THE PARKES CATALOGUE OF RADIO SOURCES DECLINATION ZONE −60° TO −90°

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Summary

A catalogue of 247 radio sources between declinations −60° and −90° is presented. In the zone −60° to −75°, the sources were selected from an initial finding survey at 408 Mc/s, while from −75° to −90° a 1410 Mc/s survey was carried out. The survey covers an area of 0·8 steradians, omitting the region near the galactic plane. Flux densities determined from source measurements at 408, 1410, and 2650 Mc/s are presented together with suggested optical identifications, radio spectra, and preliminary polarization information.

I. Introduction

This paper reports the results of a survey of radio sources in the declination zone −60° to −90° carried out at the Australian National Radio Astronomy Observatory at Parkes, New South Wales, as part of the source survey program. The results of the survey for the declination zone −20° to −60° have been reported by Bolton, Gardner, and Mackey (1964), hereafter referred to as BGM.

The zone reported in the present catalogue was divided into two zones for the purpose of the observations, namely declinations −60° to −75° and declinations −75° to −90°. The region of the Magellanic Clouds was surveyed by D. S. Mathewson of this laboratory and we are indebted to him for information on sources in this region. For further information concerning Magellanic Cloud sources the reader is referred to Mathewson and Healey (1964*a*, 1964*b*). Portions of the regions near the galactic plane were not covered in this survey since it was designed primarily for the detection of extragalactic sources.

The initial survey and the subsequent measurements at 408, 1410, and 2650 Mc/s are described. Measurements in the investigation consist of fluxes and positions for all sources, and where possible such parameters as polarization and spectra. Optical identifications are suggested for several of the sources. South of declination −75°, it is thought that the present catalogue is substantially complete for sources greater than 0·5 flux units at 1410 Mc/s (1 flux unit (f.u.) = 10^{-26} W m^{-2} (c/s)$^{-1}$). From −75° to −60° declination, the catalogue is complete for sources greater than 1 f.u. at 1410 Mc/s.

Since the limit of flux density investigated in this survey was lower than that of BGM, the log N–log S curve for the lower flux density sources is compared with the results of BGM.

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II. The Finding Survey

(a) *Declinations −60° to −75°*

In this zone the survey techniques were the same as reported by BGM except that declination scans were made at intervals of 4^{m} of right ascension. Therefore the scans were 30′ of arc apart at −60° declination and 15′·5 apart at −75° declination.

The finding survey in this zone was carried out at 408 Mc/s (∼ 75 cm wavelength), where the beam of the 210-ft telescope is 48′ of arc. The receiver used is a switched radiometer using a conventional crystal mixer with no r.f. amplification (Mackey 1964). The survey was not extended into regions near the plane of the Galaxy where the level of the background was high and confusion due to galactic structure likely. The criteria for selection of sources were the same as those adopted by BGM, i.e. sources with flux densities greater than 4 f.u. at 408 Mc/s which did not noticeably broaden the 48′ beam of the telescope were selected for further study.

(b) *Declinations −75° to −90°*

In this circumpolar zone, the finding survey was carried out using both the 408 and 1410 Mc/s receivers, a dual-feed system allowing simultaneous operation at the two frequencies. At 1410 Mc/s (∼ 21 cm wavelength) the beamwidth of the telescope is 14′ of arc. The parametric-type receiver used (Gardner and Milne 1963) has a system temperature of approximately 100°K. With a 10 Mc/s bandwidth and the output time constant of 1 s used in the finding survey, the peak-to-peak noise observed was 0·2 degK of aerial temperature.

The observations were made by scanning the region in declination at fixed values of right ascension. Because of the rapid convergence of lines of constant right ascension on the celestial sphere in this region of the sky, scans were made from −75° to −83° declination at intervals of 3^{m} of right ascension, and from −82° to −87° declination at intervals of 6^{m} of right ascension. The region −87° to the pole was surveyed in altazimuth coordinates, scanning in azimuth at 10′ intervals of zenith angle.

Scans were made at drive rates of approximately 2°/min, allowing about 7 s for passage of the 14′ beam over a point. At the frequency of 1410 Mc/s the survey was sensitivity limited, nevertheless a source of 0·15°K (approximately 0·2 f.u.) was detected if the beam passed directly over it. This detection limit rises to approximately 0·25°K for a source lying between two scans at their maximum separation of 11′·6 at declination −75°.

It is thought that nearly all point sources greater than 0·5 f.u. at 1410 Mc/s in the region have been detected. All the sources discovered in this region by the finding survey were later investigated again at 1410 Mc/s for more accurate flux and position determinations.

III. Measurements

(a) *1410 Mc/s*

All sources selected from the finding survey were observed at 1410 Mc/s for position, size, and flux measurements. The observational procedure used follows BGM.

Some sources selected from the 408 Mc/s finding survey were rejected when 1410 Mc/s observations showed them to be due to background variations. Of the probable sources located in the 1410 Mc/s finding survey, some 35% were found to be too weak for accurate measurements to be made and have been omitted from the catalogue.

(*b*) *2650 Mc/s*

All sources greater than 1·5 f.u. at 1410 Mc/s were observed at 2650 Mc/s ($\sim$ 11 cm wavelength). The receiver used is a degenerate parametric switched radiometer (Cooper, Cousins, and Gruner 1964) with an overall system temperature of approximately 150°K and an i.f. bandwidth of 40 Mc/s. Peak-to-peak noise fluctuations are about 0·15 degK with a 2 s output time constant. The selection requirements set for sources from the 1410 Mc/s observations meant that most of the sources measured at 2650 Mc/s had aerial temperatures greater than 0·4°K.

TABLE 1

ESTIMATES OF AVERAGE ERROR

Frequency (Mc/s)	R.M.S. Error
408 (75 cm)	±1·2 f.u. ±5%
1410 (21 cm)	±0·2 f.u. ±6%
2650 (11 cm)	±0·15 f.u. ±7%

IV. Determination of Flux Densities

The procedure of BGM was followed in establishing the scales of flux density from observations of sources whose flux values had been given by Conway, Kellermann, and Long (1963). Standard sources were observed on most nights for a determination of flux-density scale factors, which varied slightly with different aerial feeds and different cables used between the feed and the receiver input. Where necessary, corrections were made to flux-density values on the basis of these daily observations.

In determining the accuracy with which the flux measurements can be made there are two types of possible error which have to be considered. The first type is an error proportional to the flux density of the source. This can be due to an error in the flux scale factors adopted, unnoticed non-linearities in the system, partial resolution of the sources, or polarization of the source radiation. For extended or resolved sources, given flux densities determined from peak values of aerial temperature observed represent a lower limit of flux density. Sources of up to 3′ of arc diameter whose broadening effect on the beam was not measurable may have had their fluxes underestimated correspondingly by up to 16%. On the average, the errors due to unknown polarization of the sources are not expected to amount to more than 2% (this applies only to 1410 and 2650 Mc/s measurements, not to 408 Mc/s where the effect is negligible).

The second type of error is fixed in flux value, being due to noise fluctuations on the records and, in some cases (particularly at 408 Mc/s), to background confusion. Peak errors due to noise amount to 0·1 f.u. at 1410 and 2650 Mc/s, and 0·5 f.u. at

TABLE 2

PARKES CATALOGUE OF RADIO SOURCES −60° TO −90°

Catalogue Number	Position (1950·0)		Annual Precession		Flux Density (10^{-26} W m^{-2} (c/s)$^{-1}$)				Spectrum			Remarks	Galactic Coordinates		MSH Cat. No.
	R.A. h m s	Dec. ° ′	Δα s	Δδ ″	350	75	21	11	75→350	21→75	11→21		l^{II} °	b^{II} °	
0004−83	00 04 09	−83 22·5	−2·88	+20·04		7·9	2·5	1·3		0·9	1·0		304	−34	
0013−63	00 13 35	−63 27·6	+2·89	20·00	27	7·4	1·9	0·7	0·8	1·1	1·6		310	−53	00−*61*
0016−77	00 16 39	−77 00·1	−2·65	20·02			0·8					conf. with 0017−77	305	−40	
0017−71	00 17 30	−71 13	+2·77	19·98		2·0	1·0			0·5		ext. at 21cm	307	−46	
0017−77	00 17 44	−77 08·1	−2·60	20·02			0·8					conf. with 0016−77	305	−40	
0020−74	00 20 30	−74 44	+2·64	19·96			1·0						306	−44	
0021−68·6	00 21 48	−68 38·4	2·74	19·95		3·7	1·0					Not resolved at 75 cm	307	−49	
0021−68·2	00 21 53	−68 10·4	2·76	19·95			0·7						307	−49	
0022−74	00 22 00	−74 13	2·62	19·95		1·5	0·6			0·7			306	−43	
0022−60	00 22 53	−60 46·6	2·83	19·93		3·5	1·4	0·7		0·7	1·0		309	−56	
0032−63	00 32 47	−63 36·7	2·66	19·82		3·0	1·2			0·8			306	−54	
0036−62	00 36 30	−62 48·2	2·65	19·77		3·1	1·4	0·8		0·6	0·9		305	−55	
0037−68	00 37 00	−68 49	2·52	19·78			1·2						305	−50	
0038−72	00 38 30	−72 00	+2·39	19·76			1·2						304	−45	
0041−76	00 41 13	−76 05·7	−2·09	19·71		3·2	0·6			1·3			304	−41	
0041−84	00 41 53	−84 39·0	−0·25	19·72		1·5	0·9			0·4			303	−33	
0043−63	00 43 52	−63 51·1	+2·54	19·64		2·4	1·2			0·6			304	−54	
0048−83	00 48 11	−83 22·3	−0·45	19·60			0·8						303	−34	
0055−73	00 55 00	−73 00	+2·04	19·47	550	110	67		1·0	0·4		see Mathewson and Healey 1964*a* Centroid of SMC	302	−44	00−*71*
0101−80	01 01 03	−80 12·6	−1·05	+19·30		1·9	0·4			1·2			302	−37	

0101−76	01 01 09	−76 01·6	−1·62	+19·30			0·5						302	−41	
0106−84	01 06 40	−84 20·1	−0·72	19·20			0·6						302	−33	
0110−69	01 10 01	−69 17·2	+2·02	19·12		5·5	2·0	1·0		0·8	1·1		300	−48	
0113−80	01 13 50	−80 53·5	−0·28	19·00		2·3	0·7			1·0			302	−36	
0118−68	01 18 00	−68 26·2	+1·95	18·89		2·5	1·1			0·7			299	−50	
0119−63	01 19 58	−63 25·9	+2·08	18·83	22	5·1	1·6	0·7	0·9	0·9	1·3		297	−54	01−61
0122−75	01 22 34	−75 32·0	−1·33	18·80		2·1	0·7			0·9			300	−42	
0125−61	01 25 57	−61 34·2	+2·15	18·63	17	4·0	1·1		0·9	1·0			295	−55	01−62
0127−81	01 27 56	−81 24·4	0·31	18·60		1·9	0·8			0·7			301	−36	
0130−62	01 30 39	−62 02·6	2·09	18·47		3·4	1·1			0·9			294	−55	
0133−69	01 33 00	−69 46	1·64	18·41	22	3·2	0·6		1·2				297	−49	01−63
0141−69	01 41 00	−69 59	+1·51	18·13			0·8						296	−49	
0152−76	01 52 14	−76 29·8	−0·40	17·70		3·9	0·8			1·3			298	−40	
0155−82	01 55 14	−82 41·5	−2·25	17·60			0·6						300	−34	
0156−78	01 56 15	−78 39·7	−0·55	17·50			0·7						299	−38	
0157−78	01 57 33	−78 55·3	−0·45	17·50			1·2						299	−38	
0158−74	01 58 52	−74 46·8	+0·65	17·40		4·0	1·6			0·7			296	−43	
0202−76	02 02 00	−76 34·1	−0·15	17·30	18	8·0	2·6	1·3	0·6	0·9	1·0		297	−40	01−71?
0210−62	02 10 04	−62 12·5	+1·87	17·29	11	2·5	1·0		0·9	0·7			287	−53	02−62
0223−71	02 23 08	−71 12·5	0·78	16·25	30	5·0	1·5		1·2	1·0			292	−45	02−71?
0224−70	02 24 00	−70 05·5	+0·77	16·20		3·2	0·6			1·3			292	−45	
0230−83	02 30 23	−83 31·4	−3·92	16·10		1·7	0·7			0·7			300	−33	
0230−66	02 30 51	−66 40·1	+1·17	15·84	13	4·7	1·4	0·6	0·6	1·0	1·3		288	−48	02−63
0244−69	02 44 32	−69 22·3	+0·74	15·09		2·5	1·0			0·7			288	−45	
0247−77	02 47 56	−77 16·9	−0·89	14·90			0·5						295	−38	
0251−67	02 51 11	−67 30·4	+0·84	14·59	34	6·2	1·2		1·1	1·3		>35″ EW ext. in δ 20′S 74 II	286	−46	02−65
0252−71	02 52 19	−71 17·2	+0·39	14·63	7	14·0	5·9			0·7		350 cm flux uncertain	290	−43	02−72?
0312−77	03 12 46	−77 05·3	−1·27	13·36		2·0	0·8			0·7			293	−38	
0315−68	03 15 41	−68 31·9	+0·52	13·16		4·6	1·5			0·9			284	−44	
0324−70	03 24 10	−70 23·8	+0·16	+12·60		1·5	0·6			0·7			286	−42	

TABLE 2 (*Continued*)

Catalogue Number	Position (1950·0) R.A. h m s	Position (1950·0) Dec. ° ′	Annual Precession Δα s	Annual Precession Δδ ″	Flux Density (10^{-26} W m^{-2} (c/s)$^{-1}$) 350	75	21	11	Spectrum 75→350	21→75	11→21	Remarks	Galactic Coordinates l^{II} °	b^{II} °	MSH Cat. No.
0324−77	03 24 13	−77 10·4	−1·49	+12·60			0·6						293	−37	
0325−76	03 25 21	−76 39·9	−1·33	12·52			0·9						292	−37	
0344−85	03 44 25	−85 35·1	−11·29	11·18			0·6					ext. in δ at 21 cm	299	−31	
0349−88	03 49 00	−88 26·4	−38·21	10·83		6·8	1·5			1·2			302	−29	
0354−76	03 54 52	−76 33·2	−1·70	10·41			0·5						291	−36	
0355−66	03 55 24	−66 50	+0·40	10·37		2·3	1·2			0·5			279	−42	
0359−76	03 59 36	−76 14·3	−1·65	10·05			0·6						290	−36	
0401−64	04 01 06	−64 11	+0·68	9·94	14	4	<0·5		0·8			75 cm position	277	−42	04−61?
0408−65	04 08 06	−65 49	+0·45	9·40	36	45	15		−0·2	0·9		<15″ EW	277	−42	04−62
0410−75	04 10 11	−75 15·3	−1·43	9·24	87	40	13·5	7·5	0·5	0·8	1·0	peculiar spectrum <20″ EW P < 1% 74 I	289	−36	04−71
0411−75	04 11 10	−75 39·9	−1·58	9·16			0·5						289	−36	
0416−65	04 16 15	−65 01·9	+0·49	8·76			0·7						277	−40	
0420−62	04 20 30	−62 30	+0·75	8·43	38	9	3		0·9	0·9		20″ EW	273	−41	04−63
0423−68	04 23 06	−68 41	−0·05	8·22		2·4	0·8			0·9			280	−39	
0425−72	04 25 00	−72 48	−0·88	8·07	11	4·7	1·7		0·5	0·9			284	−37	04−72
0428−67	04 28 12	−67 52	+0·05	7·81		2·3	0·9			0·7			278	−39	
0429−61	04 29 48	−61 34	+0·80	7·69	35	6·5	1·7		1·1	1·1			271	−41	04−64
0437−74	04 37 02	−74 54·8	−1·56	7·10		1·4	0·8			0·5			288	−35	
0437−65	04 37 06	−65 03	+0·39	7·09	16	4·5	1·4		0·8	0·9			276	−38	04−65
0443−59	04 43 26	−59 29·7	0·93	6·55		3·6	1·3	0·6		0·8	1·2		269	−39	
0448−62	04 48 24	−62 20	+0·65	6·16	9	2·7	0·8		0·8	1·0		ext. at 21 cm	272	−38	04−66
0450−70	04 50 36	−70 53	−0·61	5·98		2·3	1·0			0·7			281	−36	
0454−81	04 54 43	−81 06·2	−5·12	5·63			1·1						294	−31	
0458−75	04 58 43	−75 12·1	−1·80	5·30		3·0	0·6			1·3			287	−33	
0506−61	05 06 13	−61 12·5	+0·71	+4·64	14	6·1	2·2	1·5	0·5	0·8	0·6		270	−36	05−61

0507−62	05 07 36	−62 44	+0·55	+4·54	11	3·4	1·1		0·7	0·8			271	−36	05−62?
0513−83	05 13 52	−83 38·5	−8·68	4·01			0·5						296	−30	
0522−69	05 22 00	−69 00	−0·36	3·31	4000	1100	620		0·8	0·5		Centroid of LMC see Mathewson and Healey 1964*a*	280	−33	05−*63*
0525−78	05 25 15	−78 39·6	−3·51	3·03			0·6						291	−31	
0525−66	05 26 00	−66 08	+0·09	2·96	34	9	1·3		0·9	1·5		Supernova remnant ∼30″	276	−33	05−*64*
0532−63	05 32 48	−63 50	0·37	2·37	10	2·2	0·8		1·0	0·8			271	−33	05−*65*
0534−61	05 34 30	−61 22	+0·64	2·23		3·2	1·3			0·7			269	−33	
0539−69	05 39 00	−69 07	−0·41	1·83	108							30 Doradus see Mathewson and Healey 1964*a*	279	−32	05−*66*
0540−82	05 40 11	−82 04·4	−6·49	1·73		2·7	0·6			1·2			294	−29	
0546−83	05 46 47	−83 48·3	−9·22	+1·16			0·5						296	−29	
0601−70	06 01 12	−70 38·5	+0·73	−0·10			0·7						281	−30	
0602−64	06 02 24	−64 43	+0·25	−0·21		3·4	1·4			0·7			273	−29	
0606−79	06 06 41	−79 33·6	−4·18	−0·58		3·8	1·4			0·8			291	−29	
0607−60	06 07 24	−60 31·5	+0·71	−0·65	16	3·0	1·0		1·1	0·9		ext.?	269	−28	06−*62*
0608−65	06 08 48	−65 49	+0·10	−0·77	14	2·7	1·4		1·1	0·5			274	−29	06−*61*
0611−74	06 11 36	−74 30	−1·77	−1·01		2·6	1·1			0·7		ext.?	284	−29	
0613−77	06 13 48	−77 50·4	−3·12	−1·21		3·0	0·8			1·1			289	−29	
0617−80	06 17 30	−80 43·7	−5·09	−1·53			0·6						293	−28	
0620−82	06 20 58	−82 34·7	−7·14	−1·83		4·3	1·2			1·0			295	−28	
0623−64	06 23 14	−64 34·5	+0·28	−2·04			0·8						274	−27	
0624−62	06 24 45	−62 39·8	+0·50	−2·16		4·0	0·7			1·4			272	−27	
0637−75	06 37 20	−75 14·4	−1·93	−3·28	20	9·7	6·7	4·9	0·4	0·3	0·5	P 3·6% 74 II	286	−27	06−*71*
0642−78	06 42 06	−78 12·1	−3·22	−3·66		2·7	1·1			0·7			290	−27	
0651−60	06 51 08	−60 19·0	+0·77	−4·45	9	3·7	1·4	0·7	0·6	0·8	1·1		270	−23	06−*63*
0654−79	06 54 23	−79 47·2	−4·14	−4·71			0·8						292	−27	
0658−65	06 58 16	−65 41·2	+0·21	−5·05	17		2·2						276	−24	06−*64*
0702−78	07 02 17	−78 24·6	−3·20	−5·38		1·7	0·6			0·8			290	−26	
0702−75	07 02 50	−75 46·9	−2·00	−5·43			0·6						287	−26	
0714−76	07 14 20	−76 15·6	−2·11	−6·39		2·3	0·7			0·9			288	−25	
0714−78	07 14 52	−78 12·4	−2·99	−6·43		3·3	0·8			1·1			290	−25	

TABLE 2 (*Continued*)

Catalogue Number	Position (1950·0)		Annual Precession		Flux Density (10^{-26} W m^{-2} (c/s)$^{-1}$)				Spectrum			Remarks	Galactic Coordinates		MSH Cat. No.
	R.A. h m s	Dec. ° ′	Δα s	Δδ ″	350	75	21	11	75→350	21→75	11→21		l^{II} °	b^{II} °	
0744−67	07 44 04	−67 19·7	+0·20	−8·79		11·7	5·3			0·6			279	−20	
0752−78	07 52 32	−78 03·0	−2·49	−9·45		2·5	0·6			1·1		ext. at 21 cm	290	−24	
0802−80	08 02 50	−80 49·8	−4·04	−10·23		2·5	0·7			1·0			293	−24	
0814−77	08 14 22	−77 53·6	−2·12	−11·09			0·6						291	−22	
0818−74	08 18 57	−74 44·6	−0·95	−11·42			0·6						288	−21	
0831−77	08 31 23	−77 45·4	−1·79	−12·30			0·5						291	−22	
0841−83	08 41 56	−83 34·1	−5·94	−13·01		3·9	1·0					conf. at 21 cm	297	−24	
0842−75	08 42 12	−75 29·5	−0·85	−13·04	58	10·5	4·3	2·4	1·1	0·7	0·9	$<20''$ EW $P < 2·5\%$ 74 III	289	−20	08−71
0846−81	08 46 13	−81 07·2	−3·33	−13·29		4·4	1·1			1·1			295	−23	
0859−77	08 59 53	−77 07·1	−1·06	−14·16			0·7						291	−20	
0905−68	09 05 59	−68 16·9	+1·00	−14·66		6·1	1·7	0·9		1·0	1·0		285	−14	
0910−63	09 10 46	−63 40·7	+1·15	−14·78	15	4·4	1·1		0·9	1·1			281	−11	09−62?
0916−79	09 16 48	−79 07·9	−1·47	−15·17		4·2	0·7			1·4			294	−21	
0918−76	09 18 58	−76 47·8	−0·61	−15·29			0·8						292	−19	
0924−76	09 24 16	−76 42·6	−0·48	−15·59			0·6						292	−19	
0925−81	09 25 31	−81 31·8	−2·53	−15·66			0·7						296	−22	
0926−70	09 26 50	−70 00·6	+0·80	−15·74		4·4	0·6					conf. at 75 cm?	287	−14	
0928−78	09 28 44	−78 46·3	−1·05	−15·83		3·2	1·2			0·8			294	−20	
0936−62	09 36 25	−62 16·1	+1·58	−16·21	16	3·5	0·7		0·9	1·3			283	−8	09−63
0943−76	09 43 25	−76 06·7	0·04	−16·59		6·6	2·1	1·2		0·9	0·9		292	−17	
0944−75	09 44 38	−75 44·5	0·15	−16·65			0·6						292	−17	
0953−75	09 53 25	−75 14·4	+0·13	−16·71			0·7						292	−16	
0958−84	09 58 06	−84 52·3	−4·48	−17·27			0·7						299	−24	
1010−64	10 10 49	−64 43·4	+1·76	−17·82	19	5·3	2·6	1·4	0·8	0·6	1·0		287	−7	10−61
1029−85	10 29 29	−85 27·0	−3·39	−18·50			0·7						300	−24	

1033—80	10 33 48	—80 31·3	+0·13	—18·64		3·5	0·8			1·2			297	—19	
1036—72	10 36 21	—72 51·0	1·53	—18·72		2·6	0·9			0·8			293	—13	
1036—69	10 36 57	—69 47·9	1·70	—18·75		6·9	2·4	1·2		0·8	1·1		292	—10	
1057—79	10 57 48	—79 48·0	1·08	—19·31		2·5	0·9			0·8			298	—18	
1136—67	11 36 17	—67 55·2	2·74	—19·93	34	6·6	3·1	1·7	1·0	0·6	1·0	>35″ EW	296	—6	11—64
1150—72	11 50 24	—72 23·4	2·88	—20·02		2·2	1·3	0·7		0·4	1·0	conf. at 75 cm?	299	—10	
1151—69	11 51 48	—69 28·9	2·96	—20·03	15	5·0	2·0	0·9	0·7	0·7	1·3		298	—7	11—66
1208—75	12 08 18	—75 10·7	3·26	—20·03			0·5						300	—13	
1221—82	12 21 30	—82 56·3	4·08	—19·95			0·6						302	—20	
1221—66	12 21 39	—66 34·3	3·35	—19·95		>2·0	2·0	1·2			0·8	conf. at 75 cm	300	—4	
1225—81	12 25 57	—81 37·2	4·10	—19·91		3·2	0·7			1·2			302	—19	
1239—81	12 39 00	—81 51·3	4·65	—19·75			0·5						303	—19	
1239—75	12 39 46	—75 17·7	3·95	—19·74			0·7						302	—13	
1242—84	12 42 44	—84 56·7	5·87	—19·69			1·2						303	—22	
1244—82	12 44 59	—82 46·3	5·13	—19·66			0·9						303	—20	
1251—71	12 51 46	—71 21·8	3·97	—19·69		3·0	1·0			0·9			303	—9	
1259—76	12 59 23	—76 56·3	4·55	—19·37			1·2						303	—14	
1301—86	13 01 47	—86 20·6	8·64	—19·32			0·7						303	—24	
1302—82	13 02 51	—82 42·9	5·90	—19·29			1·3						303	—20	
1305—74	13 05 08	—74 52·6	4·42	—19·36			0·5						304	—12	
1308—76	13 08 09	—76 56·9	4·76	—19·16			0·9					ext. in δ at 21 cm	304	—14	
1347—76	13 47 10	—76 24·8	5·57	—17·89		⩾2	0·6						306	—14	
1416—86	14 16 05	—86 43·1	16·11	—16·61			0·5						304	—24	
1420—74	14 20 12	—74 29·7	5·84	—16·28		3·9	1·1			1·0			309	—13	
1432—69	14 32 22	—69 22·6	5·22	—15·70		4·6	0·8			1·4			312	—9	
1445—74	14 45 35	—74 56·7	6·36	—15·03		4·8	1·3			1·0			310	—14	
1514—81	15 14 00	—81 52·4	10·08	—13·28			0·7						308	—21	
1514—86	15 14 13	—86 01·4	17·48	—13·27			1·0						305	—24	
1517—75	15 17 33	—75 16·8	6·93	—13·05			0·9						312	—15	
1540—82	15 40 28	—82 49·6	+11·78	—11·46			1·0						308	—22	

TABLE 2 (*Continued*)

Catalogue Number	Position (1950·0)		Annual Precession		Flux Density (10^{-26} W m^{-2} (c/s)$^{-1}$)				Spectrum			Remarks	Galactic Coordinates		MSH Cat. No.
	R.A. h m s	Dec. ° ′	Δα s	Δδ ″	350	75	21	11	75→350	21→75	11→21		l^{II} °	b^{II} °	
1540−73	15 40 43	−73 02·9	+6·70	−11·45		5·2	1·8			0·8			315	−15	
1545−76	15 45 53	−76 04·1	7·56	−11·07			0·6						313	−17	
1547−79	15 47 45	−79 32·6	8·40	−10·77			4·0	2·8			0·6	} Not resolved	311	−20	
1549−79	15 49 36	−79 06·3	8·49	−10·69			6·2	4·9			0·4	} at 75 cm 74 III	311	−20	
1602−63	16 02 05	−63 22·2	5·37	−9·75		14·6	5·4			0·8			323	−8	
1606−84	16 06 19	−84 11·2	14·62	−9·54			1·7						308	−24	
1606−83	16 06 48	−83 42·5	13·74	−9·50			0·7						308	−23	
1610−60	16 10 47	−60 48·2	5·19	−9·10	1190		56·0					P < 1% ⩾70″ EW shoulder in δ at 21 cm 74 II	325	−7	16−*61*
1610−77	16 10 56	−77 10·4	8·29	−9·19		6·0	5·0	5·2		0·1	0	shoulder in α at 21 cm	313	−19	
1619−63	16 19 43	−63 29·2	5·50	−8·31			0·7						324	−10	
1624−75	16 24 45	−75 01·8	7·65	−8·09	38	3·2	1·2			0·8			316	−18	16−*71*??
1632−68	16 32 48	−68 08·4	5·59	−7·26		5·0	1·3			1·1			322	−14	
1637−77	16 37 09	−77 10·3	8·56	−7·12		13·5	6·5	4·0		0·6	0·8		314	−20	
1640−76	16 40 56	−76 32·7	8·33	−6·78			0·6						315	−20	
1649−78	16 49 00	−78 53·7	9·56	−6·11			0·8						313	−21	
1655−77	16 55 13	−77 37·1	8·92	−5·62		~4	2·5					conf. at 75 cm 74 I	315	−21	
1700−85	17 00 47	−85 26·9	19·30	−5·12			0·6						307	−25	
1706−73	17 06 23	−73 39·8	7·46	−4·65		4·1	0·9			1·2			319	−20	
1707−81	17 07 10	−81 10·0	11·44	−4·58			0·6						312	−23	
1716−80	17 16 22	−80 02·2	10·54	−3·79		6·8	2·5			0·8			313	−23	
1720−83	17 20 34	−83 40·8	14·96	−3·43			1·0						309	−25	
1721−78	17 21 57	−78 12·0	9·38	−3·31			0·8						315	−23	
1726−77	17 26 42	−77 23·9	8·99	−2·90			0·5						316	−22	
1728−76	17 28 16	−76 48·9	8·72	−2·77			0·6						316	−22	
1737−60	17 37 33	−60 54·8	+5·47	−1·84		7·4	3·3			0·6			332	−16	

1740−64	17 40 20	−64 42·5	+5·91	−1·36		4·0	0·7					Not resolved at 75 cm	328	−18	
1746−64	17 46 12	−64 58·5	5·91	−1·21			1·2						328	−18	
1754−59	17 54 37	−59 46·3	5·38	−0·43	25	15	3·9	1·5	0·4	1·1	1·5	P 3·2%	334	−17	17−*51*
1814−63	18 14 49	−63 46·9	5·79	+1·40	71	34	14·2	7·5	0·5	0·7	1·0	⩽20″ EW	331	−21	18−*61*
1815−76	18 15 17	−76 36·8	8·68	1·34			0·7						318	−25	
1819−67	18 19 18	−67 20·3	6·28	1·75		4·4	2·1			0·6			327	−22	
1833−77	18 33 32	−77 13·1	8·90	2·92			0·9						317	−26	
1833−78	18 33 59	−78 59·1	9·86	2·96			0·6						315	−26	
1835−79	18 35 08	−79 44·2	10·37	3·06			0·6						314	−26	
1843−69	18 43 43	−69 02·1	6·73	3·82		4·9	0·8			1·4			326	−25	
1848−79	18 48 12	−79 38·2	10·22	4·18			0·7						315	−27	
1848−81	18 48 59	−81 09·9	11·47	4·25			0·5						313	−27	
1853−87	18 53 30	−87 31·5	33·15	4·64			0·7						306	−27	
1855−66	18 55 01	−66 20·6	6·07	4·87		4·3	1·2			1·0			329	−26	
1904−80	19 04 33	−80 15·4	10·55	5·57		5·6	1·5					Not resolved at 75 cm	314	−28	
1909−80	19 09 55	−80 05·7	10·37	6·02			0·9						314	−28	
1922−62	19 22 46	−62 47·3	5·51	7·18	12	6·0	2·4		0·5	0·7			334	−28	19−*61*?
1928−74	19 28 03	−74 55·3	7·67	7·51			0·8						320	−32	
1934−63	19 34 49	−63 49·2	5·57	8·14		5·0	16·0	11·8				Peculiar spectrum 74 II P < 1%	333	−29	
1950−79	19 50 29	−79 26·3	9·42	9·29			0·7						315	−30	
1954−87	19 54 40	−87 56·2	35·61	9·61			1·2						305	−28	
2000−79	20 00 40	−79 22·5	9·23	10·07			0·7						316	−30	
2025−77	20 25 38	−77 02·0	7·74	11·90			1·0						317	−32	
2028−73	20 28 26	−73 14·5	6·66	12·18	18	6·2	1·6		0·8	1·0			321	−33	20−*71*
2033−75	20 33 44	−75 43·8	7·19	12·46			0·6					2nd source 15′N at 21 cm	318	−34	
2041−63	20 41 03	−63 10·7	5·09	12·95		2·4	0·6			1·1			333	−37	
2041−60	20 41 19	−60 29·7	4·87	13·02	55	10·5	2·8	0·9	1·1	1·1	1·8	<15″ EW 74 I	336	−37	20−*61*
2043−67	20 43 25	−67 04·4	5·53	13·08			1·1						328	−36	
2050−75	20 50 39	−75 09·7	6·78	13·58			0·9						318	−34	
2059−64	20 59 06	−64 09·1	+5·04	+14·11	17	3·1	0·9		1·0	1·0			331	−39	20−*62*

TABLE 2 (*Continued*)

Catalogue Number	Position (1950·0)		Annual Precession		Flux Density (10^{-26} W m^{-2} (c/s)$^{-1}$)				Spectrum			Remarks	Galactic Coordinates		MSH Cat. No.
	R.A. h m s	Dec. ° ′	Δα s	Δδ ″	350	75	21	11	75→ 350	21→ 75	11→ 21		l^{II} °	b^{II} °	
2059−78	20 59 48	−78 40·6	+7·80	+14·16			0·8						314	−33	
2118−64	21 18 18	−64 16·4	4·91	15·31		⩾2·3	1·7	0·8			1·2	conf. at 75 cm	330	−40	
2127−75	21 27 45	−75 57·0	6·37	15·78			0·5						316	−36	
2132−84	21 32 34	−84 23·7	11·24	16·04			0·6						308	−31	
2141−81	21 41 14	−81 46·6	8·34	16·48		10	3·1	1·7		0·9	1·0		310	−33	
2141−75	21 41 57	−75 50·8	6·08	16·51		⩾2	1·8	1·2			0·6	conf. at 75 cm	316	−37	
2142−76	21 42 34	−76 36·9	6·24	16·54			0·7						315	−36	
2145−78	21 45 43	−78 20·6	6·66	16·70			0·6						313	−35	
2152−76	21 52 41	−76 03·8	5·91	17·03			0·6						315	−37	
2152−69	21 52 58	−69 55·8	4·98	17·09	253	80	32	17·5	0·8	0·7	0·9	25″EW P 2–3% 74I	321	−41	21−*64*
2155−83	21 55 26	−83 53·1	9·52	17·15		⩾2	1·0					conf. at 75 cm	308	−32	
2201−77·9	22 01 28	−77 51·4	6·14	17·42			0·5						313	−36	
2201−77·4	22 01 29	−77 26·9	6·04	17·42			0·6						313	−36	
2204−63	22 04 51	−63 40·8	4·39	17·65		4·1	1·1			1·1			327	−45	
2223−62	22 23 31	−62 54·3	+4·08	+18·31		1·8	1·0					conf. at 75 cm	326	−47	

2227—66	22 27 25	—66 34·7	+4·24	+18·48		5·2	1·0					conf. at 75 cm	322	—45	
2238—61	22 38 58	—61 00·4	3·95	18·82	14	3·7	1·2	0·5	0·9	0·9	1·4		327	—50	22—62
2239—80	22 39 34	—80 00·7	5·68	18·82			0·5						309	—36	
2253—65	22 53 48	—65 17·1	3·90	19·24	19		0·9						320	—48	22—63
2255—70	22 55 00	—70 31·0	4·13	19·29			1·3	0·6			1·2		316	—44	
2258—81	22 58 08	—81 42·5	5·52	19·32		2·1	0·7			0·9			308	—35	
2259—76	22 59 04	—76 59·3	4·59	19·34			0·5						311	—39	
2315—81	23 15 17	—81 14·3	4·75	19·66		2·2	0·7			0·9			307	—35	
2326—80	23 26 43	—80 35·4	4·24	19·83			0·6						307	—36	
2332—66	23 32 15	—66 54·4	3·41	19·91	26	7·8	2·5	1·3	0·8	0·9	1·0		314	—49	23—63
2336—80	23 36 53	—80 36·5	3·89	19·94			0·5						307	—36	
2351—77	23 51 01	—77 14·5	3·31	20·03			0·5					ext. to N in δ ∼ 30′	307	—40	
2353—68	23 53 31	—68 37·6	3·16	20·03		2·1	1·5	1·0			0·6	conf. at 75 cm	310	—48	
2353—79	23 53 36	—79 41·0	3·28	20·03			0·8						306	—37	
2356—61	23 56 29	—61 12·3	3·12	20·04	296	66	23·7	10·4	1·0	0·8	1·3	P 5% 40″EW 74I	314	—55	23—64
2358—75	23 58 03	—75 27·5	3·12	20·04			0·6						307	—42	
2358—83	23 58 19	—83 07·4	3·16	20·04			0·7						305	—34	

408 Mc/s. At 408 Mc/s effects of confusion could contribute an additional peak error of 1·0 f.u. in unpolarized areas, and in regions where the background is appreciably polarized (see Mathewson and Milne 1964) the errors could exceed 2 f.u.

The reader is referred to BGM for a more complete discussion of the errors. Table 1, p. 331, shows estimates of average error which apply to this survey.

V. Position Measurements

The pointing errors of the 210-ft telescope have been discussed by BGM. The corrections mentioned there have been applied to all sources in the declination zone −60° to −75°. It is thought that 90% of the positions given for this zone are correct to within 1′·5 of arc. This has been estimated from internal consistency of several measurements of the same sources and in a few cases on new optical identifications in the region (see Section IX).

In the declination zone −75° to −90° position corrections were not applied. In these cases, inadequate knowledge of corrections leaves an uncertainty of approximately 2′·0 of arc in positions.

In the entire region of this survey, mean precession only was applied to the positions in obtaining 1950·0 coordinates from the positions observed in 1962–63. Effects due to nutation, aberration, and second-order precession were neglected and are additional sources of error in the positions given.

Considering the above sources of error we believe that r.m.s. errors in the catalogue positions do not exceed 1′·5 of arc in the region −60° to −75°, and 2′·5 for sources from declination −75° to −90°.

VI. Catalogue

The Source Catalogue (Table 2) is largely self-explanatory, additional information concerning its use being given below.

Column 1.—Catalogue number.

Columns 2 and 3.—Right ascension and declination for epoch 1950·0.

Columns 4 and 5.—Annual precession in right ascension (seconds of time) and declination (seconds of arc).

Columns 6, 7, 8, and 9.—Flux densities at the indicated wavelengths, in units of 10^{-26} W m^{-2} (c/s)$^{-1}$.

Columns 10, 11, and 12.—Spectral indices for indicated wavelength ranges.

Column 13.—Remarks and miscellaneous data. Abbreviations used are as follows.

74 I, 74 II, 74 III, 74 IV: Harris–Roberts field class of identification on Mount Stromlo 74-in. plate; I, the error rectangle about the source position includes a galaxy brighter than $m_{pg} = 17$; II, the area includes a galaxy or galaxies for which $17 < m_{pg} < 19 \cdot 5$; III, the area includes no galaxies above the plate limit; IV, the field is heavily obscured.

ext. = extended; P = polarized at 1410 Mc/s, percentage indicated; conf. = confused; N = north; S = south; EW = east–west angular size.

Columns 14 and 15.—New galactic coordinates.

Column 16.—MSH catalogue number, where applicable. (MSH = 85 Mc/s survey by Mills, Slee, and Hill (1961).)

VII. Polarization

All sources greater than 2 f.u. at 1410 Mc/s were observed for linear polarization by F. F. Gardner and R. D. Davies as part of an investigation of the polarization in radio sources. A full account of this investigation will be published separately. The present catalogue includes the percentage polarization for sources with measured polarization at 1410 Mc/s.

VIII. Spectra of Sources

The spectral index has been derived from $S \propto f^{-\alpha}$, where α is the spectral index. This definition avoids the continual use of a minus sign with each spectral index.

Table 3

SOURCES WITH CURVED SPECTRA

Positive curvature:	0013−63	0202−76	0410−75
	0506−61	1151−69	1814−63
	2028−73		
Negative curvature:	0210−62		
Positive curvature with maximum in observed frequency range:	(0252−71?)	(0408−65?)	1934−63

Figure 1 shows the distribution of spectral indices taken from columns 10, 11, and 12 of the source catalogue. The number of sources for which spectral indices could be derived was less than half the number in the catalogue. This was due to two factors: (i) MSH fluxes are available for only 47 sources in the region; (ii) many of the sources have flux densities between 0·5 and 1 f.u. at 1410 Mc/s, and are therefore too weak in most cases for observation at 2650 Mc/s and likely to be below the confusion limit at 408 Mc/s. Spectral indices are not indicated in the catalogue when flux values are questioned. Figure 1 shows that spectra over the frequency range 1410–2650 Mc/s are appreciably steeper than at lower frequencies. The median spectral index for this range is 0·97, whereas for the 408–1410 Mc/s range it is 0·88, and for the 85–408 Mc/s range it is 0·82. This effect has been noted by previous authors (e.g. BGM).

In addition to sources with approximate power law spectra, some source spectra exhibit curvature. Several such cases of curvature were noted in the sources in the present catalogue and are classified in Table 3.

IX. Identifications

Positions of all the sources reported have been compared with those of NGC and IC objects and with the objects reported by de Vaucouleurs (1956) (with the exception of the areas of the Magellanic Clouds, in which case the reader is referred to radio studies of the clouds themselves, e.g. Mathewson and Healey (1964*b*)). For four sources, approximate positional agreement has been noted and they are considered as possible identifications. Further optical study of these sources has not been undertaken, and they are considered as identifications on the strength of positional agreement only.

Positions of 13 additional sources from the catalogue were observed with the Mount Stromlo 74-in. reflector, and were classified according to the field in the error rectangle of the radio position (Harris and Roberts 1960). From the sources with Class I or Class II fields, six are considered probable identifications. Table 4 lists suggested identifications; types and magnitudes for the objects listed are tentative. Further information on these objects has been compiled by Westerlund and Smith (unpublished data).

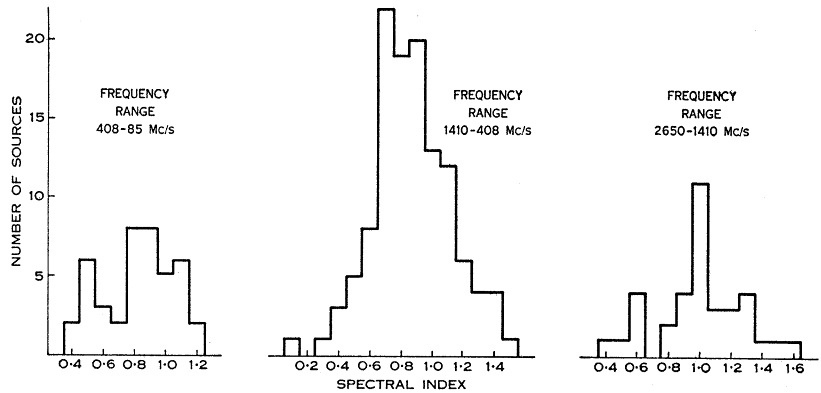

Fig. 1.—Histograms of the distribution of spectral indices.

X. Source Counts

It is thought that the present catalogue is substantially complete south of declination −75° for sources with flux density greater than 0·5 f.u. at 1410 Mc/s. Because different observing techniques were used north and south of declination −75° (see Section II), some sources with flux density between 0·5 and 1 f.u. at 1410 Mc/s have been omitted from the catalogue north of declination −75°.

The limited number of sources available makes it difficult to derive precise conclusions about the number-count–flux-density distribution, but it is of interest to see whether the distribution differs significantly from that obtained from previous work, most of which has been done at lower frequencies.

Figure 2 shows the 135 sources in the 0·27 steradians south of declination −75° plotted in the conventional manner as a log N–log S distribution, in which N is the number of sources observed with flux density greater than S. When allowance is made for the statistical error due to the small number of sources with flux density greater than 2 f.u., and for uncertainty in the flux-density determination of the

TABLE 4

SUGGESTED OPTICAL IDENTIFICATIONS

Catalogue Number	Radio Position R.A.	Radio Position Dec.	Optical Position R.A.	Optical Position Dec.	Remarks
	h m s	° ′	h m s	° ′ ″	
0251−67	02 51 11	−67 30·4	02 51 32	−67 28 57 (Westerlund–Smith)	cluster 17–18^{m}
0410−75	04 10 11	−75 15·3	04 09 36·4 04 09 57·9	−75 15 42 −75 14 06 (Westerlund–Smith)	E4 16^{m} } two bright members of cluster SO 15^{m}
1655−77	16 55 13	−77 37·1	16 55 12·4	−77 37 33 (Westerlund–Smith)	EO 16·5^{m}
1716−80	17 16 22	−80 02·2	17 15 30	−80 01·3 (IC)	IC 4640
1746−64	17 46 12	−64 58·5	17 46 12	−64 58 (de Vaucouleurs)	IC 4662 A
1934−63	19 34 49	−63 49·2	19 34 48·3	−63 49 37 (Ekers)	stellar image with jet(?) 18^{m}
2028−73	20 28 26	−73 14·5	20 30 15	−73 06·3 (IC)	IC 5016
2041−60	20 41 19	−60 29·7	20 41 12·7	−60 30 20 (Westerlund–Smith)	E 17+^{m}
2152−69	21 52 58	−69 55·8	21 52 57·8	−69 55 40 (Westerlund–Smith)	E3 14^{m}
2238−61	22 38 58	−61 00·4	22 38 18	−61 01·1 (IC)	IC 5238
2356−61	23 56 29	−61 12·3	23 56 29·3	−61 11 40 (Westerlund–Smith)	E3 16^{m}

weaker sources, it is found that the distribution can be fitted by a straight line which has a slope of $-1\cdot7\pm0\cdot3$. This value does not differ significantly from that obtained in earlier more extensive measurements (BGM, and Scott and Ryle 1961). This slope appears to be maintained down to flux density values of 0·5 f.u. at 1410 Mc/s.

XI. Comparison with MSH Sources

The survey of sources at 85 Mc/s by Mills, Slee, and Hill (1961) extends as far south as declination —80°. However, in the zone which overlaps the present survey, —60° to —80°, the MSH survey suffers from difficulty with spurious responses due to side lobes and foreshortening of the north–south arm of the cross-type aerial used.

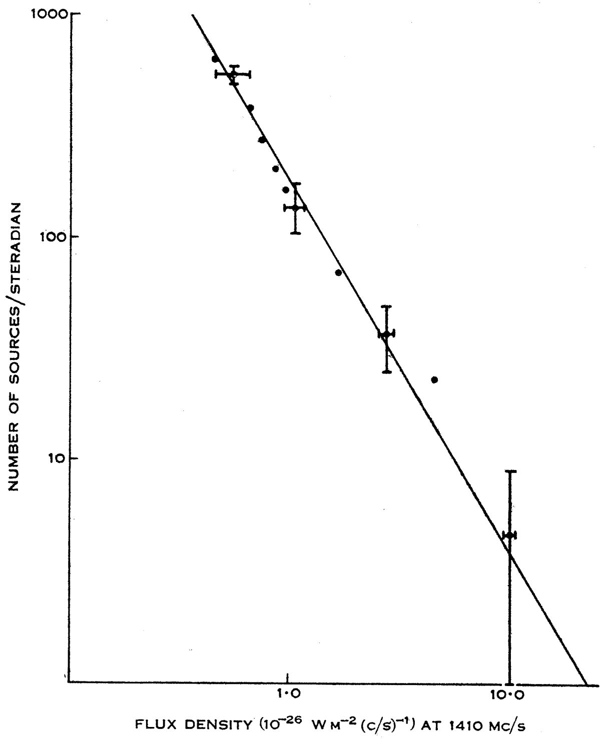

Fig. 2.—Source count for the declination zone —75° to —90°. Error bars in the ordinate indicate statistical error in the number of sources, while error bars in the abscissa are average flux-density errors.

The MSH survey reports 77 sources in the area common to the two surveys, 9 of which are listed as uncertain, possibly due to background variations or side-lobe effects. The present survey lists 40 sources considered to be the same as sources detected by MSH, and another 7 which are considered probable but are questioned on the basis of poor positional agreement. Those sources that are questionable are marked by a (?) after the MSH number in Column 16 of the present catalogue.

Figure 3 shows the differences between the MSH positions and positions given in the present catalogue. The median difference is 12′ of arc (6′·7 of arc in right ascension and 9′·8 of arc in declination). On an overall average, MSH positions tend to have an earlier right ascension (by 3′ of arc) and a more northerly declination (by 3′ of arc) than the source positions determined in the present survey.

Searches were undertaken in the region of 15 of the remaining 30 MSH sources and, in an area of 1° square, centred on the MSH position, disclosed nothing greater than the level set for the finding survey at 408 Mc/s.

Background irregularities at 408 Mc/s were noted near the positions of 07−6*1*, 15−7*1*, and 16−6*3*.

Weak sources ($<$ 1 f.u. at 1410 Mc/s) were found within 15′ of the positions of 02−6*1*, 02−6*2*, 21−6*3*, 22−6*1*, and 23−6*1*. The region of 17−6*1* is a complex of extended weak sources at 1410 Mc/s.

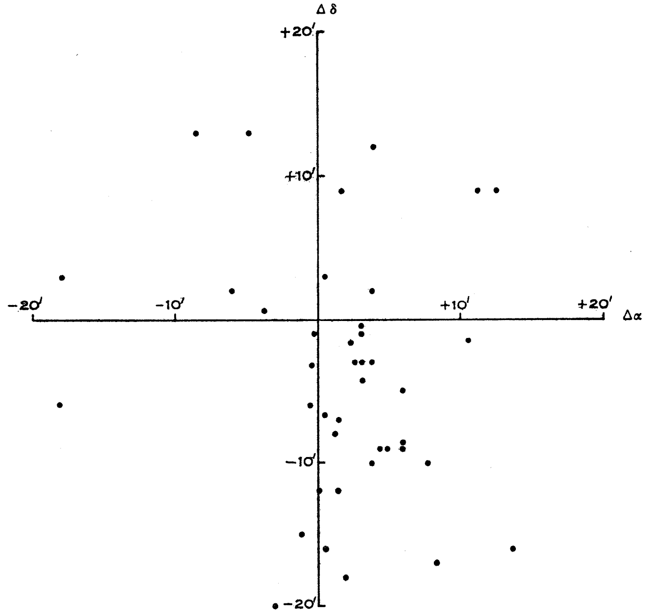

Fig. 3.—Differences between MSH positions and positions of the present catalogue, measured at 1410 Mc/s. Six sources lie outside the limits of the diagram.

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