IMPROVED POSITIONS AND SOME OPTICAL IDENTIFICATIONS FOR 451 4C RADIO SOURCES BETWEEN DECLINATIONS 4° AND 20°

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Summary

Accurate positions have been measured at Parkes for 451 4C radio sources between declinations 4° and 20°. For most of the sources the r.m.s. uncertainty is $\pm 10''$ arc in each coordinate. Optical identifications are suggested for 94 sources, of which 22 are galaxies and 72 are possible quasi-stellar objects.

I. INTRODUCTION

Searches for optical identifications of radio sources in the 4C catalogue (Pilkington and Scott 1965; Gower, Scott, and Wills 1967) have been hampered in the past by the uncertainties in the measured source declinations. Apart from occasional lobe ambiguities of $7' \cdot 5$ arc, the right ascensions given in the 4C catalogue are usually accurate to $\pm 20''$ arc, but the r.m.s. errors in declination range from $\pm 2'$ arc for the strong sources at high declinations to $\pm 10'$ arc for the weak sources at low declinations. Declinations of 64 4C sources with flux density‡ $S_{178} \geqslant 5 \cdot 0$ have been measured by Wills (1967) with an accuracy of $\pm 10''$ arc and optical identifications have been made for some of these sources.

About half of the sources in the 4C catalogue can be observed with the Parkes telescope. Accurate positions of many of the stronger sources which are also listed in the Parkes catalogue of radio sources (Shimmins and Day 1968; Division of Radiophysics, CSIRO 1969) have already been measured and optical identifications secured where possible. The positions of many of the weaker 4C sources north of declination 20° have been determined by Olsen (1967) and positions for the weaker sources between declinations 4° and −4° are currently being measured by J. V. Wall and A. J. Shimmins with the Parkes telescope. The present paper reports positional observations of 448 4C radio sources between right ascensions $03^{\rm h}30^{\rm m}$ and $23^{\rm h}30^{\rm m}$, in the declination range 4° to 20°. Three 4C sources outside this right ascension range were also measured, as were two sources which do not appear in the 4C catalogue. For most of the sources the r.m.s. uncertainty is $\pm 10''$ arc in each coordinate; it has already been amply demonstrated that this accuracy is sufficient to enable optical identifications to be made for most of the radio sources whose optical counterparts are brighter than about 19^m. From inspection of the Palomar Sky Survey prints

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‡ Throughout this paper, flux densities are given in units of $10^{-26}\,{\rm W\,m^{-2}\,Hz^{-1}}$.

identifications are suggested for 22 radio galaxies and 72 possible quasi-stellar objects. The observations were made at a frequency of 2700 MHz and the estimated r.m.s. errors in the measured flux densities are between ±5% and ±10% for most of the sources. The distribution of spectral indices for the different identification classes has been examined and the proportion of identifications at different flux density levels is discussed. The reliability of the 4C positions has been estimated from the distribution of declination and right ascension errors and from the frequency of lobe shifts.

II. Selection of Sources

The observations were made in 1969 from April 27 to May 3, mainly between $14^h 00^m$ and $08^h 00^m$ local time. In order to minimize the telescope pointing corrections it was desirable to limit the observations to within about 1 hr of meridian transit, and this fact, together with the restriction on local time, excluded the area between right ascensions $23^h 30^m$ and $03^h 30^m$. As the possibility of securing optical identifications decreases rapidly near the galactic plane no sources were observed within galactic latitudes $|b^{II}| < 10°$.

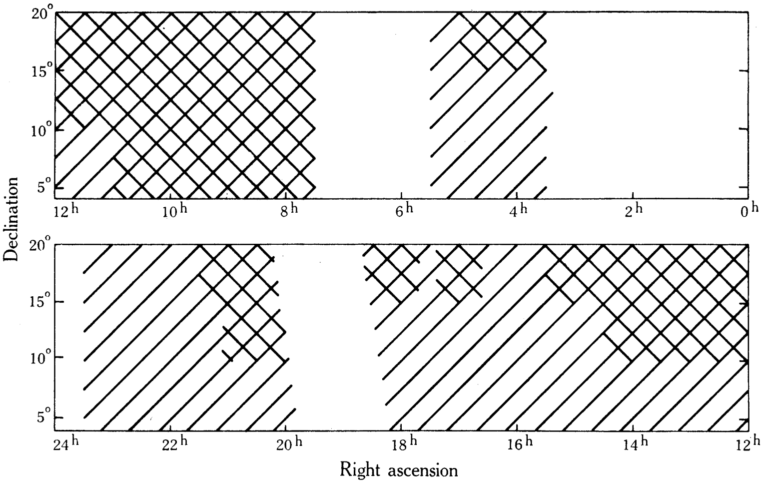

Fig. 1.—Area covered by the present observations. Single hatching indicates regions in which sources with $S_{178} \geqslant 3\cdot 0$ were observed and double hatching shows regions in which positions of all 4C sources were measured.

Of the 838 4C sources within the above region, 56 are listed in the revised 3C catalogue (Bennett 1962); these were excluded from the observing programme, as were 113 additional sources whose positions have already been measured at Parkes or for which reliable optical identifications have been suggested (e.g. Bolton and Ekers 1966; Clarke, Bolton, and Shimmins 1966; Shimmins, Clarke, and Ekers 1966; Bolton, Shimmins, and Merkelijn 1968; Shimmins 1968; Merkelijn 1969). Of the remaining 669 4C sources within the region, 478 were observed, together with 3 4C sources outside this range of right ascension. Positions were also measured for 2 sources not listed in the 4C catalogue but which were found near 4C sources.

Within the above region, accurate positions are now available for virtually all 4C sources with $S_{178} \geqslant 3\cdot 0$; positional observations are complete to $S_{178} = 2\cdot 0$ over about 60% of this area. Figure 1 shows the area covered; single hatching indicates the coverage for sources with $S_{178} \geqslant 3\cdot 0$ and double hatching the area of full coverage.

III. Observations

The observations were made with the Parkes 210 ft reflector and the 2700 MHz receiver described by Batchelor, Brooks, and Cooper (1968). A dual feed system was used in which one feed is on the optical axis of the reflector and the other is displaced by $18'\cdot 5$ arc. The output of the receiver then represents the difference between the signals received by the two feeds. With an output time constant of 2 sec, peak-to-peak noise fluctuations are equivalent to $S_{2700} = 0\cdot 07$.

The positions were measured by making forward and reverse scans at the rate of $0^\circ\cdot 5$ per minute in each coordinate. Scans in declination, with the telescope right ascension set to the precessed 4C value, were made first, since the errors in the 4C right ascensions are small compared with the beamwidth of the telescope. The declination found from the first set of scans was then used for the right ascension scans.

The off-set feed was placed at feed angle 90° for the declination scans and 0° for the right ascension scans; as the observations were made close to the meridian, feed angle differs little from position angle. Occasionally, in order to avoid a confusing source in the off-set beam, feed angles other than 90° and 0° had to be used. The use of two orthogonal feed angles ensures that the flux density of a source, calculated from the mean of the two sets of observations, is not affected by linear polarization of the source, which can be large at 2700 MHz.

In addition to the usual analogue recording, on-line data processing was available in a PDP-9 computer, using a programme written by R. N. Manchester. The receiver output and scanning coordinate were sampled at uniform time intervals, and the recorded source profile was then smoothed using a low-pass digital filter to remove most of the receiver noise. After removal of any linear baseline drift the source amplitude and position were determined. The midpoints of cuts through the smoothed profile at the 37·5%, 50%, and 62·5% levels were determined and the source position taken as the mean of these three values. Average values of the source amplitude and position were finally computed for an allocated number of scans, usually two in each coordinate.

The use of the computer considerably reduced the effort normally needed for hand analysis. It was satisfactory for about 90% of the sources observed, and hand analysis was employed for the reduction of those observations which had been affected by a confusing source.

Measurements were attempted of 478 4C sources, and successful observations were made of 451. Seventeen sources which were not found are listed below:

4C 04·31 (i), 05·32 (ii), 06·31 (ii), 07·24 (ii), 09·59 (i), 10·11 (ii), 10·16 (ii), 11·16 (ii), 11·29 (ii), 13·50 (ii), 13·63 (i), 15·50 (i), 17·51 (ii), 18·28 (i), 19·12 (i), 19·61 (i), 19·62 (i)

Where the source number is followed by (i) it indicates that a search was made for the source within 20′ arc in declination at the 4C right ascension and within 20′ arc in right ascension at the 4C declination. Where the source number is followed by (ii) a search was made within 20′ in declination at the 4C right ascension and at the two right ascensions corresponding to the nearest lobe shifts.

The following sources were found at or near the 4C position but were judged too weak ($S_{2700} < 0\cdot1$) to allow a satisfactory position to be measured:

4C 08·34, 11·43, 12·32, 14·47, 15·72, 15·74, 19·48

The following sources were found to be weak and in confused regions, and satisfactory positions could not be measured:

4C 17·17, 18·28, 18·43

Twenty-six sources were found approximately 7′·5 or 15′ arc (one or two lobe shifts) away from the 4C right ascension; they are listed below. In the list (e) and (l) indicate that the sources were found at a right ascension earlier or later than the value given in the 4C catalogue; (ee) denotes a double lobe shift to an earlier value than that given in 4C; and (e, l) indicates that components of a 4C source were found at the two nearest lobe-shifted right ascensions:

4C 04·14 (ee), 04·46 (e), 05·35 (e), 05·63 (l) 06·35 (e,l), 06·41 (l),
08·65 (l), 09·57 (ee), 10·32 (e), 10·56 (ee), 11·38 (l), 12·33 (ee),
12·46 (l), 12·64 (l), 13·27 (e), 14·40 (l), 15·12 (e,l), 15·24 (e),
15·44 (e), 15·58 (e), 16·47 (e), 16·52 (l), 17·30 (e), 18·24 (l),
19·59 (e), 19·76 (l)

The following 33 sources were found close to the right ascension given in 4C, and the possible lobe shift indicated in the catalogue is not required:

4C 04·34, 04·37, 04·59, 05·34, 05·39, 05·46, 05·54,
05·67, 06·40, 07·38, 08·60, 09·48, 09·55, 09·56,
10·26, 10·34, 11·33, 11·42, 12·47, 13·40, 13·85,
15·34, 15·35, 15·47, 15·69, 15·71, 16·36, 16·56,
16·69, 17·54, 17·75, 19·55, 19·70

IV. Positional Calibration

The telescope pointing corrections were determined from observations of sources of small radio diameter which have been optically identified, usually with quasi-stellar objects, and for which accurate optical positions are available. Table 1(*a*) lists these sources and their adopted optical positions. One calibrating source was observed, where possible, every 90 min. Unfortunately, there are no suitable calibrating sources within the declination range of interest between right ascensions $16^{h}30^{m}$ and $21^{h}00^{m}$. In this region, and in certain other cases, observations were made of sources with angular diameters either known or suspected to be larger than about 10″ arc. The adopted positions of these sources are listed in Table 1(*b*). Observations of these sources were used to check day-to-day changes in the telescope pointing but they were not used in the final calibration.

The differences between the measured radio position and adopted optical position for the calibration sources in Table 1(*a*) were first examined as a function of time throughout the observing period. The average positional difference was found to vary slightly from day to day; this was confirmed by day-to-day changes of the measured positions of the secondary calibrators (Table 1(*b*)). The maximum deviation of the day-to-day correction from the mean for the whole period was 7″ arc. A diurnal variation of the right ascension differences between $14^h 00^m$ and $17^h 00^m$, local time,

TABLE 1

POSITION CALIBRATORS

(1) PKS Catalogue Number	(2) Other Catalogue Number	(3) Optical Position (1950·0) R.A. h	m	s	(4) Dec. °	′	″	(5) Mean Residuals (radio—optical) R.A. (″arc)	(6) Dec. (″arc)	(7) No. of Observations
					(a) Primary					
0340+04	3C 93	03	40	51·47	04	48	21·6	−6	+2	1
0430+05	3C 120	04	30	31·46	05	15	01·0	−2	−6	2
0440−00		04	40	05·40	−00	23	22·0	−7	−3	2
0518+16	3C 138	05	18	16·51	16	35	26·2	0	+5	5
0725+14	3C 181	07	25	20·10	14	43	47·3	−7	+3	7
0802+10	3C 191	08	02	03·78	10	23	58·1	−2	0	2
0838+13	3C 207	08	38	01·73	13	23	05·4	+5	+7	3
0903+16	3C 215	09	03	44·15	16	58	15·7	+3	−4	3
0957+00	4C 00·34	09	57	43·84	00	19	50·0	−2	−1	1
1040+12	3C 245	10	40	06·03	12	19	15·0	0	+4	6
1116+12	4C 12·39	11	16	20·79	12	51	06·3	+5	+3	5
1241+16	3C 275·1	12	41	27·68	16	39	18·7	−7	+1	1
1328+25	3C 287	13	28	16·12	25	24	37·1	+6	−2	1
1354+19	4C 19·44	13	54	42·30	19	33	41·0	−3	+3	5
1514+07	3C 317	15	14	17·00	07	12	16·7	+5	+2	3
1622+23	3C 336	16	22	32·45	23	52	00·7	+13	−3	1
1641+17	3C 346	16	41	35·33	17	21	19·9	−9	+4	3
2045+06	3C 424	20	45	44·40	06	50	10·2	0	−8	6
2120+16	3C 432	21	20	25·64	16	51	46·0	−1	−6	2
2145+06	4C 06·69	21	45	35·90	06	43	43·0	+7	−7	2
2230+11	CTA 102	22	30	07·71	11	28	22·8	+6	+2	4
					(b) Secondary					
0947+14	3C 228	09	47	25·50	14	57	26·2	+35	−32	4
1217+02		12	17	38·35	02	20	20·9	+9	−14	2
1222+13	3C 272·1	12	22	32·47	13	09	54·8	−8	−10	2
1305+06	3C 281	13	05	22·52	06	58	16·4	−16	−14	2
1420+19	3C 300	14	20	40·10	19	49	12·4	+4	−9	4
1559+02	3C 327	15	59	55·67	02	06	12·3	+24	−8	1
1618+17	3C 334	16	18	07·40	17	43	30·5	+4	+13	7
1836+17	3C 386	18	36	12·85	17	09	06·7	−4	+9	9
1949+02	3C 403	19	49	44·57	02	22	37·1	−5	−10	5

was also found. This is presumably attributable to the effects of solar heating on the telescope (no observations were made between $08^h 00^m$ and $14^h 00^m$, when similar effects might also be expected).

The measured radio positions were corrected for the above two effects and the remaining differences were then examined as functions of zenith angle and hour angle. No variation with zenith angle was found but small variations with hour angle were found both in right ascension and in declination, as shown in Figure 2. The dashed curve in Figure 2(*a*) represents the best fit to the right ascension error. It is similar in form to the variation found by Merkelijn (1969) and has been approximated by the two straight lines. The difference between the dashed curve and the approximation has a maximum of 6″ arc near hour angle $00^{h}\,15^{m}$ but there is no significant difference over most of the hour angle range. The full line in Figure 2(*b*) indicates the corrections which were applied to the measured source declinations.

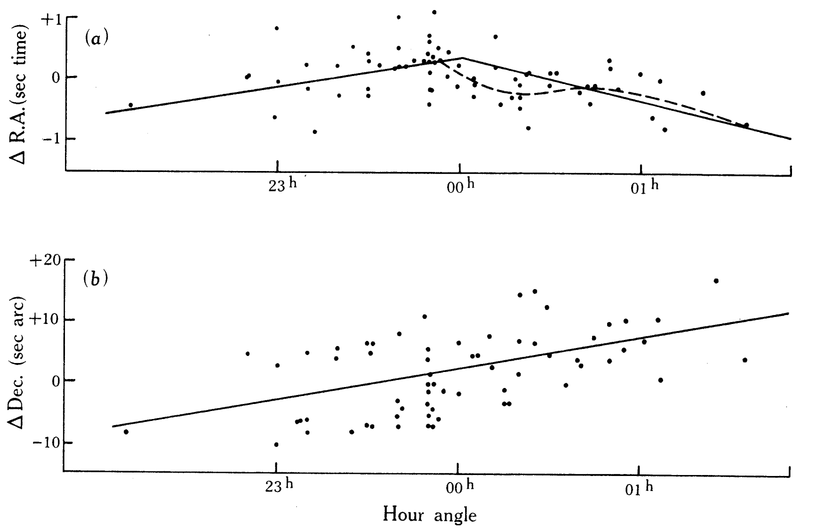

Fig. 2.—Differences between optical and radio positions of calibrating sources as functions of hour angle.

The mean corrections for day-to-day, diurnal, and hour angle effects were finally applied to the calibration sources to determine the *residual* errors (corrected radio position minus optical position). The distributions of these residuals were centred at zero and the r.m.s. deviations of the individual values were $\pm 6''$ arc in each coordinate. These values represent the combination of short-term variations in the telescope pointing, together with any remaining small systematic effects. Columns 5 and 6 of Table 1 give the mean residual in each coordinate for the source concerned, and column 7 the number of observations made. It can be seen that some of the larger angular diameter sources in Table 1(*b*) are quite suitable as position calibrators at this frequency when positions with accuracy no greater than about $\pm 10''$ arc are required; the quasi-stellar source PKS 0947+14 (3C 228) is a notable exception.

Receiver noise fluctuations do not affect the measurements of the calibration sources but they contribute considerably to the positional errors in the measurements of the weaker sources. The magnitude of this effect was estimated by examining the differences between the apparent positions of sources as determined from the individual scans of a forward and reverse pair, after removing a constant difference due to the receiver time constant. The results are summarized in Figure 3(*a*), which shows the estimated r.m.s. errors in the final source positions as a function of the flux density at 2700 MHz, after averaging one pair of scans. In this figure the calibration error ($\pm 6''$ arc) has been combined in quadrature with the errors due to receiver noise fluctuations. Sources were not used for this analysis if they were obviously affected by a confusing source; those measurements which were affected by confusion are indicated in Table 2, and the uncertainties in the positions given in these cases may be several times the error shown in Figure 3(*a*).

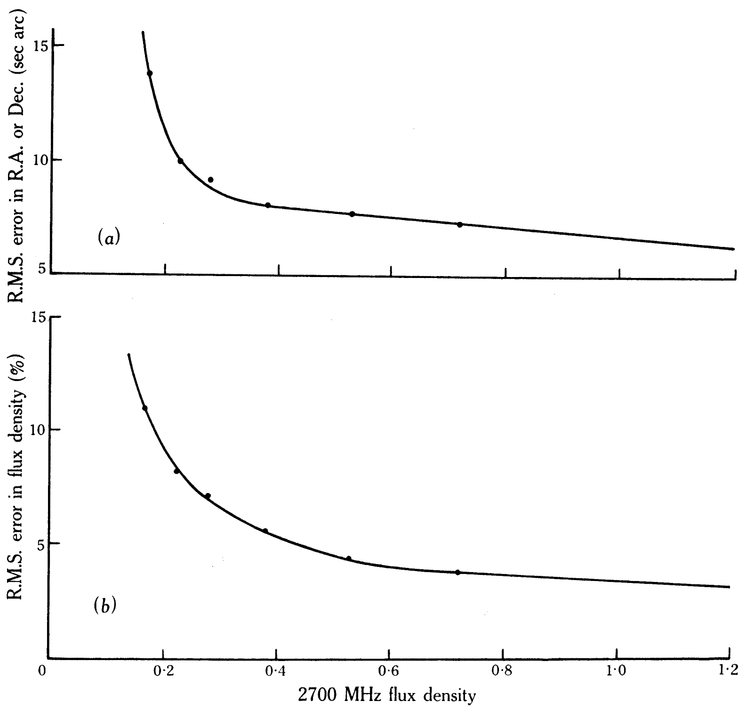

Fig. 3.—Estimated r.m.s. errors in (*a*) right ascension or declination and (*b*) flux density as functions of 2700 MHz flux density.

V. Flux Densities

After the position measurement of a source had been completed the sensitivity of the receiver was determined by injecting a 1°K noise signal from a noise discharge tube. The flux density scale was calibrated from observations of 3C 245 (PKS 1040+12) for which a value $S_{2700} = 2 \cdot 09 \pm 0 \cdot 04$ was adopted (Kellermann, Pauliny-Toth, and Tyler 1968). Observations of this source on successive days showed an r.m.s. variation of $\pm 1 \cdot 5\%$ in the ratio of the source amplitude to the amplitude of the noise signal.

The r.m.s. errors in flux density due to receiver noise fluctuations were estimated in a manner similar to that already outlined for the position errors, i.e. from a comparison of the amplitudes of the forward and reverse pairs of a scan. Figure 3(*b*) shows the overall r.m.s. errors in flux density, including a $\pm 3\%$ uncertainty in the flux density scale.

The flux densities were calculated from the mean of the source amplitudes given by the declination and right ascension scans and appropriate corrections were applied in the few cases where the coordinate set for the scan differed by more than 1′ arc from that determined in the subsequent scan pair. In some cases large differences in the source amplitudes from the two pairs of scans were noted; these are clearly due to the use of orthogonal feed angles and the intrinsic linear polarization of the sources. Such objects are noted in Table 2. The use of only two feed angles allows the detection of polarization mainly when the polarization position angle of a source is close to 0° or 90°, so that the number of highly polarized sources noted in Table 2 is a lower limit to the actual number.

The 2700 MHz flux densities given in Table 2 are peak flux densities, i.e. no corrections have been applied for beam broadening due to the angular extent of a source. Very few cases of beam broadening were found, and in the majority the broadening was found to be in declination. This is not unexpected, because the 4C catalogue was compiled from observations with an east–west interferometer and sources of large east–west extent can be excluded from 4C. In most cases where beam broadening was apparent, the skew nature of the source profile suggested a close confusing source rather than a single extended object.

In addition to the 2700 MHz flux densities from the present work, Table 2 includes the 178 MHz flux densities of the sources, as given in the 4C catalogue. In some cases, data from the pencil beam survey made at 178 MHz by Caswell and Crowther (1969) are available. Seven of the sources in the present sample have a 4C flux density which is less than 0·7 of the value found from the total power observations, implying that they are probably of large angular size ($\gtrsim$ 2′ arc) or seriously affected by confusion. They are:

4C 11·42, 11·44, 11·51, 13·62, 14·35, 14·48, 14·77

VI. Optical Identifications

The prints of the Palomar Sky Survey have been searched for optical identifications at the positions of all the sources in Table 2. The search was carried out with the aid of transparent overlays prepared on the CDC 3600 computer of CSIRO. Each overlay is marked with the positions of the radio source and 10 reference stars from the Smithsonian catalogue. The positions of suggested optical counterparts can be estimated to an accuracy of about $\pm 0'\cdot 1$ arc, except when the object is near to the edge of a Sky Survey print or where there is an unfavourable configuration of reference stars.

The results of the search are as follows:

22 fields contained a single galaxy within the estimated errors of the radio position.

6 fields contained several faint galaxies, but the accuracy of the radio position did not permit a unique identification to be made. These cases are denoted by "II" in column 7 of Table 2.

Figs 4–15.—Finding charts for the identifications. The scale is 5 mm = 1′ arc. North-east is at the top left-hand corner of each chart.

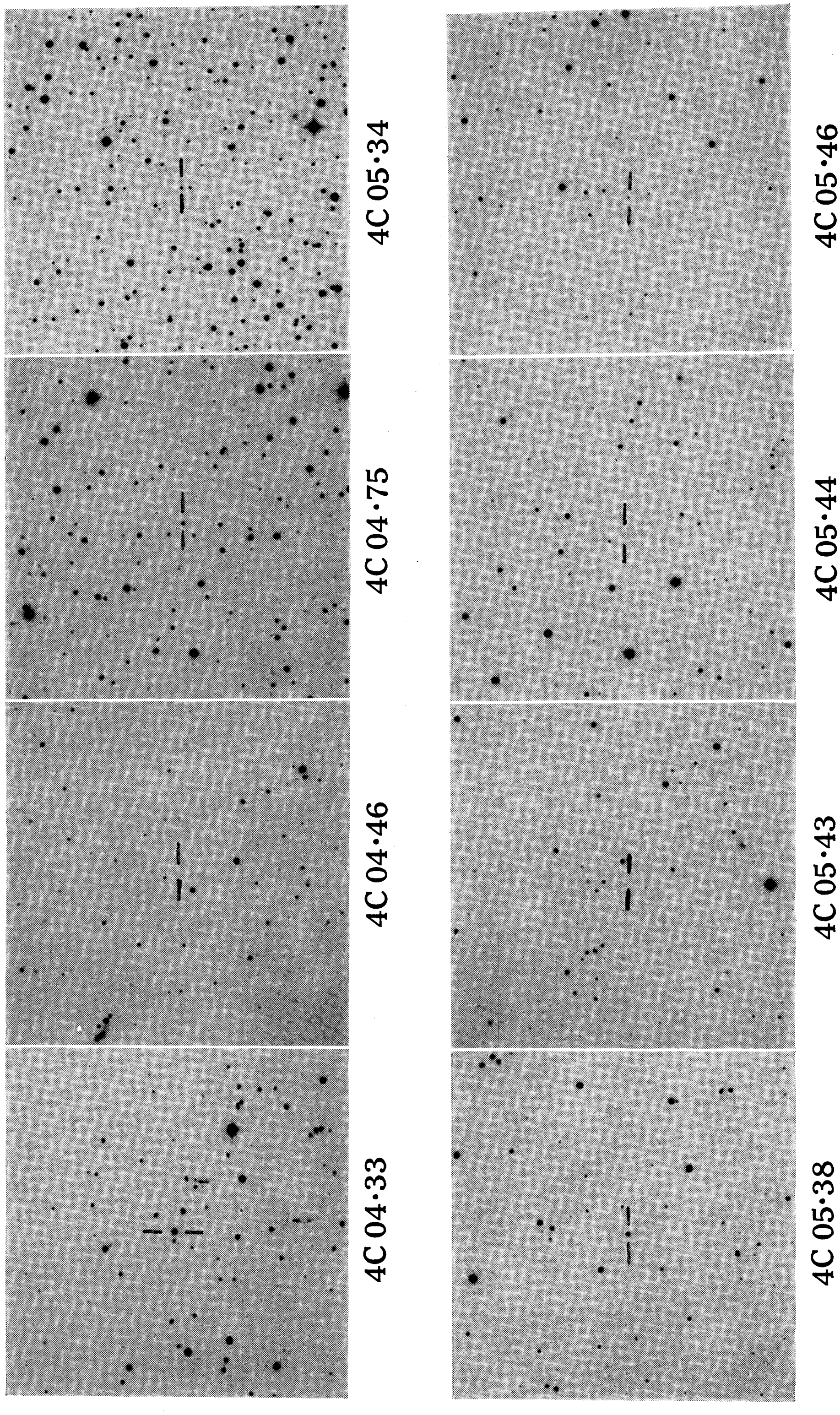

Fig. 4

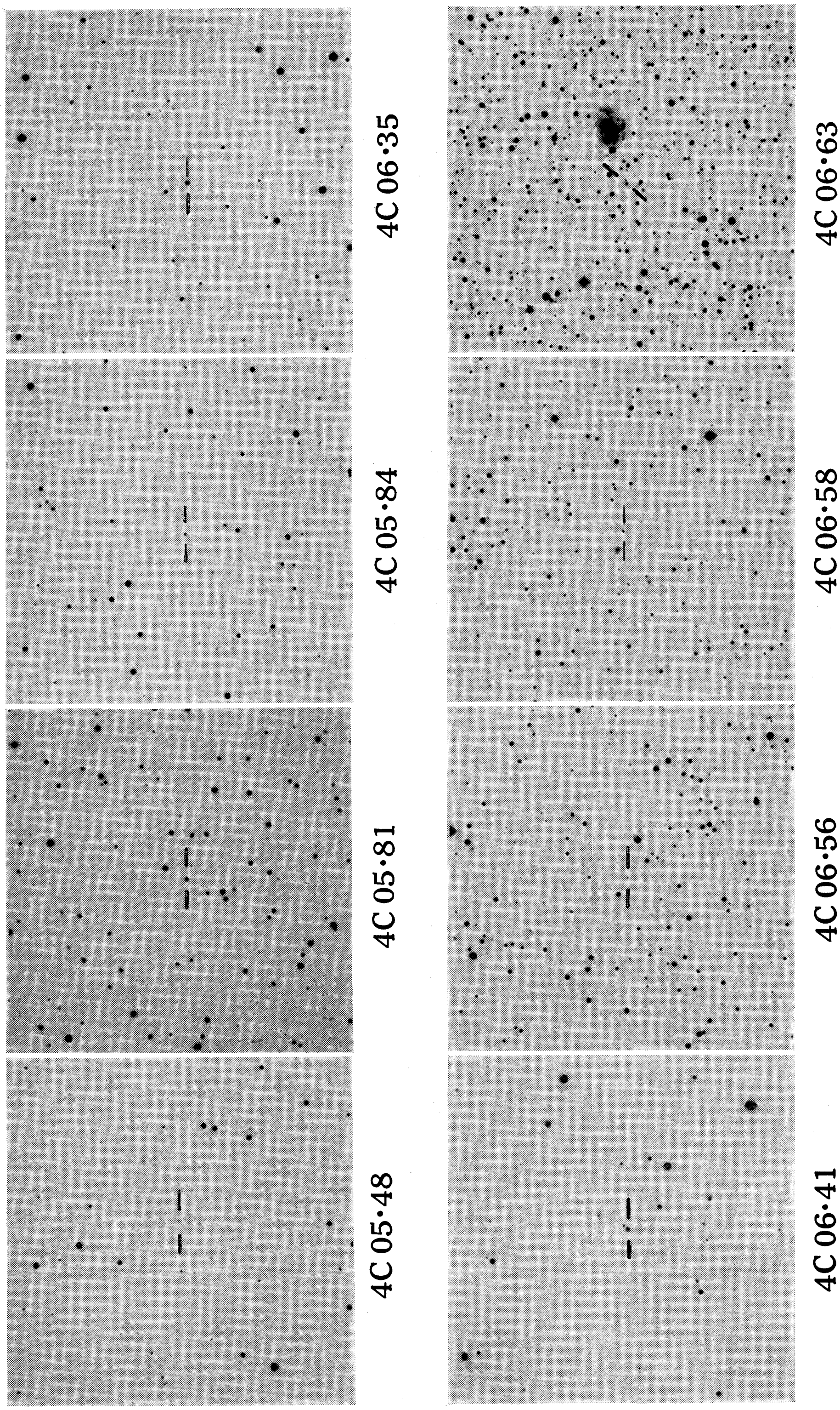

Fig. 5

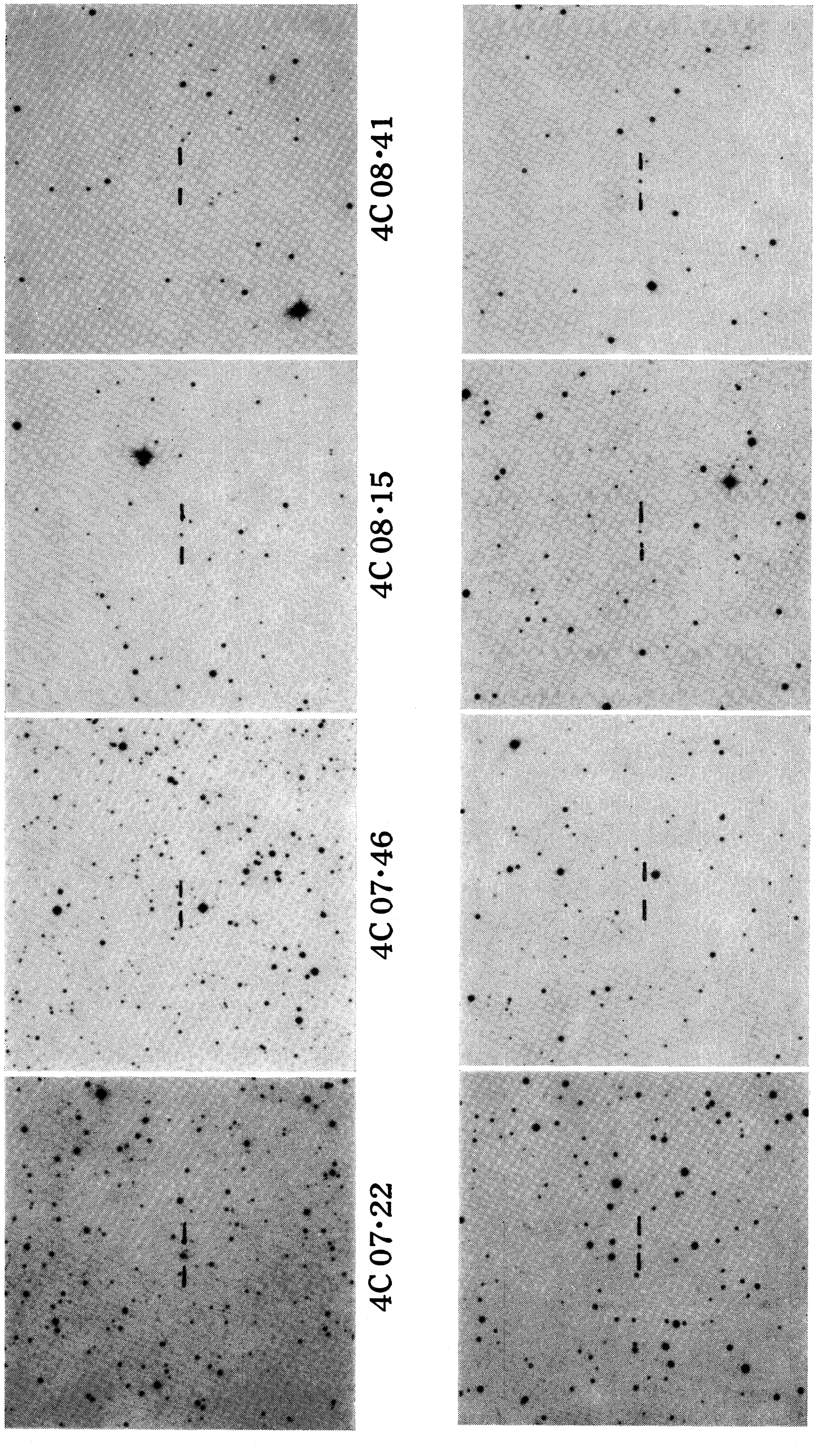

Fig. 6

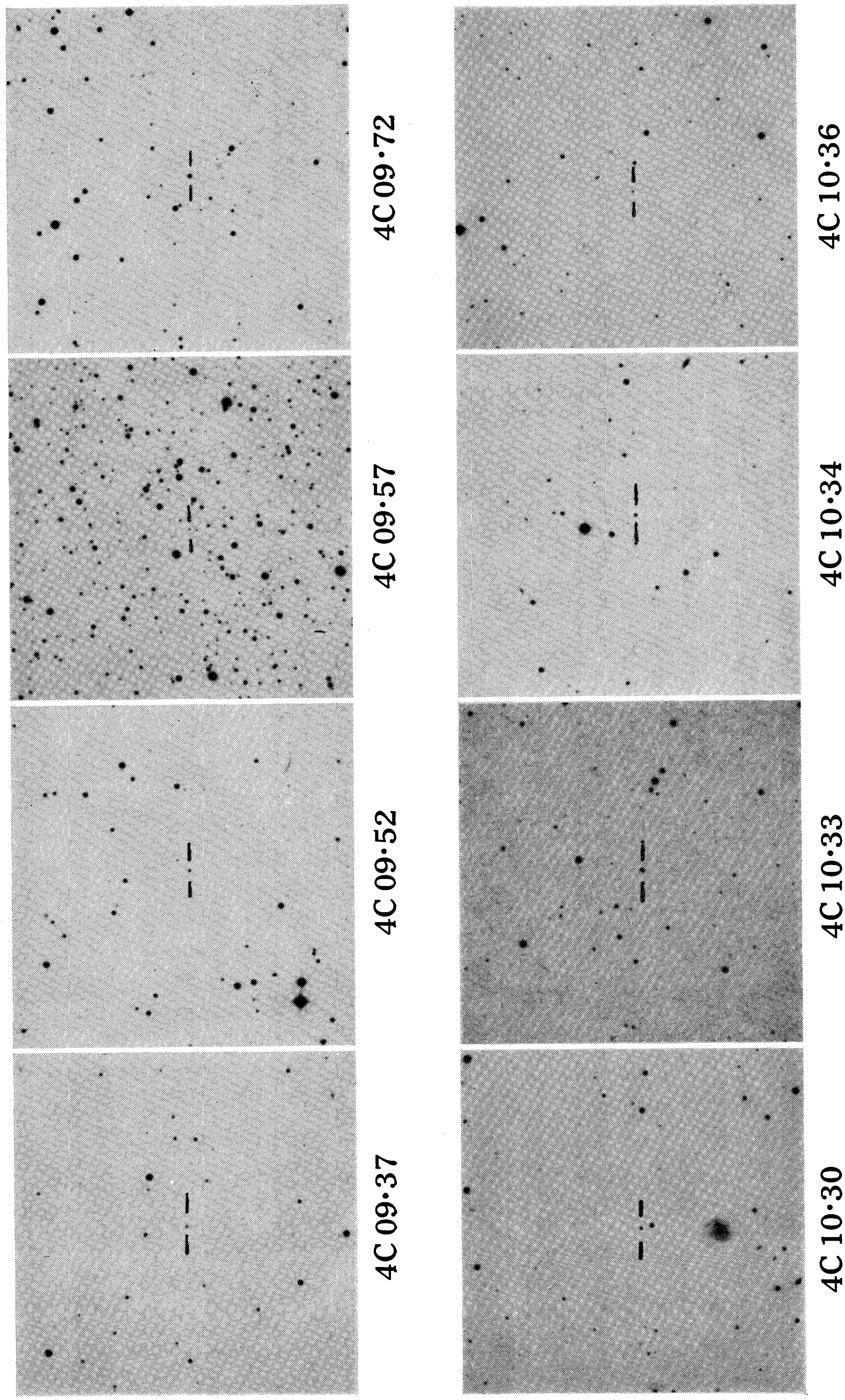

Fig. 7

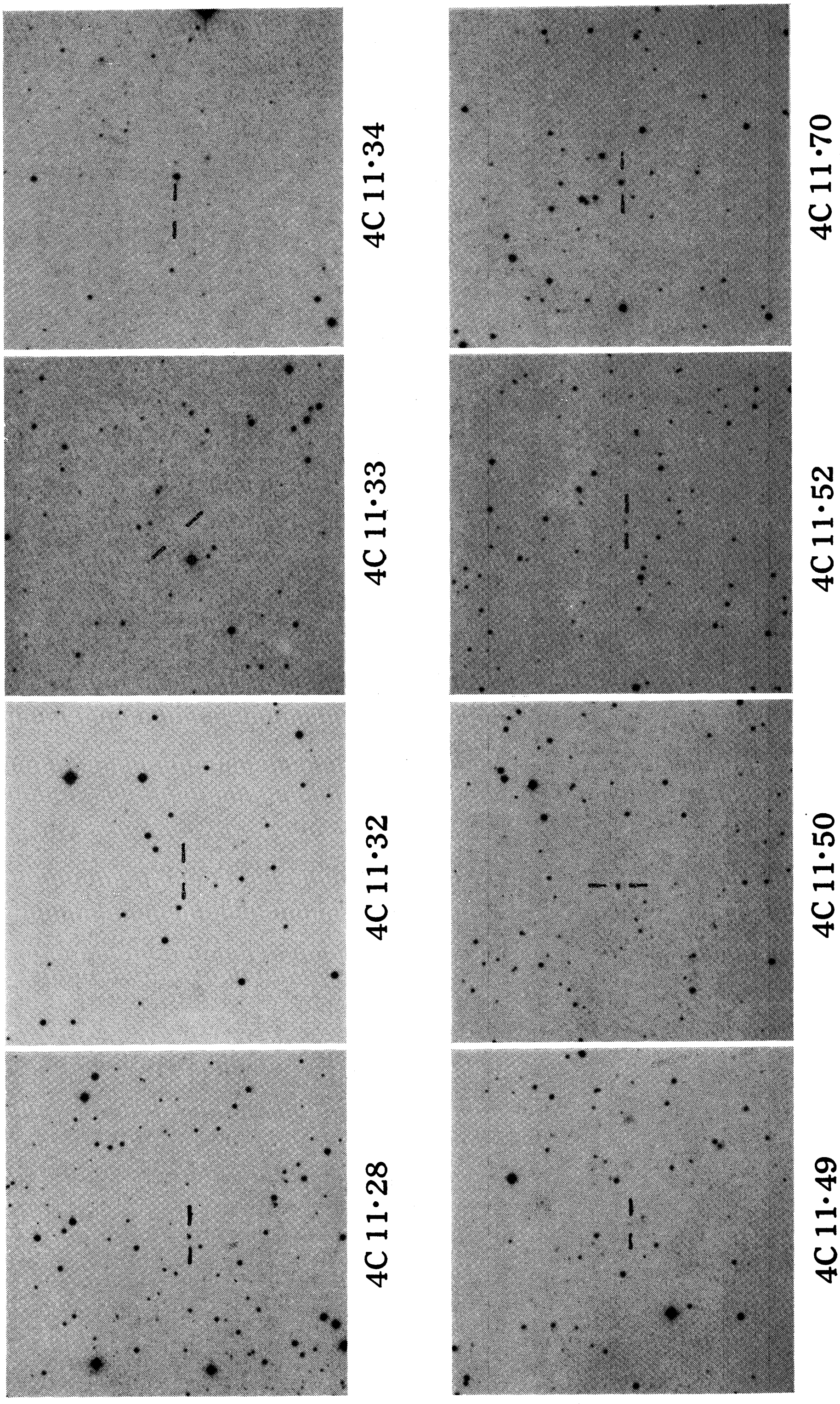

Fig. 8

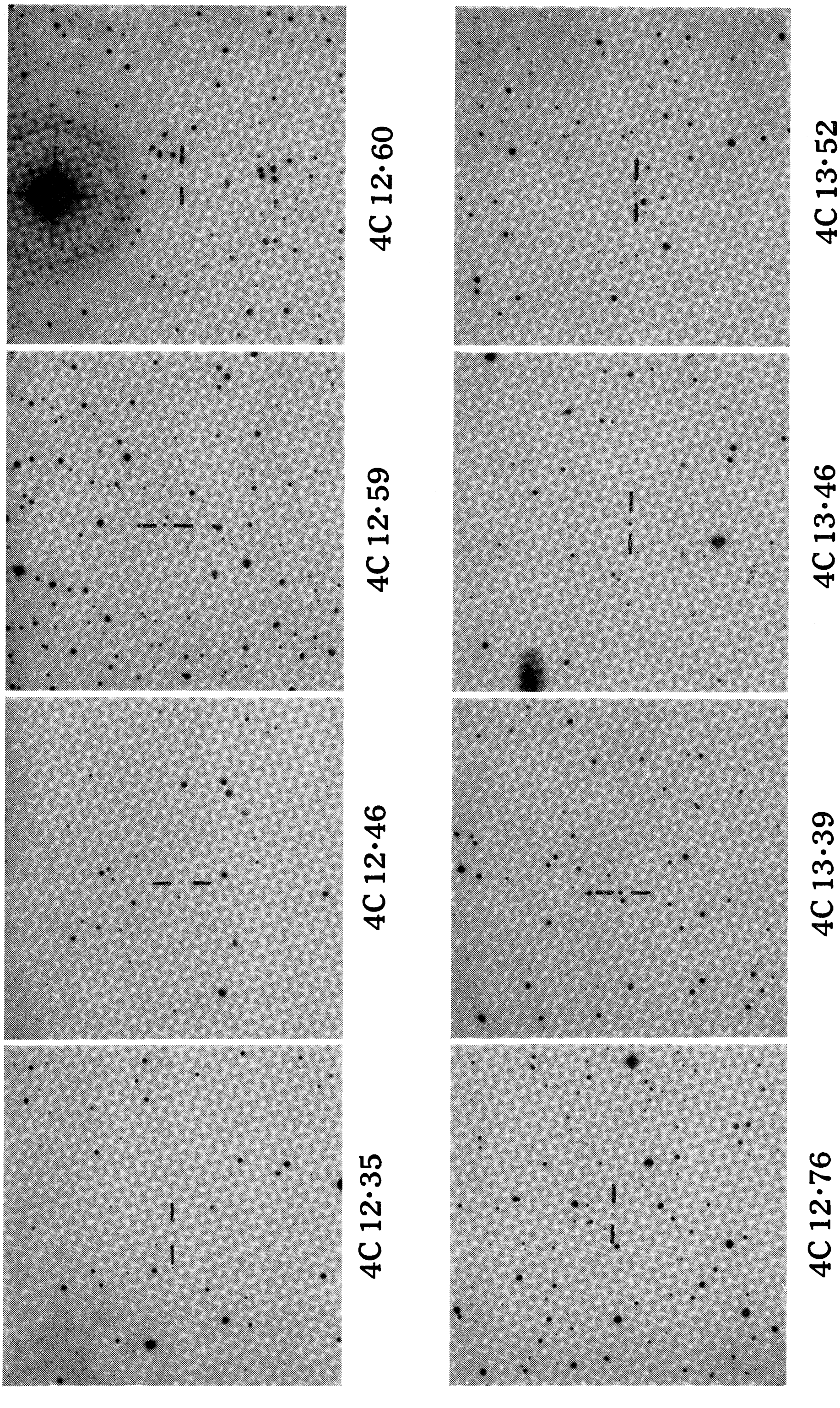

Fig. 9

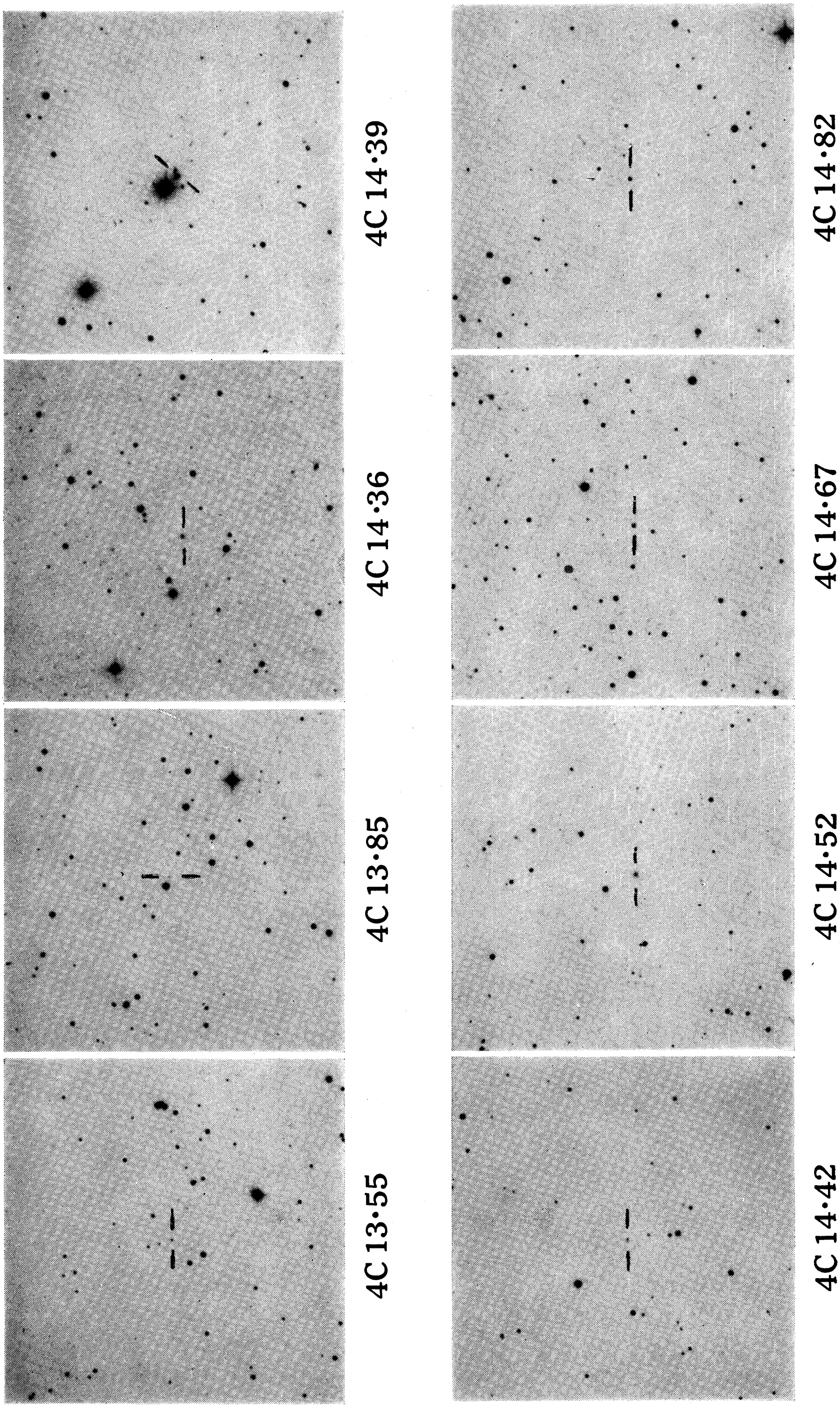

Fig. 10

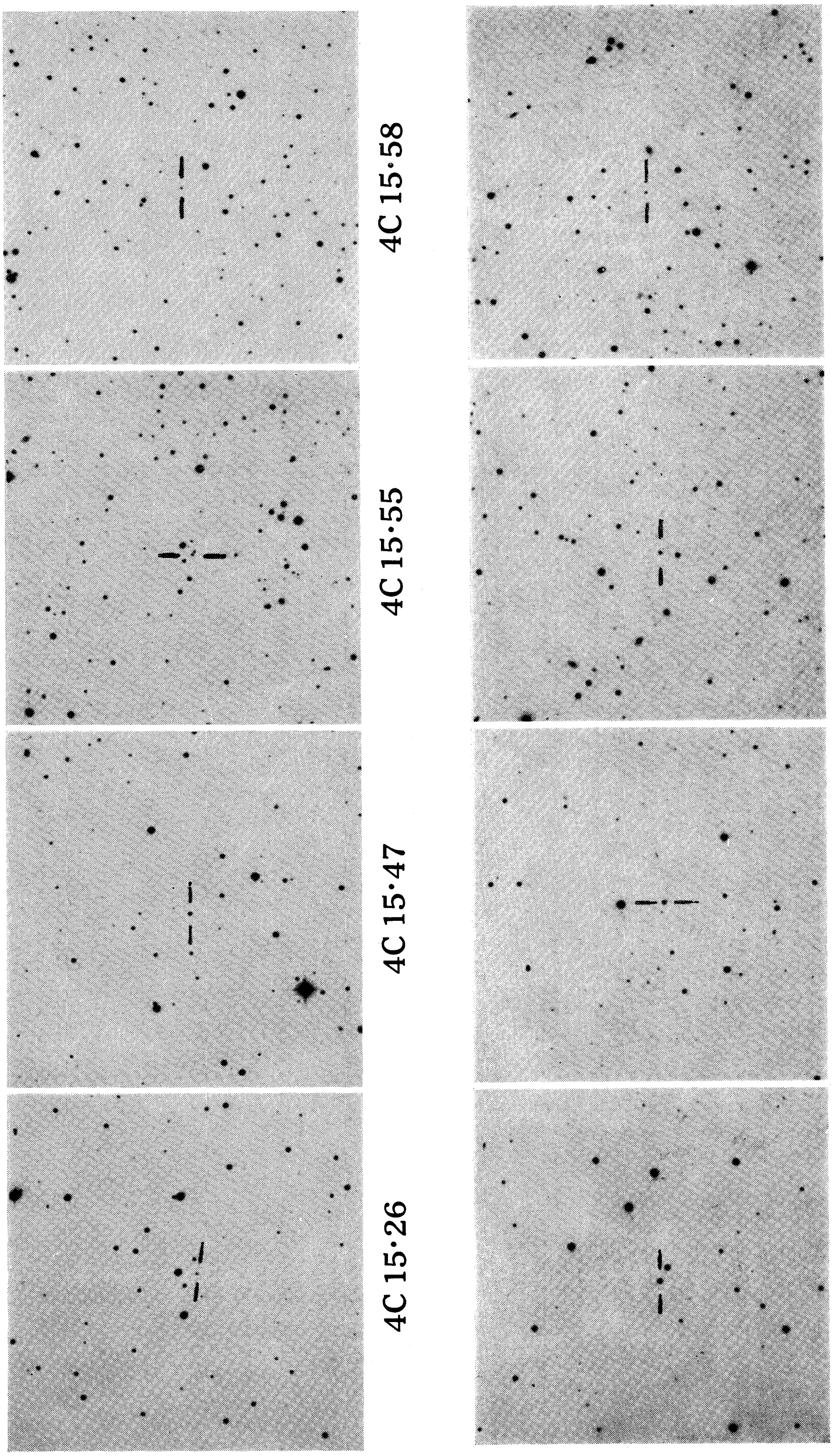

Fig. 11

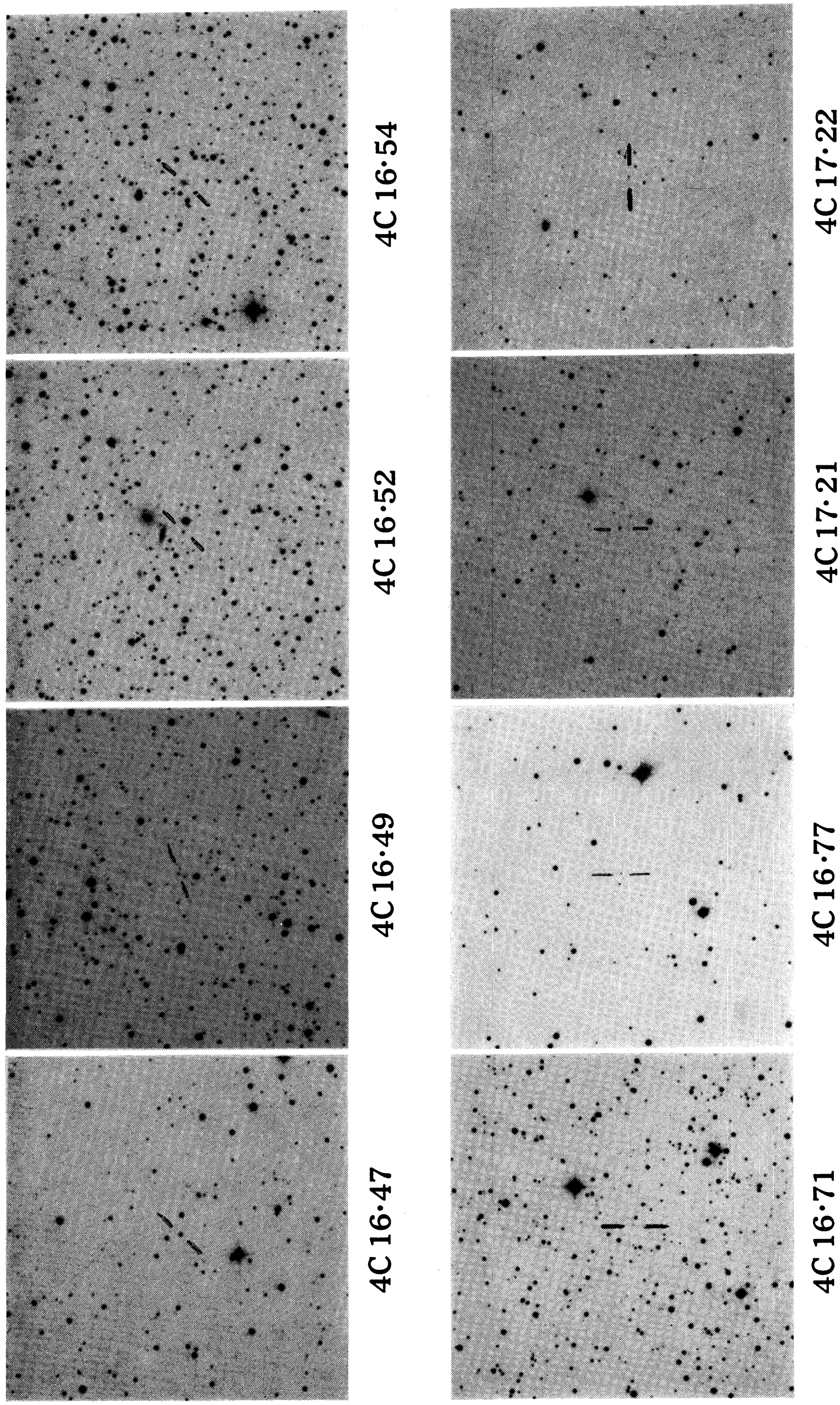

Fig. 12

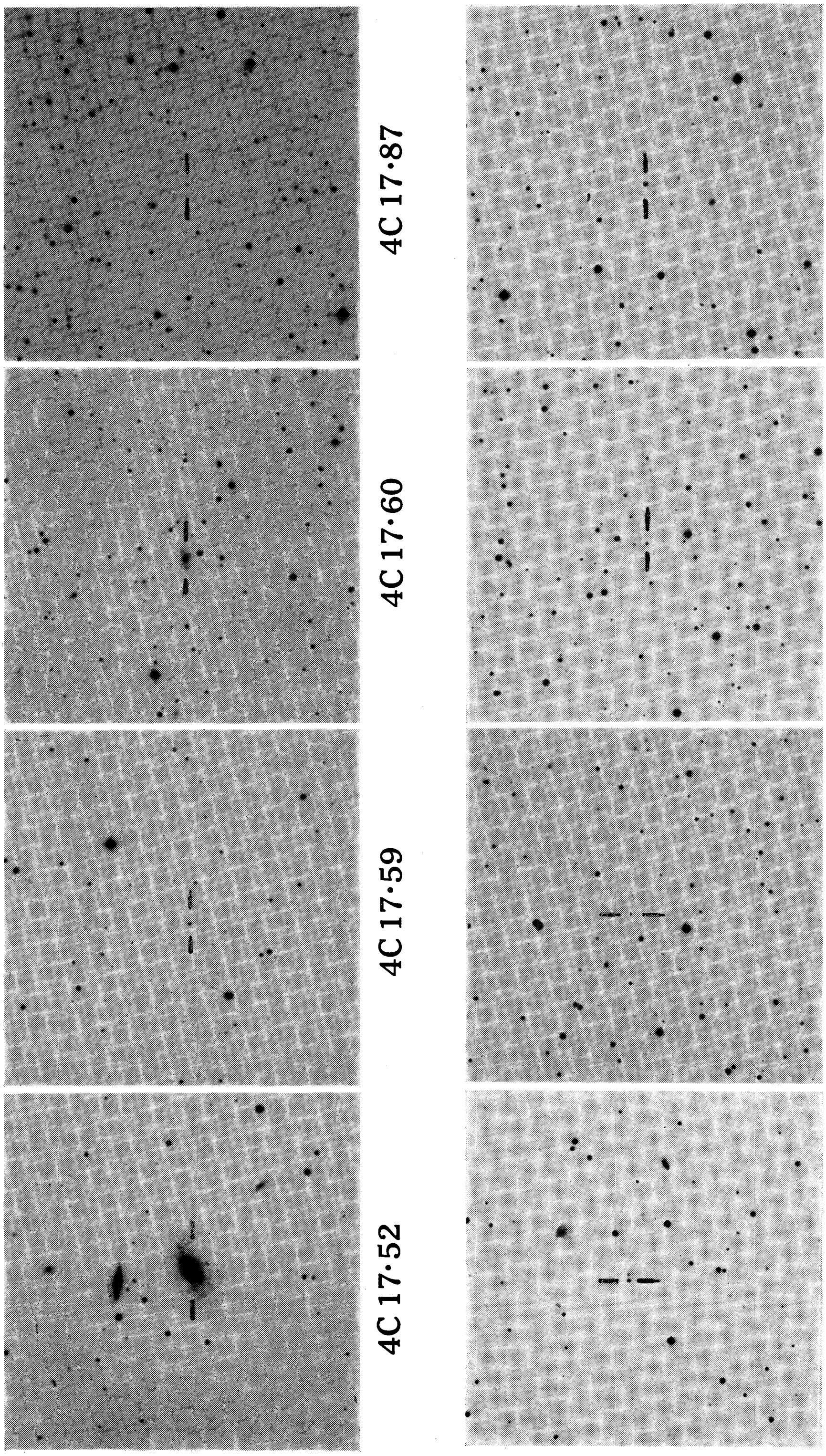
4C 17·87
4C 17·60
4C 17·59
4C 17·52
DW 0839+18
4C 18·22
4C 18·11
4C 18·07

Fig. 13

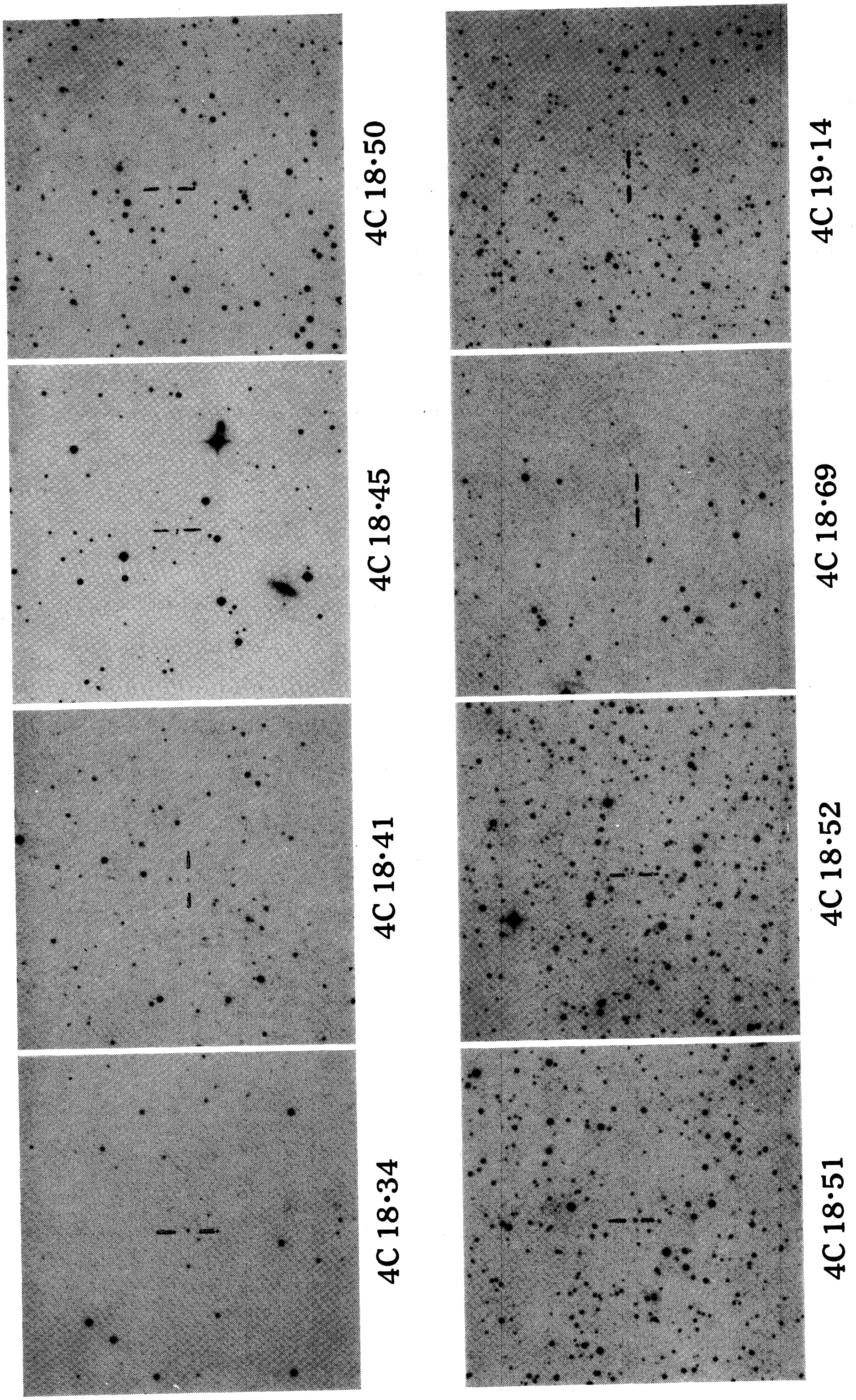

Fig. 14

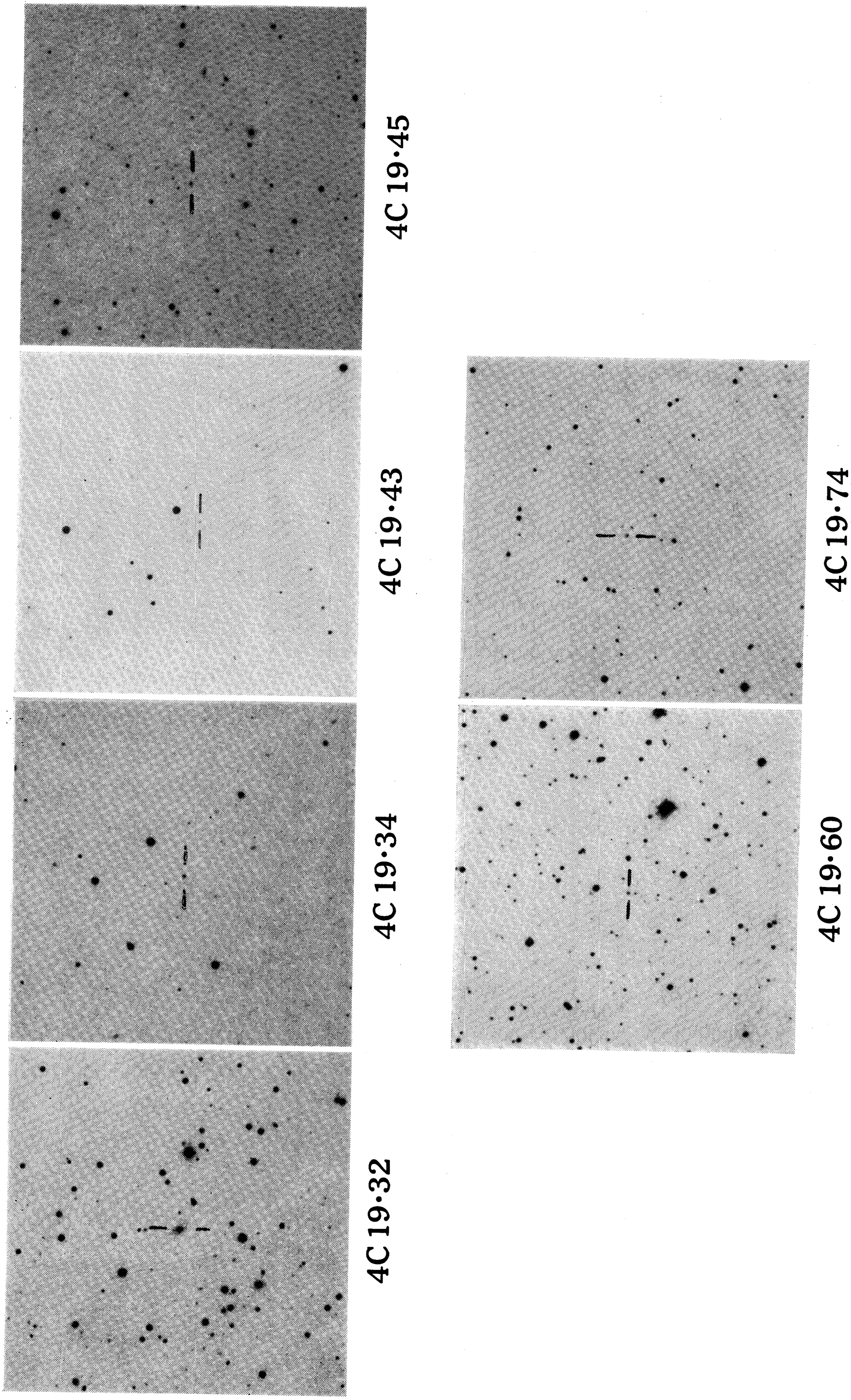

Fig. 15

72 fields contained a stellar object which was noticeably brighter on the blue survey print and which could be a quasi-stellar object.

No identifications could be suggested for the remaining sources. Classifications of their fields given in Table 2 are: III, field contains a few stars of normal colour; IIIa, as for III but some obscuration possibly present; IIIb, blank; IIIc, very crowded star field; IV, field obscured.

Finding charts for the 94 suggested identifications are given in Figures 4–15. The charts were prepared from the Palomar Sky Survey prints and are 10′ arc square, with north at the top and east to the left. Blue prints were used for the finding charts of suggested quasi-stellar objects and for the galaxies 4C 05·48 and 08·41, and red prints for the remainder of the galaxies.

VII. Source List

The results of the position measurements and identification search are given in Table 2.

Column 1 gives the 4C catalogue number and columns 2 and 3 the measured position of the source. Where, in seven cases, two positions are listed for the same 4C number the 4C results are probably a combination of the two sources.

Columns 4 and 5 contain the flux densities at 2700 MHz from the present observations and at 178 MHz from the 4C catalogue. The latter value is given in parentheses where two sources were found at 2700 MHz corresponding to one 4C source.

Column 6 contains the spectral index,* α_{2700}^{178}. The value is shown in parentheses where the 2700 MHz observation was affected by a confusing source or the source appeared to be extended in one or both coordinates.

Column 7 contains the source identification or, in cases where no identification is suggested, the field class as described in Section VI. Abbreviations used are: E, elliptical galaxy; N, galaxy with a bright semi-stellar nucleus; db, double galaxy; g, galaxy which is too faint to be classified; QSO?, possible quasi-stellar object.

Photographic magnitudes for the galaxies and visual magnitudes for the quasi-stellar objects are given in column 8. These were estimated from the Sky Survey prints and may be in error by as much as 1^m.

Columns 9 and 10 give the differences between the measured radio position of the source and the position of the suggested optical identification, as estimated from the Sky Survey prints.

Column 11 contains remarks on the 2700 MHz observations and on optical objects close to the radio position but outside the estimated error of the position measurement. Abbreviations used are: conf., confused; ext., extended; pol., strongly polarized at 2700 MHz; BSO, blue stellar object; Sp., spiral galaxy; n., north; s., south; p., preceding; f., following. "R.A. from 4C" indicates that the 4C right ascension is given in column 2. The 4C value was used in a few cases where the source was weak at 2700 MHz and the 2700 MHz observation was marred by interference or receiver instability.

* Spectral index is defined by $S(\nu) \propto \nu^{-\alpha}$, where ν is the frequency.

TABLE 2

POSITIONS AND IDENTIFICATIONS OF SOURCES

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α^{178}_{2700}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
04.14	03 51 46.8	04 32 07	0.34	3.6	0.85	III				
04.15	04 23 38.9	04 43 32	0.65	6.3	0.85	IIIa				
04.16	04 32 33.4	04 27 44	0.54	5.0	0.80	III				
04.30	09 05 14.2	04 25 51	0.37	3.9	0.85	IIIa				
04.33	09 44 06.1	04 32 48	0.33	2.3	0.70	E	16.5	2 p.	2 n.	
04.34	10 17 57.9	04 05 52	0.33	3.4	0.85	III				
04.35	11 07 35.8	04 33 36	0.34	4.7	(0.95)	III				19^m g 0'.8 s.p. Conf. in Dec.
04.37	11 52 19.1	04 40 20	0.41	4.8	(0.90)	III				Conf. or ext. in Dec.
04.43	12 24 21.1	04 45 14	0.35	3.3	0.80	III				
04.46	13 38 50.1	04 29 07	0.38	3.5	0.80	g	19	0	0	
04.49	14 56 29.7	04 28 03	0.68	4.2	0.65	III				
04.59	17 19 47.3	04 45 54	0.38	7.0	1.05	IIIc				
04.63	18 10 47.9	04 38 24	1.23	9.4	0.75	IIIc				
04.69	19 51 00.3	04 26 33	0.24	2.2	0.80	IIIc				Pol.
04.72	21 11 03.5	04 32 39	0.35	2.9	0.90	III				
04.75	21 42 47.4	04 17 40	0.82	5.6	0.70	QSO?	17	3 f.	0	
05.17	03 59 30.8	05 32 54	0.34	3.6	0.85	III				
05.31	07 31 02.4	05 51 50	0.29	3.0	0.85	IIIa				
05.33	07 40 01.2	05 14 02	0.44	3.6	(0.75)	IIIa				Conf.
05.34	08 05 20.9	04 41 36	0.46	2.6	(0.65)	QSO?	18	2 p.	2 s.	Conf. or ext.
05.35	08 06 04.1	05 59 15	0.29	2.3	0.75	IIIc				
05.36	08 34 08.0	05 23 30	0.15	2.0	0.95	III				
05.37	09 02 30.4	05 49 13	0.25	2.0	0.75	III				
05.38	09 11 24.3	05 19 53	0.26	2.0	0.75	QSO?	16	0	3 n.	
05.39	09 15 08.5	05 35 10	0.34	2.4	0.70	III				
05.40	09 44 32.4	05 56 13	0.35	5.5	1.00	III				
05.41	10 16 53.3	05 50 15	0.18	2.1	0.90	III				
05.42	10 22 56.3	05 33 47	0.19	3.3	1.05	III				18^m g 0'.5 s.f.
05.43	10 28 43.1	04 58 18	0.37	4.8	0.95	g	19	0	0	
05.44	10 36 52.4	05 51 50	0.34	2.8	0.80	g	18.5	1 p.	1 n.	

05.45	10 41 04.3	05 52 39	0.28	3.5	(0.95)	III				Conf. in Dec.
05.46	10 46 57.3	05 21 36	0.16	2.6	1.00	QSO?	18.5	0	1 s.	
05,47	10 57 35.2	04 59 09	0.31	2.3	0.75	III				18^m g 1' s.f.
05.48	11 04 39.8	05 49 23	0.30	4.2	(0.95)	N	18.5	1 f.	0	Or QSO? Conf. in Dec.
05.54	12 36 36.8	05 35 26	0.51	5.1	0.85	III				
05.56	12 51 18.4	05 51 41	0.23	3.1	(0.95)	III				
05.62	14 59 27.9	05 36 43	0.18	3.9	(1.15)	III				Ext.
05.63	15 23 33.3	05 20 33	0.15	3.5	1.15	III				Double or ext. in R.A.
05.67	17 34 51.6	05 38 55	0.29	3.7	(0.95)	IIIc				Nearby source
05.80	21 22 54.8	05 15 19	0.14	2.0	0.95	III				Conf.
05.81	21 50 55.1	05 22 00	0.63	6.3	0.85	QSO?	17	1 p.	1 n.	
05.84	22 22 44.8	05 11 52	0.44	5.8	0.95	QSO?	18	3 p.	0	
06.18	03 49 13.0	06 19 37	0.36	4.8	0.95	III				
06.29	08 01 57.5	06 42 35	0.29	3.3	0.90	III				
06.33	08 52 42.8	06 06 20	0.18	3.3	1.05	IV				Obscured by close bright star
06.34	08 53 49.4	06 45 43	0.22	3.8	1.05	III				
06.35	{09 21 51.1	06 20 08	0.25	(3.6)		QSO?	16	2 f.	0	
	{09 22 41.2	06 19 13	0.18	(3.6)		III				
06.36	09 27 37.6	06 28 25	0.14	3.5	1.20	III				
06.37	09 55 30.3	05 55 27	0.16	2.1	0.95	III				
06.39	10 10 44.4	07 00 04	0.16	2.2	(0.95)	II				17^m g 1' p., 18^m g 0'.6 n.f. Conf.
06.40	10 23 55.2	06 43 32	0.34	9.5	1.25	III				19^m g 0'.5 s.f., BSO 0'.8 s.
										3C 243
06.41	10 38 41.4	06 25 53	1.74	2.8	0.15	QSO?	16.5	1 p.	1 n.	
06.43	12 11 18.3	06 39 33	0.22	3.0	0.95	III				
06.48	13 31 47.0	06 50 05	0.21	3.2	1.00	III				
06.50	14 31 48.6	06 35 15	0.60	4.8	0.75	III				Pol.
06.53	15 08 29.6	05 54 00	0.13	7.0	1.45	III				BSO 1' s.
06.55	16 14 45.9	06 44 19	0.38	3.0	0.75	III				BSO 0'.5 s.f., 18^m g 0'.5 n.f.
06.56	16 19 04.0	06 14 20	0.17	2.2	0.95	g	18.5	2 f.	0	
06.58	16 59 19.4	06 21 09	0.23	3.9	(1.05)	QSO?	18.5	2 f.	3 s.	16^m E 0'.7 f. Conf. or ext. in R.A.
06.60	17 14 12.0	06 02 11	0.36	3.8	(0.90)	III				Conf. or ext. to n.
06.62	17 39 19.4	06 03 56	0.47	4.8	0.85	III				
06.63	17 57 05.2	06 16 42	0.40	4.4	0.90	QSO?	17.5	1 f.	0	Crowded field
06.64	18 05 21.5	06 25 09	0.73	7.0	(0.85)	IIIc				Conf.
06.71	21 58 28.6	06 54 01	0.47	3.7	0.75	III				
07.19	07 35 02.4	07 41 34	0.22	2.8	0.95	IIIa				
07.20	07 37 25.6	07 36 01	0.14	2.5	1.05	III				
07.21	07 51 40.2	07 46 24	0.26	2.1	0.75	III				
07.22	08 10 41.9	07 43 03	0.24	2.3	0.85	E	16.5	2 f.	0	With "jets"
07.23	08 14 36.8	07 19 49	0.15	2.0	0.95	III				

TABLE 2 (*Continued*)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α^{178}_{2700}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
07.26	08 40 17.2	07 32 29	0.32	3.3	0.85	III				
07.27	08 51 08.9	07 06 14	0.70	2.0	0.40	III				
07.28*	09 23 27.4	07 57 28	0.25	2.3	(0.80)	III				
07.31	10 23 27.7	07 50 53	0.24	3.1	0.95	III				
07.33	13 17 54.7	07 00 01	0.39	3.5	0.80	III				
07.35	14 14 31.0	07 24 36	0.76	7.5	0.85	III				Pol.
07.38	14 44 03.0	07 41 22	0.30	4.0	0.95	III				BSO 0'.7 n.
07.42	15 55 20.0	07 17 45	0.65	3.8	0.65	III				
07.43	16 06 15.6	07 40 43	0.34	3.2	0.80	III				
07.44	16 43 47.6	07 31 16	0.44	2.2	0.60	III				
07.45	17 20 35.2	07 20 40	0.76	8.0	0.85	III				
07.46	17 43 41.2	07 29 29	0.29	4.1	0.95	QSO?	17	3 f.	1 n.	
07.47	17 55 03.5	07 31 33	0.37	5.1	0.95	III				NRAO 541
07.53	20 28 20.3	07 52 10	0.23	3.0	0.95	III				
07.57	22 07 40.8	07 07 01	0.47	3.8	0.75	III				
07.58 {	22 11 39.5	06 56 42	0.27	(3.7)		III				2 BSOs 0'.7 p.
	22 11 51.0	07 11 30	0.22	(3.7)		III				
08.15	04 24 40.0	08 46 32	0.48	3.7	(0.75)	QSO?	17.5	1 p.	1 n.	Conf. in Dec.
08.17	05 26 55.7	08 57 43	0.39	3.7	0.85	IV				
08.29	09 19 15.6	08 41 33	0.28	3.5	0.95	III				
08.30	09 28 21.8	08 43 35	0.12	2.1	1.05	III				
08.31	09 32 23.8	08 55 01	0.49	3.3	0.70	III				
08.32	09 50 28.5	08 57 49	0.18	2.5	0.95	III				BSO 0'.8 n.p.
08.33	10 47 28.9	08 25 43	0.20	2.8	0.95	III				
08.38	13 12 39.1	08 55 54	0.40	3.8	0.85	III				
08.41	14 12 07.7	08 18 50	0.14	3.4	1.15	db	18.5	1 f.	1 n.	
08.47	16 07 00.0	08 52 00	0.31	3.3	0.85	III				
08.49	17 41 43.2	08 16 48	0.25	3.3	(0.95)	III				Conf. or ext. in Dec.
08.50	17 45 03.3	08 49 42	0.39	3.5	0.80	III				
08.51	17 56 01.3	08 28 35	0.38	3.5	0.80	IIIc				

08.53	18 20 00.3	08 09 14	0.13	2.1	1.05	IIIc				R.A. from 4C
08.57	20 12 33.6	08 39 38	0.25	2.0	0.75	IIIc				
08.60	20 55 24.0	08 49 01	0.13	2.4	1.10	III				BSO 1' f.
08.61	20 57 03.5	08 50 39	0.20	2.3	(0.90)	III				Conf. source f.
08.62	21 28 55.3	08 59 11	0.59	4.4	0.75	QSO?	18	1 p.	1 n.	
08.65	22 11 27.0	08 58 06	0.45	3.4	0.75	III				
08.67	22 26 41.0	08 59 06	0.44	5.6	0.95	III				
09.17	04 45 36.7	09 45 40	0.66	4.2	0.70	QSO?	19.5	0	0	
09.20	05 21 12.4	09 01 43	0.22	2.6	0.90	IV				
09.28	08 17 59.2	09 56 37	0.42	5.7	0.95	III				
09.29	08 26 53.4	09 35 40	0.38	5.4	0.95	III				
09.31	08 46 57.3	10 00 42	0.29	3.0	(0.85)	QSO?	18.5	1 f.	1 s.	Conf.
09.33	09 09 50.0	09 24 50	0.17	2.2	0.95	III				
09.34	09 25 14.9	09 17 36	0.18	2.3	0.95	III				
09.35	09 52 17.6	09 44 19	0.25	2.4	0.85	QSO?	18	0	2 s.	
09.36	10 13 53.6	09 59 12	0.31	2.1	0.70	III				BSO 0'.6 f.
09.37	10 47 47.0	09 41 54	0.22	2.7	0.90	QSO?	18.5	4 f.	2 s.	
09.38	10 57 04.6	09 16 46	0.29	5.0	1.05	III				
09.48	13 52 47.3	09 54 18	0.28	3.1	0.90	III				
09.50	14 24 05.4	09 38 40	0.25	3.1	0.90	III				
09.52	14 51 27.6	09 46 27	0.34	3.7	0.90	QSO?	18.5	0	0	
	14 51 32.4	09 27 30	0.28			III				BSO 0'.5 n.f. Uncatalogued source near 4C 09.52
09.53	15 03 54.0	09 46 23	0.29	3.2	0.90	III				
09.55	17 19 43.6	09 23 14	0.26	3.8	1.00	IV				Obscured by "ghost" image of bright star
09.56	17 46 22.3	09 20 00	0.20	6.8	1.30	IIIc				
09.57	17 49 11.1	09 39 36	1.66	4.2	(0.35)	QSO?	19	0	2 s.	Possibly not the 4C source
09.58	18 11 54.6	09 20 53	0.42	3.0	0.70	IIIc				Pol.
09.68	20 23 50.7	09 27 35	0.11	2.0	1.05	IIIc				R.A. from 4C
09.71	22 55 12.5	09 16 57	0.33	3.1	0.80	III				
09.72	23 08 47.2	09 51 56	0.36	3.1	0.80	QSO?	16.5	2 p.	1 s.	
10.13	04 17 28.5	10 38 14	0.36	3.2	0.80	III				
10.23	07 44 31.2	09 59 36	0.39	3.2	0.80	III				
10.26	09 28 29.2	10 09 48	0.22	3.2	1.00	IIIb				
10.28†	{10 01 09.2	10 33 38	0.14	(2.3)		III				BSO 0'.8 s. Conf. or ext. in R.A.
	(10 01 35.1	10 33 38)	0.14	(2.3)		III				R.A. from 4C

*For 4C 07.28 the position given is the mean of two components, separation approximately $2^s.4$ in R.A., 5′ arc in Dec.

†For 4C 10.28 the right ascension is very uncertain. A search for the optical identification was also made at the same declination, using the 4C right ascension.

TABLE 2 (*Continued*)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α_{2700}^{178}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
10.29	10 17 27.3	10 54 59	0.23	2.6	0.90	III				
10.30	10 58 10.5	11 02 23	0.38	4.5	0.90	QSO?	18	0	1 s.	Pol.
10.32	11 26 53.8	10 27 23	0.24	2.1	0.80	III				
10.33	11 30 24.9	10 40 18	0.47	4.1	0.80	QSO?	17	2 p.	0	
10.34	12 03 23.1	10 59 48	0.22	2.2	0.85	QSO?	17.5	1 p.	1 s.	
10.35	13 06 36.6	10 45 26	0.28	2.5	0.80	II				Abell cluster. 17^m g 0′.7 p.
10.36	13 38 38.0	10 47 03	0.30	2.9	0.85	QSO?	19	2 f.	2 s.	
10.37	13 59 46.6	10 20 26	0.21	2.1	0.85	III				
10.38	14 05 52.4	10 22 01	0.25	3.7	1.00	III				
10.40	15 09 03.0	10 12 48	0.36	3.1	0.80	III				
10.42	15 19 50.0	10 23 29	0.19	2.2	0.90	III				R.A. from 4C
10.46	16 18 47.2	10 53 18	0.61	3.4	0.65	III				BSO 0′.6 s.p.
10.47	16 37 27.0	10 34 47	0.31	5.0	1.00	III				
10.55	18 02 19.6	09 59 49	0.64	5.0	0.75	IIIc				BSO 0′.4 p. Pol.
10.56	18 07 53.8	10 16 48	0.22	4.2	(1.10)	IIIc				Conf. Possibly not the 4C source
10.61	19 56 20.2	10 26 36	0.23	2.7	(0.90)	IIIc				Conf. or ext. in Dec.
10.62	20 02 07.5	10 21 11	0.45	3.6	0.75	IIIc				Pol.
10.63	20 21 18.6	10 31 29	0.21	3.5	1.05	III				
10.64	20 57 39.2	10 11 32	0.20	2.5	0.95	III				
10.67	21 58 49.6	10 08 34	0.28	3.2	(0.90)	III				BSO 0′.5 n. Conf. in Dec.
11.19	04 37 26.6	11 28 20	0.42	3.0	0.70	III				
11.20	05 23 27.9	11 38 28	0.49	5.5	0.90	IV				
11.27	07 45 06.8	11 53 32	0.23	2.6	0.90	III				
11.28*	08 30 34.1	11 38 10	0.35	5.0	(0.95)	QSO?	17	2 p.	1 s.	
11.30	08 41 00.6	11 24 56	0.19	2.7	0.95	III				
11.32	09 26 02.3	11 47 16	0.26	3.0	0.90	QSO?	19	1 p.	2 n.	
11.33	09 58 49.2	11 23 14	0.27	2.9	0.85	g	18.5	0	1 s.	Other gals nearby
11.34	10 11 37.6	11 06 13	0.52	2.7	0.60	QSO?	19.5	1 p.	1 s.	
11.35	10 31 25.9	11 27 41	0.65	5.4	0.80	III				Nearby source
11.36	10 42 05.0	10 54 01	0.09	2.1	(1.05)	III				Possibly not the 4C source

11.37	10 55 47.9	11 21 44	0.17	2.2	0.95	III				
11.38	11 02 00.4	11 19 30	0.37	3.6	0.85	III				
11.41	11 56 55.4	11 02 42	0.35	3.6	0.85	III				
11.42	12 01 52.5	11 45 48	0.33	2.0	(0.65)	IIIb				Conf.
11.44	13 01 29.3	11 43 06	0.18	2.6	(1.00)	III				Conf. source 10' n.
11.46	13 50 28.2	11 21 40	0.78	3.4	0.55	III				
11.49	15 21 32.7	11 06 18	0.56	4.0	0.70	db	18.5	1 f.	0	In cluster
11.50	15 48 21.4	11 29 28	0.52	3.9	0.75	QSO?	17.5	0	3 n.	
11.51	15 56 56.0	11 24 30	0.39	3.2	0.80	III				Possibly faint cluster
11.52	16 01 46.6	11 36 00	0.30	3.4	0.90	QSO?	18.5	0	0	Pol.
11.61	20 07 14.7	12 00 23	0.16	2.0	0.95	IIIc				
11.62	20 14 50.5	11 36 59	0.20	2.4	0.90	IIIc				
11.63	20 19 05.7	11 26 30	0.28	3.0	0.85	IIIc				
11.64	20 22 59.6	11 56 43	0.45	3.3	0.75	IIIc				
11.65	20 57 42.0	12 12 48	0.19	2.3	0.90	IIIc				
11.66	21 36 01.8	11 44 23	0.36	3.7	0.85	IIIc				
11.70	22 39 06.3	11 29 53	0.43	3.8	0.80	QSO?	15.5	2 f.	2 s.	
12.16	03 48 36.5	12 33 42	0.32	3.6	(0.90)	III				Conf. in R.A.
12.22	05 01 57.4	12 40 18	0.28	3.3	0.90	III				
12.31	07 42 41.9	12 16 58	0.36	4.0	0.90	III				
12.33	09 00 54.7	12 42 26	0.27	2.4	0.80	III				
12.34	09 15 25.6	12 40 32	0.31	2.3	0.75	III				
12.35	09 43 07.1	12 19 20	0.27	2.1	0.75	QSO?	19.5	1 f.	2 n.	BSO 0'.7 n.f.
12.36	09 48 08.4	12 29 36	0.19	2.6	0.95	III				
12.38	11 04 43.3	12 55 58	0.34	3.8	0.90	III				
12.40	11 18 49.6	12 52 27	0.13	2.1	1.00	III				
12.43	11 58 22.4	12 27 06	0.23	2.7	0.90	III				
12.44	11 59 35.3	13 02 20	0.15	2.9	1.10	IIIb				Source 13' p.
12.46	13 07 05.5	12 10 21	0.58	2.1	0.50	QSO?	19	2 p.	0	
12.47	13 08 25.8	12 05 38	0.35	2.6	0.60	III				
12.48	13 25 26.6	12 38 32	0.35	2.3	(0.70)	III				Conf. source 10' s.
12.51	13 59 22.9	12 30 27	0.20	2.0	0.85	III				
12.52	14 01 05.6	12 20 18	0.15	2.3	1.00	III				
12.56	15 56 47.4	12 19 14	0.34	3.9	0.90	III				Possibly faint cluster
12.57	16 20 43.3	12 46 54	0.25	3.3	0.95	III				

*For 4C 11.28 the declination given is the mean of two components, separation approximately 7′ arc in Dec.

Table 2 (*Continued*)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α^{178}_{2700}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
12.59	16 29 24.6	12 02 28	1.04	4.4	0.50	QSO?	18.5	2 p.	0	
12.60	16 38 28.4	12 25 42	1.48	3.4	0.30	QSO?	19	1 p.	3 s.	
12.62	18 18 22.9	12 39 54	0.32	3.6	0.90	IV				
12.63	18 20 22.2	12 14 48	0.47	2.6	0.65	IIIc				16^m g? 0'.5 s.
12.64	18 22 42.7	12 45 54	0.37	2.5	0.70	IIIc				
12.71	20 49 35.5	12 43 47	0.24	2.9	0.90	III				
12.76	21 53 16.5	12 16 19	0.22	4.4	1.10	QSO?	19	3 p.	2 s.	17^m g 1' n.
13.27	04 52 31.6	13 52 04	0.24	3.9	1.00	III				18^m g 0'.6 n.
13.29	05 17 23.7	13 39 16	0.12	(4.2)		IIIa				
	05 17 24.9	13 53 41	0.13	(4.2)		IIIa				
13.39	08 43 01.8	13 40 08	0.28	2.8	0.85	QSO?	17.5	0	3 s.	
13.40	08 58 56.4	13 51 23	0.27	2.1	0.75	III				
13.42	10 12 24.9	13 28 28	0.13	2.3	1.05	III				
13.43	11 26 43.1	13 24 37	0.24	2.8	0.90	III				Possible faint gal. 0'.2 s.
13.44	11 34 14.6	13 22 26	0.22	3.5	1.00	III				
13.46	12 10 59.5	13 23 58	0.95	3.1	0.45	QSO?	18	2 p.	0	
13.48	13 27 49.6	13 17 42	0.16	2.3	1.00	III				
13.49	13 55 19.2	13 36 59	0.17	2.5	1.00	III				
13.51	14 09 15.6	13 18 06	0.19	2.1	0.90	III				
13.52	14 26 20.5	13 10 00	0.31	2.3	0.75	g	18	0	0	Pol.
13.55	15 30 53.8	13 42 23	0.63	4.7	0.75	QSO?	19	1 f.	0	
13.57	16 13 52.4	13 10 46	0.44	5.0	0.90	III				
13.60	16 27 29.9	13 48 59	0.36	3.0	0.80	III				Pol.
13.61	16 38 15.6	13 12 57	0.29	3.5	0.90	III				BSO 0'.6 s.f.
13.62	16 42 22.1	13 10 44	0.52	5.0	0.85	III				
13.64	16 46 59.4	13 18 03	0.13	2.5	1.10	III				
13.65	17 56 14.5	13 28 49	1.26	9.0	0.70	IIIc				
13.76	20 15 33.7	13 08 11	0.30	2.8	0.80	IIIc				
13.77	20 36 02.8	13 38 50	0.19	2.0	0.85	IIIc				
13.78	20 48 50.3	13 37 27	0.09	2.2	1.20	III				

13.79	20 59 39.7	14 00 43	0.25	3.2	0.95	III				
13.80	21 01 13.9	13 55 58	0.38	3.5	0.80	III				
13.85	22 51 53.1	13 25 51	0.98	4.7	0.60	QSO?	19.5	3 p.	0	
14.13	05 14 53.9	14 09 14	0.22	3.4	1.00	III				
14.14	05 16 40.6	14 25 47	0.50	3.3	0.70	IV				
14.26	08 29 10.4	14 03 15	0.28	3.1	0.90	IIIa				
14.27	08 32 16.8	14 22 11	0.56	9.3	1.05	III				
14.33	09 42 44.7	14 41 53	0.25	2.7	0.85	III				
14.35	09 57 43.9	14 15 46	0.68	5.1	0.95	III				
14.36	10 07 13.3	14 16 43	0.60	3.5	0.65	E	17.5	1 f.	1 s.	
14.37	10 43 52.7	14 03 14	0.14	2.0	0.95	III				NGC 3367 is 2' s.f.
14.38	10 51 53.6	14 47 37	0.33	3.2	0.85	III				
14.39	11 04 13.4	14 11 35	0.25	2.2	0.80	E	16.5	3 p.	2 s.	Pol.
14.40	11 05 30.0	14 51 57	0.82	3.0	0.45	III				
14.42	11 32 45.1	15 00 12	0.24	2.4	0.85	g	18	3 f.	2 n.	
14.43	11 33 23.7	14 02 19	0.12	2.0	1.05	III				
14.44	11 46 06.8	14 18 48	0.16	2.8	(1.05)	III				14^m Sp 1' n.f.
14.45	11 54 06.2	14 41 16	0.16	3.1	(1.10)	III				Conf.
14.46	12 11 54.3	14 19 40	0.38	3.7	0.85	III				
14.48	13 28 47.5	14 08 13	0.35	2.8	(0.75)	III				Ext. in R.A.
14.50	13 47 29.0	14 21 33	0.13	2.3	1.05	III				
14.51	14 08 36.4	14 10 48	0.45	3.7	0.75	III				
14.52	14 17 17.4	14 26 34	0.15	(3.2)		III				
	14 17 21.5	14 01 33	0.14	(3.2)		E	17	2 p.	3 s.	
14.60	15 38 30.6	14 57 26	1.98	3.6	0.20	III				
14.63	16 16 52.9	14 39 58	0.38	3.7	0.85	III				
14.64	16 20 14.6	14 33 23	0.23	(3.1)		III				
	16 20 16.9	14 23 24	0.24	(3.1)		III				
14.66	16 26 22.3	14 44 42	0.50	8.5	1.05	III				BSO 0'.6 n.p.
14.67	16 28 00.3	14 41 20	0.28	2.8	0.85	QSO?	17	0	4 n.	NRAO 503
14.68	16 58 23.1	14 52 57	0.92	7.8	0.80	III				Pol.
14.75	20 27 38.1	14 32 48	0.15	2.5	1.05	IIIc				BSO 0'.6 n.f.
14.76	20 49 27.7	14 57 55	0.50	4.0	0.75	IIIc				
14.77	21 06 17.7	14 17 19	0.43	2.4	(0.65)	III				Conf. source s.
14.79	21 40 44.9	14 00 14	0.24	2.3	0.85	III				
14.81	21 52 09.8	14 29 23	0.56	6.3	0.90	III				NRAO 673
14.82	22 47 57.1	14 04 06	1.34	4.0	0.40	QSO?	17.5	1 p.	0	
15.12	04 01 12.6	15 52 16	0.33	(3.9)		III				
	04 02 10.3	16 02 38	0.56	(3.9)		III				
15.14	04 26 24.6	15 44 19	0.16	2.8	(1.05)	III				Conf. in R.A.

TABLE 2 (*Continued*)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α^{178}_{2700}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
15.15	04 42 30.0	15 05 09	0.25	3.0	0.90	III				
15.16	05 26 06.2	15 16 56	0.66	6.8	0.85	III				
15.21	07 38 44.9	15 43 46	0.36	3.1	0.80	III				
15.22	08 06 04.2	15 16 03	0.24	2.0	0.80	III				
15.23	08 22 24.3	15 07 31	0.46	4.2	0.80	III				
15.24	08 29 57.9	15 28 35	0.14	2.6	1.10	III				
15.26	08 43 19.2	15 10 11	0.35	4.0	0.90	QSO?	18.5	1 f.	3 n.	Nearby source 18^m g 1' p.
15.27	08 53 10.8	15 23 46	0.17	2.2	0.95	III				
15.28	08 55 36.4	15 50 51	0.28	3.0	0.85	III				
15.29	09 01 24.8	15 43 10	0.14	2.1	1.00	III				
15.30	09 05 12.6	15 00 35	0.36	2.6	0.75	IIIb				
15.31	09 14 56.7	15 57 28	0.29	2.8	0.85	III				
15.32	10 25 38.7	15 26 55	0.35	4.3	(0.90)	III				Conf. in R.A.
15.33	10 39 03.8	15 21 06	0.27	2.7	0.85	II				Cluster of faint gals, 18^m g 0'.4 p. Pol.
15.34	10 43 55.7	15 59 28	0.55	6.0	0.90	III				
15.35	10 45 17.9	15 30 54	0.17	2.2	(0.95)	II				Abell cluster. Conf.
15.36	10 57 59.5	15 40 37	0.24	3.1	0.95	III				
15.37	11 38 32.9	15 15 19	0.19	3.0	1.00	III				
15.38	11 57 59.5	15 02 36	0.17	2.1	0.90	III				
15.39	12 02 10.6	15 18 33	0.26	2.6	0.85	II				Abell cluster
15.41	12 54 41.4	15 20 56	0.36	3.6	0.85	III				
15.42	12 59 12.3	15 02 47	0.28	2.8	0.85	III				BSO 0'.5 f.
15.43	13 26 08.6	15 03 45	0.26	3.5	0.95	III				
15.44	14 08 44.0	15 31 44	0.17	2.1	(0.90)	III				2 19^m gals 0'.7 n.f. Conf.
15.46	15 11 52.4	15 52 50	0.11	2.0	1.05	III				
15.47	15 18 11.7	15 37 02	0.27	2.1	0.75	QSO?	17	2 p.	1 n.	
15.49	15 30 54.8	15 26 33	0.59	3.1	0.60	III				BSO 0'.4 n.
15.55	16 22 57.6	15 52 16	0.57	5.2	0.80	QSO?	18	0	1 s.	Pol.
15.56	16 35 32.8	15 54 40	0.32	6.5	1.10	III				
15.57	16 36 18.3	14 58 34	0.21	2.2	0.85	III				

15.58	16 39 45.3	15 31 20	0.37	2.8	(0.95)	QSO?	19	5 p.	1 s.	Ext. or double in R.A.
15.60	18 10 09.1	15 33 41	0.40	2.8	0.70	III				
15.61	18 33 36.2	15 13 27	0.58	4.4	0.75	IIIc				Pol.
15.69	20 18 52.2	15 35 36	0.25	2.1	0.80	IIIc				
15.70	20 24 36.3	15 27 23	0.53	7.7	1.00	IIIc				
15.71	20 35 23.5	15 55 40	0.24	2.5	0.85	IIIc				
16.11	04 40 04.1	16 45 22	0.26	2.5	0.85	III				
16.22	07 36 32.2	16 41 32	0.17	2.7	1.00	III				
16.23	07 46 06.9	16 17 14	0.26	2.3	0.80	III				
16.24	07 48 11.3	16 28 13	0.37	2.5	0.75	III				
16.25	08 19 44.2	16 57 49	0.37	4.2	0.90	III				
16.28	09 54 43.9	16 20 51	0.36	3.2	0.80	III				
16.29	10 14 24.1	17 00 20	0.19	2.1	0.90	III				
16.30	11 04 35.2	16 44 06	0.68	3.9	0.65	QSO?	16.5	2 f.	0	
16.31	11 21 57.1	16 33 26	0.14	2.0	0.95	III				
16.32	12 21 22.9	16 24 20	0.41	2.3	0.65	III				
16.35	13 13 24.2	16 33 07	0.17	2.0	0.90	III				
16.36	13 35 32.0	17 04 05	0.14	2.0	(0.95)	III				Conf. or ext.
16.37	13 48 32.1	16 06 48	0.36	3.1	0.80	III				
16.39	14 00 20.7	16 14 28	0.56	2.2	0.50	QSO?	16.5	2 p.	0	Pol.
16.40	14 31 04.5	16 19 50	0.18	2.1	(0.90)	III				Ext.
16.41	14 42 44.9	17 01 45	0.20	2.2	(0.90)	III				Conf. in R.A.
16.43	14 53 43.9	16 39 47	0.56	6.8	(0.90)	III				Conf. in Dec. NRAO 461
16.44	15 04 49.0	16 19 09	0.26	2.6	0.85	QSO?	17	3 f.	0	
16.45	15 23 14.6	16 06 19	0.29	2.5	(0.80)	QSO?	18.5	4 p.	0	Ext. in R.A.
16.46	15 57 36.8	16 26 59	0.63	3.1	0.60	III				
16.47	16 48 20.1	16 50 08	0.30	4.2	0.95	QSO?	17	2 f.	0	
16.48	17 25 23.2	16 46 36	0.12	2.6	1.10	III				
16.49	17 32 27.7	16 02 27	0.68	10.5	1.00	QSO?	18.5	1 p.	3 n.	
16.51	17 39 14.4	16 17 16	0.17	3.0	1.05	III				
16.52	17 40 38.0	16 12 57	0.36	2.9	0.75	QSO?	18.5	0	0	16^m Sp 0'.6 n.f., 15^m E 1'.0 n.
16.53	17 42 50.2	16 35 39	0.39	3.4	0.80	III				
16.54	17 46 15.0	16 45 02	0.10	3.0	1.25	g	16.5	0	1 s.	R.A. from 4C
16.55	17 55 29.2	16 35 35	0.35	3.9	(0.90)	III				Ext. in R.A.
16.56	18 07 23.5	16 35 51	0.22	2.3	0.85	III				
16.57	18 20 17.0	16 29 10	0.16	3.4	(1.10)	IIIc				Conf.
16.58	18 23 06.2	16 15 37	0.33	2.6	(0.75)	IIIc				Ext. in R.A.
16.59	18 28 47.4	16 21 02	0.11	2.0	1.05	IIIc				
16.67	20 12 46.2	16 13 13	0.37	4.3	0.90	IIIa				
16.68	20 21 18.2	16 51 47	0.59	5.2	0.80	III				

TABLE 2 (Continued)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α_{2700}^{178}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
16.69	20 41 59.8	16 59 58	0.39	4.5	0.90	III				
16.70	20 42 41.7	16 23 37	0.29	3.1	0.85	III				
16.71	20 49 06.3	16 41 33	0.41	3.7	0.80	QSO?	19.5	1 f.	0	
16.73	21 31 07.6	16 16 22	0.07	4.3	1.50	III				BSO 0'.6 s.f., R.A. from 4C
16.74	22 10 45.3	16 25 51	0.17	2.9	1.05	III				
16.77	22 41 35.8	16 17 28	0.51	4.0	0.75	QSO?	19	1 p.	2 s.	
16.79	22 49 27.8	17 01 27	0.32	3.1	0.85	III				17^m g 1' n.f.
17.16	03 29 26.0	17 02 36	0.14	3.2	1.15	III				
17.18	03 45 06.6	17 40 28	0.44	2.6	0.65	III				
17.20	03 51 10.4	17 16 59	0.33	3.2	0.85	III				
17.21	04 02 27.6	17 58 12	0.47	2.2	0.55	g	18	0	0	R.A. from 4C
17.22	04 04 36.4	17 42 35	0.28	2.0	0.75	QSO?	19	0	3 n.	
17.23	04 08 48.0	17 06 19	0.57	5.5	0.85	III				
17.25	04 22 31.5	17 48 58	0.49	2.3	0.55	IV				Obscured by nearby bright star
17.27	04 39 35.1	17 54 18	0.22	2.3	0.85	III				
17.28	04 44 13.3	17 09 07	0.29	2.8	(0.85)	IV				Conf. or double in Dec.
17.29	04 46 14.8	17 36 40	0.29	3.1	0.85	IV				Nearby source
17.30	04 49 23.6	17 40 14	0.13	2.1	1.00	III				
17.31	05 05 05.4	17 20 02	0.39	4.5	0.90	III				
17.42	07 38 07.6	17 52 50	0.19	2.1	0.90	III				
17.43	08 12 44.2	17 50 29	0.20	3.1	1.00	III				
17.47	08 57 34.8	17 06 22	0.22	3.3	(1.00)	III				Conf.
17.49	09 42 29.1	17 08 58	0.58	4.5	0.75	III				
17.50	10 30 46.9	17 58 12	0.51	2.8	0.65	III				
17.52	11 37 41.2	18 00 28	0.75	3.4	0.55	E	13.3	0	1 s.	NGC 3801
17.53	11 49 25.3	17 24 11	0.17	3.0	0.85	IIIb				
17.54	12 12 37.2	17 46 25	0.53	2.9	0.65	III				
17.55	12 45 40.9	17 01 56	0.23	3.2	0.95	III				
17.58	14 30 40.7	17 16 06	0.51	2.2	0.55	III				
17.59	14 33 36.4	17 42 36	0.64	4.2	0.70	QSO?	17.5	0	0	

17.60	14 43 37.4	17 51 25	0.44	4.6	0.85	E	15.5	1 f.	3 s.	Brightest in cluster
17.61	14 44 49.2	18 00 14	0.53	5.7	0.85	III				
17.63	15 34 18.5	17 25 49	0.20	2.4	0.90	III				
17.64	15 51 03.1	17 59 56	0.25	2.1	0.80	III				
17.67	16 12 34.1	17 36 36	0.53	3.3	0.65	III				Pol.
17.72	16 58 53.5	17 07 25	0.17	2.5	(1.00)	III				Conf.
17.73	17 00 40.4	18 03 17	0.24	2.0	0.80	III				
17.74	17 04 03.3	17 02 36	0.47	5.6	0.90	III				
17.75	17 20 59.0	17 38 49	0.21	2.1	0.85	III				
17.76	17 27 52.1	17 27 01	0.64	5.7	0.80	III				BSO 0'.5 s.p.
17.80	18 22 33.6	17 49 09	0.33	2.5	(0.75)	III				Ext. in R.A.
17.84	20 24 41.8	17 10 09	0.34	3.0	0.80	IIIc				
17.85	20 38 25.2	17 01 01	0.15	2.0	(0.95)	IIIc				Conf. in R.A.
17.86	21 12 39.2	17 16 57	0.24	3.1	0.95	III				
17.87	21 31 56.5	17 33 12	0.22	2.2	0.85	QSO?	19	2 p.	3 n.	
17.90	22 41 28.0	17 58 51	0.50	5.4	0.90	III				
17.91	22 43 34.3	17 27 17	0.23	5.3	1.15	III				
17.94	23 29 27.8	17 12 24	0.48	6.6	0.95	IIIb				
18.07	01 58 55.4	18 21 40	0.63	4.9	0.75	QSO?	17.5	1 f.	3 n.	
18.10 {	03 49 36.0	18 27 20	0.22	(3.0)		III				
	03 49 41.9	18 37 27	0.17	(3.0)		III				
18.11	03 53 38.7	18 52 14	0.57	4.5	0.75	QSO?	19	2 f.	3 s.	
18.12	04 30 04.7	18 51 16	0.16	2.5	1.00	III				
18.21	07 32 12.9	18 15 24	0.50	3.0	0.65	III				Several gals s.f.
18.22	07 48 58.7	18 45 41	0.52	2.6	0.60	QSO?	18.5	1 f.	1 s.	
18.23	07 52 50.0	18 31 48	0.34	3.4	0.85	III				
18.24	08 18 52.0	17 57 56	1.10	8.3	0.75	III				
	08 39 14.0	18 46 29	1.08			QSO?	17	0	0	DW 0839+18 (Davis 1967)
18.25	08 40 18.8	18 24 39	0.27	2.4	0.80	III				14^m Sp 0'.7 s.p.
18.26	08 48 44.1	18 08 06	0.11	2.0	1.05	III				BSO 0'.6 s.f.
18.27	08 57 58.8	18 43 58	0.62	5.8	0.80	III				
18.30	09 42 54.2	18 07 52	0.27	2.2	0.75	III				
18.31	11 06 27.5	18 52 18	0.38	2.3	0.65	IIIb				
18.33	11 52 52.5	18 37 19	0.13	2.4	1.10	IIIb				
18.34	12 21 13.8	18 37 30	0.26	2.1	0.75	QSO?	18.5	1 f.	1 n.	
18.35	12 38 29.7	18 48 55	0.32	2.4	0.75	II				18^m g 0'.4 p., 16^m E 0'.8 n.
18.36	13 08 28.6	18 16 02	0.23	2.4	0.85	III				
18.37	13 21 12.3	18 09 39	0.28	2.8	0.85	IIIb				
18.38	14 04 10.5	18 45 15	0.26	3.0	0.90	III				Pol.
18.39	14 54 21.8	18 20 00	0.19	2.6	0.95	III				

TABLE 2 (Continued)

(1) 4C Catalogue Number	(2) Position (1950·0) R.A. h m s	(3) Dec. ° ′ ″	(4) S_{2700}	(5) S_{178}	(6) α_{2700}^{178}	(7) Type	(8) Mag.	(9) Posn relative to Radio Source (units 0′·1 arc) R.A.	(10) Dec.	(11) Remarks
18.40	14 56 15.5	18 42 37	0.26	3.4	0.95	III				
18.41	15 08 46.3	18 15 02	0.37	2.0	(0.60)	QSO?	19.5	0	0	Conf. or ext. in Dec.
18.42	15 14 40.0	18 41 32	0.72	5.9	0.75	III				
18.45	15 47 22.0	18 44 15	0.33	3.6	(0.90)	QSO?	19	1 p.	0	Conf. or ext. to n.
18.47	16 06 55.6	18 05 16	0.44	3.7	0.80	III				
18.48	17 02 55.9	18 36 19	0.22	2.3	0.85	III				
18.49	17 05 51.4	18 20 15	0.19	2.7	0.95	III				BSO 0'.5 s.
18.50	17 05 42.0	18 50 24	0.29	4.3	1.00	QSO?	19.5	0	0	Possibly not the 4C source
18.51	17 39 54.6	18 28 51	0.58	5.0	0.80	QSO?	17.5	2 f.	2 s.	NRAO 536
18.52	17 44 55.7	18 22 54	0.55	5.3	(0.85)	QSO?	19	0	1 s	Conf. in Dec.
18.53	17 50 23.8	18 31 34	0.16	2.3	0.95	III				
18.54	17 59 47.1	18 11 08	0.33	2.4	0.70	III				
18.55	18 16 33.8	18 39 15	0.42	3.3	(0.75)	III				Ext. in Dec. Pol.
18.61	20 39 08.3	18 44 01	0.29	2.9	0.85	IIIc				Pol.
18.62	21 16 12.5	18 03 53	0.72	6.2	0.80	III				
18.64	22 02 46.1	18 51 42	0.19	3.1	1.05	III				
18.66	22 45 47.7	18 11 17	0.20	4.4	(1.15)	III				BSO 0'.6 n. Conf. in Dec.
18.69	23 05 28.1	18 18 46	0.41	3.6	0.80	N	18	0	0	18^m g 0'.4 n. Pol.
19.07	02 00 44.3	19 36 54	0.44	4.8	0.90	III				
19.13	04 58 47.7	19 09 19	0.07	2.9	1.35	III				R.A. from 4C
19.14	05 19 07.9	19 39 08	0.10	2.1	1.10	QSO?	18	2 p.	2 n.	R.A. from 4C
19.30	08 27 14.9	19 20 52	0.17	2.2	0.95	III				BSO 0'.8 p. Pol.
19.32	08 58 29.1	20 03 43	0.29	2.7	0.80	g	16.5	2 p.	1 n.	Peculiar optical structure
19.33	10 19 25.0	19 57 18	0.21	2.0	0.80	III				
19.34	10 22 01.2	19 27 40	0.56	2.4	0.55	QSO?	17.5	0	1 s.	
19.35	11 04 15.1	19 25 11	0.28	2.2	0.75	III				
19.36	11 14 39.9	19 20 52	0.41	3.1	0.75	III				
19.37	11 18 07.4	19 39 17	0.20	2.8	0.95	III				15^m Sp 1' s.f.
19.39	11 28 56.7	19 45 28	0.30	2.4	0.75	III				
19.41	11 55 00.0	19 19 17	0.35	3.1	0.80	III				

19.42	12 16 38.1	19 19 00	0.26	2.5	0.85	III				
19.43	13 03 19.1	19 17 52	0.35	2.3	0.70	QSO?	18.5	1 f.	1 s.	
19.45	13 57 26.4	19 35 10	0.23	3.1	(0.95)	E	17	2 f.	4 s.	In cluster. Conf. or ext. to n.
19.47	14 21 49.8	19 06 26	0.64	4.2	0.70	IIIb				
19.49	15 15 50.7	19 52 42	0.18	2.3	0.95	III				
19.50	15 32 31.6	19 28 07	0.38	2.4	0.70	IIIb				
19.51	15 43 40.9	19 16 00	0.49	3.1	0.65	III				
19.52	15 52 25.8	19 55 53	0.67	4.4	0.70	III				
19.54	16 48 42.0	19 52 47	0.16	2.5	1.00	III				
19.55	16 59 55.4	19 10 53	0.13	2.1	1.00	III				
19.56	17 08 42.7	19 34 26	0.31	2.6	0.80	III				
19.57	17 11 58.9	19 52 35	0.32	4.3	(0.95)	III				g 1' n.p. Conf. source 13' s.
19.58	17 14 48.9	19 46 53	0.23	2.0	0.80	III				
19.59	17 18 54.8	19 15 16	0.18	5.1	1.25	III				Source 12' p.
19.60	17 27 40.5	19 47 38	0.08	2.1	(1.20)	QSO?	18	2 n.	1 f.	Possibly not the 4C source
19.63	18 14 15.1	19 39 40	0.24	2.3	0.85	III				
19.69	20 33 26.7	19 39 58	0.37	3.9	0.85	III				
19.70	21 02 03.3	19 05 23	0.23	2.3	0.85	III				
19.72	21 48 34.1	19 50 29	0.49	3.2	0.70	III				
19.74	22 48 06.0	19 15 08	0.45	6.1	0.95	QSO?	18.5	0	0	
19.76	23 10 21.2	19 09 41	0.29	3.4	0.90	III				

VIII. Discussion

(a) *Errors in 4C Catalogue Positions*

The estimated accuracy of the positions given in Table 2 exceeds that of the 4C catalogue positions by a factor of 2 in right ascension and by a factor of at least 12 in declination. The differences between the present positions and those listed in the 4C catalogue have been examined for all sources which are not noted in Table 2 as being confused or extended or as having two components at 2700 MHz and which are not noted as unreliable in the 4C catalogue.

In right ascension the average difference between the present positions and the 4C positions was found to be $0^{s}\cdot1\pm0^{s}\cdot05$, and the r.m.s. position difference was $\pm1^{s}\cdot25$. No investigation was made of right ascension differences as a function of 178 MHz flux density or of the 4C reliability class (a, b).

Table 3

Differences in declination between 4C catalogue positions and present measurements

178 MHz Flux Density	4C Class	No. of Sources	Systematic Declination Error	R.M.S. Declination Error
$S_{178} \geqslant 3$	a	161	$-0'\cdot3\pm0'\cdot2$	$2'\cdot5$
$2 \leqslant S_{178} < 3$	a	115	$-0'\cdot3\pm0'\cdot3$	$3'\cdot0$
$S_{178} \geqslant 3$	b	45	$+0'\cdot7\pm0'\cdot6$	$3'\cdot9$
$2 \leqslant S_{178} < 3$	b	39	$-1'\cdot0\pm0'\cdot9$	$5'\cdot4$

In declination the positional differences were examined separately for sources with flux density greater or less than $S_{178} = 3\cdot0$, and for sources in the two reliability classes. The results are summarized in Table 3. The accuracy of the declinations for weaker sources of class a is clearly greater than that for the stronger sources in class b. The values given for the stronger 4C sources may not be representative of all the strong 4C sources, since the observing list did not contain those sources for which accurate positions had previously been measured.

The individual sources which were found to be lobe shifted in right ascension have been listed in Section III. The 26 sources comprise 6% of the present sample, which is lower than the 41 (9%) suggested lobe ambiguities in the present sample of 4C. While the proportion of actual lobe shifts (8 out of 41) is higher for sources listed with possible lobe ambiguities in 4C, most of the actual lobe shifts occur for sources not listed as such.

(b) *Source Spectra*

Of the 451 4C sources in Table 2, there are 386 for which the observations of flux density at both 178 MHz and 2700 MHz are believed to be unaffected by confusion or the angular extent of the source. The median spectral index for these 386 sources is $0\cdot86$, and the dispersion is $\pm0\cdot16$. There is no significant difference between the median spectral indices for sources above and below $S_{178} = 3\cdot0$.

The sample of 386 sources does not include 105 4C sources which are common to the Parkes catalogue and for which flux densities and more precise positions were already available. For these sources the median spectral index between 178 MHz and 2700 MHz is 0·73 and the dispersion ±0·23. The lower value of spectral index is not unexpected, because the finding survey for the Parkes catalogue was made at 408 MHz and further selection was made at 1410 MHz.

The median spectral index of 0·77 for the 57 possible quasi-stellar objects in the sample is lower than that for the other sources and the distribution of their spectral indices is markedly skew. Of 11 sources in the whole sample with spectral index $\leqslant 0\cdot5$, 8 are identified with possible quasi-stellar objects and the remainder are unidentified.

(c) *Identification Content*

A remarkable feature of the present study is the very small proportion of fainter 4C sources which can be identified with galaxies, and the relatively high proportion of sources which are quasi-stellar objects. Only 22 identifications with individual galaxies are suggested and only one of these is brighter than 15^m. Of five suggested identifications with bright galaxies in the region (Caswell and Wills 1967), on the basis of the 4C catalogue positions, only one (4C 17·52) is confirmed. The four disproved identifications with bright galaxies are:

4C 08·47, 11·35, 14·37, 19·42

Table 4

Cumulative identification percentage at different flux density levels

178 MHz Flux Density	Quasi-stellar Objects (%)	Galaxies (%)	Unidentified (%)
$S_{178} \geqslant 10$	17	50	33
$S_{178} \geqslant 4\cdot5$	22±4	27±3	51±6
$S_{178} \geqslant 3\cdot0$	19±3	18±2	63±5
$S_{178} \geqslant 2\cdot0$	20±2	14±2	66±4

The results of the present study have been combined with the results of identifications of sources in the revised 3C catalogue and the brighter 4C sources in the present area, to determine the percentage of sources which can be identified above a particular flux density. For this purpose only those sources outside galactic latitude $|b^{\mathrm{II}}| < 20°$ have been considered, in order to avoid those in crowded star fields or obscured regions.

The results are summarized in Table 4, which shows the cumulative percentage of sources in the different identification classes. For sources with $S_{178} \geqslant 10$, data from the entire revised 3C catalogue were used, since the total number of revised 3C sources in the present area is rather small (44). Data for the range $4\cdot5 \leqslant S_{178} < 10$ comprise 121 sources, most of which were previously observed at Parkes. There are 183 sources in the range $3\cdot0 \leqslant S_{178} < 4\cdot5$ from the whole area of the present investigation and 191 sources in the range $2 \leqslant S_{178} < 3$ from the area of double hatching in Figure 1. Normalization was carried out for the area changes involved for sources with $S_{178} < 10$ and $S_{178} < 3$. The errors indicated in Table 4 are the statistical errors based on the normalized source count at each level of flux density.

The decrease in the percentage of fainter sources which can be identified with galaxies follows naturally from the known form of the radio luminosity distribution for galaxies and from the small spread in their absolute optical magnitudes. The constancy of the percentage of quasi-stellar objects among radio sources at different flux density levels, and selected at a given frequency, has been pointed out by Bolton (1968) for frequencies of 408 MHz and above; the present results show that this trend is closely followed at 178 MHz, where few previous data were available at the low flux densities.

The interpretation of this result and of the rather small spread in the *apparent* optical magnitudes of quasi-stellar objects so far identified with radio sources depends critically on the distances assumed for the objects. If their redshifts are not of cosmological origin and they are local objects, the identification results would be consistent with a model in which the quasi-stellar objects have a small spread in absolute optical luminosity (and distance) but a fairly steep radio luminosity function, which has the same shape over a wide range of frequencies. If the quasi-stellar objects are at distances consistent with a cosmological interpretation of their redshifts then the results imply a rather delicate balance between their luminosity or space density evolution and the metric of the cosmology.

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