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Radio star catalogue observed in San Juan (RSSJ95)

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Abstract. Using the data observed in San Juan with the photoelectric Astrolabe Mark II of the Beijing Astronomical Observatory from February, 1992 to March, 1997, the radio star catalogue in San Juan(RSSJ95) has been compiled. There are 69 radio stars in this catalogue. The positions of the radio stars are for the epoch of observation and the equinox J2000.0 and a system close to that of the system FK5. The mean precisions are ± 2.2 ms and $\pm 0.035''$ in right ascensions and declinations, respectively. The magnitudes of stars are from 0.9 to 10.7. The declinations are from $-2\overset{\circ}{.}5$ to $-60°$. The mean epoch is 1995.1. Finally, the comparison results between the Hipparcos catalogue and RSSJ95 are given.

Key words: radio continuum: stars — 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 a semi-automatic instrument with a limiting magnitude of only 7.0. Since 1987, the astronomers of the Beijing Astronomical Observatory began to improve the instrument. Automatic observation with the instrument started in 1988. A new method of photon-counting was used for data processing in 1990. And the limiting magnitude is increased to 11.5.

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 the San Juan Observatory (OAFA) in Argentina for observations of the catalogue of stars in the southern hemisphere.

Radio stars are suitable intermediaries for linking optical stellar reference frames to the quasi-inertial radio reference frame represented by compact extragalactic radio sources. From Feb. 1992 to Mar. 1997, we observed radio stars with the photoelectric astrolabe using the list provided by H.G. Walter at Astronomishes Rechen-Institut, Heidelbery (Walter 1990).

In 1996, we presented the preliminary results (Lu et al. 1996). In this paper we submit all results observed from Feb. 1992 to Mar. 1997. The positions of these radio stars are fixed for epoch of observation and the equinox J2000.0 and in system close to that of the FK5.

2. The observation and reduction

There are 384 stars which are from FK5/FK4 Supp. in 12 fundamental groups. The observations of radio stars were placed in the reference group of stars. The residuals of the radio stars are calculated applying the corrections of astronomical time, latitude and zenith distance found from fundamental group observations. Then the mean values of the residuals of radio stars are calculated by weighted average.

Assuming $V_{\rm e}$ and $V_{\rm w}$ 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 are determined in right ascension and declination from double transits by the formulas:

$$\Delta\alpha = \frac{V_{\rm e} - V_{\rm w}}{30\cos\varphi_0|\sin A|}, \tag{1}$$

and

$$\Delta\delta = -\frac{V_{\rm e} + V_{\rm w} - 2K}{2\cos q}, \tag{2}$$

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 transits the almucantar of the astrolabe.

We used the stars with $|\cos q| < 0.2$ to calculate $2K$ by averaging

$$K = \frac{1}{2}(V_{\rm e} + V_{\rm w}), \tag{3}$$

and obtain $2K = 0.018'' \pm 0.003''$.

3. Results

From Feb. 1992 to Mar. 1997, there are 69 radio stars to be observed with the photoelectric astrolabe. Using the data, the radio star catalogue observed in San Juan (RSSJ95) has been compiled from double transits of given radio stars at both eastern and western passages. The mean number of observations of each star is about 132 (63 in the eastern passage, 69 in western passage). The mean precisions are ± 2.2 ms and $\pm 0.035''$ in right ascension and declination, respectively.

The Radio star catalogue observed in San Juan is given in Table 1. The description of each column is:

1: INCA: star number in the proposals of radio stars submitted to the Input Catalogue Consortium of Hipparcos;
2: HD: HD number;
3: SAO: SAO number;
4: Mag: visual magnitude;
5: Sp: spectral type;
6: α_{2000}: right ascension referred to equinox J2000.0 at observation epoch;
7: σ_α: mean errors of position in right ascension in unit of $0.001^{\rm s}$;
8: δ_{2000}: declination referred to equinox J2000.0 at observation epoch;
9: σ_δ: mean errors of position in declination in unit of $0.01''$;
10: $N_{\rm e}$: number of observations in the eastern transit;
11: $N_{\rm w}$: number of observations in the western transit;
12: Epoch: mean epoch of observations.

There are 68 radio stars commented RSSJ95 and the Hipparcos catalogue provided by CDS at nearly identical observational epochs. So we try to do a comparison between respective positions after reducing to the epoch of the Hipparcos catalogue, 1991.25, using the proper motions of the Hipparcos catalogue. The differences in the sense (Hipparcos − RSSJ95) are shown in Table 2.

In Table 2, the columns are as follows:

1: INCA: star number in the proposals of radio stars submitted to the Input Catalogue Consortium of Hipparcos;
2: HIP: number in Hipparcos catalogue;
3: $\alpha_{\rm hip}$: right ascension of Hipparcos catalogue referred to equinox J2000.0 at epoch 1991.25;
4: $\delta_{\rm hip}$: declination of Hipparcos catalogue referred to equinox J2000.0 at epoch 1991.25;
5: $\alpha_{\rm rssj}$: right ascension of RSSJ95 referred to equinox J2000.0 at epoch 1991.25;
6: $\delta_{\rm rssj}$: declination of RSSJ95 referred to equinox J2000.0 at epoch 1991.25;
7: $\Delta\alpha$: the difference in right ascension (HIP−RSSJ95) in unit of $0.001^{\rm s}$;
8: $\Delta\delta$: the difference in declination (HIP−RSSJ95) in unit of $0.01''$.

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Table 1. Radio star catalogue observed in San Juan

INCA	HD	SAO	Mag	Sp	α_{2000} h m s	σ_α ms	δ_{2000} ° ′ ″	σ_δ 0.01″	N_e	N_w	Epoch 1900+
2003	1835	147237	6.39	G2	0 22 51.661	1.7	−12 12 34.26	2.5	68	83	95.37
2701	6882	232306	3.91	F7	1 08 23.074	2.6	−55 14 44.96	2.5	69	56	95.49
1010	7672	129204	5.35	G5	1 16 36.319	5.6	−2 30 01.18	2.1	51	42	95.40
2652	10909	67287	8.10	G5	1 46 41.592	1.6	−24 00 50.69	5.4	53	45	94.94
2653	17084	193879	8.10	G5	2 43 25.544	1.4			110	75	94.95
2703	19754	130323	7.80	K0	3 10 38.501	2.4	−5 23 38.08	1.9	51	92	95.83
2602	21985	130554	8.29	A4	3 32 25.155	5.0	−3 18 47.90	2.5	33	90	95.46
1031	25038	216568	6.90	K2	3 57 01.776	1.4			65	106	95.18
1032	26354	233401	9.30	K1	4 07 29.129	2.2	−52 34 16.14	3.0	44	102	95.49
2083	26337	130994	7.10	G2	4 09 40.889	2.0	−7 53 34.83	2.1	52	52	94.81
1043	30050	149847	8.40	A	4 43 45.829	2.3	−10 40 56.12	3.2	53	27	95.48
2657	34198	170320	7.10	K0	5 14 30.552	1.1	−26 12 31.14	4.3	111	106	95.72
2115	37017	132317	6.54	B2	5 35 21.887	4.8	−4 29 39.07	3.2	25	29	94.16
1060	37847	170678	7.00	G3	5 40 39.703	1.6	−20 17 55.79	4.1	46	42	94.58
1061	37806	132452	8.00	A0	5 41 02.307	5.1	−2 43 00.87	2.1	31	38	95.43
2704	39576	170952	9.50	G0	5 52 15.990	2.2			29	29	94.58
1062	39937	234181	7.30	F7	5 52 20.196	3.5	−57 09 21.94	2.4	45	70	95.15
1076	51268	234770	9.10	K2	6 53 33.583	2.2	−54 52 58.96	2.2	63	34	95.22
1075	50896	172546	6.71	WN	6 54 13.051	1.4	−23 55 41.97	4.9	41	83	95.03
1078	54791	218478	9.90	G8	7 08 21.047	1.5			81	48	95.55
1079	56096	218549	2.60	M5	7 13 32.269	1.7			116	46	95.25
2603	57167	152724	5.70	F1	7 19 28.123	1.6	−16 23 42.24	3.2	36	114	94.52
1083	60414	153072	4.90	M2	7 33 47.969	1.7	−14 31 26.04	3.0	45	55	95.14
2659	61245	218831	7.00	K0	7 36 13.790	2.0			38	100	94.83
1087	66811	198752	2.25	O5	8 03 35.066	2.0			44	44	94.82
2660	71071	135893	7.80	G5	8 25 14.124	2.7	−7 10 12.90	2.6	38	44	94.65
2661	72688	199353	6.36	K0	8 32 58.524	2.0			30	78	95.34
1092	77137	176805	7.20	G2	8 59 42.745	1.4			79	46	95.64
1093	81410	177412	7.45	K0	9 24 49.031	1.2	−23 49 34.75	4.2	59	112	95.34
2707	82558	155272	7.50	K0	9 32 25.658	2.1	−11 11 04.78	3.0	35	46	95.14
1097	83442	221347	8.84	K2	9 37 12.991	1.7			48	78	95.14
2663	94389	201857	8.20	K2	10 53 14.885	1.2			91	95	95.49
1112	96751	0	9.80	G3	11 07 56.348	1.9	−51 07 08.06	3.2	37	98	95.41
1114	98803	222744	9.00	G6	11 21 44.513	1.9	−49 54 07.79	3.7	59	70	95.22
1116	101309	202671	8.10	G5	11 39 22.237	1.6			98	38	94.09
1119	102077	222993	8.90	K0	11 44 38.547	1.6	−49 25 02.38	3.5	97	114	94.71
1123	103197	0	9.90	K1	11 52 53.007	2.6	−50 17 34.07	5.0	84	43	95.19
1124	103855	223131	9.20	G8	11 57 26.717	2.0	−48 39 30.85	4.7	100	48	95.19
2605	105452	180505	4.02	F2	12 08 24.788	1.5	−24 43 43.88	5.5	99	33	95.50
2664	106225	138652	8.30	K0	12 13 20.701	2.3	−9 04 47.02	2.7	54	49	94.79
2607	115122	157818	8.98	A2	13 15 20.756	2.2	−17 28 16.97	4.7	17	111	94.11
1141	117600	224225	9.90	K2	13 32 16.205	2.9	−47 25 06.47	8.0	23	151	94.62
2665	118238	204640	8.84	K2	13 36 08.303	1.5			92	56	95.68
2709	123485	224722	8.90	A0	14 09 02.201	2.2			93	37	95.13
1154	127535	252794	9.70	K1	14 34 16.110	8.8	−60 24 28.65	2.5	48	14	95.45
1155	128171	158665	9.80	G5	14 35 48.434	1.7	−18 02 11.18	3.8	40	97	95.30
2609	132742	140270	4.91	A0	15 00 58.380	1.9	−8 31 08.23	2.2	49	71	94.38
2290	136905	140499	7.40	K0	15 23 26.070	2.2	−6 36 37.19	2.0	77	85	95.37
1168	139084	242791	8.10	G5	15 38 57.586	4.3	−57 42 26.80	2.8	31	37	95.30
2610	142217	207103	8.20	F5	15 54 27.052	1.1			129	120	95.30

Table 1. continued

INCA	HD	SAO	Mag	Sp	α_{2000} h m s	σ_α ms	δ_{2000} ° ′ ″	σ_δ 0.01″	N_e	N_w	Epoch 1900+
1173	146550	0	10.10	F6	16 18 41.508	2.1			122	26	94.80
1176	148478	184415	.90	M1	16 29 24.461	1.4			38	64	95.26
2710	152556	141428	8.10	K5	16 54 17.932	2.2	−6 42 42.62	2.1	94	33	94.81
2666	156026	185213	6.70	K2	17 16 13.542	1.5			68	58	95.10
2711	161741	209291	8.20	B9	17 48 47.620	1.7			76	34	94.53
1190	164794	186204	5.97	O5	18 03 52.449	1.8	−24 21 38.72	6.2	55	42	94.60
1191	165141	228707	8.00	G8	18 07 00.246	1.9	−48 14 50.36	4.8	45	62	93.99
1198	169515	161458	9.70	O9	18 25 31.469	2.7	−12 41 24.39	4.3	30	44	95.30
1202	174429	245781	8.36	K0	18 53 05.868	2.0	−50 10 49.51	3.9	58	85	95.17
1208	181809	188043	6.90	K0	19 22 40.303	1.2	−20 38 34.01	3.3	98	119	95.26
1209	181943	162546	9.20	G5	19 22 57.246	2.5	−14 15 31.77	4.3	31	71	94.54
1210	182776	229695	9.60	K0	19 28 05.557	1.5			134	72	94.62
1212	185510	143657	8.30	G5	19 39 38.810	2.0	−6 03 49.34	1.7	71	137	95.42
2715	187949	163080	6.46	A2	19 53 06.389	1.5	−14 36 11.26	2.7	49	132	95.13
1226	195040	189349	9.00	K0	20 29 36.871	2.2	−21 07 34.39	6.0	29	71	95.49
1238	202134	212824	7.80	K0	21 14 52.733	2.2			25	56	94.88
2470	205249	164484	8.00	G5	21 34 16.566	1.2	−13 29 01.50	1.9	153	138	95.21
1242	206046	164558	10.77	G5	21 39 48.908	1.7	−16 00 21.10	3.4	44	93	95.48
2476	207098	164644	2.81	A7	21 47 02.362	1.6	−16 07 36.81	3.1	96	71	94.98

Table 2. The difference of positions (HIP−RSSJ95)

INCA	HIP	α_{hip} h m s	δ_{hip} ° ′ ″	α_{rssj} h m s	δ_{rssj} ° ′ ″	$\Delta\alpha$ ms	$\Delta\delta$ 0.01″
2003	1803	0 22 51.5530	−12 12 34.506	0 22 51.5502	−12 12 34.509	2.8	0.3
2701	5348	1 08 23.0601	−55 14 44.996	1 08 23.0635	−55 14 45.086	−3.4	9.0
1010	5951	1 16 36.3467	−2 30 00.766	1 16 36.3469	−2 30 00.915	−0.2	14.9
2652	8281	1 46 41.5509	−24 00 51.153	1 46 41.5513	−24 00 51.049	−0.4	−10.4
2653	12716	2 43 25.5086	−37 55 41.893	2 43 25.5193		−10.7	
2703	14763	3 10 38.4881	−5 23 38.100	3 10 38.4842	−5 23 38.095	3.9	−0.5
2602	16496	3 32 25.1439	−3 18 47.729	3 32 25.1635	−3 18 47.727	−19.6	−0.2
1031	18482	3 57 01.7716	−40 02 13.071	3 57 01.7735		−1.9	
1032	19248	4 07 29.0608	−52 34 15.189	4 07 29.0606	−52 34 15.200	0.2	1.1
2083	19431	4 09 40.8728	−7 53 35.177	4 09 40.8807	−7 53 35.191	−7.9	1.4
1043	22000	4 43 45.8268	−10 40 56.100	4 43 45.8272	−10 40 56.161	−0.4	6.1
2657	24430	5 14 30.5313	−26 12 30.725	5 14 30.5333	−26 12 30.852	−2.0	12.7
2115	26233	5 35 21.8655	−4 29 39.029	5 35 21.8866	−4 29 39.073	−21.1	4.4
1060	26714	5 40 39.7010	−20 17 55.489	5 40 39.6968	−20 17 55.754	4.2	26.5
1061	26752	5 41 02.2904	−2 43 00.722	5 41 02.3059	−2 43 00.867	−15.5	14.5
2704	27727	5 52 15.9839	−28 39 24.748	5 52 15.9886		−4.7	
1062	27737	5 52 20.1821	−57 09 21.600	5 52 20.1874	−57 09 21.633	−5.3	3.3
1076	33093	6 53 33.5566	−54 52 59.299	6 53 33.5606	−54 52 59.331	−4.0	3.2
1075	33165	6 54 13.0465	−23 55 42.053	6 54 13.0521	−23 55 41.988	−5.6	−6.5
1078	34436	7 08 21.0406	−41 54 38.319	7 08 21.0419		−1.3	

Table 2. continued

INCA	HIP	$\alpha_{\rm hip}$ h m s	$\delta_{\rm hip}$ ° ′ ″	$\alpha_{\rm rssj}$ h m s	$\delta_{\rm rssj}$ ° ′ ″	$\Delta\alpha$ ms	$\Delta\delta$ 0.01″
1079	34922	7 13 32.2309	−44 38 25.906	7 13 32.2289		2.0	
2603	35487	7 19 28.0814	−16 23 41.686	7 19 28.0854	−16 23 41.794	−4.0	10.8
1083	36773	7 33 47.9679	−14 31 26.044	7 33 47.9711	−14 31 26.054	−3.2	1.0
2659	36992	7 36 13.7799	−44 57 27.298	7 36 13.7799		0.0	
1087	39429	8 03 35.0701	−40 00 11.478	8 03 35.0756		−5.5	
2660	41274	8 25 14.1507	−7 10 12.767	8 25 14.1509	−7 10 12.867	−0.2	10.0
2661	41939	8 32 58.5138	−34 38 02.567	8 32 58.5301		−16.3	
1092	44164	8 59 42.7510	−27 48 58.301	8 59 42.7596		−8.6	
1093	46159	9 24 49.0391	−23 49 34.434	9 24 49.0422	−23 49 34.618	−3.1	18.4
2707	46816	9 32 25.7159	−11 11 04.992	9 32 25.7236	−11 11 04.916	−7.7	−7.6
1097	47206	9 37 13.0182	−42 01 14.654	9 37 13.0163		1.9	
2663	53227	10 53 14.8848	−32 59 18.994	10 53 14.8927		−7.9	
1112	54401	11 07 56.3925	−51 07 07.958	11 07 56.4060	−51 07 08.204	−13.5	24.6
1114	55478	11 21 44.5184	−49 54 07.700	11 21 44.5215	−49 54 07.781	−3.1	8.1
1116	56851	11 39 22.2374	−39 23 07.143	11 39 22.2374		0.0	
1119	57269	11 44 38.5864	−49 25 02.351	11 44 38.5957	−49 25 02.215	−9.3	−13.6
1123	57931	11 52 53.0522	−50 17 34.225	11 52 53.0401	−50 17 34.099	12.1	−12.6
1124	58310	11 57 26.7308	−48 39 30.752	11 57 26.7307	−48 39 30.849	0.1	9.7
2605	59199	12 08 24.7527	−24 43 43.608	12 08 24.7567	−24 43 43.713	−4.0	10.5
2664	59600	12 13 20.7009	−9 04 46.877	12 13 20.7038	−9 04 47.018	−2.9	14.1
2607	64672	13 15 20.7662	−17 28 16.740	13 15 20.7660	−17 28 16.907	0.2	16.7
1141	66032	13 32 16.2427	−47 25 06.080	13 32 16.2537	−47 25 06.212	−11.0	13.2
2665	66358	13 36 08.3219	−33 28 44.771	13 36 08.3037		18.2	
2709	69130	14 09 02.2093	−45 34 30.575	14 09 02.2054		3.9	
1155	71380	14 35 48.4310	−18 02 11.373	14 35 48.4398	−18 02 11.104	−8.8	−26.9
2609	73473	15 00 58.3877	−8 31 08.166	15 00 58.3940	−8 31 08.219	−6.3	5.3
2290	75325	15 23 26.0581	−6 36 36.683	15 23 26.0699	−6 36 36.682	−11.8	−0.1
1168	76629	15 38 57.6023	−57 42 26.411	15 38 57.6127	−57 42 26.371	−10.4	−4.0
2610	77896	15 54 27.0549	−30 25 31.054	15 54 27.0577		−2.8	
1173	79913	16 18 41.5107	−42 42 29.729	16 18 41.5147		−4.0	
1176	80763	16 29 24.4675	−26 25 55.006	16 29 24.4640		3.5	
2710	82699	16 54 17.9303	−6 42 42.438	16 54 17.9326	−6 42 42.575	−2.3	13.7
2666	84478	17 16 13.6754	−26 32 36.299	17 16 13.6796		−4.2	
2711	87191	17 48 47.5985	−35 03 25.626	17 48 47.6184		−19.9	
1190	88469	18 03 52.4445	−24 21 38.613	18 03 52.4488	−24 21 38.714	−4.3	10.1
1191	88743	18 07 00.2464	−48 14 50.304	18 07 00.2450	−48 14 50.384	1.4	8.0
1198	90303	18 25 31.4774	−12 41 24.177	18 25 31.4685	−12 41 24.385	8.9	20.8
1202	92680	18 53 05.8592	−50 10 49.148	18 53 05.8612	−50 10 49.182	−2.0	3.4
1208	95244	19 22 40.2969	−20 38 33.558	19 22 40.3015	−20 38 33.589	−4.6	3.1
1209	95266	19 22 57.2314	−14 15 31.960	19 22 57.2341	−14 15 31.748	−2.7	−21.2
1210	95714	19 28 05.5466	−40 50 04.835	19 28 05.5487		−2.1	
1212	96714	19 39 38.8041	−6 03 49.218	19 39 38.8036	−6 03 49.224	0.5	0.6
2715	97849	19 53 06.3859	−14 36 11.089	19 53 06.3892	−14 36 11.064	−3.3	−2.5
1226	101098	20 29 36.8542	−21 07 34.640	20 29 36.8704	−21 07 34.349	−16.2	−29.1
1238	104894	21 14 52.7391	−31 11 00.813	21 14 52.7484		−9.3	
2470	106497	21 34 16.5606	−13 29 01.516	21 34 16.5617	−13 29 01.514	−1.1	−0.2
1242	106961	21 39 48.8892	−16 00 21.016	21 39 48.8950	−16 00 21.091	−5.8	7.5
2476	107556	21 47 02.2853	−16 07 35.637	21 47 02.2939	−16 07 35.705	−8.6	6.8