IMPROVED POSITIONS AND SOME IDENTIFICATIONS FOR 108 RADIO SOURCES BETWEEN DECLINATIONS −33° AND +27°

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Abstract

Positions of improved accuracy have been obtained for 108 sources from the Parkes catalogue between declinations −33° and +27°. The estimated errors in the positions are less than 15″ arc in both coordinates. Identifications are suggested for 17 sources, 12 with possible quasi-stellar objects and 5 with galaxies.

I. INTRODUCTION

Positions with an accuracy of about 15″ arc in both coordinates have been determined for many of the sources in the Parkes catalogue (Ekers 1969). In the past, sources have been selected for the position programs for two reasons: (1) an identification appeared likely on the basis of the Parkes catalogue position; (2) the flux density of the source was above a chosen limit at 2700 MHz, the frequency used for position measurements. The sources were selected for the present measurements so as to produce samples that were complete to chosen limits at the catalogue survey frequencies of 408 MHz (for declinations −33° to +20°) and 635 MHz (for declinations +20° to +27°). These samples were required for the construction of a luminosity function for radio galaxies (Merkelijn 1971). Observations were made of 108 sources with $S_{408} > 3{\cdot}5$ f.u.† or $S_{635} > 2{\cdot}0$ f.u.

II. OBSERVATIONS AND REDUCTION

The observations were made using a 2700 MHz receiver and a dual-feed system on the Parkes 64 m telescope. The feed system produced on- and off-axis beams separated by 18′·5 arc, each 8′·0 arc to half-power points. The difference between the signals received by the two feeds was recorded. The receiver had a bandwidth of 400 MHz and a system temperature of 80 K. With a 2 s output time constant, peak to peak noise fluctuations were approximately 0·04 K, equivalent to 0·07 f.u.

The methods of observation and reduction have been described in detail by Merkelijn (1968). The observations consisted of pairs of forward and reverse scans through the source in each coordinate. The results were recorded in analogue form on a paper chart recorder and by a PDP–9 computer which carried out an on-line analysis to determine the average peak amplitude and average position centroid of the two scan profiles. The computer reduction program was developed by R. N. Manchester and A. J. Shimmins and has been described by Wills and Bolton (1969).

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† 1 flux unit (f.u.) = 10^{-26} W m^{-2} Hz^{-1}.

Telescope pointing corrections were determined from observations of calibration sources, whose adopted positions are listed in Table 1 together with the associated references and other details. An observation of a calibration source was made at least once every 2 hr during the observing session. The receiver sensitivity was calibrated by injection of a noise signal of approximately 1 K immediately following the observation of a source. The value of this signal in flux units was determined from observations of four standard flux calibrators: PKS 0316+16 (CTA 21), 0518+16 (3C 138), 0915−11 (Hydra A), and 1040+12 (3C 245).

TABLE 1

POSITION CALIBRATORS

PKS catalogue number	Position (1950·0) R.A. h m s	Dec. ° ′ ″	S_{1400} (f.u.)	S_{2700} (f.u.)	Associated optical object	Ref.*	Other catalogue number
0003−00	00 03 48·70	−00 21 05·6	4·0	2·3	$19^m·5$ QSO	1	3C 2
0127+23	01 27 15·18	23 22 52·0	3·0	1·9	19^m QSO	1	3C 43
0130−17	01 30 17·63	−17 10 10·3	1·0	1·2	19^m QSO	2	
0316+16	03 16 09·11	16 17 41·2	8·2	4·8	Occultn.†	3	CTA 21
0518+16	05 18 16·51	16 35 26·2	9·3	6·3	$18^m·8$ QSO†	1	3C 138
0725+14	07 25 20·10	14 43 47·3	2·1	1·1	$18^m·9$ QSO	2	3C 181
0850+14	08 50 22·79	14 03 58·3	2·6	1·0	$17^m·4$ QSO	1	3C 208
0915−11	09 15 41·18	−11 53 04·4	42·0	23·5	$14^m·8$ D†	4	Hydra A
1040+12	10 40 06·03	12 19 15·0	3·0	2·1	$17^m·2$ QSO†	2	3C 245
1237−10	12 37 07·30	−10 07 04·0	1·9	1·2	17^m QSO	5	
1241+16	12 41 27·68	16 39 18·7	2·9	1·5	$19^m·0$ QSO	1	3C 275·1
1354+19	13 54 42·30	19 33 41·0	2·3	1·5	$16^m·5$ QSO	6	4C 19·44
1453−10	14 53 12·22	−10 56 39·9	4·2	2·5	$17^m·5$ QSO	7	14−12*1*
1510−08	15 10 08·9	−08 54 48	3·4	3·2	$16^m·5$ QSO	2	
1618+17	16 18 07·4	17 43 30·5	2·2	1·0	$16^m·4$ QSO	1	3C 334
1622+23	16 22 32·45	23 52 00·7	2·7	1·5	$17^m·5$ QSO	1	3C 336
2120+16	21 20 25·64	16 51 46	1·7	0·7	$18^m·0$ QSO	8	3C 432
2230+11	22 30 07·71	11 28 22·8	6·7	5·2	$17^m·5$ QSO	9	CTA 102
2251+15	22 51 29·46	15 52 53·6	12·8	10·0	QSO‡	2	3C 454·3
2354+14	23 54 44·7	14 29 26	1·4	0·5	$18^m·2$ QSO	10	4C 14·85

* References for positions: 1, Sandage, Véron, and Wyndham (1965); 2, Bolton (1968); 3, Clarke and Batchelor (1965); 4, Griffin (1963); 5, Bolton *et al.* (1966); 6, Bolton and Kinman (1966); 7, Véron (1965*b*); 8, Véron (1966); 9, Véron (1965*a*); 10, Kinman *et al.* (1967).

† Flux calibrator.

‡ Optical variable.

III. IDENTIFICATIONS

The search for identifications was carried out on the Palomar Sky Survey prints with the aid of transparent computer-drawn overlays, each showing a 2′ arc square centred on the source with the positions of the source and 10 nearby reference stars marked.

The results of the search were:

13 fields contained blue stellar objects within the estimated position errors. These are possibly quasi-stellar objects.

5 fields contained galaxies within the estimated position errors.

Figs. 1–3.—Finding charts for the identifications. The scale is approximately 5 mm = 1′ arc. North-east is at the top left-hand corner of each chart.

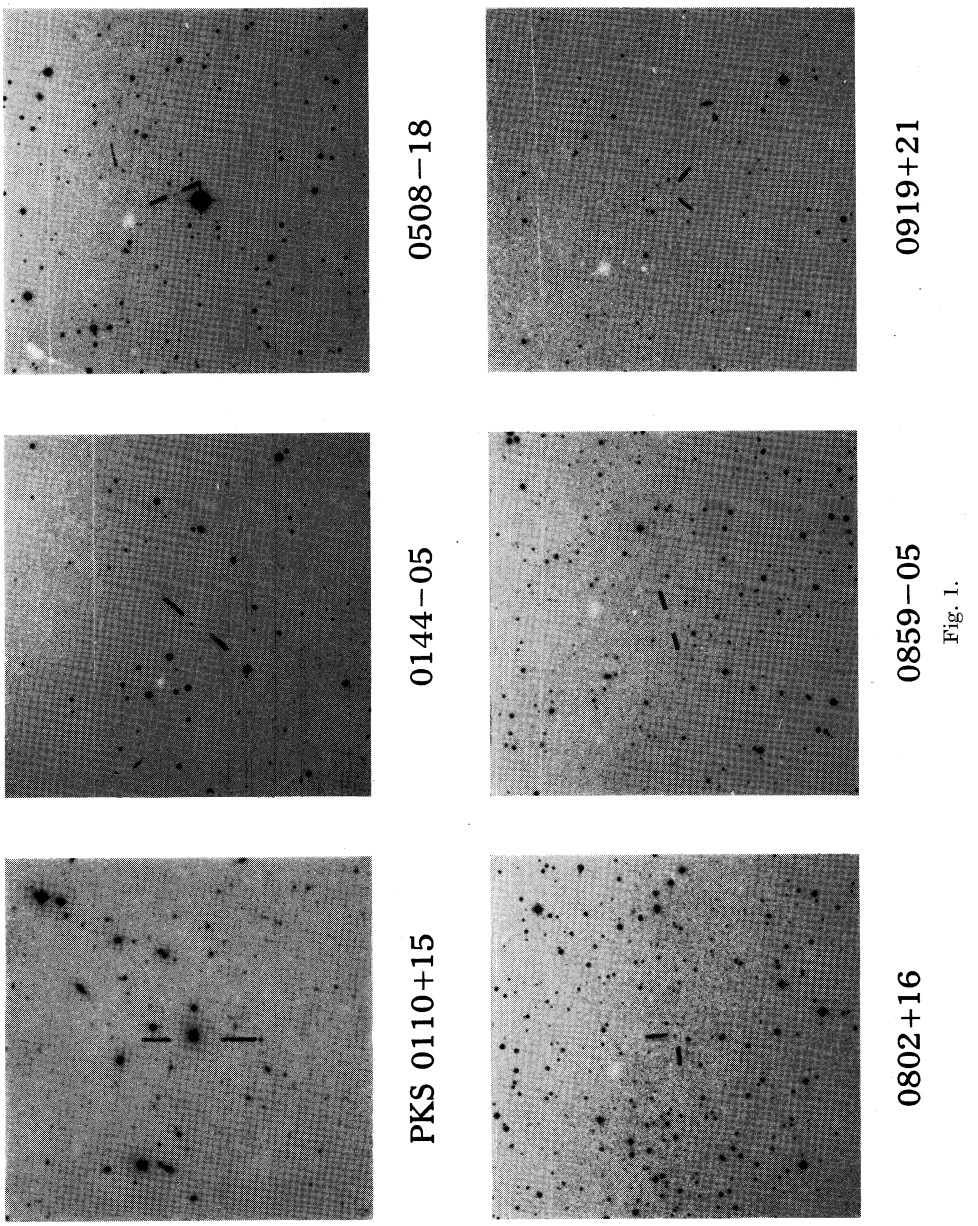

Fig. 1.

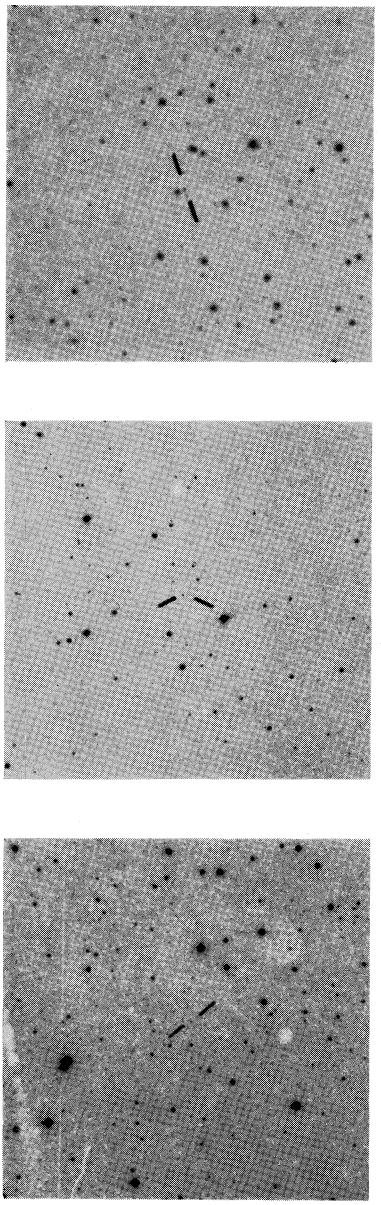

Fig. 2.

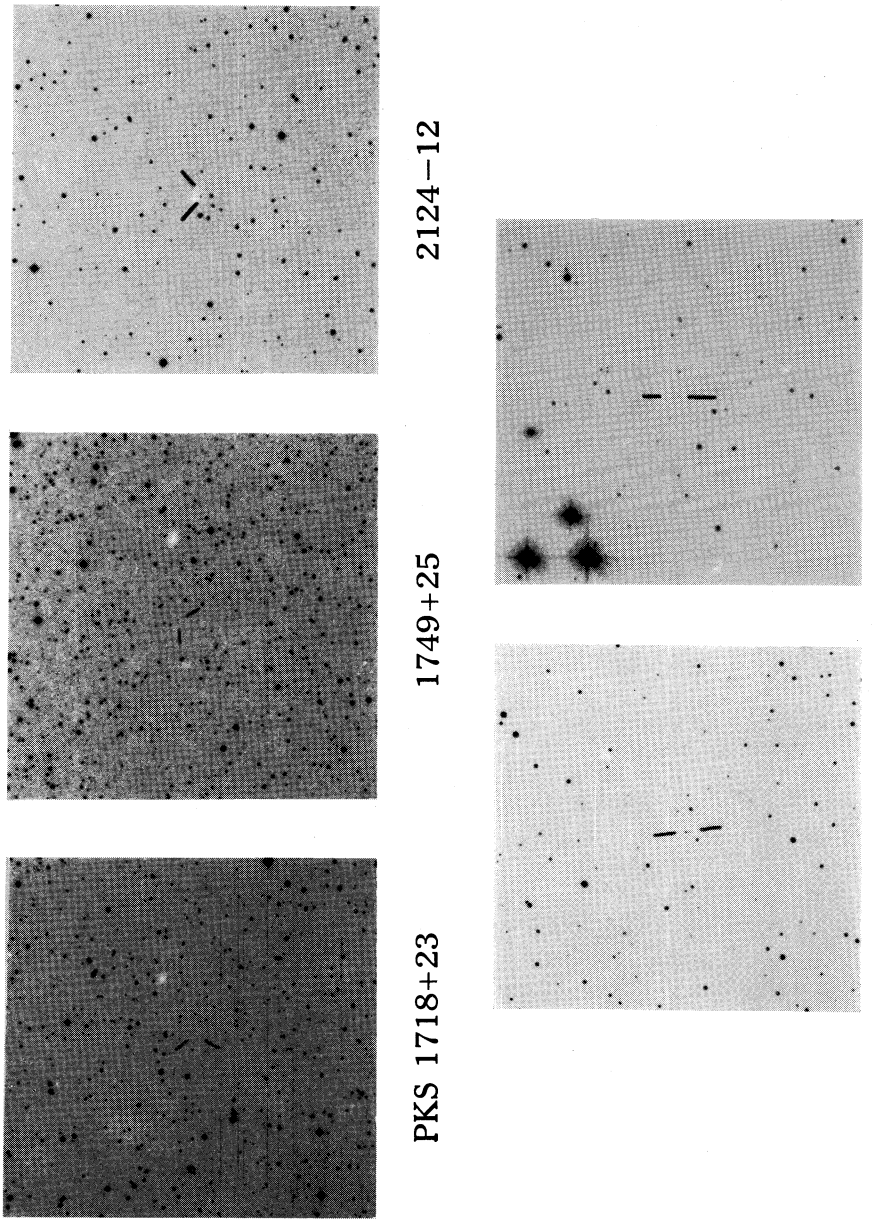

Fig. 3.

TABLE 2

SOURCE AND IDENTIFICATION DATA

(1) Parkes catalogue number	(2) R.A. h m s	(3) Position (1950·0) ΔR.A. ″	(4) Dec. ° ′ ″	(5) ΔDec. ″	(6) Rel. posn. R.A. s	(7) Dec. ′	(8) Type	(9) Mag.	(10) S_{2700} (f.u.)	(11) α_{2700}^{1410}	(12) Refs.*	(13) Remarks	(14) Gal. coords. l^{II} °	(15) b^{II} °	(16) Other catalogue number
0023−13	00 23 30·6	9	−13 04 13	8			III		0·58	1·2			99	−74	
0023−20	00 23 43·3	9	−20 21 40	7			III		0·64	0·7		Possible blue gal. 0′·6 n.p.	82	−81	
0025+21	00 25 48·0	9	+21 00 40	8			III		0·55	0·7			116	−41	4C 20·2
0027−12	00 27 28·0	10	−12 00 52	8			III		0·44	0·9			104	−74	00−1*12*
0037+04	00 37 19·0	11	+04 39 34	8			III		0·39	0·9			118	−58	4C 04·03
0038+25	00 38 40·3	12	+25 33 12	9			III		0·23	0·8			120	−37	4C 25·2
0041−16	00 41 24·6	10	−16 21 17	9			III		0·39	1·3			114	−79	
0110+15	01 10 20·5	9	+15 13 27	7	1·0p.	0·1n.	E	14	0·62	0·6	1,R	Brightest gal. of cluster	131	−47	
0119+03	01 19 50·8	11	+03 16 11	8			III		0·31	1·3			138	−58	
0128−26	01 28 08·5	9	−26 25 22	7			III		0·62	0·6	2		209	−81	01−2*11*
0144−05	01 44 15·7	8	−05 52 39	7	1·3p.	0·3s.	QSO?	18	0·76	0·6			157	−65	4C −05·07
0202−18	02 02 59·4	9	−18 15 29	8			III		0·56	0·3			189	−71	
0210+05	02 10 57·6	11	+05 33 37	9			III		0·34	0·8			157	−52	
0221−28	02 21 32·2	9	−28 32 34	8			III		0·57	0·9			220	−70	02−2*6*
0253−23	02 54 03·5	8	−23 36 44	7			III		0·65	0·9		Blue object 3^{s}·2 p.	212	−62	02−2*19*
0309−13	03 09 24·7	10	−13 22 52	8			III		0·44	1·1			197	−54	
0418−05	04 18 27·4	9	−05 44 41	8			III		0·52	0·7			199	−36	4C −05·18
0423+04	04 23 40·1	9	+04 43 28	7			III		0·69	0·9	3		190	−29	4C 04·15
0446+20	04 46 28·0	11	+20 39 45	10			III		0·29				180	−15	4C 20·15
0447−10	04 47 12·2	11	−10 02 12	9			III		0·35	0·8		Object 1^{s}·0 p., 0′·1 n. might be blue	208	−32	
0454−11	04 54 03·8	9	−11 49 29	8			III		0·50	0·7			211	−31	04−1*19*
0507+21	05 07 23·6	11	+21 03 48	10			III		0·32	1·0			182	−11	
0508−18	05 08 21·7	13	−18 42 30	11	0·7p.	0·1n.	QSO?	18·5	0·20	1·1		Cluster of gals. nearby	220	−30	05−1*3*
0538+23	05 38 17·2	9	+23 43 31	7			III		0·59	0·9			184	−4	4C 23·15
0618+233	06 17 57·9	9	+23 20 09	8			IIIa		0·49				189	4	(4C 23·16)
0618+236	06 18 14·2	11	+23 38 23	9			IIIa		0·37				189	4	(4C 23·16)
0619+22	06 19 49·3	9	+22 01 26	7			III		0·64	1·0			190	4	4C 22·16
0655+22	06 55 41·8	13	+22 24 56	11			III		0·12	1·4			193	12	
0706+26	07 06 03·6	8	+26 09 24	7			III		0·72	0·5		16^{m} gal. 1′·0 n.	191	15	4C 26·26
0715+20	07 15 12·5	9	+20 15 26	8			III		0·46	0·6			198	15	
0730+25	07 30 09·7	11	+25 42 29	9			III		0·30	1·3			194	20	4C 25·21
0740+23	07 40 45·4	12	+23 35 18	11			III		0·22	0·9		Blue object 0′·7 n.	197	22	
0802+16	08 02 10·9	11	+16 22 25	9	0·4f.	0	QSO?	19	0·36	1·0			206	23	
0804−05	08 04 43·8	8	−05 32 33	8			III		0·53	0·2			227	14	

0827+23	08 27 24·4	9	+23 33 30	7			III		0·66	0·6			201	32	
0832−07	08 32 39·2	14	−07 36 47	11			III		0·19	1·1			233	19	08−0*10*
0859−05	08 59 56·4	9	−05 05 03	7	0·9f.	0	QSO?	20	0·58	0·8			234	26	4C −04·29
0907+24	09 07 28·1	10	+24 31 24	8			III		0·42	0·8			203	41	4C 24·19
0919+21	09 19 53·1	11	+21 49 14	9	0·4f.	0·1s.	QSO?	19	0·31	0·4			208	42	4C 21·25
0932+25	09 32 38·8	9	+25 23 15	8			III		0·43	0·7			204	46	4C 25·26
0939−11	09 39 34·1	11	−11 32 48	10			III		0·29	1·1			247	30	3C 224
1005−09	10 05 33·3	11	−09 44 26	10	1·4f.	0·1s.	QSO?	19·5	0·28	0·5			250	36	10−0*1*
1049+20	10 49 44·7	8	+20 45 55	7	0·9p.	0·3s.	QSO?	19	1·13	0·4			220	62	4C 20·23
1102+21	11 02 45·3	9	+21 08 10	8			III		0·56	0·7			222	65	
1133+26	11 33 13·5	10	+26 13 58	10			III		0·24	1·4			213	73	4C 26·32
1135−12	11 35 25·7	10	−12 48 47	8			III		0·39	1·1			277	46	
1140+21	11 40 22·1	10	+21 45 52	8			III		0·42	1·3			229	73	(4C 21·33)
1144+25	11 44 40·1	9	+25 40 08	8			III		0·49	1·1			216	76	4C 25·36
1152+04	11 52 19·8	9	+04 40 20	8			III		0·38	1·1	3		270	64	4C 04·37
1158+252	11 58 15·5	10	+25 14 16	9			III		0·38	1·1		Blue object 3^{s}·2 p.	221	78	4C 25·37
1158+256	11 58 55·0	10	+25 36 57	7			III		0·48	0·3			219	79	4C 25·38
1206+23	12 06 32·1	10	+23 26 13	9			III		0·34	0·8			233	80	4C 23·29
1218+22	12 18 12·7	10	+22 48 47	8			III		0·41	0·8			244	82	4C 22·35
1223−04	12 23 11·6	14	−04 16 42	11			III		0·18				291	58	
1224−040	12 24 13·3	11	−04 04 19	10			III		0·30				291	58	4C 03·45
1224−043	12 24 23·3	14	−04 19 19	11			III		0·18			Possible blue object 2^{s}·0 f., 0′·4 s.	291	58	
1233+26	12 34 00·5	11	+26 51 29	10			III		0·29	0·5			221	87	4C 26·39
1241+23	12 41 23·3	13	+23 12 34	11			III		0·22	0·5			281	85	4C 23·32
1251−18	12 51 33·4	9	−18 29 24	8			III		0·50	1·1			304	44	
1312−18	13 12 24·0	9	−18 42 35	8			III		0·54	1·2			311	44	13−1*4*
1312+21	13 12 37·0	9	+21 00 17	7			III		0·63	0·7			344	82	4C 20·31
1317+25	13 17 15·0	11	+25 49 00	10			III		0·31	1·2		Blank field	21	83	4C 25·42
1330−14	13 30 44·0	10	−14 20 40	8	1·3p.		QSO?	18·5	0·45	0·9			318	47	13−1*5*
1331−09	13 31 16·4	9	−09 52 29	7			III		0·65	1·4			320	51	13−0*6*
1341+14	13 41 58·0	9	+14 24 10	7			III		0·68	1·0	1,R	Blue object 3^{s}·0 p., 0′·3 s.	349	72	4C 14·49
1344−11	13 44 33·3	11	−11 26 24	12			III		0·23	0·8			324	49	
1345+24	13 45 54·9	13	+24 31 50	11			III		0·22	1·2		Blue object 3^{s}·0 p., 0′·1 s.	24	77	4C 24·28
1346+26	13 46 34·0	9	+26 50 13	8	0·4p.	0·3n.	D2	14·8	0·52	1·0			34	77	(4C 26·42)
1348−12	13 48 09·2	9	−12 57 30	7	0·4f.	0·1s.	QSO?	20	0·64	1·1			324	47	
1348−05	13 48 42·9	9	−05 34 18	8			III		0·52			Blue object 4^{s}·0 p.	329	54	
1349−05	13 49 33·3	9	−05 28 41	8			III		0·50				329	54	13−0*15*
1353+18	13 53 48·3	11	+18 34 00	8			III		0·34	1·1		Blue object 0′·5 n.	6	73	
1405+23	14 05 41·9	9	+23 46 40	7			III		0·43	0·7			26	72	4C 23·36
1406+24	14 06 04·3	9	+24 01 33	7			III		0·53	1·0			26	72	4C 24·30
1409+21	14 09 48·6	11	+21 06 38	10			III		0·21	1·0			19	71	
1414−04	14 14 32·4	11	−04 14 30	10			III		0·26	1·3			339	52	

* See references to other observations at end of table.

TABLE 2 (*Continued*)

(1) Parkes catalogue number	(2) R.A. h m s	(3) Position (1950·0) ΔR.A. s	(4) Dec. ° ′ ″	(5) ΔDec. ″	(6) Rel. posn. R.A. s	(7) Dec. ′	(8) Type	(9) Mag.	(10) S_{2700} (f.u.)	(11) α_{2700}^{1410}	(12) Refs.*	(13) Remarks	(14) Gal. coords. l^{II} °	(15) b^{II} °	(16) Other catalogue number
1414−21	14 14 38·1	9	−21 12 53	7	0·5f.	0·1s.	g	19·0	0·65	0·5			328	37	14−*26*
1424−11	14 24 54·9	8	−11 50 19	7			III		0·76	0·9			337	44	14−*110*
1455+25	14 55 35·9	11	+25 18 22	9			III		0·37	0·7			36	62	4C 25·47
1500−14	15 00 49·4	11	−14 46 15	9			III		0·33	1·1			344	37	15−*11*
1509+15	15 09 51·1	9	+15 51 36	7	1·1f.	0·1n.	QSO?	18	0·56	0·5	4		21	55	4C 15·45
1557−00	15 57 26·8	9	−00 30 18	8			III		0·57	1·1			10	37	
1604+22	16 04 37·8	11	+22 50 22	12			III		0·14	1·2			38	46	
1611+04	16 11 44·9	9	+04 13 20	7			III		0·60	1·1		Blue object 0′·8 n.	17	37	4C 04·56
1643+13	16 43 10·9	8	+13 27 56	8			III		0·43	0·7			31	34	4C 13·63?
1718+23	17 18 09·4	10	+23 38 29	9	0·6f.	0·4n.	g	19	0·20			Blue object $2^s·5$ p., 0′·1 n.	46	30	
1749+25	17 49 37·7	11	+25 54 11	8	1·4f.	0	QSO?	19·5	0·30	0·7			51	24	4C 25·52
1804+26	18 04 50·8	8	+26 05 27	7			III		0·52	0·7			52	21	4C 26·54
1819+26	18 19 27·7	10	+26 34 47	9			III		0·20	1·1			54	18	CTD 106?
1836+21	18 36 42·0	10	+21 18 39	8			IV		0·26	0·2			51	12	
2107+23	21 07 45·6	10	+23 48 46	8			III–IV		0·38	0·9			72	−16	4C 23·57
2116+18	21 16 11·3	8	+18 03 55	7			III		0·78	0·7	3		68	−21	4C 18·62
2120+15	21 20 54·9	8	+15 35 15	7			III		0·84	0·5			67	−24	3C 434
2124−12	21 24 47·9	12	−12 04 25	9	0·4p.	0	QSO?	19	0·30	0·4		Not very blue	40	−40	
2142+04	21 42 47·0	8	+04 17 43	7			III		0·91	0·7	3,5	Object $1^s·2$ f., 0′·2 s. might be blue	61	−25	4C 04·75
2149−20	21 49 04·6	8	−20 00 14	7	0·4p.	0	QSO	18·5	1·24	0·7	6	Second fainter blue object $1^s·6$ p., 0′·15 s.	33	−48	21−*221*
2149+21	21 49 23·8	9	+21 15 58	8			III		0·52	0·7		Blue object $2^s·5$ f., 0′·2 n.	77	−25	4C 21·59
2228+24	22 28 04·5	10	+24 59 51	8			III		0·28	0·5			87	−28	(4C 24·58)
2235−14	22 35 34·8	10	−14 21 38	8	0	0·4s.	g	20	0·47	0·6			49	−56	
2246+208	22 46 30·3	9	+20 50 52	8			III		0·61	−0·3			88	−34	
2246+205	22 46 48·4	10	+20 32 48	9			III		0·22	0·9	4		88	−33	4C 20·55
2313−14	23 13 57·8	9	−14 25 36	8			III		0·51	0·9		Blue object 2′·0 f., 0′·4 n.	59	−64	23−*15*
2325−05	23 25 37·3	11	−05 12 31	9			III		0·37	1·2			77	−60	4C −05·97
2331−09	23 31 13·1	9	−09 19 52	7			III		0·60	1·1			74	−64	
2336−04	23 36 25·1	8	−04 30 16	7			III		0·80	0·7			83	−61	4C −04·89
2337+13	23 38 00·0	8	+13 16 24	7			III		0·85	1·1	2		98	−46	4C 13·88
2339+26	23 39 24·4	12	+26 03 30	10			III		0·12	1·8			104	−34	4C 25·60
2342−15	23 42 14·6	12	−15 21 28	10			III		0·25	1·8			68	−70	23−*122*

* References: 1, Clarke, Bolton, and Shimmins (1966); 2, Shimmins, Clarke, and Ekers (1966); 3, Wills and Bolton (1969); 4, Merkelijn (1969); 5, object originally accepted as identification by Wills and Bolton (1969) is a galactic star (Bolton, personal communication); 6, identification as QSO confirmed by Shimmins *et al.* (1970); R, previous identification retracted.

1 field was heavily obscured and 3 were possibly obscured.

86 fields contained only stars of normal colour within the estimated errors. However, 14 of these fields contained blue or possible blue stellar objects and 2 contained galaxies outside the estimated position errors. These objects are noted in column 13 of Table 2.

The fraction of sources for which identifications are suggested is considerably lower than in previous samples of sources. However, the present sample is heavily biased in that the possibility of an identification had previously been dismissed on the basis of the Parkes catalogue position. For most of the sources whose identification is now suggested, the present position differs from the catalogue position by two to three times the r.m.s. error given in the Parkes catalogue.

Positions for a few of the sources in the present list have also been measured by Wills and Bolton (1969). In all cases the agreement is consistent within the estimated position errors.

One of the new identifications, namely that suggested for PKS 0508−18, might prove particularly interesting. For this source, it was difficult to choose between identification with the brightest galaxy of a cluster or with a blue object, and it would be interesting to investigate whether this is a case of a low-redshift quasar associated with a cluster of galaxies. It is of course also possible that the blue object is a compact galaxy rather than a true quasi-stellar object.

IV. Source List

Results of the observations are given in Table 2.

Column 1 gives the Parkes catalogue number. Sources not in the Parkes catalogue have been numbered according to the same system.

Columns 2 and 3 give the measured right ascension and the r.m.s. error in this measurement, while columns 4 and 5 give the measured declination and the corresponding r.m.s. error.

Columns 6 and 7 give the position of the optical identification relative to the radio position as measured from the Palomar Sky Survey prints. The error in this quantity is $< 0'{\cdot}2$ arc. Abbreviations used are: p., preceding; f., following; n., north; s., south.

Column 8 gives the type of identification: QSO?, blue stellar object within the estimated position errors; E, elliptical galaxy; D, galaxy with diffuse outer envelope; g, galaxy too faint for classification; III, only stars of normal colours present; IIIa, as for III with possible optical obscuration; IV, heavy optical obscuration.

Column 9 gives the optical magnitude of the identification. For most sources this has been estimated to the nearest half-magnitude from the Sky Survey prints. The values for galaxies have been estimated from the red prints and those for possible quasi-stellar objects from the blue prints. The magnitudes estimated in this way may be in error by as much as 1^m.

Column 10 gives the peak flux density at 2700 MHz. No corrections have been made for possible extension.

Column 11 gives the spectral index between 1410 and 2700 MHz.

Column 12 gives reference numbers for other observations, which are listed in the footnote at the end of the table, while column 13 gives additional remarks on some of the sources.

Columns 14 and 15 give the position in galactic coordinates.

Column 16 gives other catalogue numbers.

Finding charts for the identifications are given in Figures 1–3. They have been enlarged from the Sky Survey prints by a factor of five, and the scale is now about 5 mm = 1′ arc. The blue or "O" prints were used for quasi-stellar objects, and the red or "E" prints for galaxies.

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