Arcsecond Positions for Milliarcsecond VLBI Nuclei of Extragalactic Radio Sources, Part II: 207 Sources

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VLBI measurements of time delay and fringe frequency at 2.29 GHz on baselines of 10^4 km between Deep Space Network stations have been used to determine the positions of the milliarcsecond nuclei in 207 extragalactic radio sources. Estimated accuracies generally range from ~0."1 to ~1."0, in both right ascension and declination, with all sources having uncertainties < 4" in both coordinates. The observed sources are part of an all-sky VLBI catalog of milliarcsecond radio sources. Arcsecond positions have now been determined for 752 of these sources. Arcsecond positions serve as a useful starting point in the construction of high-precision VLBI reference frames and are also important for unambiguous determination of optical counterparts to compact radio sources.

I. Introduction

A survey is underway to develop an all-sky catalog of radio sources with milliarcsecond components at 2.29 GHz. This is being accomplished by searching for compact components in known extragalactic sources with intercontinental VLBI baselines (Refs. 1 and 2). We have used the VLBI measurements of time delay and fringe frequency at 2.29 GHz to determine the positions of the milliarcsecond nuclei. Previously we determined the positions of 546 nuclei (Ref. 3). In this article we determine the positions of an additional 206 nuclei and include an improved position for one source (M 104) from Ref. 3. Estimated accuracies in this article range from 0."1 to 3."8 in both right ascension and declination. The addition of the Australia to South Africa baseline has allowed the survey to continue south of −45° declination. In total we have determined arcsecond positions for 84% of the detected sources.

Arcsecond positions serve as a useful starting point in the construction of a high precision VLBI reference frame as well as allow unambiguous optical identifications. The positions from this article and Ref. 3 are presently being used as a first step in the formation of a precision reference frame of about 200 sources in which relative radio positions should be determined to milliarcsecond accuracy (Ref. 4).

II. The Observations

The observations were performed with pairs of antennas on either California-Australia, California-Spain, or Australia-South Africa baselines (see Table 1) in 16 separate observing sessions between 1978 and 1982. A list of experiments appears in Table 2. The observations were performed at 2.29 GHz with MK II VLBI recording systems as described in Ref. 3. The length of each observation was a few minutes with 38% of the sources being observed more than once.

III. Method of Position Determination

The details of position determination for this set of sources closely follow the analysis given in Ref. 3, except for three differences:

(1) The data for the 207 sources reported here were reduced using the Caltech/JPL VLBI Mark II correlator and post-correlation software, whereas the data in Ref. 3 were reduced using the NRAO Mark II correlator and post-correlation software.

(2) Increased accuracy in modeling of the troposphere and earth rotation parameters yielded a smaller scatter in the time delay and fringe frequency residual. Typical residual values for the rms time delay scatter were ~10 ns and for the rms fringe frequency scatter ~0.1 mHz. The observed scatter was assumed to be an estimate of the random measurement error. Earth rotation corrections were obtained from final smoothed values of UT1-UTC and polar motion from Bureau International de l'Heure (BIH).

(3) Due to improved modeling of the troposphere and earth rotation parameters, $0''.3$ rather than $0''.5$ was added in a root-sum-square manner to formal estimates of right ascension and declination uncertainty in each experiment to account for unmodeled effects.

As in Ref. 3, observations of sources with well-known positions allowed instrumental delays and frequency offsets to be determined. At least 3 such calibration sources per experiment were spread in time among the sources whose positions we wished to determine (see Table 2). A list of the 44 calibration sources utilized appears in Table 3. Twenty-eight of the calibration source positions have been determined with VLBI (Ref. 5) and can be referred to the FK4 reference frame (Ref. 6) with an accuracy of $0''.1$. Other calibration source positions came from 1) Ref. 7, 8 sources, $0''.1$ accuracy; 2) Ref. 3, 5 sources, $0''.5$ accuracy, 3) Ref. 8, 2 sources, $1''$ accuracy, and 4) D. L. Jauncey et al. (private communication), 1 source, $0''.1$ accuracy.

IV. Results

The calculated positions of 207 sources and the corresponding uncertainties are shown in Fig. 1. The positions are referred to the equinox of 1950.0, and elliptical aberration terms are included so as to agree with past astronomical convention. The source positions and position uncertainties for sources which were multiply observed were estimated from a weighted average.

Seventy-eight sources were observed two or more times, and the scatters in their position estimates are consistent with the estimated uncertainties. Figure 2 displays a histogram of the ratio of the weighted rms scatter of the individual position coordinate estimates from the mean position of each multiply observed source, to the weighted rms estimate of position coordinate uncertainty. For the 78 multiply observed sources, the rms value of this ratio is 0.4 for right ascension and 0.5 for declination. Thus there is excellent agreement between the multiple observations of each source.

In addition to the 207 sources listed in Fig. 1, we also reobserved 22 sources whose positions were reported in Ref. 3. For these 22 sources, Fig. 3 shows a histogram of the absolute value of the difference in each position coordinate between the two separate observations divided by the RSS error of the position coordinate uncertainties. There is excellent agreement between the common sources. The calculated ratio has an RMS value of 1.3 for right ascension and 1.0 for declination. For one source, M104, an erroneous position was given in Ref. 3. The position for M104 cited in Fig. 1 should be used instead.

For 25 sources, we could compare our position estimates with other position estimates of better or similar accuracy (Refs. 7, 9, and 10). Figure 4 displays the ratio of the value of the difference between our source position estimate and the other catalog value to the RSS of the position uncertainties of both catalogs. For these 25 sources, the rms value of this ratio is 0.5 for right ascension and 0.9 for declination. For both right ascension and declination, the value of the ratio never exceeds 3.2. The bias offsets between our position estimates relative to those of the other catalogs for these 25 sources are $0^s.005 \pm 0^s.008$ for right ascension and $-0''.11 \pm 0''.06$ for declination. Hence, these position estimate comparisons along with the multiple observation comparisons indicate our position uncertainty estimates are realistic.

Figure 5 shows histograms of the number of sources versus estimated position uncertainty for declination and right ascension, respectively. Estimated accuracies range from $\sim 0''.1$ to $3''.8$ in both right ascension and declination.

V. Conclusion

Positions for the milliarcsecond nuclei of 207 extragalactic sources have been determined to an accuracy of $\sim 0''.1$ to $3''.8$ in both right ascension and declination. The reliability of the determined positions has been demonstrated by testing the repeatability of multiple observations on the same source and by comparing the results with other radio catalogs. Arcsecond positions have now been determined for 752 milliarcsecond nuclei.

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Table 1. Participating observatories

Location	Designation	Diameter, m	Baseline Length	
			Kilometers	Wavelengths
Tidbinbilla, Australia	DSS 43	64		
			10.6×10^3	8.1×10^7
Goldstone, California	DSS 14	64		
	DSS 13	26		
			8.4×10^3	6.4×10^7
Madrid, Spain	DSS 63	64		
Parkes, Australia	PK	64		
			9.7×10^3	7.5×10^7
Hartebeesthoek, So. Africa	HT	26		

Table 2. Experiment list

Experiment			Stations	Number of Position Calibrator Source Observations	Number of Source Positions Determined
Yr.	Mo.	Day			
78	05	30/31	13/43	4	27
78	06	29/30	13/43	8	10
80	02	01	14/43	4	7
80	02	27/28	14/43	3	10
80	03	03	13/63	8	25
80	03	12/13	13/63	13	26
80	03	28	13/63	4	25
80	04	24	PK/HT	9	17
80	04	25	PK/HT	11	14
80	04	25/26	PK/HT	10	14
80	06	19	14/43	6	9
81	05	08	14/43	3	1
82	02	14	43/HT	8	25
82	02	17	43/HT	3	33
82	02	19	43/HT	8	38
82	04	20	43/HT	6	43

Table 3. List of calibration sources (all positions from Ref. 5 unless otherwise noted)

P0003-00[2]	P0743-006[3]	3C345
0016+73[1]	4C7107	NRA0530
P0104-408	OJ287	P1741-038
P0106+01	3C212[3]	1749+70[1]
P0113-118	4C39.25	1803+78[1]
P0332-403	P1104-445	OV-236
P0402-362	P1127-14	1928+73[1]
P0438-43	P1144-379	P1933-400
P0537-441	1150+81[1]	2007+77[1]
DA193	3C273	P2134+004
P0605-08	3C274[3]	P2215+02[2]
0615+82[1]	P1333-33[3]	OY-172.6
0716+71[1]	3C309.1	P2245-328
P0723-008[3]	DW1555+00	P2345-16
P0727-11	P1610-77[4]	

[1] Ref. 7
[2] Ref. 8
[3] Ref. 3
[4] D. L. Jauncey, et al., private communication

SOURCE NAME	RIGHT ASCENSION HR	MIN	SEC	ERROR	DECLINATION DEG	MIN	SEC	ERROR
P 0002-478	0	2	2.978	0.033	-47	53	1.81	0.30
0014+81	0	14	4.473	0.151	+81	18	28.71	0.22
0018+72	0	18	34.482	0.107	+72	56	3.93	0.24
P 0019-00	0	19	51.665	0.020	- 0	1	41.88	0.32
P 0022-423	0	22	15.413	0.020	-42	18	41.12	0.21
0027+70	0	27	17.026	0.083	+70	21	6.26	0.31
P 0034-01	0	34	30.555	0.020	- 1	25	37.78	0.36
P 0035-02	0	35	47.176	0.020	- 2	24	9.45	0.30
P 0036+03	0	36	44.176	0.020	+ 3	3	24.54	0.43
P 0047-579	0	47	48.238	0.064	-57	54	46.83	0.30
P 0055-01	0	55	1.572	0.020	- 1	39	39.40	0.34
P 0056-572	0	56	38.640	0.041	-57	15	22.07	0.30
P 0131-522	1	31	5.633	0.022	-52	15	26.40	0.17
P 0133-203	1	33	13.577	0.025	-20	24	4.01	0.44
0149+71	1	49	20.814	0.057	+71	0	20.76	0.24
B2 0149+33	1	49	40.027	0.024	+33	35	46.85	0.31
0153+74	1	53	4.339	0.054	+74	28	5.69	0.21
0159+72	1	59	13.059	0.057	+72	18	29.24	0.23
P 0202-76	2	2	1.005	0.422	-76	34	26.34	0.30
0205+72	2	5	26.907	0.050	+72	15	16.40	0.22
GC 0206+35	2	6	39.339	0.032	+35	33	41.36	0.40
P 0208-512	2	8	56.970	0.019	-51	15	7.53	0.17
0212+73	2	12	49.935	0.050	+73	35	40.15	0.21
P 0214-522	2	14	17.229	0.029	-52	14	5.49	0.21
P 0219-637	2	19	37.871	0.062	-63	43	59.84	0.21
P 0220-349	2	20	49.570	0.028	-34	55	4.67	0.35
GC 0223+34	2	23	9.735	0.027	+34	8	1.56	0.33
P 0226-038	2	26	21.984	0.021	- 3	50	57.25	0.42
P 0229-398	2	29	51.990	0.017	-39	49	0.15	0.18
P 0230-790	2	30	28.852	0.139	-79	1	0.77	0.21
P 0232-04	2	32	36.512	0.022	- 4	15	8.90	0.65
P 0235-618	2	35	37.782	0.034	-61	49	13.47	0.21
P 0244-452	2	44	4.579	0.023	-45	12	13.34	0.21
GC 0248+43	2	48	18.504	0.027	+43	2	56.98	0.34
P 0252-549	2	52	0.273	0.023	-54	54	2.27	0.17
P 0302-623	3	2	48.181	0.034	-62	23	3.71	0.21
P 0308-611	3	8	51.298	0.027	-61	9	58.24	0.17
P 0312-77	3	12	56.328	0.205	-77	3	0.15	0.30
P 0316-444	3	16	13.353	0.056	-44	25	11.24	0.30
DW 0326+27	3	26	56.037	0.026	+27	46	0.31	0.33
P 0332-403	3	32	25.244	0.026	-40	18	24.04	0.30
P 0334-546	3	34	36.057	0.029	-54	40	16.95	0.21
OE 367	3	40	14.804	0.029	+36	12	44.47	0.42
P 0355-66	3	55	27.892	0.095	-66	54	11.43	0.22
P 0355-483	3	55	52.505	0.027	-48	20	49.14	0.21
GC 0402+37	4	2	29.854	0.029	+37	55	26.85	0.42
0403+76	4	3	59.196	0.067	+76	48	52.75	0.25
P 0414-341	4	14	16.908	0.028	-34	10	26.06	0.37
3C 119	4	29	7.937	0.027	+41	32	8.24	0.31
P 0431-512	4	31	4.407	0.043	-51	15	42.11	0.23
P 0437-454	4	37	30.667	0.025	-45	28	12.26	0.22
P 0446-519	4	46	35.030	0.049	-51	56	13.75	0.23
P 0448-392	4	48	0.452	0.017	-39	16	15.74	0.18
P 0450-469	4	50	27.871	0.024	-46	58	16.45	0.21
P 0454+039	4	54	8.935	0.020	+ 3	56	14.71	0.41
P 0454-81	4	54	18.188	0.176	-81	5	54.13	0.21
P 0454-46	4	54	24.188	0.031	-46	20	38.47	0.23

Fig. 1. Calculated positions and corresponding uncertainties of 207 sources

SOURCE NAME	RIGHT ASCENSION HR	MIN	SEC	ERROR	DECLINATION DEG	MIN	SEC	ERROR
0454+84	4	54	57. 212	0. 147	+84	27	53. 01	0. 21
P 0459+135	4	59	43. 842	0. 021	+13	33	56. 20	0. 31
P 0503-608	5	3	24. 298	0. 090	-60	53	56. 16	0. 31
P 0509+152	5	9	49. 674	0. 024	+15	13	49. 21	0. 41
P 0514-459	5	14	19. 327	0. 022	-45	59	58. 50	0. 18
P 0521-262	5	21	17. 209	0. 035	-26	16	52. 90	0. 55
P 0522-611	5	22	0. 426	0. 066	-61	10	41. 35	0. 31
P 0523-570	5	23	48. 149	0. 056	-57	1	27. 40	0. 23
P 0524-460	5	24	6. 001	0. 020	-46	0	28. 01	0. 18
0532+82	5	32	31. 216	0. 136	+82	36	53. 05	0. 23
P 0537-158	5	37	17. 184	0. 037	-15	52	5. 10	0. 35
P 0543-735	5	43	2. 748	0. 072	-73	33	31. 98	0. 18
0604+72	6	4	39. 237	0. 053	+72	49	27. 21	0. 23
P 0622-441	6	22	2. 686	0. 033	-44	11	22. 97	0. 22
P 0629-418	6	29	37. 684	0. 034	-41	52	14. 26	0. 30
0633+73	6	33	6. 438	0. 074	+73	27	35. 75	0. 31
P 0637-75	6	37	23. 422	0. 065	-75	13	37. 38	0. 15
0718+79	7	18	8. 892	0. 082	+79	17	22. 60	0. 22
P 0722+145	7	22	27. 228	0. 127	+14	31	7. 94	1. 81
P 0736+01	7	36	42. 553	0. 020	+ 1	43	59. 44	0. 31
0740+82	7	40	33. 222	0. 187	+82	49	24. 17	0. 22
P 0743-67	7	43	22. 189	0. 052	-67	19	9. 09	0. 31
P 0757-737	7	58	1. 046	0. 150	-73	44	57. 34	0. 30
0824+11	8	24	22. 311	0. 026	+11	2	19. 22	0. 37
0830+11	8	30	29. 914	0. 028	+11	33	52. 30	0. 37
P 0842-75	8	42	6. 608	0. 635	-75	29	19. 76	0. 40
P 0851+071	8	51	8. 451	0. 023	+ 7	6	11. 84	0. 33
P 0907-023	9	7	13. 129	0. 020	- 2	19	16. 43	0. 31
P 0915-213	9	15	10. 447	0. 026	-21	18	56. 88	0. 32
P 0925-203	9	25	33. 523	0. 021	-20	21	44. 65	0. 30
P 0931-114	9	31	8. 908	0. 020	-11	26	4. 59	0. 30
P 0932+02	9	32	43. 652	0. 021	+ 2	17	12. 21	0. 73
0950+74	9	50	4. 573	0. 113	+74	50	7. 67	0. 22
P 0957+00	9	57	43. 824	0. 020	+ 0	19	48. 94	0. 32
1003+83	10	3	25. 911	0. 307	+83	4	56. 52	0. 30
P 1020-103	10	20	4. 181	0. 083	-10	22	33. 40	0. 99
1023+747	10	23	13. 015	0. 121	+74	43	43. 43	0. 31
1027+74	10	27	13. 502	0. 424	+74	57	22. 48	0. 31
P 1030-357	10	30	52. 089	0. 035	-35	46	27. 46	0. 31
P 1032-199	10	32	37. 372	0. 021	-19	56	2. 19	0. 31
P 1034-058	10	34	16. 967	0. 049	- 5	50	16. 28	0. 95
P 1034-374	10	34	38. 242	0. 026	-37	28	39. 66	0. 30
1039+81	10	39	27. 818	0. 128	+81	10	23. 54	0. 21
1044+71	10	44	49. 741	0. 047	+71	59	26. 72	0. 21
P 1046-409	10	46	22. 645	0. 038	-40	58	7. 69	0. 33
1053+70	10	53	27. 729	0. 045	+70	27	47. 78	0. 21
1053+81	10	53	36. 302	0. 108	+81	30	35. 41	0. 17
P 1057-79	10	57	49. 877	0. 406	-79	47	47. 60	0. 31
1058+72	10	58	20. 119	0. 060	+72	41	44. 72	0. 22
P 1102-242	11	2	19. 825	0. 023	-24	15	13. 82	0. 30
P 1103-006	11	3	58. 359	0. 020	- 0	36	40. 84	0. 31
1104+72	11	4	17. 980	0. 080	+72	48	49. 95	0. 22
P 1105-680	11	5	17. 769	0. 139	-68	4	35. 70	0. 31
P 1106+023	11	6	11. 190	0. 020	+ 2	18	56. 23	0. 31
P 1110-217	11	10	21. 668	0. 024	-21	42	8. 72	0. 33
P 1116-46	11	16	6. 200	0. 032	-46	17	50. 01	0. 22
P 1120-274	11	20	28. 477	0. 026	-27	26	20. 21	0. 30

Fig. 1 (contd)

SOURCE NAME	RIGHT ASCENSION				DECLINATION			
	HR	MIN	SEC	ERROR	DEG	MIN	SEC	ERROR
P 1133-681	11	33	46.785	0.134	-68	10	29.41	0.30
P 1133-739	11	34	1.524	0.323	-73	59	8.91	0.31
P 1142-225	11	42	50.234	0.026	-22	33	51.75	0.33
P 1143-287	11	43	54.800	0.024	-28	42	37.96	0.31
P 1143-331	11	43	57.498	0.039	-33	12	2.60	0.45
P 1145-676	11	45	9.366	0.058	-67	37	1.66	0.35
P 1148-671	11	48	46.744	0.068	-67	11	29.38	0.22
P 1203-26	12	2	58.823	0.022	-26	17	22.59	0.30
P 1207-399	12	6	59.486	0.020	-39	59	31.49	0.18
P 1221-82	12	21	25.115	0.163	-82	56	33.54	0.31
1221+80	12	21	47.662	0.218	+80	56	41.03	0.21
P 1236-684	12	36	44.606	0.095	-68	29	2.18	0.31
M 104	12	37	23.378	0.013	-11	20	55.04	0.21
P 1240-294	12	40	30.049	0.028	-29	26	57.05	0.35
P 1250-330	12	50	14.899	0.025	-33	3	42.65	0.31
P 1251-71	12	51	40.129	0.063	-71	22	3.72	0.31
P 1256-229	12	56	27.621	0.023	-22	54	28.09	0.31
1305+80	13	5	22.143	0.191	+80	24	21.27	0.18
P 1347-218	13	47	28.024	0.024	-21	49	49.70	0.34
P 1349-439	13	49	52.576	0.029	-43	57	54.04	0.30
P 1349+027	13	49	58.378	0.020	+ 2	47	33.84	0.44
P 1351+021	13	51	18.912	0.020	+ 2	6	37.46	0.32
1357+76	13	57	42.177	0.133	+76	57	53.05	0.30
P 1406-267	14	6	58.442	0.024	-26	43	27.76	0.32
1436+76	14	36	4.574	0.317	+76	18	23.82	0.36
P 1438-347	14	38	20.331	0.027	-34	43	57.60	0.32
1448+76	14	48	56.492	0.078	+76	13	33.81	0.22
P 1451-400	14	51	20.602	0.018	-40	0	22.46	0.22
P 1509+022	15	9	43.717	0.020	+ 2	14	32.10	0.31
P 1549-79	15	49	28.382	0.211	-79	5	17.75	0.30
P 1602+01	16	2	12.955	0.020	+ 1	25	58.69	0.32
P 1602-00	16	2	21.909	0.020	- 0	10	57.17	0.32
P 1603+00	16	3	38.909	0.020	+ 0	8	30.12	0.36
P 1610-77	16	10	51.750	0.104	-77	9	52.60	0.30
1616+85	16	16	22.349	3.021	+85	9	26.04	0.42
P 1635-035	16	35	41.407	0.020	- 3	34	8.85	0.43
1637+82	16	37	56.847	0.332	+82	38	18.48	0.23
P 1706+006	17	6	11.695	0.020	+ 0	38	54.89	0.31
P 1718-649	17	18	46.160	0.022	-64	57	47.87	0.12
P 1719-729	17	19	52.046	0.089	-72	57	18.81	0.22
P 1732-598	17	32	2.807	0.046	-59	50	6.38	0.30
P 1733-56	17	33	24.401	0.045	-56	31	39.93	0.32
P 1758-651	17	58	25.634	0.037	-65	7	40.83	0.21
P 1800-709	18	0	36.223	0.099	-70	58	44.21	0.24
P 1815-554	18	15	35.184	0.044	-55	22	38.16	0.31
P 1823-455	18	23	31.139	0.034	-45	34	19.00	0.33
P 1831-711	18	31	41.335	0.078	-71	11	14.56	0.30
P 1853-534	18	52	59.134	0.042	-53	28	58.63	0.31
P 1925-610	19	25	40.692	0.034	-61	2	24.34	0.22
P 1929-457	19	29	8.055	0.034	-45	43	5.21	0.30
P 1935-692	19	35	11.833	0.116	-69	14	52.50	0.39
P 1936-623	19	36	52.756	0.067	-62	18	21.43	0.30
P 1941-554	19	41	23.321	0.038	-55	28	6.09	0.23
1946+70	19	46	12.035	0.072	+70	48	21.66	0.25
P 2004-447	20	4	25.155	0.031	-44	43	28.51	0.30
P 2005-489	20	5	46.605	0.034	-48	58	43.55	0.30
2007+77	20	7	20.428	0.094	+77	43	57.95	0.30

Fig. 1 (contd)

SOURCE NAME	RIGHT ASCENSION HR	MIN	SEC	ERROR	DECLINATION DEG	MIN	SEC	ERROR
2010+72	20	10	16.194	0.050	+72	20	20.82	0.22
P 2022-702	20	22	20.971	0.175	-70	17	9.67	0.35
P 2025-538	20	25	48.485	0.028	-53	49	9.48	0.22
P 2036-577	20	36	5.898	0.042	-57	45	47.41	0.22
P 2044-02	20	44	34.223	0.020	- 2	47	25.99	0.31
P 2052-47	20	52	50.125	0.026	-47	26	19.61	0.21
P 2056-369	20	56	32.104	0.033	-36	57	37.29	0.33
P 2058-425	20	58	42.240	0.022	-42	31	6.07	0.22
P 2105-48	21	5	24.687	0.075	-48	58	32.36	0.33
P 2109-811	21	9	15.991	0.660	-81	6	22.82	0.32
2136+82	21	36	2.190	0.178	+82	25	38.62	0.23
P 2139+02	21	39	39.584	0.023	+ 2	48	45.48	0.67
P 2146-78	21	46	36.334	0.117	-78	21	10.41	0.21
2155-304	21	55	58.321	0.023	-30	27	54.47	0.30
P 2204-54	22	4	26.295	0.027	-54	1	15.02	0.21
2205+74	22	5	8.831	0.136	+74	21	41.93	0.23
P 2205-636	22	5	10.069	0.156	-63	40	30.90	0.35
2207+74	22	7	41.445	0.134	+74	8	53.82	0.28
P 2217+018	22	17	57.958	0.024	+ 1	49	45.62	0.88
2229+69	22	29	11.643	0.042	+69	31	2.79	0.22
P 2232-488	22	32	11.475	0.028	-48	51	30.81	0.22
P 2243-03	22	43	36.312	0.020	- 3	16	26.03	0.36
P 2311-477	23	11	3.004	0.064	-47	45	32.46	0.36
P 2314-409	23	14	2.006	0.037	-40	57	44.66	0.31
P 2314+03	23	14	2.226	0.020	+ 3	48	56.56	0.38
P 2324-02	23	24	19.582	0.020	- 2	18	43.96	0.31
P 2326-477	23	26	33.717	0.019	-47	46	51.76	0.18
P 2326-502	23	26	36.011	0.034	-50	12	13.45	0.30
P 2327-459	23	27	54.722	0.036	-45	56	31.42	0.31
P 2329-415	23	29	37.842	0.055	-41	35	11.90	0.33
P 2332-017	23	32	46.422	0.020	- 1	47	45.37	0.31
P 2333-528	23	33	28.781	0.040	-52	52	58.43	0.30
P 2335+03	23	35	34.273	0.021	+ 3	10	12.18	0.54
P 2351-006	23	51	35.377	0.020	- 0	36	29.42	0.31
P 2352-455	23	52	53.312	0.050	-45	30	7.95	0.34
P 2355-534	23	55	18.190	0.025	-53	27	55.98	0.21

Fig. 1 (contd)

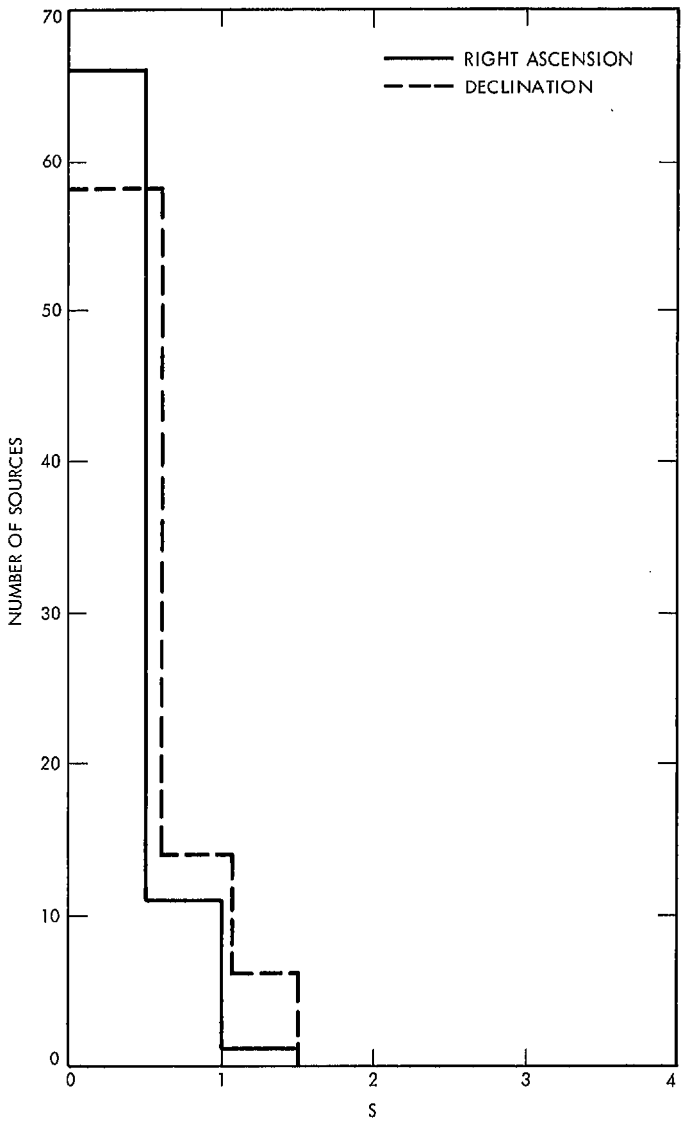

Fig. 2. Comparison of position estimates for 78 multiply observed sources. For each source, *S* is the ratio of the weighted rms scatter of individual position coordinate estimates about the mean value to the weighted rms estimate of the uncertainty in that position coordinate.

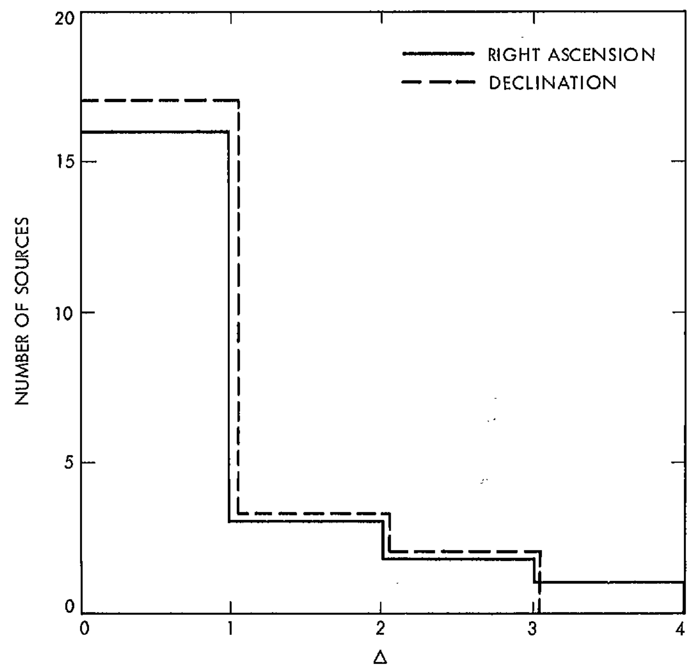

Fig. 3. Comparison of position estimates with 22 sources common with Ref. 3. For each source, Δ is the ratio of the absolute value of the difference between the source coordinate estimate in this set of data and the source coordinate estimate cited in Ref. 3 to the weighted rms estimate of the uncertainty in that position coordinate.

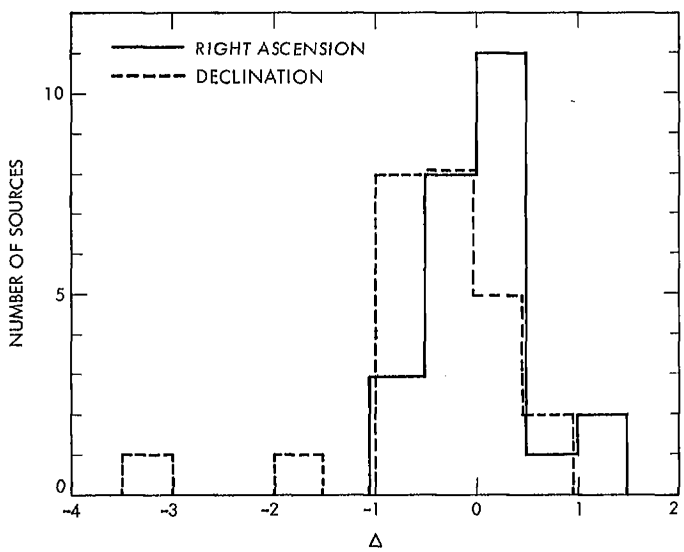

Fig. 4. Comparison of position estimates with other radio positional catalogs. For each source, Δ is the ratio of the difference between our source coordinate estimate and the other catalog value to the RSS of the uncertainties of both catalogs.

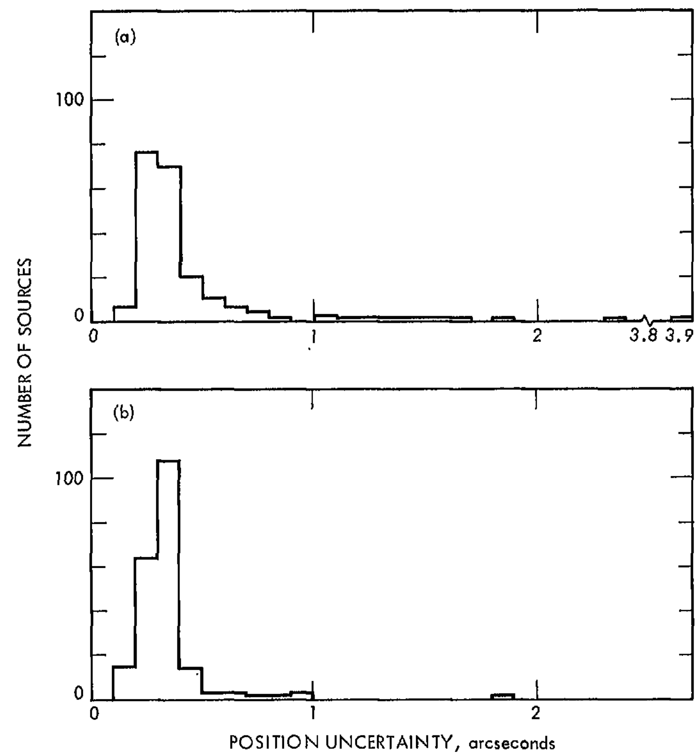

Fig. 5. Histogram of number of sources versus estimated position uncertainty: (a) right ascension; (b) declination