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Optical positions of 68 radio stars

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Abstract. — Optical positions of 68 radio stars observed with the photoelectric astrolabe Mark II of Beijing Astronomical Observatory in San Juan are presented. The Positions of the radio stars are for the epoch of observation and the equinox J2000.0 and a system close that of the system FK5. The mean precisions are ± 2.8 ms and $\pm 0.046''$ in right ascensions and declinations, respectively. The magnitudes of stars are from 0.9 mag to 10.7 mag. The declinations are from -3° to -58°. The mean epoch is 1994.2.

Key words: stars: general — astronomical data bases: miscellaneous — astrometry — reference system

1. Introduction

The photoelectric astrolabe Mark II(PA II) was made at Nanjing Astronomical Instrument Factory in 1974 and was put into operation since Mar. 1976 (Luo 1979). The aperture of object mirror is 200 mm and the equivalent focal length is 2400 mm. The zenith distance observed is 30°.

Before modernization, the Astrolabe was semi-automatic instrument with the limiting magnitude of 7 mag. In 1988, the automatic observation of the instrument was realized controlled with a micro-computer (PC/AT). And a method of photon-counting was adopted for data processing instead of original electric recorder of time in 1990. The limiting magnitude is increased to more 11 mag.

Using the data observed with the instruments from 1976 to 1991, several general catalogues (Zhu et al. 1981; Working Group of GCPA, 1983; Working Group of CGSC, 1991; Lu 1991) of stars had been compiled.

In 1992, the instrument was moved and installed at San Juan Observatory (OAFA) in Argentina for Observations of the catalogue of stars in southern hemisphere.

Radio stars are suitable intermediaries for linking optical stellar reference frames to the quasi-inertial radio reference frame (RRF) represented by compact extragalactic radio sources. From February, 1992 to February, 1995, we observed radio stars with the photoelectric astrolabe using the list provided by H.G. Walter at Astronomishes Rechen Heidelbery (Walter 1990).

This Paper presents the positions of these radio stars for epoch of observation and the equinox J2000.0 and in the system close to that of the FK5.

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2. The observation and reduction

The observations of radio stars were placed in the reference group of stars.

The residuals of the radio stars are calculated with the corrections of astronomical time, latitude and zenith distance of reference groups of stars. Then, the mean values of the residuals of radio stars are calculated by weighted average.

Assumed V_e and V_w are the residuals reduced to the mean instrumental system after adding the group corrections of reference groups at both eastern and western transits, the position corrections of the radio stars in right ascension and declination from double transits are determined by the formulas:

$$\Delta\alpha = \frac{V_e - V_w}{30\cos\varphi_0|\sin A|} , \quad (1)$$

and

$$\Delta\delta = -\frac{V_e + V_w - 2K}{2\cos q} , \quad (2)$$

where

φ_0 − the adopted value of latitude at the site of the instrument;

A − the azimuth of a star observed, measured eastwards from north;

q − the parallactic angle of a star as it transit the almucantar of the astrolabe.

We used the stars of $|\cos q| < 0.2$ (about 490 stars) to calculated $2K$ from follow:

$$K = \frac{1}{2}(V_e + V_w). \quad (3)$$

and obtained $2K$=0.020″ ± 0.003″.

3. Results and comparison with CAMC4

From February, 1992 to February, 1995, there are 68 radio stars to be observed. Using the data observed with the photoelectric astrolabe, the catalogue of radio stars in San Juan (RSSJ) has been compiled from double transits. The mean number of observation of each star is about 80 (38 in the eastern transit, 42 in the western transits) The mean precisions are ±2.8 ms and ±0.046″ in right ascension and declination, respectively.

There are 42 radio stars in both program between RSSJ and CAMC4 at near observational epoch. So we try to do a comparison between their respective position after reducing to same epoch, 1990. The differences in the sense RSSJ − CAMC4 are shown in the Table 1.

In Table 1, the columns are as follow:

1. Radio stars number of INCA;

2: CAMC4 number;

3: Visual magnitude;

4: Spectral type;

5: Right ascension of RSSJ referred to equinox J2000.0 at epoch 1990;

6: Declination of RSSJ referred to equinox J2000.0 at epoch 1990;

7: Right ascension of CAMC4 referred to equinox J2000.0 at epoch 1990;

8: Declination of CAMC4 referred to equinox J2000.0 at epoch 1990;

9: The difference on right ascension (RSSJ-CAMC4) in unit of 0.001^s;

10: The difference on declination (RRSJ-CAMC4) in unit of 0.01″;

The catalogue of radio stars observed in San Juan is given in Table 2. The description of each column are:

1. Radio stars number of INCA;

2: SAO number;

3: HD number;

4: Visual magnitude;

5: Spectral type;

6: Right ascension referred to equinox J2000.0 at observation epoch;

8: Mean errors of position on Right ascension in unit of 0.001^s;

7: Declination referred to equinox J2000.0 at observation epoch;

9: Mean errors of position on declination in unit of 0.01″;

10: Number of observations in the eastern transit;

11: Number of observations in the western transit;

12: Mean epoch of observations.

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Table 1. The difference of positions (RSSJ-CAMC4)

INCA	CAMA4	Mag	Sp	$\alpha_{\rm rssj}$ h m s	$\delta_{\rm rssj}$ ° ′ ″	$\alpha_{\rm camc}$ h m s	$\delta_{\rm camc}$ ° ′ ″	$\Delta\alpha$ ms	$\Delta\delta$ 0″.01
1010	200882	5.35	G5	1 16 36.353	-2 30 00.82	1 16 36.364	-2 30 00.73	-11	-9
1043	202728	8.40	A	4 43 45.822	-10 40 56.21	4 43 45.816	-10 40 56.21	6	0
1060	203132	7.00	G3	5 40 39.688	-20 17 55.79	5 40 39.707	-20 17 55.91	-19	12
1061	203137	8.00	A0	5 41 02.295	-2 43 00.85	5 41 02.297	-2 43 00.82	-2	-3
1075	203719	6.71	Wn	6 54 13.050	-23 55 41.93	6 54 13.046	-23 55 42.23	4	30
1083	203955	4.90	M2	7 33 47.968	-14 31 26.08	7 33 47.962	-14 31 26.03	6	-5
1092	204385	7.20	G2	8 59 42.760	00 00.00	8 59 42.742	-27 48 58.28	18	
1093	306733	7.45	K0	9 24 49.040	-23 49 34.61	9 24 49.048	-23 49 34.30	-8	-31
1097	406021	8.84	K2	9 37 13.024		9 37 12.998	-42 01 14.70	26	
1116	308446	8.10	G5	11 39 22.239		11 39 22.244	-39 23 07.21	-5	
1155	310689	9.80	G5	14 35 48.437	-18 02 11.25	14 35 48.426	-18 02 11.49	11	24
1190	206894	5.97	O5	18 03 52.450	-24 21 38.63	18 03 52.441	-24 21 38.61	9	-2
1198	207024	9.70	O9	18 25 31.469	-12 41 24.38	18 25 31.492	-12 41 24.25	-23	-13
1208	315232	6.90	K0	19 22 40.299	-20 38 33.47	19 22 40.298	-20 38 33.80	1	33
1209	207559	9.20	G5	19 22 57.224	-14 15 31.78	19 22 57.212	-14 15 31.99	12	21
1210	413340	9.60	K0	19 28 05.543		19 28 05.505	-40 50 05.15	38	
1212	207751	8.30	G5	19 39 38.804	-6 03 49.29	19 39 38.799	-6 03 49.08	5	-21
1226	316144	9.00	K0	20 29 36.859	-21 07 34.70	20 29 36.862	-21 07 34.40	-3	-30
1238	208993	7.80	K0	21 14 52.750		21 14 52.752	-31 11 00.58	-2	
1242	317194	10.77	G5	21 39 48.889	-16 00 21.09	21 39 48.872	-16 00 20.99	17	-10
2003	200228	6.39	G2	0 22 51.515	-12 12 34.52	0 22 51.505	-12 12 35.04	10	52
2083	202464	7.10	G2	4 09 40.870	-7 53 35.30	4 09 40.868	-7 53 35.42	2	12
2115	304046	6.54	B2	5 35 21.883	-4 29 39.06	5 35 21.858	-4 29 39.13	25	7
2167	305357	5.79	G8	7 27 51.683	-11 33 25.18	7 27 51.664	-11 33 24.83	19	-35
2290	410516	7.40	K0	15 23 26.070	-6 36 36.59	15 23 26.059	-6 36 36.51	11	-8
2470	104462	8.00	G5	21 34 16.560	-13 29 01.58	21 34 16.564	-13 29 01.50	-4	-8
2602	302705	8.29	A4	3 32 25.145	-3 18 47.77	3 32 25.148	-3 18 47.68	-3	-9
2603	305266	5.70	F1	7 19 28.067	-16 23 41.68	7 19 28.066	-16 23 41.66	1	-2
2605	308764	4.02	F2	12 08 24.752	-24 43 43.61	12 08 24.728	-24 43 43.62	24	1
2607	408760	8.98	A2	13 15 20.783	-17 28 16.82	13 15 20.756	-17 28 17.13	27	31
2610	311909	8.20	F5	15 54 27.056		15 54 27.052	-30 25 31.00	4	
2652	301370	8.10	G5	1 46 41.538	-24 00 51.26	1 46 41.539	-24 00 51.41	-1	15
2653	201760	8.10	G5	2 43 25.506		2 43 25.476	-37 55 41.93	30	
2657	402781	7.10	K0	5 14 30.531	-26 12 30.79	5 14 30.520	-26 12 30.54	11	-25
2659	404542	7.00	K0	7 36 13.773		7 36 13.774	-44 57 27.01	-1	
2660	405128	7.80	G5	8 25 14.155	-7 10 12.79	8 25 14.165	-7 10 13.00	-10	21
2661	405211	6.36	K0	8 32 58.531		8 32 58.521	-34 38 02.37	10	
2663	406942	8.20	K2	10 53 14.896		10 53 14.880	-32 59 18.95	16	
2664	407969	8.30	K0	12 13 20.708	-9 04 47.07	12 13 20.703	-9 04 47.04	5	-3
2665	309814	8.84	K2	13 36 08.312		13 36 08.310	-33 28 44.54	2	
2666	206583	6.70	K2	17 16 13.728		17 16 13.722	-26 32 34.91	6	
2710	206416	8.10	K5	16 54 17.937	-6 42 42.60	16 54 17.917	-6 42 42.43	20	-17

Table 2. Optical positions of radio stars observed in San Juan

INCA	SAO	HD	Mag	Sp	α_{2000} h m s	M_α ms	δ_{2000} ° ′ ″	M_δ 0″.01	N_e	N_w	Epoch 1900+
1010	7672	129204	5.35	G5	1 16 36.326	8.1	-2 30 01.10	3.0	22	30	94.26
1032	26354	233401	9.30	K1	4 07 29.119	2.7	-52 34 16.00	3.8	33	69	94.86
1043	30050	149847	8.40	A	4 43 45.825	3.1	-10 40 56.15	4.2	37	15	94.53
1060	37847	170678	7.00	G3	5 40 39.696	2.2	-20 17 55.84	5.7	47	47	93.97
1061	37806	132452	8.00	A0	5 41 02.301	4.7	-2 43 00.87	1.9	17	38	94.97
1062	39937	234181	7.30	F7	5 52 20.195	4.2	-57 09 21.83	3.0	33	37	94.02
1075	50896	172546	6.71	Wn	6 54 13.052	1.8	-23 55 41.93	6.2	30	55	94.03
1076	51268	234770	9.10	K2	6 53 33.575	3.8	-54 52 59.03	3.9	30	36	94.53
1078	54791	218478	9.90	G8	7 08 21.046	2.0			50	36	94.89
1079	56096	218549	2.60	M5	7 13 32.261	2.1			38	46	94.27
1083	60414	153072	4.90	M2	7 33 47.967	2.1	-14 31 26.07	3.8	31	40	94.34
1087	66811	198752	2.25	O5	8 03 35.065	2.0			45	44	94.82
1092	77137	176805	7.20	G2	8 59 42.748	1.8			44	18	93.97
1093	81410	177412	7.45	K0	9 24 49.033	1.7	-23 49 34.71	5.6	44	52	94.03
1097	83442	221347	8.84	K2	9 37 12.997	1.9			37	38	93.88
1112	96751		9.80	G3	11 07 56.354	3.0	-51 07 07.92	5.1	47	52	94.44
1114	98803	222744	9.00	G6	11 21 44.513	2.5	-49 54 07.75	5.1	33	56	94.57
1116	101309	202671	8.10	G5	11 39 22.240	1.8			85	26	93.20
1123	103197		9.90	K1	11 52 53.016	3.2	-50 17 34.03	6.1	61	31	94.47
1124	103855	223131	9.20	G8	11 57 26.725	2.7	-48 39 30.79	6.4	41	35	94.04
1141	117600	224225	9.90	K2	13 32 16.213	3.0	-47 25 06.40	8.4	23	90	94.19
1155	128171	158665	9.80	G5	14 35 48.431	2.6	-18 02 11.33	5.9	30	53	94.38
1168	139084	242791	8.10	G5	15 38 57.595	7.3	-57 42 26.72	4.6	16	13	94.30
1173	146550		10.10	F6	16 18 41.509	3.0			40	31	93.99
1176	148478	184415	.90	M1	16 29 24.459	1.9			22	41	94.45
1182			9.80	pe	17 09 01.019	7.5	-56 54 47.83	5.5	11	26	94.23
1190	164794	186204	5.97	O5	18 03 52.452	3.0	-24 21 38.64	10.6	18	43	93.03
1198	169515	161458	9.70	O9	18 25 31.471	3.5	-12 41 24.39	5.6	19	27	94.54
1202	174429	245781	8.36	K0	18 53 05.860	3.2	-50 10 49.29	6.2	24	45	93.74
1208	181809	188043	6.90	K0	19 22 40.301	1.9	-20 38 33.87	5.0	53	57	93.90
1209	181943	162546	9.20	G5	19 22 57.240	2.7	-14 15 31.81	4.7	32	47	94.08
1210	182776	229695	9.60	K0	19 28 05.555	1.7			114	38	93.82
1212	185510	143657	8.30	G5	19 39 38.812	3.4	-6 03 49.39	2.9	35	42	93.70
1226	195040	189349	9.00	K0	20 29 36.862	2.5	-21 07 34.73	7.0	19	43	94.43
1238	202134	212824	7.80	K0	21 14 52.731	2.4			25	43	94.60
1242	206046	164558	10.77	G5	21 39 48.905	2.7	-16 00 21.09	5.3	32	28	94.61
1254	214479	191294	9.07	M1	22 38 45.403	2.8	-20 37 15.27	7.6	22	26	94.42
2003	1835	147237	6.39	G2	0 22 51.635	2.2	-12 12 34.26	3.4	40	53	94.45
2083	26337	130994	7.10	G2	4 09 40.889	2.4	-7 53 34.86	2.5	42	40	94.24
2115	37017	132317	6.54	B2	5 35 21.885	4.7	-4 29 39.05	3.2	25	29	94.16
2167	59067	152909	5.79	G8	7 27 51.683	2.0	-11 33 25.17	2.9	61	42	93.98
2290	136905	140499	7.40	K0	15 23 26.066	3.1	-6 36 37.04	2.8	37	35	93.98
2470	205249	164484	8.00	G5	21 34 16.565	1.7	-13 29 01.56	2.9	97	68	94.01
2476	207098	164644	2.81	A7	21 47 02.334	2.0	-16 07 36.51	4.0	54	45	93.82
2602	21985	130554	8.29	A4	3 32 25.136	5.9	-3 18 47.93	3.0	21	45	94.16

Table 2. continued

INCA	SAO	HD	Mag	Sp	α_{2000} h m s	M_α ms	δ_{2000} ° ′ ″	M_δ 0″.01	N_e	N_w	Epoch 1900+
2603	57167	152724	5.70	F1	7 19 28.120	1.7	-16 23 42.25	3.5	37	96	94.27
2605	105452	180505	4.02	F2	12 08 24.781	1.9	-24 43 43.78	6.7	62	17	94.37
2607	115122	157818	8.98	A2	13 15 20.761	2.4	-17 28 16.93	5.3	17	55	93.35
2609	132742	140270	4.91	A0	15 00 58.382	2.3	-8 31 08.25	2.6	33	53	93.53
2610	142217	207103	8.20	F5	15 54 27.053	1.6			62	61	94.06
2652	10909	167287	8.10	G5	1 46 41.584	1.8	-24 00 50.84	6.2	40	33	94.27
2653	17084	193879	8.10	G5	2 43 25.534	1.7			57	58	93.94
2657	34198	170230	7.10	K0	5 14 30.548	1.7	-26 12 30.99	7.1	46	53	94.22
2659	61245	218831	7.00	K0	7 36 13.788	2.3			39	46	94.03
2660	71071	135893	7.80	G5	8 25 14.124	2.8	-7 10 12.90	2.7	35	44	94.49
2661	72688	199353	6.36	K0	8 32 58.525	2.2			30	47	94.83
2663	94389	201857	8.20	K2	10 53 14.888	1.5			36	39	94.26
2664	106225	138652	8.30	K0	12 13 20.701	2.4	-9 04 47.01	2.9	55	36	94.47
2665	118238	204640	8.84	K2	13 36 08.309	2.5			33	21	94.29
2666	156026	185213	6.70	K2	17 16 13.596	2.2			25	31	93.71
2701	6882	232306	3.91	F7	1 08 23.071	3.5	-55 14 44.99	3.4	44	40	94.76
2703	19754	130323	7.80	K0	3 10 38.497	3.7	-5 23 38.09	2.9	16	46	94.39
2704	39576	170952	9.50	G0	5 52 15.988	2.4			32	32	94.61
2707	82558	155272	7.50	K0	9 32 25.676	2.4	-11 11 04.96	3.4	34	19	94.16
2709	123485	224722	8.90	A0	14 09 02.190	2.9			31	34	93.79
2710	152556	141428	8.10	K5	16 54 17.936	3.6	-6 42 42.61	3.4	30	37	93.98
2711	161741	209291	8.20	B9	17 48 47.622	2.0			58	35	94.08
2715	187949	163080	6.46	A2	19 53 06.385	1.9	-14 36 11.22	3.3	38	60	94.38