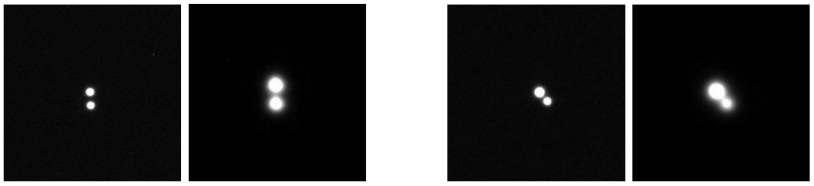

Fig. 3. CCD frames: the first two on the left are the pair PTT24 at ASV (left) and at NAOR (right); the other two to the right are the pair STI763 at ASV (left) and at NAOR (right).

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