

STATISTICAL PROPERTIES OF RADIO SOURCES OF INTERMEDIATE STRENGTH

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Summary. — A catalogue is presented of sources belonging to either or both of two samples complete to 3.7 Jy at 178 MHz and 2.2 Jy at 408 MHz respectively. The best available information on radio structure, radio spectrum, and optical identification is given for these sources. Most of the radio information has been obtained with the Westerbork Synthesis Radio Telescope. Finding charts are provided for those optical identifications that are thought to be new. The material in the catalogue has been used for statistical purposes, as follows: Firstly, the spectral index information has been used to investigate the dependence of spectral index on redshift and/or radio luminosity. It is concluded that, where as there certainly is a dependence on one of these quantities, it is very difficult to make the selection. The results seem to favour slightly a dependence on redshift.

Secondly, the structure information was used to investigate the dependence of intrinsic size on power. Such a dependence has been previously found by Gavazzi and Perola; our results confirm their finding, i.e. galaxies with $\log P_{408} > 25.5$ are seen to have larger intrinsic diameters.

Using only these higher-luminosity galaxies, the θ - z relation was derived. A Euclidean relation is found, implying a cosmological evolution of source metric diameter, such that $D = D_0(1+z)^{-n}$ with $n = 1.1$ for $q_0 = 0$ and $n = 1.5$ for $q_0 = 1$.

Thirdly, the information on the relative positions of optical identifications for double sources has been used to make an estimate of the rate of separation of double radio sources. Source symmetry was assumed. A distribution of separation velocities with a mean v of 0.24 c , a dispersion of 0.12 c and a lower limit of ca. 0.1 c gives a good fit to the distribution of relative positions found. This implies a median age of 2×10^6 years, indicating that either sources are asymmetric or active part of the time only. Some sources of particular interest are discussed separately.

Key words: Radio source catalogue — Spectral index — Angular size — Separation velocity.

1. Introduction. — The Westerbork Synthesis Radio Telescope (hereafter referred to as WSRT) has been used to observe various samples of 4C sources. Results of these observations have been published by Conway *et al.* (1977) and Tielens *et al.* (1979). These two samples were defined to have flux density limits of $3.7 < S_{178} < 9.0$ Jy and contain sources in limited ranges of spectral index: $0.7 < \alpha(408-1420) < 0.9$ for Conway *et al.* and $\alpha(408-1420) > 1.0$ for Tielens *et al.*, where α is defined such that $S_\nu \propto \nu^{-\alpha}$. Furthermore, there also exists a considerable body of high-resolution, high-sensitivity data for sources that satisfy the flux density selection criteria used by the above mentioned authors except for the spectral index. We have made a compilation of these data, which were scattered throughout the literature, in order to extend the 4C samples to completeness for all spectral indices.

In the area of the sample of Conway *et al.*, namely $25^\circ < \delta < 31^\circ$, $33^\circ < \delta < 40^\circ$ and $|b| > 15^\circ$ for both, it was found that for 27 sources not enough data were available; these sources have now been observed by us with the WSRT at 5 GHz. A further 9 sources were added to re-define a complete sample, at 408 MHz, in

the same area. 408 MHz flux densities (from the B2 catalogue) are more suitable for defining a complete sample, due to the better resolution and sensitivity of the instrument used for their determination. The resulting 408 MHz sample contains 145 sources in the aforementioned area with flux densities in the range $2.2 < S_{408} < 6.5$ Jy, and the 178 MHz sample contains 141 sources with $3.7 < S_{178} < 9.0$ Jy.

Of the sources observed by us, structural properties have been determined and an identification programme carried out. Those sources for which no identification had been attempted previously were added to the sources for the identification programme. The resulting samples are very suitable for statistical investigations and have been used thus in section 5.

2. Radio observations and reduction. — The 36 sources for which, to our knowledge, no suitable data existed, were observed with the WSRT at 5 GHz. The original observing list contained another four sources that proved not to belong to the complete samples; they have also been included in the catalogue.

For a description of the instrument, see e.g. Högbom and Brouw (1974).

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All sources were observed for a minimum of 5 min. at three widely spaced hour angles (generally 0^{h} and $\pm 4^{\text{h}}$). The calibrated data were Fourier transformed to produce a two-dimensional map, mostly approx. $2' \times 4'$ in size. A CLEAN and restore technique (Högbom, 1974) was applied to remove grating responses from the maps. The results were inspected and compared with the results of one-dimensional transforms to check their plausibility. In most cases the results were consistent, and sources with $S_{5.0} > 25$ mJy could be seen to be real.

For complex sources (i.e. typically sources with more than 3 point-like components) three hour angles did not suffice to define the structure unambiguously. For a few sources we were able to obtain further 5 GHz observations, sufficient to solve ambiguities. Four of the most complex sources (two of them so resolved as to be not detected at 5 GHz, B2 0136 + 39 and B2 2249 + 37) were re-observed at 1.4 GHz at from six to nine hour angles. All four sources were detected easily. One source, B2 1646 + 37, was never detected at 5 GHz and not re-observed at 1.4 GHz.

A few sources were observed at the wrong position, generally at the 4C position, where in the B2 catalogue there were two sources widely separated in declination. Such discrepancies were easily found in the ambiguity test mentioned above. Most have been corrected by hand, using one-dimensional transforms.

The flux densities as found in the maps were corrected for resolution; the resulting values were compared to the total flux density in the field as derived from the visibility function (all sources found in the field were assumed to be components of the source under study, bar clear evidence to the contrary). For most sources the two values agree very well. It is possible that, for the extremely resolved sources, some part of the total flux remains undetected. However, when one takes data at other frequencies into account, the radio spectra for these sources show no high-frequency curvature, indicating that the total flux density given is unlikely to be very far wrong.

The positions (namely the centroids of the sources and of their individual components) are thought to be as accurate as previous positions determined at 5 GHz with the WSRT, i.e. to ~ 1 arcsec in RA and 2 arcsec in Dec. for point sources. Contour maps at 5 GHz of the sources extended by more than 10 arcsec are given in figure 1. 1.4 GHz contour maps of the most extended sources are given in figure 2. In all contour maps a cross marks the position of the optical identification.

3. Optical identifications. — Optical identifications were made from the Palomar Sky Survey (PSS) prints. The positions of the optical candidates were measured to an accuracy of $1''$ arc. As the radio positions have about the same accuracy, in the first instance only positional agreement need be used as a criterion for an optical identification, as follows:

For single-component sources, objects were accepted as identifications when the positional discrepancy was no greater than $4''$ arc in Right Ascension and $6''$ arc in Declination. For sources with more than one component, identifications were accepted for each component

as for single-component sources and for the source as a whole in a strip of $\pm 4''$ arc along the major axis. We have estimated the number of spurious identifications using background counts as given by Fanti and Padrielli (1977). In table I we give the number of identifications of different types and the expected number of contaminating objects. Entered in table I are also the results for *a*) the sample of Conway *et al.* (1977), identified by Padrielli and Conway (1977), *b*) all other sources in the sample. Inspection of the table shows that, firstly, all identifications with red objects and, secondly, identifications of extended sources with possible QSO's are almost certainly spurious. The amount of contamination expected in the third sample is somewhat higher than that actually found. The reason for this is most likely that part of these samples had already been studied fairly thoroughly by means of spectroscopy, etc., so a number of chance coincidences will already have been discarded. For statistical purpose, RO identifications and identifications of extended sources with QSO?'s will henceforth be classed as unidentified while QSO?'s identified with point sources or individual components of double sources will be classed as QSO's. QSO? and RO observations have however been included in table II for completeness. Redshifts are available for about 50 % of the reliable identifications in table II: among the 60 galaxies and 33 QSO's listed, redshifts are known for 25 and 22 respectively. Finding charts of the new identifications are given in figure 3. They have been reproduced from the red or « E » prints of the PSS for galaxies and red objects, from the blue of « O » print for possible QSO's.

4. Table of data. — All pertinent available information for the complete sample is listed in table II. For resolved sources, the first line always lists data for the source as a whole, while any further lines list the data for the individual components. The first asterisk indicates that the source belongs to the sample complete at 408 MHz, the second that it belongs to the sample complete at 178 MHz.

Column 1	B2 name.
Column 2	3C or 4C name.
Columns 3 and 4	Position of the centroid of the radio emission. The positions are given in 1950.0 coordinates.
Columns 5-8	Flux densities at the frequencies (in MHz) listed in the heading, in mJy. Fluxes of individual components of resolved sources, where known, are listed in successive lines.
Column 9	Spectral index $\alpha(408-4995)$, defined such that $S_{\nu} \propto \nu^{-\alpha}$. If S_{4995} is unknown, $\alpha(408-1415)$ or even $\alpha(178-408)$ has been listed.
Column 10	Angular extent in seconds of arc.
Column 11	Position angle in degrees, from north through east.

Column 12	Type of identification, as follows : GAL galaxy, GAL? galaxy with $m_v > 20.5$ (see references to table), QSO? blue stellar object, QSO confirmed by spectroscopy, RO red object, NI object in field appears normal star, E empty field.
Columns 13 and 14	Differences between optical and radio positions. The identification is entered in the same line as the radio component it coincides with. If it is between the two components of a double source it is entered in the first line.
Column 15	Magnitude. For galaxies and RO's this has been estimated from the PSS « E » print (m_v), for blue objects from the PSS « O » print (m_b).
Column 16	Redshift if known.
Column 17	References as listed in footnotes. We have confined ourselves mainly to references for the position and for the (confirmation of the) identification.

5. **Source statistics.** — For statistical purposes we have confined ourselves, unless stated otherwise, to the sample complete at 408 MHz. We have carried out all statistical investigations for the 178 MHz sample also, and these gave essentially the same result.

a) **SPECTRAL INDEX DISTRIBUTIONS.** — Spectral index distributions for the 408 MHz complete sample are given in figure 4, separately for galaxies, QSO's and empty fields. There is a clear difference between the spectral index distributions of galaxies and QSO's on the one hand, and for empty fields on the other hand, in the sense that the mean spectral index for empty fields is higher. This difference has been noted by many previous authors, e.g. recently by Tielens *et al.* (1979) who found a strong correlation between identification percentage and spectral index. To their data points, which derive mostly from sources included in our complete sample, we have been able to add additional data points for $\alpha < 0.7$ and $0.9 > \alpha > 1.1$. The results for this range (Fig. 5) fully confirm those of Tielens *et al.*

These are two possible explanations for this effect, namely : a) there is a correlation between α and luminosity, b) there is a correlation between α and distance.

We have attempted to discriminate between a) and b) by investigating the correlation between α and m_v for radio galaxies (m_v being a measure of the distance when the redshift is unknown, assuming a single z -independent M_v), or the correlation between α and radio luminosity P_{408} ⁽¹⁾. We have only included radio galaxies, because these cause most of the effect, and because in including QSO's one includes other, unknown, factors, such as their M_v dispersion.

⁽¹⁾ P in $\text{W Hz}^{-1} \text{sr}^{-1}$.

There is a fair correlation between both sets of properties, with a correlation coefficient of 0.58. Figure 6 gives the spectral index distribution for various ranges of m_v ; this distribution for various ranges of P_{408} gives a very similar picture. Further investigation shows that m_v and P_{408} correlate extremely well for this sample, due of course to the smallness of the flux density interval.

To enlarge the flux density interval we have included in the statistics the result for a complete sample of 3C sources with $S_{408} > 10$ Jy, as given by Robertson (1973). We have taken some care to insure that the spectral index distribution for this sample is comparable to the one for the 408 MHz sample by determining the best approximation to the B2 flux density scale. The 5 GHz flux densities were taken from Pauliny-Toth and Kellermann, 1968; these and the Westerbork 5 GHz flux densities are all on the same scale (Kellermann *et al.*, 1969). The properties of the spectral index distribution for this sample and for the 408 MHz sample are summarized in table III.

On inspection of table III we may note the following points : There is a clear trend within the individual samples if one compares far away and nearby objects, and also if one compares high-luminosity and low-luminosity objects. However, these distributions only give a very rough picture of the situation. We have therefore tried a different approach, as follows :

I) In order to enlarge the samples, we have taken into consideration all the galaxies (197) for which we have collected data to be used in section 5b. Although this means that we have different selection frequencies, viz. 178 and 408 MHz, there should be no selection effects in the ranges of distance and luminosity concerned, at least as long as there is no correlation between S and α .

II) We have binned the combined samples in two ways, as follows :

a) All sources with $26 < \log P_{408} < 27$ were collected, and the distribution of their spectral index with z plotted (Fig. 7a). For those galaxies for which z is not known, an estimate was made as described in section 5b.

b) Also all sources were collected with (i) $0.1 < z < 0.2$ and (ii) $0.3 < z < 0.4$ and the distribution of α with $\log P_{408}$ was plotted in figure 7b and 7c.

Inspecting figure 7a, we note that there may be a slight correlation of α with z in the expected direction (the formal correlation coefficient $r = 0.42$). This correlation is mainly determined by sources with $z > 0.3$. Now if the dependence of α is on $\log P$, this effect could be caused by a slight change in the mean $\log P$ value for nearer and farther sources (those nearby having $\log P$ nearer 26, those further away nearer 27). However, one would then expect a pronounced correlation in figure 7b, which covers two decades of $\log P$; no such correlation is seen ($r = -0.13$), neither is it seen in figure 7c (also $r = -0.13$). $\langle \alpha \rangle$ for figure 7c is slightly higher than for figure 7b, in agreement with the slight trend with z .

We conclude that the change in α between the various sets is more likely to be intrinsically related to z than to power. However, the result is marginal.

This conclusion can be compared with the conclusion reached by Colla *et al.* (1975) that there is a correlation between spectral index and radio luminosity for low-luminosity radio galaxies. This correlation they ascribed to the combination of flat-spectrum core and steep-spectrum extended components in a large fraction of the sources: at high frequencies the flat-spectrum core dominates to such an extent that the total spectrum for the source flattens. This is found not to be the case for the present sample: the spectral index distribution for sources with a central component is very similar to that for the whole sample ($\langle \alpha \rangle = 0.85$, $\sigma = 0.15$). Note also that there is very little overlap in the range of radio luminosities ($23 < \log P_{408} < 25$ for the sample of Colla *et al.*, and $\log P_{408}$ generally > 24.5 in our sample). The results may indicate that the radio luminosity function of core sources is considerably steeper than it is for extended components and that there is no correlation between the radio luminosity of core and extended components.

b) REDSHIFT — ANGULAR SIZE DISTRIBUTION OF GALAXIES. — In table IV we have entered: θ_{median} of the complete 408 MHz sample divided into two flux density intervals. The two points thus obtained are in good agreement with the θ - S diagram given by Swarup (1975).

Kapahi (1975) has studied the θ - S relation of radio sources and has shown that, in order to explain the data, apart from the usual cosmological evolution implied by the $\log N$ - $\log S$ relation, evolution of the intrinsic source diameter was needed. He assumed an evolution of the form $(1+z)^n$ for an Einstein-De Sitter model with a density evolution of the type $\rho = \rho_0(1+z)^k$ for the stronger sources; he derived values for n of approx. 1.5 for $k = 5.5$.

A more direct approach to the problem of source diameter evolution is to analyze the θ - z diagram. Direct comparison of θ_{med} within the redshift ranges also allows us to investigate possible correlations between the intrinsic dimensions of the sources and their radio luminosity, independent of the assumed luminosity function and the choice of the evolutionary form.

To this end, we have considered a sample of 197 galaxies that derive partly from the present sample and partly from data compiled from the literature.

The optical identifications and radio structure data have been taken from Fanti *et al.* (1977), and Fanti *et al.* (1978) for galaxies from the B2 sample. The corresponding data for the 3C galaxies have been taken mainly from the Cambridge 5 GHz papers (see Jenkins *et al.*, 1977, for further references) and from Smith *et al.* (1976) and Laing *et al.* (1978) for optical data. A few of the remaining data were taken from Högbom and Carlsson (1974) and Bash (1968). We have only taken into account galaxies with $\log P_{408} > 24.5$ in order to have a data set that, with respect to structure, is directly comparable to the galaxies and the empty fields of the present sample.

Redshifts were unknown for 40 sources (out of 183 with $m_v < 20.5$). For these sources the redshift has been estimated from m_v , assuming a value of M_v of -21.5

and a K -correction in the visual taken from Schild and Oke (1971).

For each galaxy in the sample, we have calculated an intrinsic diameter of *a)* the Euclidean case; *b)* a Friedmann model with $q_0 = 0$, $H = 100$ km/s/Mpc; *c)* the same with $q_0 = 1$, $H = 100$ km/s/Mpc. The investigation of the possible dependence of the linear diameters of the radio galaxies on their radio luminosity is biased by a strong correlation between redshifts and radio power, as discussed in section 5*a*.

In table V the values of median linear diameters (computed for the case of $q_0 = 0$) are listed for 3 radio power intervals in constant ranges of redshift. As can be seen in table V, there is a limited possibility of comparing median linear diameters of sources with different radio powers at the same redshift.

In figure 8 the histograms (for $q_0 = 0$) of the intrinsic sizes of galaxies in two categories of radio power ($24.5 < \log P < 25.5$ and $25.5 < \log P < 26.5$) in the range of redshift $0.05 < z < 0.2$ are given. It seems that the more powerful radio galaxies show a more pronounced tail, with sizes ranging up to 3 Mpc. A χ^2 test on the two distributions of linear diameters gives a probability of less than 2 % that the two histograms are the result of a random extraction from the same distribution.

A similar dependence on the radio power of the linear diameters of the radio galaxies was found by Gavazzi and Perola (1978) from statistical analyses of a sample of radio galaxies, which is a subsample of our sample.

For higher redshifts (interval $0.2 < z < 0.37$) the statistics are poorer, but the data do not seem to show the same effect, indicating that there is a discontinuity in size at $\log P > 25.5$ rather than a continuous increase with $\log P$ (as also found by Gavazzi and Perola).

In figure 9 the θ - z diagram is given for the sample of galaxies with $\log P_{408} \geq 25.5$, together with the point derived from the data of Laing *et al.* (1978) on the identification of 3C sources with objects beyond the Palomar Sky Survey plate limits (included in this point are objects with $m_v \geq 20.5$; the brighter ones have been put into lower redshift bins). The median redshift of these faint objects has been taken to be 0.7.

A further point is given by the empty fields of the present sample, which are assumed to be galaxies beyond the limit of the PSS. Since some of the more extended doubles among the empty fields will be due to chance superposition of unrelated sources, we have made an estimate of the number of spurious doubles. On the basis of the $\log N$ - $\log S$ relation given by Willis *et al.* (1979), one does not expect more than 4 spurious doubles with $\theta < 3'$. This causes a very small change in the θ_{med} of the Empty-fields point and it has been taken into account in the calculation of the errors.

The median redshift of this category has been obtained by considering the distribution of z expected for density evolution for radio galaxies described by either $(1+z)^{4.5}$ or $e^{br(z)}$ ($b \simeq 10$ and $\tau(z)$ is the lookback time) and $q_0 = 0$, adopting the radio luminosity function given by Katgert (1977). Varying the constant in the exponent of the density evolution expressions by ± 1

does not entail large differences in the median redshift. The median value of z is expected to lie in the range 0.7 to 1.0, depending on the specific parameters of the model. The adopted value for z for the empty fields is 0.85; the following discussion does not depend very strongly on its exact value.

The points of figure 9 are best-fitted with 3 curves: $q_0 = 1$, $q_0 = 0$ and a linear fit.

A χ^2 test shows that the linear fit has a probability of greater than 0.995 of agreeing with the data. The fit with the curve corresponding to $q_0 = 0$ is still compatible, with a probability of 10%. The $q_0 = 1$ curve does not fit the data at all, having a probability of less than 0.2%.

The conflict between the θ - z relation found here and the standard curves in Friedmann universe models implies a cosmological evolution for source metric diameters. If we assume an evolution of linear diameter of type $D = D_0(1+z)^n$, the best fit for the data is given by $D_0 = 155$ kpc and $n = 1.1$ for $q_0 = 0$, and $D_0 = 150$ kpc and $n = 1.5$ for $q_0 = 1$. These results are in agreement with those found by Kapahi from analyses of the θ - S relation of radio sources. A similar result was also obtained by Wardle and Miley (1974), who studied the θ - z diagram for 166 radio sources identified with quasars with measured redshifts.

Grueff *et al.* (1977) have investigated the θ - z relation for galaxies from a B2 sample complete to $S_{408} = 0.9$ Jy. They found a linear dependence similar to ours. Their value of θ_{med} for sources with $z > 0.5$ is $9_{-1.0}^{+1.5}$, which differs from our best-fit by about 2.0 sigma. Their point may be underestimated by up to 20% (this number is derived by taking into account all sources for which they note the *possible* presence of a second component). The disagreement is therefore not significant.

c) FLUX RATIOS AND RELATIVE POSITIONS OF IDENTIFICATIONS. — In the literature one frequently finds the assumption that identifications should be looked for preferably in the center of gravity of multiple sources (e.g. De Ruiter *et al.*, 1977). We have used the present sample to find out if this assumption is justified. First, we note that for this investigation completeness again is of no particular importance. We have, therefore, looked at all multiple sources that have a (suggested) identification that has a good chance of being correct. For these sources we have calculated the distance of the optical object from the stronger component as a fraction of the size of the source; the relative positions thus obtained are plotted against $S1/S2$ in which $S1$ is the flux density of the stronger component and $S2$ of the weaker; central components have been disregarded. The result is given in figure 10 together with *a*) those unidentified sources that has a central component, *b*) a number of identified 3C sources that have $S1/S2 \geq 2$. Not included are sources for which the optical identification was on either of the components, as these may be *a*) spurious doubles, *b*) triples with one undetected component, and they would unnecessarily confuse the picture.

It is obvious that the assumption that one typically finds the identification in the center of gravity is not supported. One typically finds the identification fairly

near the mid-way point, with a slight bias towards the stronger component, as has been noted previously by Fomalont (1969) and Mackay (1971).

A further possible locus of the identification is given by the model that takes relativistic corrections across the source (delay in arrival times, Doppler correction for separation velocities) into account. According to this model, in symmetric sources without flux evolution one expects the identification on the line given by $S1/S2 = (\theta1/\theta2)^{3+\alpha}$. This line has also been drawn in figure 10, and one can see that the identifications are not found in these relative positions either. This can mean one or more of three things:

- a) The assumption of source symmetry is incorrect.
- b) The luminosity of individual components evolves (in which case, due to the delay time of electromagnetic waves across the sources, we see the components at different times, and thus at different stages in evolution).
- c) The Doppler correction for separation velocities may not be applicable in the case of a relativistic beam model, as the radio emitting material does not necessarily move with the beam (see also Longair *et al.*, 1979). Data similar to the present have been used before to estimate the separation velocities v of the components of double sources (Ryle and Longair, 1967; Mackay, 1973; Longair *et al.*, 1979). Under the assumptions given above, both $S1/S2$ and $\theta1/\theta2$ can be used as estimators. As for $S1/S2$ the assumptions are less likely to be correct, we have followed Longair *et al.* in using $\theta1/\theta2$ as an estimator assuming only intrinsic source symmetry. We used two samples, one containing all multiple sources with central identification from the 408 MHz sample, the other containing similar sources from the 3C sample of Jenkins *et al.* We get a distribution of $\theta1/\theta2$ essentially similar to that of Longair *et al.*; they conclude that the narrowness of the distribution requires v to be $\lesssim 0.2 c$.

We have followed a slightly more complicated procedure by fitting the distribution with transformations of distributions of separation velocities with varying peak values and dispersions. We find that we get a very good fit when we assume a distribution of v with the following properties: $\langle v/c \rangle = 0.24$, with a dispersion of 0.12, and a lower limit of 0.1. Figure 11 gives the distribution of $\theta1/\theta2$ actually observed together with the distribution expected when the separation velocities are distributed as just given. The exact form of the distribution of v probably does not matter greatly, but its gross properties evidently can be determined fairly well. It is of interest that a minimum separation velocity results.

It is not clear a priori what this distribution of separation velocities represents. If one takes the results at face value, one can derive a distribution of the ages of double sources (Fig. 12) (to do this, one needs to make some assumptions about the isotropy of the distribution of angles with the line of sight). One then obtains a median age of approx. 10^6 years. This seems rather too short in the light of other information: e.g. the radio luminosity function of galaxies implies lifetimes typically of the order of 10^8 years (Auremma *et al.*, 1977). Possibly it could indicate that the relativistic beams are

active only intermittently, during 10 % of the total lifetime of the radio source. The lower limit to the expansion velocities *could* be interpreted as indicative of an upper limit to the density of the intergalactic gas (of $8 \times 10^{-4} \text{ cm}^{-3}$, assuming a maximum energy density in the heads of double sources of $10^{-8} \text{ erg cm}^{-3}$; this value is very close to typical values inside clusters). It is also possible that the distribution of θ_1/θ_2 is influenced to a large extent by local density differences in the ambient medium, so that the assumption of source symmetry is not correct, and the θ_1/θ_2 distribution can no more be used as an estimator of separation velocities than can the S_1/S_2 distribution.

6. Individual sources. — Six sources are sufficiently complex to merit a short separate discussion :

B2 0136 + 39 (4C39.04) is easily the largest single source in the sample ; its total extent is of the order of 5'.5. In the first instance it remained undetected at 5 GHz ; the result of 20-minute observations in 7 hour angles at 1415 MHz is shown in figure 2. The source has been identified with a 19.5 mag galaxy ($z = .2107$) ; the redshift implies a linear size of approx. 1.6 Mpc ($q_0 = 1$, $H = 100$), which puts it comfortably among the largest sources in the universe. We are at present studying it at 5 GHz ; preliminary reduction shows the central source, a point source corresponding to the left-most component, and resolved emission over a large area to both sides of the central component. The source has also been studied at 5 GHz with the VLA by Fomalont and Bridle (1978) ; their result looks very similar to our 1415 MHz result.

B2 0204 + 29 (3C59) consists of a very extended component identified with a 16^m.5 galaxy, and an unidentified point-like component. A third component seen at 1415 MHz has since been found to be real (Meurs, private communication). The 5 GHz information was fairly uncertain due to the extent of the source ; fortunately a few more short observations were contributed by Grueff, or an unambiguous solution would have been impossible. The structure is fully confirmed by the 1415 MHz data.

B2 1151 + 38 (4C38.32) is fairly complex ; nothing much new was added by the 1 415 MHz data. The faint component north-west of the central component seen at 5 GHz is probably not real.

B2 1316 + 29 (4C29.47). Here again the structure of the source could only be resolved with the aid of additional short observations contributed by Grueff and by Fanti. Even so, with the normal 8" by 16" arc beam only the central component was visible. The contour map given in figure 1 was obtained by convolving the beam to a total size of approx. 20" by 40".

B2 2249 + 38 (4C37.66). This extremely complex source remains (so far) undetected at 5 GHz at Westerbork. It bears a striking resemblance to 3C433 (Pooley and Henbest, 1975). At first sight one could have taken it for a supernova remnant, which would have been (barely) within the limits of possibility considering its galactic latitude ($- 20^\circ$) and expected surface brightness (J. Dickel, private communication). However, the identi-

fication is rather secure (a 15^m galaxy in a cluster), indicating that this is probably another head-tail galaxy.

B2 2339 + 25 (4C25.60). This source was not detected at 5 GHz, due to position differences : if one observes at the centroid, as we did, neither of the « components » is within the field of view. In fact, it is very unlikely that this is one (double) source ; but it was entered as such in the table due to the selection criteria.

7. Conclusions. — It has been possible to draw several interesting conclusions from the present sample :

a) The spectral index statistics indicate, as usual, a dependence on either z or $\log P_{408}$ (or both). By enlarging the sample and by binning it in various ways it can be shown that a dependence on z may be somewhat more likely than a dependence on $\log P$.

b) The structure information was used to test for dependence of the size on redshift or radio luminosity. A dependence on radio luminosity was found in the sense that luminous radio sources have larger intrinsic diameters. This had already been found by Gavazzi and Perola (1978). Deriving the θ - z relation for these luminous sources ($\log P_{408} > 25.5$) one obtains a linear relationship. This indicates that in a Friedmann universe size evolution must occur. Specifically, with size evolution of the type $D = D_0(1 + z)^n$, the parameters of the best fit are as follows : for $q_0 = 0$, $D_0 = 155 \text{ kpc}$, $n = 1.1$; for $q_0 = 1$, $D_0 = 150 \text{ kpc}$ and $n = 1.5$.

c) The information on relative positions of the optical identifications was used to estimate the separation velocity of radio sources, following a procedure roughly analogous to that used by Longair *et al.* (1978). After obtaining a first estimate of the mean velocity of 0.24 c , the rough properties of the velocity distribution were determined by deriving the expected distribution of the relative positions θ_1/θ_2 for various velocity distributions and comparing them to the observed θ_1/θ_2 distribution. The best-fitting velocity distribution has a dispersion of 0.12 c and a cut-off at 0.1 c . This distribution implies a median source age of 2×10^6 years. This is low in the light of ages derived by other means. This would indicate either that radio sources are active emitters for something like 10 % of their total life-times, or that some critical assumption (in this case most likely the one of source symmetry) is wrong.

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References

- AURIEMMA, C., PEROLA, G. C., EKKERS, R., FANTI, R., LARI, C., JAFFE, W. J., ULRICH, M. H. : 1977, *Astron. Astrophys.* **57**, 41.
 BASH, F. N. : 1968, *Astrophys. J. Suppl. Ser.* **16**, 373.
 COLLA, G., FANTI, C., FANTI, R., GIOIA, I., LARI, C., LEQUEUX, J., LUCAS, R., ULRICH, M. H. : 1975, *Astron. Astrophys.* **38**, 209.
 CONWAY, R. G., BURN, B. J., VALLÉE, J. P. : 1977, *Astron. Astrophys. Suppl. Ser.* **27**, 155.
 FANTI, R., PADRIELLI, L. : 1977, *Astron. Astrophys. Suppl. Ser.* **29**, 263.
 FANTI, C., FANTI, R., GIOIA, I., LARI, C., PARMA, P., ULRICH, M. H. : 1977, *Astron. Astrophys. Suppl. Ser.* **29**, 279.
 FANTI, R., GIOIA, I. M., LARI, C., ULRICH, M. H. : 1978, *Astron. Astrophys. Suppl. Ser.* **34**, 341.
 FOMALONT, E. B. : 1969, *Astrophys. J.* **157**, 1027.
 FOMALONT, E. B., BRIDLE, A. H. : 1978, *Astron. J.* **83**, 725.
 GAVAZZI, G., PEROLA, G. C. : 1978, *Astron. Astrophys.* **66**, 407.
 GRUEFF, G., SCHIAVICAMPO, P., VIGOTTI, M., ZANNI, M. : 1977, *Astron. Astrophys.* **60**, 321.
 HÖGBOM, J. A., BROUW, W. N. : 1974, *Astron. Astrophys.* **33**, 289.
 HÖGBOM, J. A. : 1974, *Astron. Astrophys. Suppl. Ser.* **15**, 417.
 HÖGBOM, J. A., CARLSSON, I. : 1974, *Astron. Astrophys.* **34**, 341.
 JENKINS, C. J., POOLEY, G. G., RILEY, J. M. : 1977, *Mem. R. Astron. Soc.* **84**, 61.
 KAPAHI, V. K. : 1975, *Mon. Not. R. Astron. Soc.* **172**, 513.
 KATGERT, P. : 1977, Thesis, unpublished.
 KELLERMANN, K. I., PAULINY-TOTH, I. I. K., WILLIAMS, P. J. S. : 1969, *Astrophys. J.* **157**, 1.
 LAING, R. A., LONGAIR, M. S., RILEY, J. M. : 1978, *Mon. Not. R. Astron. Soc.* **184**, 149.
 LONGAIR, M. S., RILEY, J. M. : 1979, *Mon. Not. R. Astron. Soc.* **188**, 625.
 MACKAY, C. D. : 1971, *Mon. Not. R. Astron. Soc.* **154**, 209.
 MACKAY, C. D. : 1973, *Mon. Not. R. Astron. Soc.* **162**, 1.
 PADRIELLI, L., CONWAY, R. G. : 1977, *Astron. Astrophys. Suppl. Ser.* **27**, 171.
 PAULINY-TOTH, I. I. K., KELLERMANN, K. I. : 1968, *Astron. J.* **73**, 953.
 POOLEY, G. G., HENBEST, S. N. : 1974, *Mon. Not. R. Astron. Soc.* **169**, 477.
 ROBERTSON, J. G. : 1973, *Aust. J. Phys.* **26**, 403.
 RUITER, H. R. de, WILLIS, A. G., ARP, H. C. : 1977, *Astron. Astrophys. Suppl. Ser.* **28**, 211.
 RYLE, M., LONGAIR, M. S. : 1967, *Mon. Not. R. Astron. Soc.* **136**, 123.
 SCHILD, R., OKE, J. B. : 1971, *Astrophys. J.* **169**, 209.
 SMITH, H. E., SPINRAD, H., SMITH, E. O. : 1976, *Publ. Astron. Soc. Pac.* **88**, 621.
 SWARUP, G. : 1975, *Mon. Not. R. Astron. Soc.* **172**, 501.
 TIELENS, A. G. G. M., MILEY, G. K., WILLIS, A. G. : 1979, *Astron. Astrophys. Suppl. Ser.* **35**, 153.
 WARDLE, J. F. C., MILEY, G. K. : 1974, *Astron. Astrophys.* **30**, 305.
 WILLIS, A. G., MILEY, G. K. : 1979, *Astron. Astrophys.* **76**, 65.

TABLE I. — Statistics of the optical identifications.

Type	QSO+QSO?		GAL		RO		
	F	E	F	E	F	E	
Present Sample	P	2+4	0.4	2	0.2	3	0.8
	X	0+3	1.9	11	0.7	3	3.6
Padrielli and Conway	P	3+4	0.4	9	0.2	1	0.8
	X	2+1	0.4	10	0.9	5	4.6
Other	P	10+1	0.4	5	0.2	0	0.8
	X	7+0	1.6	16	0.6	1	3.0

F= Found

E= Expected by chance

P= Point source

X= Extended Source

QSO= Quasar

QSO?= Blue stellar object, possible quasar

GAL= Galaxy

RO= Red object

TABLE II.

B2	OTHER	RA(1950,0)	DEC(1950,0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**0011+34	4C34.01	00 11 07.83	34 24 58.2	4900	3570		530	0.76	5		NI					
* 0031+39	3C13	00 31 32.69 00 31 33.76	39 07 47.9 39 07 30.7	11600	5950	1560	520 390 120	0.97	28	144	E					2
*0035+38	4C38.03	00 35 04.97 00 35 01.23 00 35 08.14	38 31 25.0 38 31 36.2 38 31 15.6	3900	1770	862	254 449 413	0.79	84	104	QSO?	-1.04	+5.9	21.0		1
**0038+25B	4C25.02	00 38 39.80	25 33 27.0	5000	2630			0.87	<10		E					3
**0049+37	4C37.03	00 49 31.59	37 59 12.0	3900	2620		176	1.08	< 6		E					
**0055+26	4C26.03 NGC326	00 55 41.40 00 55 34.00 00 55 39.40 00 55 44.10	26 35 48.1 26 35 20.0 26 35 54.0 26 35 41.0	5100	3600	1700	700 90 890 810	0.65	64	101	GAL	-0.70	-4.1	14.5	0.0483	4 11
**0100+25	4C25.03	01 00 07.84	25 36 10.2	4800	3020	1078	300	0.92	< 4		E					1
**0127+25	4C25.06	01 27 37.43	25 52 41.1	3800	3170		608	0.66	< 6		E					
**0128+25	4C25.07	01 28 33.87 01 28 33.67 01 28 34.02	25 05 05.7 25 05 17.2 25 04 57.2	8600	5470	1735	478 960 775	0.97	21	167	E					1
**0132+37	3C46	01 32 34.28 01 32 28.70 01 32 36.87 01 32 40.80	37 38 52.5 37 38 26.0 37 38 53.0 37 39 24.0	6600	3520	1200	400 580 120 500	0.87	155	68	GAL	-0.19	-5.5	19.5		2
**0134+29	4C29.03	01 34 04.80 01 34 05.10 01 34 04.34	29 59 11.8 29 58 59.7 29 59 30.6	6200	4280		375 228 147	0.97	32	162	E					
*0136+39	4C39.04	01 36 34.36 01 36 23.74 01 36 29.69 01 36 34.61 01 36 42.36 01 36 47.76	39 42 02.8 39 40 57.6 39 41 36.1 39 42 07.8 39 42 47.6 39 43 08.8	4300	2100	979	296 166 111 296 111	0.73	307	66	GAL	-0.70	-10.2	19.5	0.2107	11
*0140+38	4C38.07	01 40 35.75	38 47 05.2	4200	1880			1.06	<18		E					3
**0141+33	4C33.03	01 41 18.41	33 56 54.2	4600	2800		330	0.85	< 6		QSO	+0.14	+0.0	17.5	1.455	12 13
* 0146+36		01 46 49.95	36 13 40.8		2460		310	0.83	< 4		E					10
**0158+29	4C29.05	01 58 43.72	29 19 12.7	4800	3000	1162	413	0.79	34	10	GAL	-0.57	+4.5	15.9	0.1482	1 11
**0204+29	4C29.06	02 04 10.41 02 04 07.57 02 04 16.67	29 16 43.7 29 16 23.6 29 17 28.0	5300	3820	2397	890 1540 857	0.58	135	62						11
**0206+35	4C35.03	02 06 39.20	35 33 42.0	6900	4560	2080	970	0.62	45	120	GAL	+0.10	-1.0	13.0	0.0375	4
**0211+34	4C34.06	02 11 58.63 02 11 58.43 02 11 59.31	34 52 42.5 34 52 36.7 34 53 02.6	4500	2700	857	274 635 222	0.91	28	23	E					1
**0214+27	4C27.07	02 14 08.31 02 14 07.22 02 14 08.66	27 51 08.2 27 50 55.6 27 51 12.4	4200	3040	1026	297 271 755	0.93	25	49	E					1
**0218+39B	4C39.06B	02 18 42.86 02 18 40.60 02 18 44.97	39 41 51.6 39 42 27.4 39 41 18.5		2490		274 118 127	0.88	85	144	NI					1
*0222+26	4C26.08	02 22 24.92 02 22 24.35 02 22 25.17	26 39 37.1 26 39 27.9 26 39 41.0	4500	2030	672	172 272 400	0.99	17	40	E					1
**0223+34	4C34.07	02 23 09.74	34 08 01.6	4100	2890	2170	1375	0.30	< 4		E					

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**0228+39B	4C39.08	02 28 41.78 39 19 49.2		6500	2620		249	0.94	18	58	E					
		02 28 41.11 39 19 44.4					129									
		02 28 42.50 39 19 54.3					120									
* 0229+34	3C68.1	02 29 26.95 34 10 55.2		12100	6400	2420	800	0.83	56	177	QSO	+0.29	-21.1	19.0	1.238	2 12
		02 29 26.95 34 10 55.7					2170									
		02 29 27.19 34 10 00.0					250									
**0229+35	4C35.05	02 29 26.49 35 17 43.9		4500	2490	686	213	0.98	14	99	E					1
		02 29 25.91 35 17 45.1					327									
		02 29 26.96 35 17 43.0					359									
**0232+28	4C28.06	02 32 38.52 28 55 53.2		8400	4800	1311	303	1.10	24	15	E					1
		02 32 38.32 28 55 43.8					710									
		02 32 38.79 28 56 06.3					601									
**0235+27	4C27.09	02 35 16.90 27 12 29.0		5200	2210	635		1.00	<10		RO?	+0.03	-8.1	18.9		
0241+39	4C39.09	02 41 19.04 39 20 58.1		4500	2830		200	1.06	40	67	NI					
		02 41 17.07 39 20 48.3					66									
		02 41 20.22 39 21 04.0					110			8						
**0241+29	4C29.08	02 41 42.90 29 12 10.5		4300	2350	859	299	0.82	28	117	E					1
		02 41 42.04 29 12 16.3					476									
		02 41 43.92 29 12 03.7					383									
**0244+28	4C28.08	02 44 45.31 28 11 37.6		4600	2260	665	174	1.02	8	170	E					1
**0247+39	4C39.10	02 47 04.83 39 22 10.2		8100	4380	1830		0.75	130		GAL	-0.05	-1.4	18.6		10
*0258+35A	4C35.06	02 58 44.35 35 38 36.8		4700	2110	700	216	0.91	20	104	GAL	+0.37	+3.1	14.0	0.0466	1 11
**0258+35B	4C34.09	02 58 35.36 35 00 33.4		5000	3910	1700	1100	0.51	< 6		GAL	+0.24	-2.4	13.5	0.0160	4 11
**0308+30	4C30.04	03 08 32.26 30 32 03.8		4200	3220		278	0.98	< 4		E					
0313+34	4C34.13	03 13 45.96 34 26 15.6		4000	1800	592	172	0.94	24	44	QSO	+0.36	+4.2	18.8	1.152	1 12
		03 13 45.52 34 26 09.9					427									
		03 13 46.86 34 26 27.2					165									
*0315+28	4C28.09	03 15 35.84 28 06 37.0		3900	2110	650		0.95	67	145	E					
		03 15 33.99 28 07 09.0					260									
		03 15 37.08 28 06 15.7					390									
**0349+26	4C26.12	03 49 02.77 26 15 24.9		6500	3990	1332	394	0.92	41	42						1
		03 49 01.42 26 15 04.8					567				RO	+0.36	+6.4	17.9		
		03 49 03.47 26 15 35.2					765									
0658+35	4C35.15	06 58 26.41 35 22 41.6		5700	3270	987	284	0.98	29	12	E					1
		06 58 25.96 35 22 19.5					322									
		06 58 26.55 35 22 47.6					665									
0700+37	4C37.18	07 00 41.80 37 31 28.5		4000	2370	642	148	1.11	12	134	E					1
* 0722+39	4C39.17	07 22 25.13 39 23 25.8		2800	2840		260	0.95	< 4		E					
**0732+33	4C33.21	07 32 41.76 33 13 50.4		7400	5540	2320	865	0.74	< 6		GAL?	+0.00	+0.5			5
**0733+29	4C29.25	07 33 01.31 29 06 44.4		4400	2630	780	218	0.99	58	2	NI					1
		07 33 01.28 29 06 21.4					535									
		07 33 01.40 29 07 19.5					245									
**0733+36	4C36.13	07 33 45.81 36 10 03.6		5000	2780		250	0.96	< 4		E					10
* 0740+38	3C186	07 40 57.02 38 00 22.9			5700	1240	380	1.05	96	154						12 16
		07 40 56.69 38 00 30.9					1180				QSO	+0.08	+0.0	18.0	1.063	
		07 41 00.29 37 59 05.2					100									
* 0742+37	4C37.19	07 42 20.13 37 38 59.0		3600	2360		136	1.14	59	131						10
		07 42 18.85 37 39 13.1					90									
		07 42 22.62 37 38 33.4					46				QSO?	-0.02	+0.8	20.4		

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
* 0755+37	4C37.21A	07 55 09.32	37 55 21.9		5020	2540	1150	0.59	90	104						4
		07 55 05.70	37 55 33.0				450		35	104						
		07 55 09.10	37 55 22.0				250				GAL	-0.12	+0.1	14.9	0.0413	
		07 55 13.10	37 55 11.0				450									
* 0756+37	4C37.21B	07 56 28.63	37 47 02.9		5050		375	1.04	15	124	E					10
		07 56 28.03	37 47 06.4				160									
		07 56 29.07	37 47 00.3				215									
**0801+30	4C30.13	08 01 34.86	30 21 10.9	4700	3430		390	0.87	< 6		QSO	+0.04	+0.0	19.0	1.446	5 12
**0809+36	4C35.18	08 09 32.88	36 00 22.3	4800	2560	806	241	0.94	31	15	E					1
		08 09 32.57	36 00 07.9			471	87									
		08 09 33.23	36 00 38.1			335	80									
0813+37	4C38.24	08 13 27.75	37 58 36.2	3400	1120		56	1.20	10	45	E					
**0821+39	4C39.23A	08 21 37.28	39 26 28.4	4800	2810	2650	1025	0.40	< 6		QSO	+0.17	+1.1	17.4	1.216	12
*0822+34	4C34.28	08 22 04.06	34 17 05.4	3800	1680		158	0.94	17	102	GAL			20.0		5
		08 22 03.42	34 17 07.3				57									
		08 22 04.68	34 17 03.8				59									
* 0824+29	3C200	08 24 21.43	29 28 38.4	13000	6100	2000	610	0.92	17	156						2 14
		08 24 21.18	29 28 46.6				240									
		08 24 21.38	29 28 39.8				88				GAL	+0.01	+0.5	19.0	0.457	
		08 24 21.68	29 28 30.9				270									
**0827+37	4C37.24	08 27 55.17	37 52 18.6	8500	6020	2220		0.69	< 6		QSO	+0.13	-2.6	18.5	0.914	3 12
**0835+25	4C25.22	08 35 52.87	25 37 48.7	4200	2490		301	0.85	36	4	GAL			19.0		5
		08 35 52.83	25 37 32.0				160									
		08 35 52.98	25 38 07.7				141									
**0840+29	4C29.31	08 40 06.72	29 54 54.7	4700	2800	946	343	0.84	72	10						1
		08 40 06.21	29 54 21.3				140									
		08 40 07.13	29 54 57.0				44									
		08 40 07.21	29 55 32.4				122				GAL	-0.21	-2.9	18.8		
* 0850+34	4C34.29	08 50 35.00	34 17 43.6	2800	2320		230	0.92	10		GAL?	+0.18	+1.2			5
*0853+29	4C29.32	08 53 00.57	29 10 06.1	4300	2080	671	184	0.97	< 6		QSO	+0.02	+1.3	18.7		1
**0854+34	4C34.30	08 54 33.47	34 15 42.7	8500	5170	1809	581	0.87	31	88						1 5
		08 54 31.75	34 15 42.2			595	166									
		08 54 34.20	34 15 43.0			1214	405				GAL?	-0.20	-1.4			
* 0855+28	3C210	08 55 10.82	28 02 29.3	9500	6120	1740	475	1.02	16	158	R0?	-0.02	+3.4			5
		08 55 10.54	28 02 39.8				128									
		08 55 10.95	28 02 25.2				319									
**0858+29	3C213.1	08 58 05.25	29 13 37.6	6600	4300	1930	840	0.65	< 4		GAL	-0.12	-3.8	19.0	0.194	15
**0908+38	4C38.27	09 08 54.13	38 03 54.9	9000	4500	1120		1.12	30		E					3
* 0914+35	4C34.31	09 14 06.72	35 00 07.5	3200	2320		235	0.91	123	137	QSO?	-0.29	-33.7	20.3		10
		09 14 04.84	35 00 42.6				170									
		09 14 11.62	34 59 12.0				65									
**0918+38	4C38.29	09 18 39.76	38 07 00.5	4700	2510		290	0.86	26	133	E					
		09 18 39.07	38 07 08.6				99									
		09 18 40.69	38 06 50.3				77									
**0923+39	4C39.25	09 23 55.31	39 15 23.6	5400	3420	2520	9600	C	< 4		QSO	+0.00	-0.7	18.0	0.699	6 12
**0927+36	3C220.2	09 27 29.88	36 14 36.2	8600	5360	1750	640	0.85	8	40						2 12
		09 27 29.69	36 14 33.7				340									
		09 27 28.91	36 14 32.7				60				QSO	+0.04	+0.2	19.0	1.157	
		09 27 30.15	36 14 39.7				230									
**0931+39	4C39.26	09 31 59.70	39 55 32.1	6300	3410	1076	425	0.83	10	81	GAL	+0.08	-1.7	20.0		1
*0937+39	4C39.27	09 37 59.22	39 07 30.0	4300	2080	663	215	0.90	50	136						12 13
		09 37 57.48	39 07 50.0				259									
		09 37 59.25	39 07 29.0				37				QSO	-0.05	+1.0	18.0	0.617	
		09 38 00.20	39 07 19.0				379									

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**0938+39	3C223.1	09 38 18.40	39 58 27.2	8700	4940	1860	710	0.77	76	15	GAL	-0.07	-5.0	16.0	0.1075	2
		09 38 17.48	39 57 47.0			1960	320									
		09 38 19.18	39 59 00.2			780	360			8	15					
*0939+26	4C26.29	09 39 38.36	26 40 29.5	4100	1940	583	162	0.99	52	19	E					1
		09 39 37.48	26 39 50.5			141	31									
		09 39 38.64	26 40 40.2			442	113									
* 0949+28	4C28.24	09 49 12.80	28 42 39.8	3500	2740		539	0.81	< 4		GAL?	+0.00	+0.0			5
**0950+25	4C25.29	09 50 48.44	25 30 35.0	5700	3680	1004	236	1.10	26	42						1
		09 50 47.48	25 30 20.5			288	54				GAL	+0.43	+3.8	20.0		
		09 50 48.73	25 30 39.2			716	185									
*0958+25	4C25.30	09 58 35.75	25 40 56.1	3800	1480			1.23	<18		E					3
**1014+39A	4C39.29	10 14 16.50	39 16 23.9	6100	3190	1325	215	1.08	12	97	GAL	+0.12	-2.9	20.0		1
*1014+39B	4C39.30	10 14 21.36	39 46 11.8	5200	2050		157	1.03	126	132	GAL	-0.67	+9.7	19.5		
		10 14 15.55	39 47 13.1				38									
		10 14 23.61	39 45 48.5				100		9	90						
**1015+27	4C27.21	10 15 00.61	27 47 08.7	5000	3310		441	0.81	19	63	QSO	-0.19	-3.6	19.1	0.469	5 12
		10 14 59.58	27 47 01.2				79									
		10 15 00.85	27 47 10.4				362									
**1029+25B	4C25.33	10 29 59.15	25 17 55.9	4300	2560	796	238	0.95	38	48	E					1
		10 29 57.65	25 17 36.7			280	59									
		10 29 59.72	25 18 03.0			516	161									
* 1045+35	4C35.23	10 45 45.85	35 13 16.4		2400	960		0.74	< 4		E					7
**1049+34	4C34.33	10 49 10.89	34 29 16.2	3700	2260	729	228	0.92	47	56	E					1
		10 49 08.97	34 28 59.7			282	77									
		10 49 12.11	34 29 26.4			447	125									
**1057+30	4C30.20	10 57 20.85	30 43 09.7	6100	3300	860	240	1.05	111	136	GAL?	-0.30	+5.9			5
		10 57 17.44	30 43 55.6				87									
		10 57 23.42	30 42 35.6				117									
**1059+35	4C35.24	10 59 23.00	35 11 18.8	4100	2210	728	268	0.84	< 4		GAL	-0.07	-1.8	19.5		1
**1105+39	4C39.34	11 05 49.90	39 15 15.0	3700	2580			0.53	< 4		E					10
* 1106+25A	3C250	11 06 10.77	25 17 06.9	7900	3640	1020	300	1.00	49	53	GAL	+0.98	-13.2	21.5		2 14
		11 06 09.67	25 16 55.5			500	110									
		11 06 12.56	25 17 25.0			520	70									
**1107+37	4C37.29B	11 07 04.74	37 54 48.7	7500	5580	2096	741	0.81	70	64	GAL	-0.19	-2.5	19.5	0.3456	1 11
		11 07 01.92	37 54 32.2			1060	216									
		11 07 07.23	37 55 03.2			1036	248			20	64					
* 1108+35	3C252	11 08 47.74	35 57 02.2	10800	4940	1510	350	1.06	57	105	GAL	+1.19	-1.9	21.5		2 14
		11 08 45.91	35 57 08.4			970	200									
		11 08 50.41	35 56 53.4			540	140			6	42					
**1113+29	4C29.41	11 13 53.48	29 31 33.9	5500	4210	2200	860	0.64	52	93						4 11
		11 13 52.00	29 31 35.0			960	500									
		11 13 55.50	29 31 36.0			860	60				GAL	-0.10	-2.0	14.0	0.0489	
		11 13 56.00	29 31 32.0			840	300									
*1114+26	4C26.31	11 14 06.53	26 04 39.3	3700	1950	637	154	1.02	66	114	RD	+0.42	-2.9	20.0		1
		11 14 04.97	26 04 48.9			305	96									
		11 14 09.44	26 04 22.1			332	53									
**1123+30	4C30.21	11 23 28.75	30 20 07.7	4900	3110	935	254	1.00	19	130	RD	-0.15	+0.3	18.7		1
		11 23 28.15	30 20 14.9			327	111									
		11 23 29.31	30 20 01.7			608	130									
* 1123+34	4C33.26	11 23 43.08	34 01 57.5	2800	3380		371	0.88	< 4		E					5
**1130+33A	4C33.27	11 30 30.17	33 59 44.7	4100	2210	1080	330	0.76	15	32	GAL	-0.01	+2.3	17.3		
		11 30 29.82	33 59 36.5				108									
		11 30 30.43	33 59 50.0				170									
**1130+33B	4C33.28	11 30 53.17	33 34 40.6	4800	2570	738	191	1.04	6	103	GAL	-0.20	-0.5	19.6		1

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**1132+30	4C30.22	11 32 16.34	30 22 00.5	6500	3790	1120	371	0.93	8	138	QSO	-0.08	+1.0	18.4	0.614	12 13
*1133+26	4C26.32	11 33 12.01	26 13 56.5	4300	1880	537	139	1.04	54	10						1
		11 33 11.68	26 13 31.0			276	69				QSO?	+0.04	+7.6	16.2		
		11 33 12.37	26 14 24.6			259	63									
* 1141+30	4C30.23	11 41 44.58	30 15 03.9	3600	2760	1030	340	0.84	22	29	NI					5
		11 41 44.33	30 14 57.3				128									
		11 41 45.11	30 15 16.2				69									
**1141+37	4C37.32	11 41 51.37	37 25 42.1	3700	5140	2110	495	0.94	266	43	GAL	-1.37	-36.1	16.5		
		11 41 41.84	37 23 41.2			840	175									
		11 41 57.16	37 26 55.2			968	290			7						
*1144+25	4C25.36	11 44 38.96	25 40 00.2	3700	2130	868	229	0.89	26	2	E					1
		11 44 38.96	25 39 48.1			488	91									
		11 44 38.97	25 40 14.6			380	77									
*1148+38	4C38.31	11 48 53.40	38 42 33.1	3700	1920	617	213	0.88	< 6		QSO?	-0.13	+1.1	16.2		1
**1151+38	4C38.32	11 51 17.76	38 28 26.8	5100	2920	869	400	0.80	62	80						
		11 51 14.53	38 28 20.0			389	88									
		11 51 17.26	38 28 26.4			51	51				GAL	+0.20	+3.6	17.3		
		11 51 19.74	38 28 30.7			480	160									
**1151+29	4C29.44	11 51 38.39	29 32 49.6	6700	5200	1720	480	0.95	18	156	GAL	-0.44	+0.8	19.0	0.3292	3 11
* 1156+29	4C29.45	11 56 57.78	29 31 26.3	2800	2790	1980	1150	0.35	< 4		QSO	+0.00	+1.0	17.5	0.728	5 12
*1158+25A	4C25.37	11 58 12.87	25 13 40.1	4200	1930	689	178	0.95	<10		E					1
**1202+29	4C29.46	12 02 19.46	29 46 43.0	6000	3580	1215	438	0.84	98	7						1
		12 02 19.01	29 45 51.7				123									
		12 02 19.59	29 46 47.7				49									
		12 02 19.87	29 47 28.9				133				GAL	-0.01	-1.6	19.6		
1204+37	4C37.33	12 04 21.17	37 08 22.2	3600	1710	608	164	0.94	50	107	E					1
		12 04 20.09	37 08 26.4			423	114									
		12 04 24.11	37 08 11.6			185	44									
* 1213+35	4C35.28	12 13 24.80	35 04 54.1	2200	2400		955	0.37	< 4		QSO?	+0.13	+1.6	20.5		
**1215+25	4C25.39	12 15 25.53	25 46 06.1	4200	2250		230	0.91	10	90	QSO?	-0.08	-0.8	16.9		
*1222+26	4C26.37	12 22 02.99	26 29 51.9	4000	2080	668	231	0.88	37	82						1
		12 22 01.28	26 29 48.6			257	44				GAL	+0.45	+2.7	18.1		
		12 22 04.04	26 29 54.0			411	72									
*1232+39	4C39.37	12 32 43.00	39 42 12.0	5300		230		1.55	<10		E					9
*1234+26	4C26.39	12 34 02.42	26 51 45.2	4200	2050	620	147	1.05	19	131						5
		12 34 02.02	26 51 50.4			340	87									
		12 34 03.06	26 51 37.9			280	60				QSO	-0.37	+1.4	20.5		
**1234+37	4C37.34	12 34 24.11	37 11 49.6	5000	2620	934	283	0.89	17	17	E					1
		12 34 23.86	37 11 37.2			430	69									
		12 34 24.25	37 11 54.9			504	164									
* 1242+36	4C36.21	12 42 24.91	36 26 12.3	3100	2290		225	0.93	145	172	E					10
		12 42 23.51	36 28 11.9				37									
		12 42 25.19	36 25 48.8				188									
*1244+38	4C38.33	12 44 23.00	38 58 01.5	3700	2060	573	138	1.08	23	106	E					1
		12 44 22.05	38 58 05.0			284	58									
		12 44 23.88	38 57 58.6			289	67									
* 1247+33	4C33.30	12 47 28.08	33 39 45.1	3600	2890	892	404	0.79	75	79	GAL	-1.37	-6.7	19.0		5
		12 47 24.19	33 39 36.0			375	228									
		12 47 30.10	33 39 49.8			517	220			8						
* 1251+27B	3C277.3	12 51 45.95	27 53 50.5		6300	2890	1310	0.63	32	163						2
		12 51 45.70	27 53 58.0				540									
		12 51 45.71	27 54 07.5				90									
		12 51 46.28	27 53 35.9				660			11	69					
		12 51 46.29	27 53 48.8				20				GAL	+0.01	+0.2	15.5	0.0857	

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**1253+37B	4C37.35	12 53 55.97	37 29 55.5	4900	2340	679	185	1.02	45	27	E					1 8
		12 53 55.23	37 29 34.4			263	86									
		12 53 52.94	37 29 55.1			140										
		12 53 56.70	37 30 15.8			276	93									
*1257+38	4C38.34	12 57 53.30	38 20 39.1	4100	2040	710	190	0.95	34	55	E					1
		12 57 52.32	38 20 30.6			395	108									
		12 57 54.66	38 20 50.5			315	81									
*1301+38	4C38.35	13 01 24.34	38 12 14.4	3700	1610	579	210	0.81	24	45	GAL	+0.22	+0.2	19.6		1
		13 01 23.77	38 12 07.4			322	114									
		13 01 25.16	38 12 23.9			256	84									
*1302+38	4C38.36	13 02 39.83	38 48 32.3	3900	1930	506	113	1.14	< 6		E					1
**1308+27	3C284	13 08 36.84	27 44 13.3	6100	3760	1930	640	0.71	176	101	GAL	+4.49	-10.7	18.5	0.2394	2
		13 08 33.68	27 44 22.0			430	40									
		13 08 46.64	27 43 47.1			1270	130									
1315+39	4C39.38	13 15 02.80	39 41 15.6	2400	1460		429	0.49	< 6		GAL	+0.08	-0.5	18.3		
* 1316+29	4C29.47	13 16 43.16	29 54 12.5	3200	2430	1110	443	0.68	92	90						5 11
		13 16 39.86	29 54 06.5				88			20						
		13 16 43.17	29 54 23.6				45				GAL	+0.05	-2.8	15.2	0.0728	
		13 16 46.95	29 54 12.7				79			40 50						
**1319+27	4C27.25	13 19 52.90	27 01 26.7	3900	2930		398	0.80	< 4		E					5
**1320+29	4C29.48	13 20 41.35	29 57 16.9	4000	3220	1500	621	0.66	52	120						5
		13 20 40.45	29 57 24.8				331			7 149	QSD?	+0.02	-1.6	20.7		
		13 20 42.09	29 57 11.3				233			7 57						
		13 20 43.70	29 56 54.9				57									
**1328+25B	4C25.44	13 28 57.07	25 06 16.0	6000	2490		193	1.02	26	177	E					
		13 28 57.04	25 06 29.6				93									
		13 28 57.09	25 06 03.4				100			6						
**1333+27	4C27.26	13 33 13.57	27 32 35.1	4500	2710	909	300	0.88	11	88	E					1
		13 33 13.17	27 32 35.0				527									
		13 33 14.10	27 32 35.4				382									
* 1340+35	4C35.30	13 40 17.91	35 22 16.8	3300	2210		315	0.78	10	90	E					
**1346+28	4C28.34	13 46 04.94	28 47 51.0	6100	2730		255	0.95	67	29	E					5
		13 46 03.45	28 47 15.0				83									
		13 46 05.91	28 48 13.8				132									
**1346+26	4C26.42	13 46 33.95	26 50 27.8	4900	3150	1020	250	1.01	10	21	GAL	+1.05	+2.2	14.8	0.0633	4 11
* 1404+34	3C294	14 04 34.08	34 25 41.6	10300	5190	1250	266	1.19	13	37	E					5
		14 04 33.73	34 25 34.9				88									
		14 04 34.29	34 25 45.0				177									
**1408+37	4C37.40	14 08 36.13	37 01 27.1	3900	2700		440	0.73	< 4		E					
**1417+27	4C27.28	14 17 44.55	27 15 27.2	5000	3540		362	0.91	13	158	E					5
		14 17 44.41	27 15 33.2				177									
		14 17 44.73	27 15 21.2				177									
**1425+28	4C28.35	14 25 28.32	28 46 49.1	4100	2710	872	203	1.04	< 4		E					1
* 1444+28	4C28.37	14 44 33.08	28 09 32.7	3100	2290		414	0.68	< 4		E					5
*1508+38	4C37.42	15 08 13.27	38 01 16.1	3800	1990		320	0.73	27	163	E					
		15 08 13.18	38 01 22.2				244									
		15 08 13.86	38 00 56.5				75									
*1512+37	4C37.43	15 12 46.87	37 01 54.0	4800	2140	953	338	1.07	55	110						12 13
		15 12 44.53	37 02 04.1				485			14 108						
		15 12 46.87	37 01 55.1				80				QSD	+0.00	+0.0	15.5	0.371	
		15 12 48.79	37 01 45.1				512			9 105						
**1526+37	4C37.44	15 26 34.83	37 48 26.9	5400	3030	1122	353	0.86	< 4		E					1
* 1529+35	3C320	15 29 29.72	35 43 49.5		4940	1750		1.04	<15		GAL			18.0	0.342	2 15

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**1539+34	4C34.42	15 39 31.78	34 20 34.6	3700	2340	829	282	0.85	56	28	GAL	-0.03	-1.6	18.0	0.4018	1 11
		15 39 30.85	34 20 11.6			461	119									
		15 39 32.95	34 21 01.7			368	101									
**1547+30	4C30.29	15 47 12.33	30 56 20.3	6800	4270	1231	339	1.01	11	104						1 11
		15 47 12.05	30 56 21.4			808	214				GAL	-0.02	+0.7	16.5	0.1111	
		15 47 13.01	30 56 18.1			423	103									
*1547+38	4C38.40	15 47 55.15	38 37 34.3	4500	1750		170	0.93	< 6		E					
**1548+33	4C33.36	15 48 53.53	33 29 15.6	4500	2250	707	196	0.98	34	124	E					1
		15 48 51.97	33 29 29.5			261	51									
		15 48 54.18	33 29 10.2			446	130									
*1549+34	4C33.37	15 49 30.27	34 04 51.2	3900	1360	560	100	1.04	28	76	E					5
		15 49 29.53	34 04 36.3				23									
		15 49 30.73	34 04 59.9				39									
**1559+34	4C34.43	15 59 36.55	34 31 26.7	4600	2420	870	262	0.89	55	75	E					1
		15 59 33.91	34 31 17.7			381	92									
		15 59 38.23	34 31 32.4			489	147									
* 1600+33	4C33.38	16 00 11.91	33 35 10.0	2400	2350	2360	2030	C	< 6		E					5
* 1606+28	4C28.40	16 06 10.04	28 56 54.3	3500	2420		161	1.08	40	165	QSO	-0.09	+0.8	19.0	1.989	5 12
		16 06 09.66	28 57 15.4				56									
		16 06 10.40	28 56 36.4				66									
**1608+33	4C33.39	16 08 09.80	33 06 26.7	7200	5340	1850	660	0.84	63	92	E					5
		16 08 07.83	33 06 30.3				275			14						
		16 08 12.22	33 06 17.4				91									
		16 08 12.86	33 06 25.7				107									
* 1611+34		16 11 47.91	34 20 19.8		2930	2920	2500	C	< 4		QSO	+0.02	+0.5	17.5	1.401	6 12
**1615+35B	4C35.40B	16 15 48.94	35 07 31.9		3680	2100	550	0.76	< 6		GAL	+0.06	+0.1	13.0	0.0296	4
**1623+25	4C25.48	16 23 02.71	25 12 07.6	3900	2320	710	165	1.06	10	22	E					1
* 1623+26A	4C26.48A	16 23 11.31	26 57 13.9		3280	1200		0.81	<10		QSO	+0.09	-0.3	17.4	0.779	3 12
* 1626+27	3C341	16 26 02.51	27 48 17.5	10800	5840	2470	530	0.96	71	47	GAL	-0.03	-2.5	19.0	0.448	2 14
		16 26 00.61	27 47 55.3			1630	210									
		16 26 04.60	27 48 42.0			840	190			12 36						
**1634+26	4C26.49	16 34 34.96	26 54 08.2	6900	3790	1347	427	0.87	37	101	QSO	-0.69	+1.7	18.0	0.561	1 12
		16 34 32.76	26 54 14.2			265	69									
		16 34 35.47	26 54 06.9			1082	302									
*1640+30	4C30.30	16 40 43.65	30 01 27.1	3900	2110	719	183	0.98	< 6		E					1
**1641+37	4C37.49	16 41 20.54	37 35 08.4	8600	4420	1403	445	0.92	31	15	GAL	+0.20	-5.3	20.0		1
		16 41 20.16	37 34 48.9			535	150									
		16 41 20.78	37 35 19.1			868	276									
*1646+37	4C37.50	16 46 12.90	37 59 46.0	6500	2100			1.45	R							
**1702+29	4C29.50	17 02 10.53	29 51 05.7	6600	3340	1412	568	0.71	< 4		QSO	+0.00	-0.4	19.2	1.927	1 12
**1703+38	4C38.43	17 03 23.13	38 44 38.1	7400	3560	1362	411	0.84	76	93	E					1
		17 03 19.95	38 44 40.4			770	117			25 93						
		17 03 26.39	38 44 35.8			592	116			25 93						
*1707+34	4C34.45	17 07 49.84	34 29 34.2	4200	1940	630	190	0.90	28	140	GAL	-0.53	+1.8	15.5	0.0801	7 11
* 1711+28	4C28.43	17 11 26.98	28 16 32.6	3200	2250			0.52	<20		E					3
**1721+34	4C34.47	17 21 32.44	34 20 29.9	5000	2960	1736	670	0.59	220	159						1 12
		17 21 29.34	34 22 35.4			420	32									
		17 21 32.08	34 20 41.3			580	508				QSO	-0.11	-0.1	15.6	0.206	
		17 21 34.96	34 19 06.4			580	116									

TABLE II (continued).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
**1749+29B	4C29.53	17 49 50.92	29 50 57.0	5100	2480	808	253	0.91	43	6	RO	+0.15	+0.8	20.0		1
		17 49 50.78	29 50 36.3				428									
		17 49 51.10	29 51 19.3				360									
**1751+27	4C27.40	17 51 14.65	27 01 26.8	4800	3240	1014	272	0.99	< 4		E					1
**1754+37	3C364	17 54 02.48	37 43 03.3	5300	2320	520	92	1.29	< 4		GAL	-0.28	-4.4	20.2		
* 1804+26	4C26.54	18 04 50.88	26 05 14.8	3400	2360		208	0.97	41	4	GAL	+0.04	-0.5	20.0		
		18 04 50.70	26 05 11.0				38									
		18 04 50.97	26 04 52.9				52				RO	-0.25	+6.7	18.0		
		18 04 50.97	26 05 34.1				67				RO	+0.02	-6.7	20.0		
**1809+37	4C37.52	18 09 49.06	37 12 46.7	4400	2640	791	193	1.05	< 4		E					1
**1810+26	4C26.55	18 10 30.62	26 28 31.4	7000	3600		260	1.05	40	144						
		18 10 29.58	26 28 52.1				98				QS0?	-0.17	+1.6	20.7		
		18 10 31.29	26 28 18.8				161									
* 1818+35		18 18 56.13	35 39 12.8		2210		519	0.58	< 6		E					
**1819+36	4C36.29	18 19 16.90	36 00 49.7	5300	2270		270	0.85	37	52	QS0?	-0.52	-4.1	17.4		
		18 19 15.52	36 00 36.1				88									
		18 19 17.92	36 00 59.3				125									
**1819+35	4C35.43	18 19 33.34	35 13 28.4	5500	2290		347	0.75	< 4		E					
**1819+39	4C39.56	18 19 42.31	39 41 14.8	6700	6330	3390	970	0.75	< 4		GAL	-0.15	+0.6	19.0		10
*1820+35	4C35.44	18 20 49.59	35 05 49.7	4400	1830		170	0.95	27	49	GAL	+0.22	-1.6	19.7		
		18 20 48.71	35 05 40.0				74			8						
		18 20 50.33	35 05 57.6				92									
2204+33A	4C33.53A	22 04 21.64	33 17 02.7		1050	504	209	0.65	10	7	E					1
**2227+26A	4C26.62	22 27 13.71	26 04 49.1	5000	2270	630	116	1.19	15	172	E					9
2231+35	4C35.53	22 31 23.09	35 45 26.9	5800	3640	1209	393	0.89	13	121						1
		22 31 22.73	35 45 29.6				688				QS0?	-0.47	+5.5	20.7		
		22 31 23.58	35 45 23.3				521									
**2239+33	4C33.57	22 39 08.76	33 21 29.1	6800	3680	1120	258	1.06	22	78	E					1
		22 39 08.13	33 21 27.5				661									
		22 39 09.82	33 21 31.9				459									
**2244+36	4C36.47	22 44 12.52	36 40 34.7	8800	4970	2026	732	0.77	10	35	GAL	+0.29	+6.8	16.3	0.0815	1 11
*2245+36	4C36.48	22 45 55.35	36 25 04.9		1790	340		1.34	<10		E					
2249+37	4C37.66	22 49 06.02	37 56 47.3	2800	1840	881		0.60	CO	MPL	GAL	+0.32	-2.1	15.2		
**2251+37	4C37.67	22 51 36.25	37 54 23.9	5300	2720	825	222	1.00	98	151	E					1
		22 51 33.37	37 55 26.5				55									
		22 51 35.54	37 54 47.4				20									
		22 51 37.35	37 54 00.6				167									
* 2304+37		23 04 39.39	37 46 28.2		2760		590	0.62	< 4		RO	-0.16	+0.1	19.5		
**2308+25	4C25.59	23 08 55.08	25 31 28.7	4000	2920		400	0.80	< 6		E					
**2315+39	4C39.73	23 15 25.15	39 36 06.0	4200	2390	1074	408	0.71	47	1	GAL	-0.11	+5.8	20.0		1
		23 15 25.13	39 35 52.1				671									
		23 15 25.19	39 36 39.5				403									
**2316+36	4C37.69	23 16 03.32	36 59 33.8	4000	2340	819	251	0.89	11	103	E					1
		23 16 02.86	36 59 35.2				445									
		23 16 03.61	36 59 33.0				374									
* 2317+28	4C28.56	23 17 24.18	28 12 03.0	2900	2770		195	1.06	< 6		E					
*2319+29	4C29.67	23 19 16.80	29 39 19.4	3700	1770	410	100	1.15	16	50	E					9
		23 19 16.90	29 39 20.8				310									
		23 19 15.79	29 39 08.6				100									

TABLE II (*continued*).

B2	OTHER	RA(1950.0)	DEC(1950.0)	S178	S408	S1415	S4995	SI	EXT	PA	TYPE	OFFRA	OFFD	MAGN	Z	REF
* 2325+26	4C27.52	23 25 28.48	26 59 24.5		3980		444	0.88	7	145						12 13
		23 25 28.30	26 59 26.5				225				QSO	-0.06	+0.5	18.0	0.875	
		23 25 28.66	26 59 22.5				225									
**2325+29	4C29.68	23 25 42.35	29 20 36.1	6700	4410	1420	382	0.98	51	115						12 13
		23 25 40.32	29 20 48.6				555				QSO	-0.12	+0.0	17.9	1.015	
		23 25 42.35	29 20 38.6				700									
		23 25 43.76	29 20 27.6				228									
**2329+29	4C29.69	23 29 31.63	29 40 15.1	6900	4080	1201	267	1.09	< 4		GAL	-0.10	+0.0	19.8		1
*2339+25	4C25.60	23 39 37.53	25 59 31.3	4400	2220	420		1.34	695	35	NI					9
		23 39 22.75	26 04 15.8				212									
		23 39 52.35	25 54 46.8				210									
**2356+27	4C27.54	23 56 02.92	27 37 50.3	4800	3210	1189	381	0.85	77	52	GAL	-0.10	+2.5	19.8		1
		23 56 00.92	27 37 29.2				648									
		23 56 05.49	27 38 17.2				549									

Footnotes to table II.

- CONWAY, R. G., BURNS, B. J., VALLÉE, J. P. : 1977, *Astron. Astrophys. Suppl.* **27**, 155.
PADRIELLI, L., CONWAY, R. G. : 1977, *Astron. Astrophys. Suppl.* **27**, 171.
- MCDONALD, G. H., KENDERDINE, S., NEVILLE, A. S. : 1968, *Mon. Not. R. Astron. Soc.* **138**, 259.
MACKAY, C. D. : 1969, *Mon. Not. R. Astron. Soc.* **145**, 31.
POOLEY, G. G., HENBEST, S. N. : 1974, *Mon. Not. R. Astron. Soc.* **169**, 477.
RILEY, J. M., POOLEY, G. G. : 1975, *Mem. R. Astron. Soc.* **80**, 105.
JENKINS, C. J., POOLEY, G. G., RILEY, J. M. : 1977, *Mem. R. Astron. Soc.* **84**, 61.
- DOUGLAS, S. N., BASH, F. N., GHIGO, F. D., MOSELEY, G. F., TORRENCE, G. W. : 1973, *Astron. J.* **78**, 1.
GHIGO, F. D., OWEN, F. N. : 1973, *Astron. J.* **78**, 848.
SHARP, J. R., BASH, F. N. : 1975, *Astron. J.* **80**, 335.
- COLLA, G., FANTI, C., FANTI, R., GIOIA, I., LARI, C., LEQUEUX, J., LUCAS, R., ULRICH, M. H. : 1975, *Astron. Astrophys. Suppl.* **20**, 1.
FANTI, R., GIOIA, I., LARI, C., ULRICH, M. H. : 1978, *Astron. Astrophys. Suppl.* **34**, 341.
FANTI, C., FANTI, R., GIOIA, I. M., LARI, C., PARMA, P., ULRICH, M. H. : 1977, *Astron. Astrophys. Suppl.* **29**, 279.
- GRUEFF, G., VIGOTTI, M. : 1975, *Astron. Astrophys. Suppl.* **19**, 117.
GRUEFF, G., VIGOTTI, M. : 1975, *Astron. Astrophys. Suppl.* **20**, 57.
FANTI, C., FANTI, R., FORMIGGINI, L., LARI, C., PADRIELLI, L. : 1977, *Astron. Astrophys. Suppl.* **28**, 351.
FANTI, C., FANTI, R., FICARRA, A., FORMIGGINI, L., GIOVANNINI, G., LARI, C., PADRIELLI, L. : *Astron. Astrophys. Suppl.* **19**, 143.
- ELSMORE, B., RYLE, M. : 1976, *Mon. Not. R. Astron. Soc.* **174**, 411.
- RILEY, J. M. : 1975, *Mon. Not. R. Astron. Soc.* **170**, 53.
- KATGERT, P., KATGERT-MERKELIJN, J. K., LE POOLE, R. S., LAAN, H. VAN DER : 1973, *Astron. Astrophys. Suppl.* **23**, 171.
- TIELENS, A. G. G. M., MILEY, G. K., WILLIS, A. G. : 1979, *Astron. Astrophys. Suppl.* **35**, 153.
- KAPAHU, V. K. : private communication.
- SARGENT, W. L. W. : 1973, *Astrophys. J.* **182**, L13.
- BURBIDGE, G. R., CROWNE, A. V., SMITH, H. E. : 1977, *Astrophys. J. Suppl.* **33**, 113.
- MILEY, G. K., HARTSUIJKER, A. P. : 1978, *Astron. Astrophys. Suppl.* **34**, 127.
- LAING R. A., LONGAIR, M. S., RILEY, J. M., KIBBLEWHITE, E. J., GUNN, J. E. : 1978, *Mon. Not. R. Astron. Soc.* **183**, 547.
- SPINRAD, H. : 1976, *Publ. Astron. Soc. Pac.* **88**, 565.
- HÖGBOM, J. A., CARLSSON, E. : 1974, *Astron. Astrophys.* **34**, 41.

TABLE III. — Comparison between spectral indices of 3C and Present Sample.

	3C Sample			Present Sample			3C Sample			Present Sample			
	N	$\langle\alpha\rangle$	σ	N	$\langle\alpha\rangle$	σ	N	$\langle\alpha\rangle$	σ	N	$\langle\alpha\rangle$	σ	
$m_V < 19$	49	0.82	0.19	22	0.76	0.15	$P_{408} < 3 \times 10^{26}$	33	0.79	0.21	24	0.77	0.14
$m_V \geq 19$	9	0.89	0.10	21	0.91	0.15	$P_{408} \geq 3 \times 10^{26}$	25	0.88	0.10	19	0.92	0.15

TABLE IV. — Flux-angular size distribution.

Flux interval Jy	S_{med} Jy	Θ_{med} arcsec	N
3.0 S_{408}	6.6	$3.96^{+0.24}_{-0.28}$	21^{+7}_{-3} 72
2.2 S_{408}	3.0	$2.48^{+0.08}_{-0.06}$	14^{+4}_{-3} 73

TABLE V. — Linear sizes ($q_0 = 0$, $H = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$) for different $\log P_{408}$ intervals in redshift ranges.

	$24.5 \leq \log P < 25.5$	$25.5 \leq \log P < 26.5$	$26.5 \leq \log P < 27.5$
$0.01 < z < 0.05$	71^{+9}_{-11}	-	-
No. of obj.	27		
$0.05 < z < 0.20$	100^{+15}_{-20}	140^{+22}_{-8}	190^{+50}_{-50}
No. of obj.	38	41	7
$0.20 < z < 0.37$	-	105^{+60}_{-20}	95^{+60}_{-45}
No. of obj.		10	31
$0.37 < z < 0.50$	-	-	65^{+30}_{-15}
No. of obj.			29

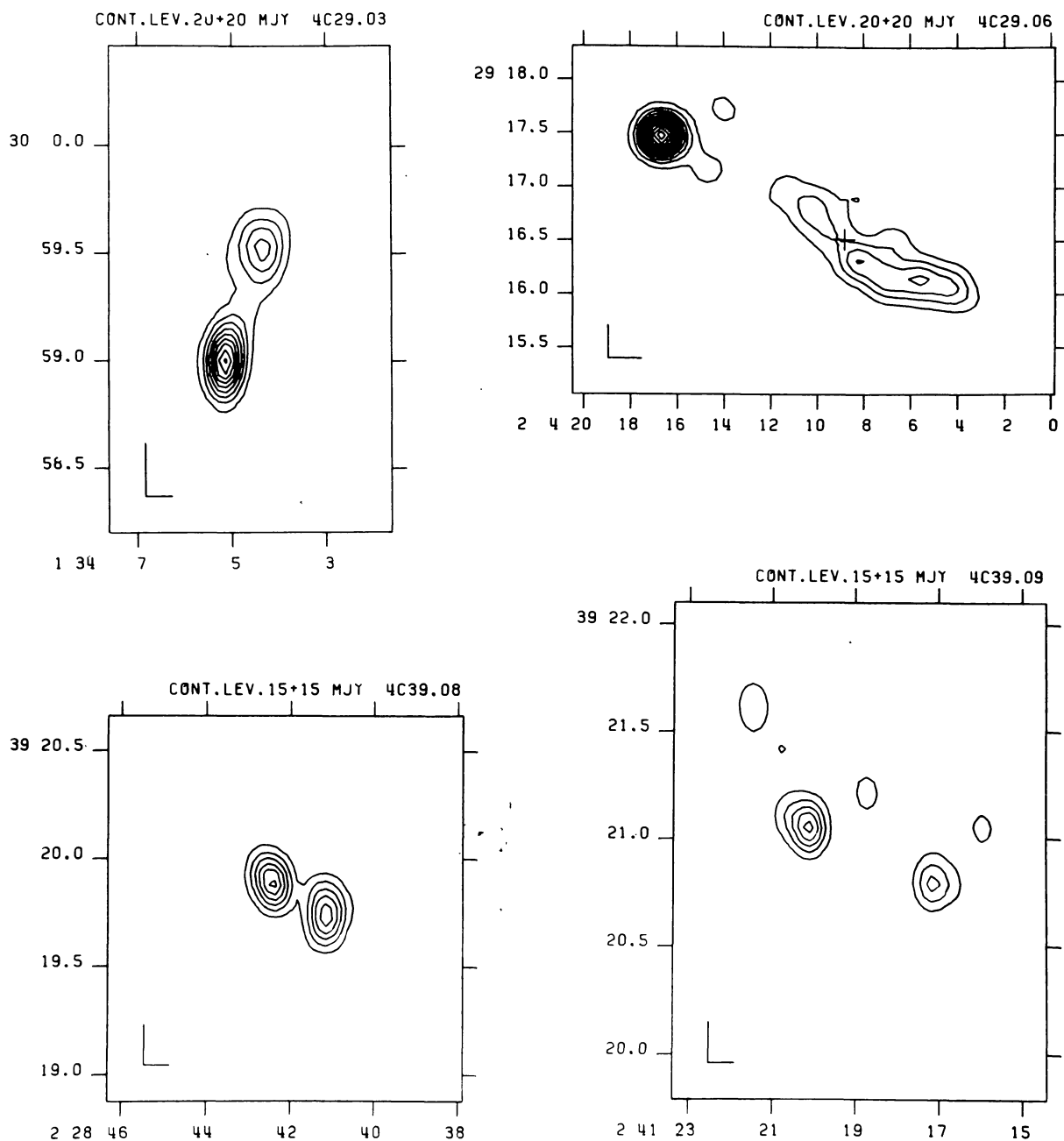


FIGURE 1-1.

FIGURE 1. — 5 GHz contour maps for newly observed sources with extent $> 10''$ arc. Names and contour intervals are given at the top of the figures. Beam sizes are indicated in the lower left-hand corners. Identifications, if any, are marked by a cross.

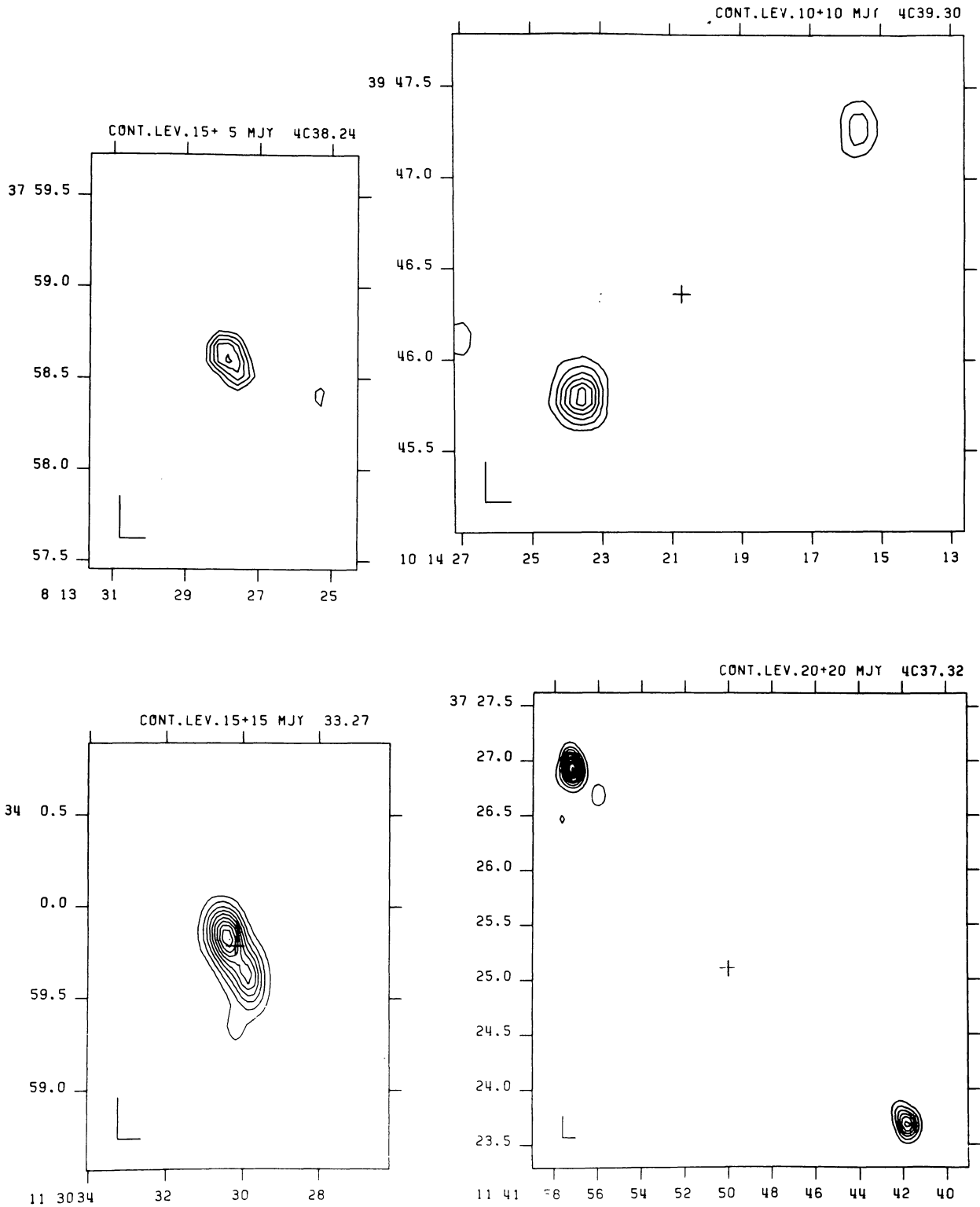


FIGURE 1-2.

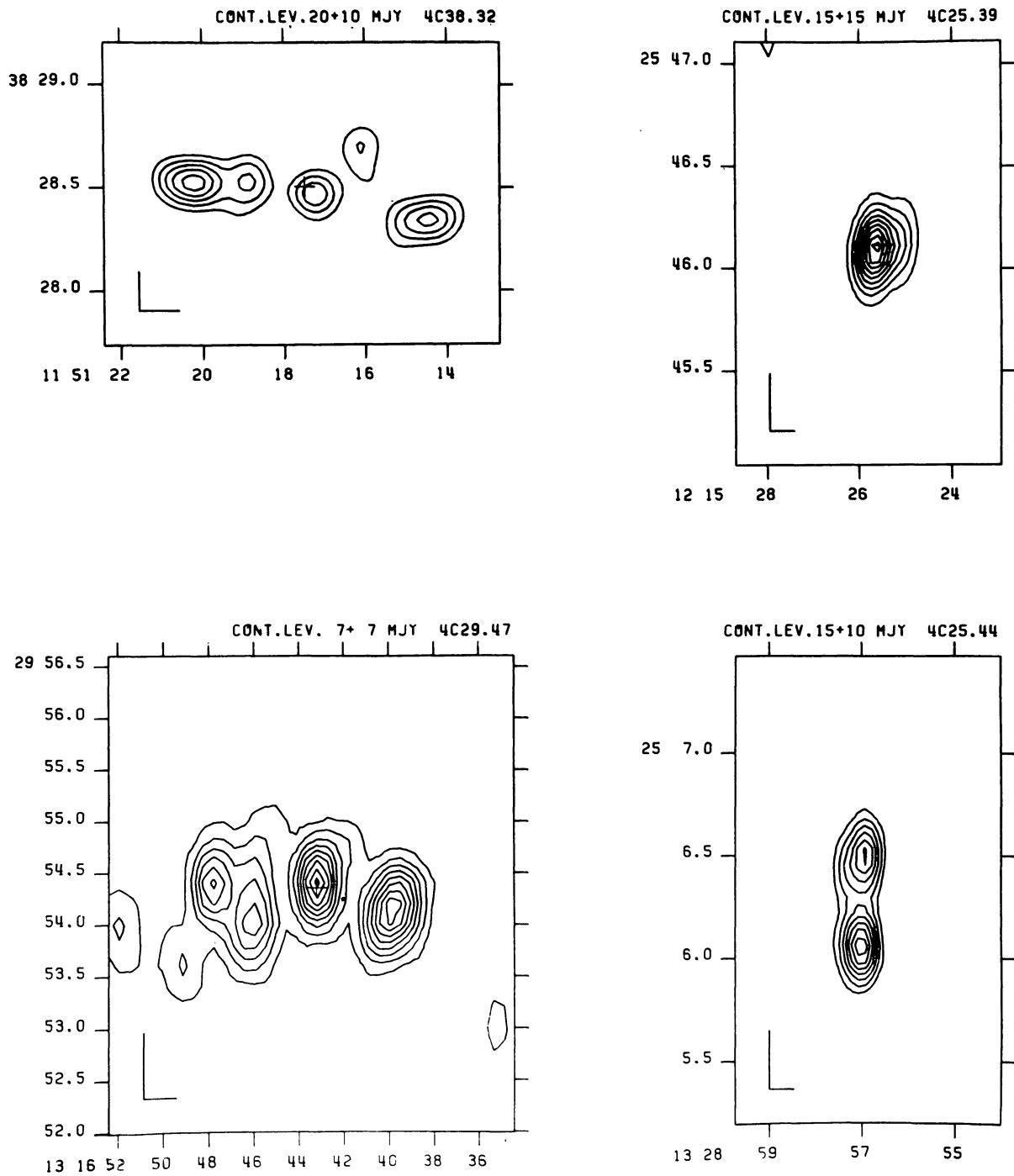


FIGURE 1-3.

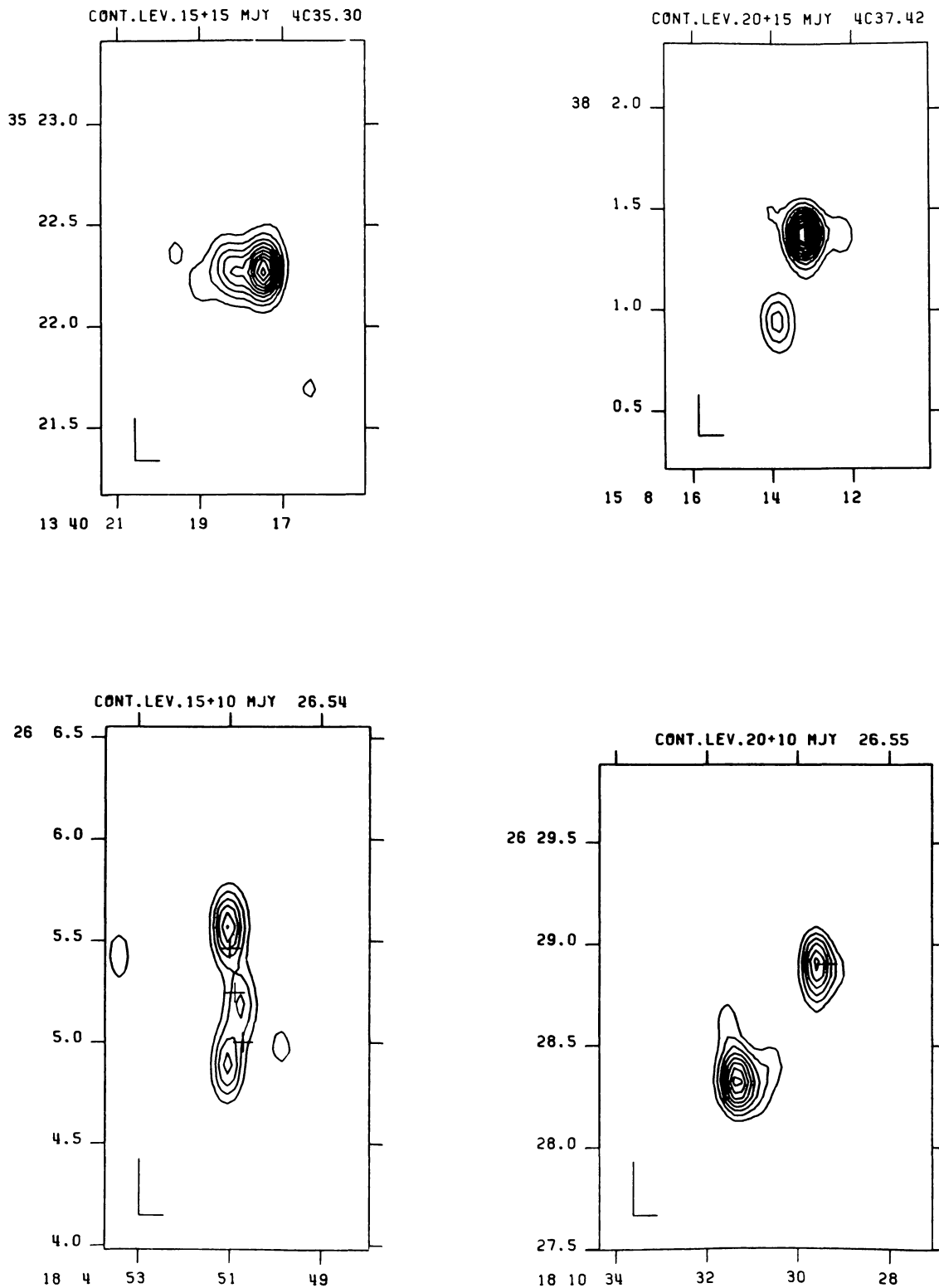


FIGURE 1-4.

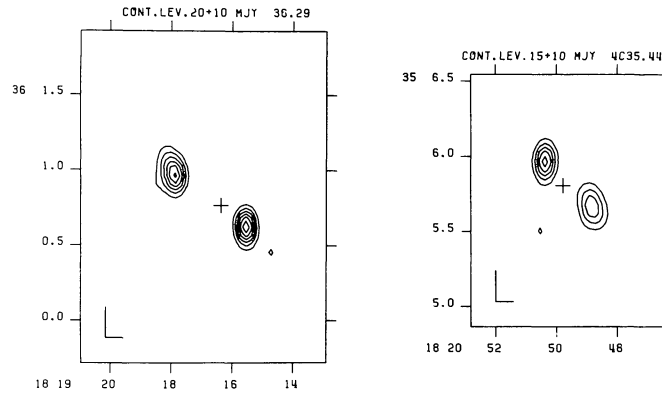


FIGURE 1-5.

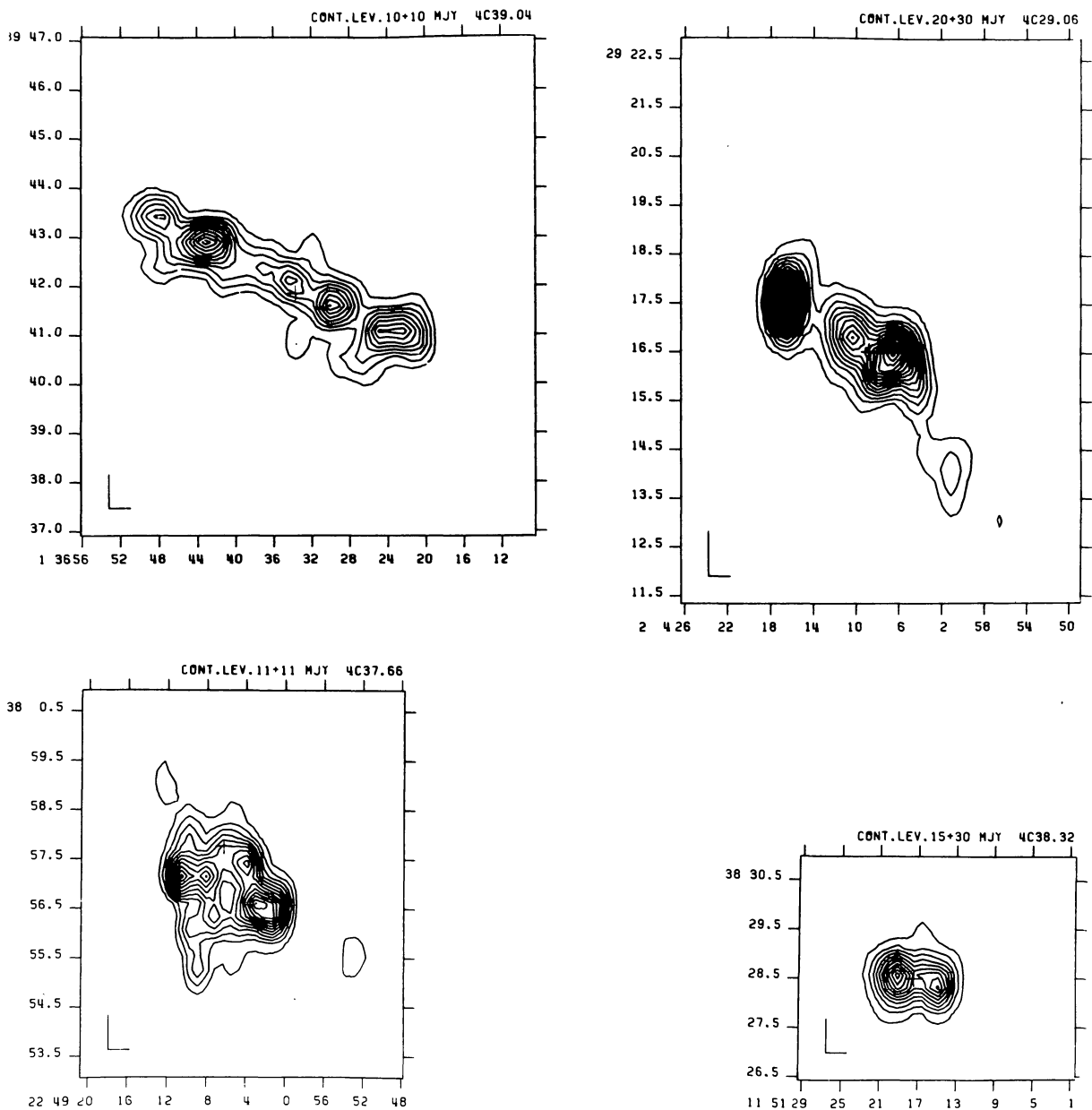


FIGURE 2. — 1 415 MHz contour maps for some very extended sources. For further information see legend to figure 1.

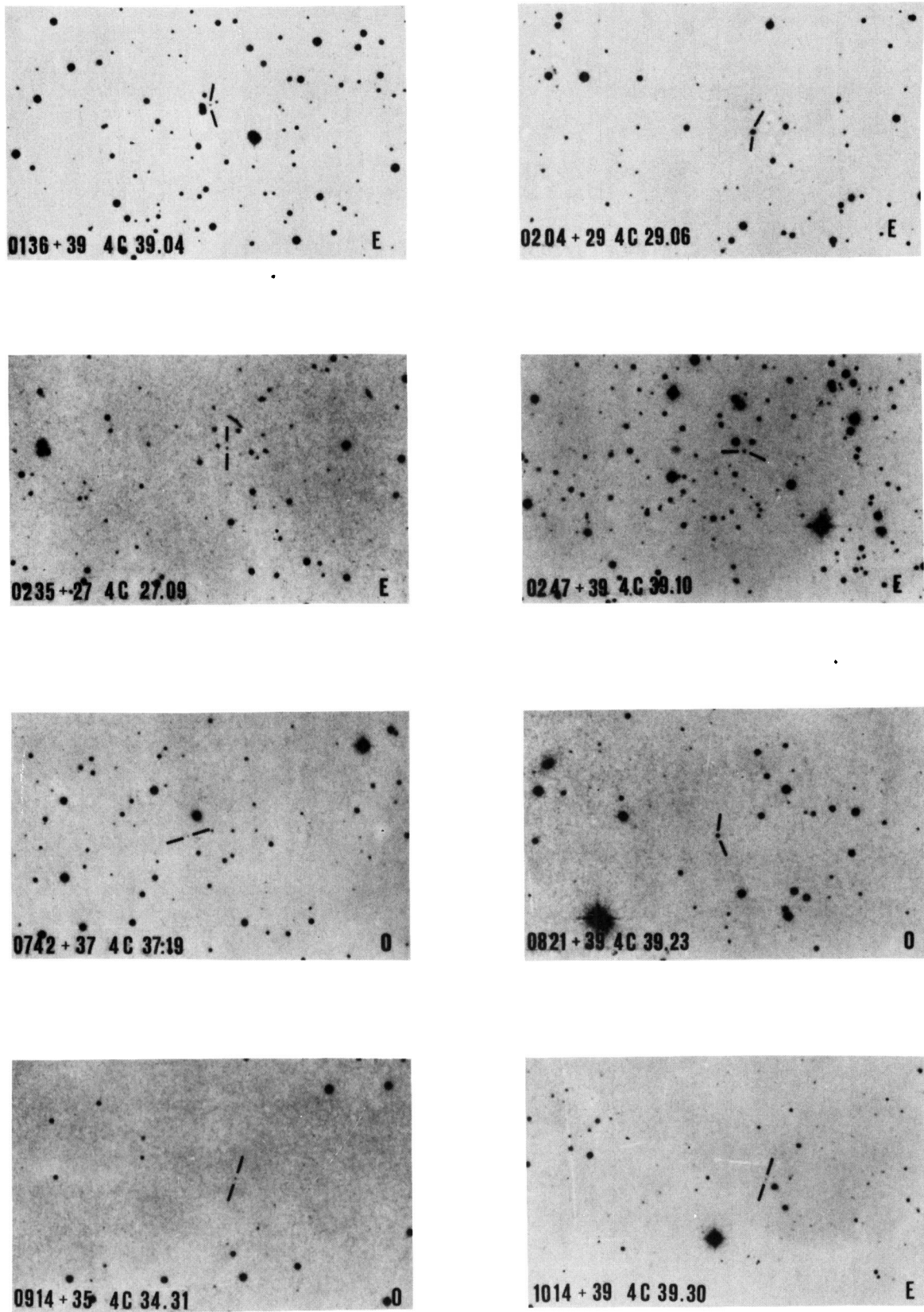


FIGURE 3. — Finding charts for new identifications. The scale is 1 mm = 6" arc. Finding charts for galaxies and Red Objects have been reproduced from the PSS red or « E » prints ; for possible QSO's from the blue or « O » prints. Reproductions courtesy of National Geographic Society-Palomar Sky Survey.

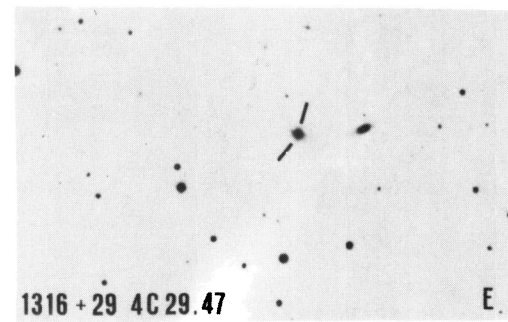
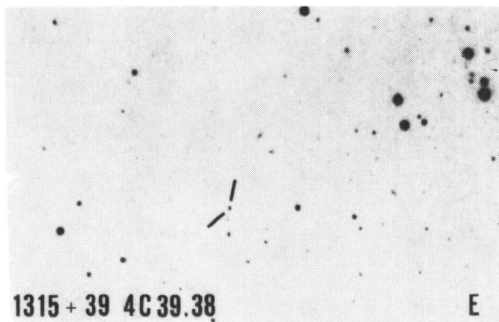
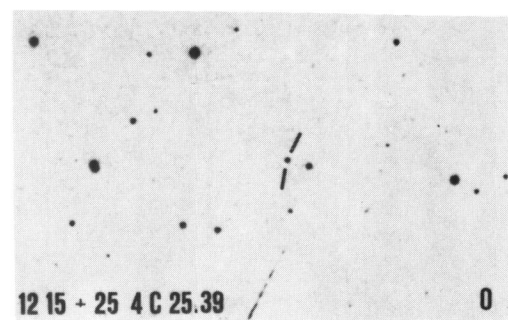
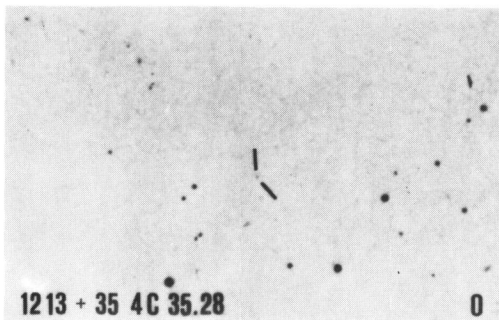
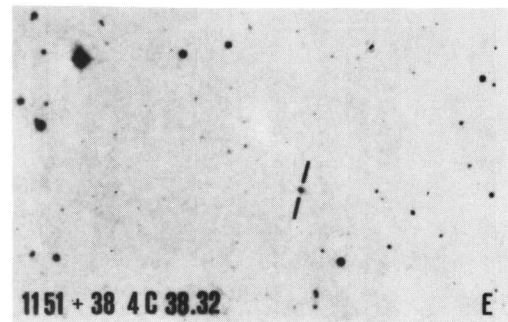
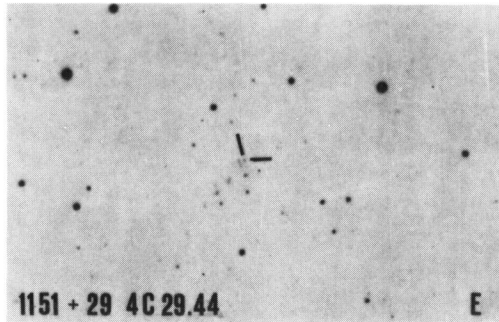
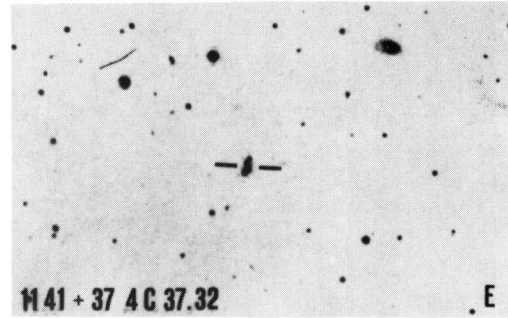
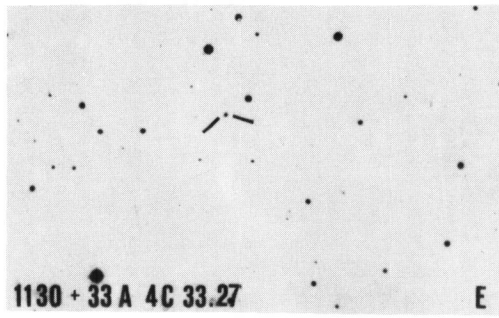


FIGURE 3 (continued).

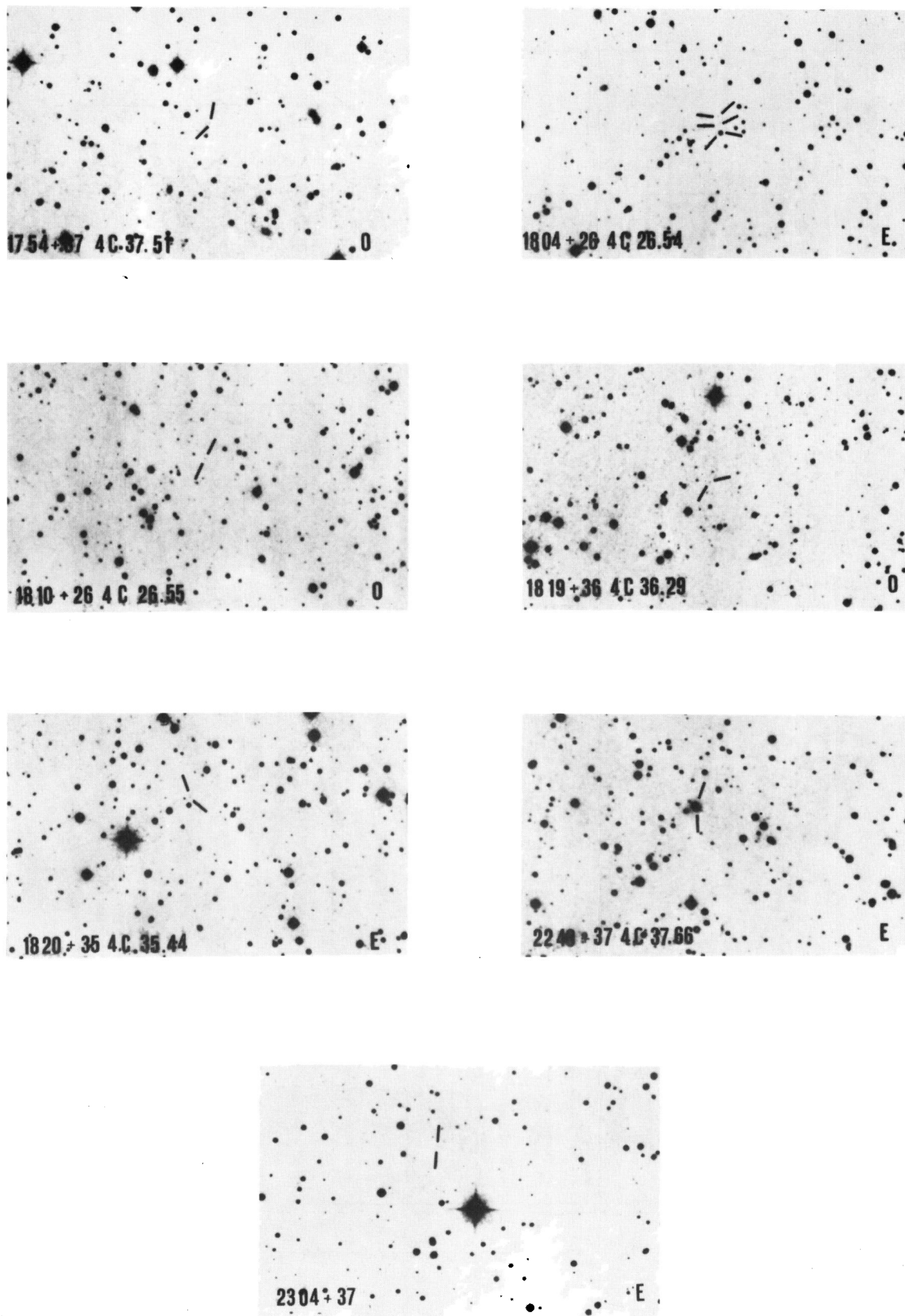


FIGURE 3 (continued).

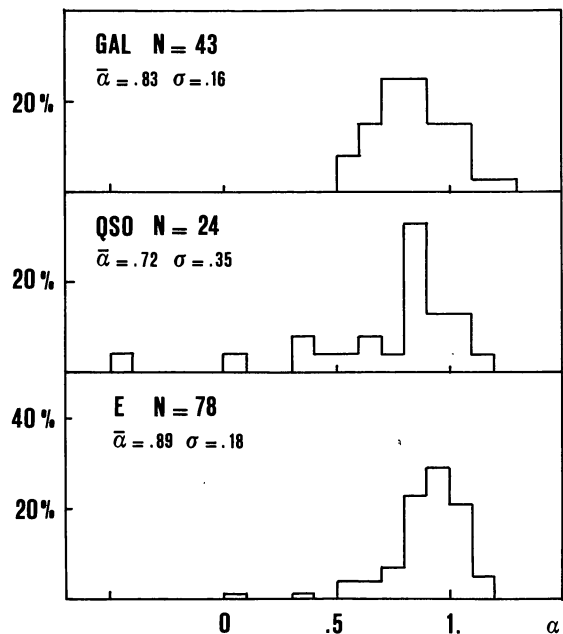


FIGURE 4. — Normalized spectral index distributions for Galaxies, QSO's and Empty Fields from the 408 MHz complete sample.

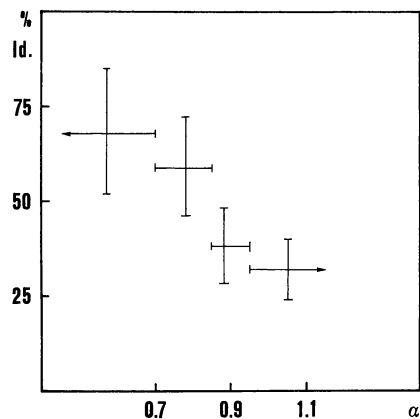


FIGURE 5. — Percentage of identifications as a function of spectral index.

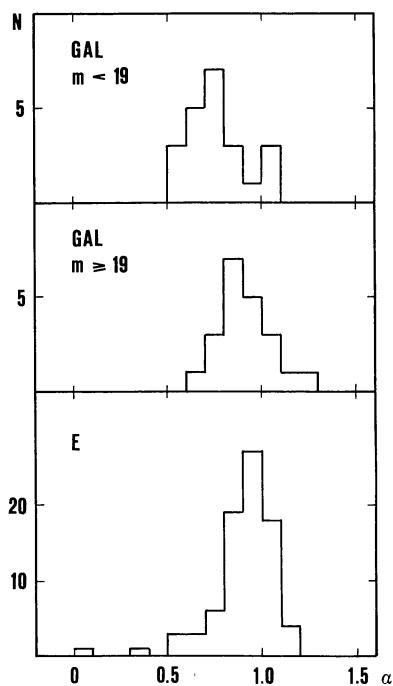


FIGURE 6. — Spectral index distributions for various ranges of magnitude for radio galaxies.

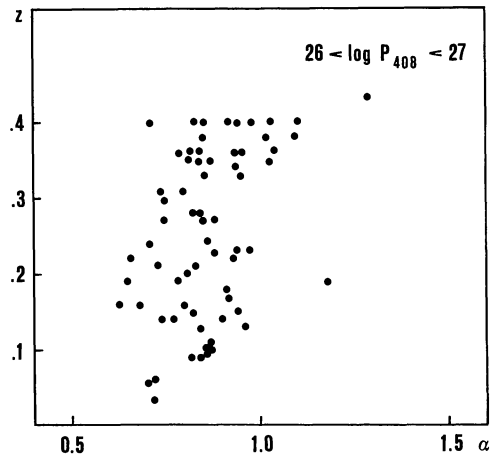


FIGURE 7a. — The distribution of spectral indices with z for all sources in the extended sample with $26 < \log P_{408} < 27$.

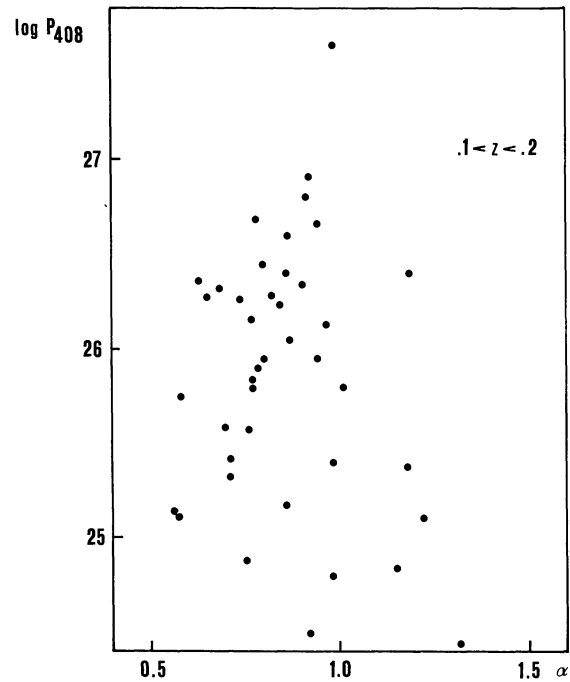


FIGURE 7b. — The distribution of spectral indices with $\log P$ for all sources in the extended sample with $0.1 < z < 0.2$.

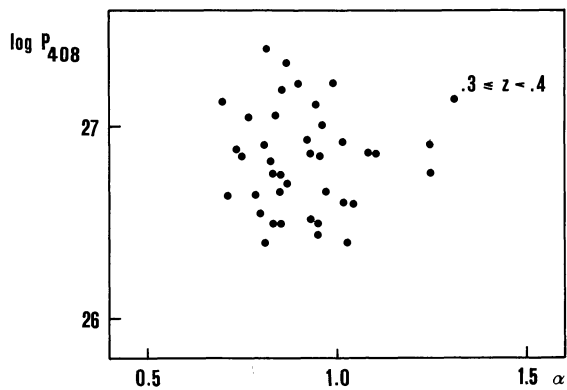


FIGURE 7c. — The same for $0.3 < z < 0.4$.

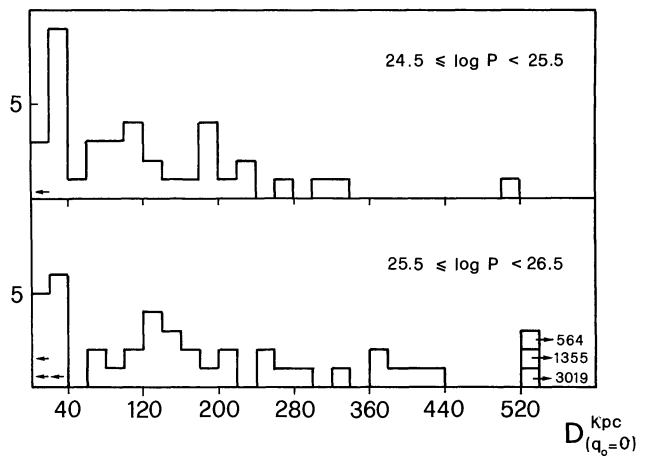


FIGURE 8. — The distribution of the projected linear diameters of radio galaxies in the redshift range $0.05 < z < 0.2$ for two intervals of $\log P_{408}$ ($q_0 = 0$, $H = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$).

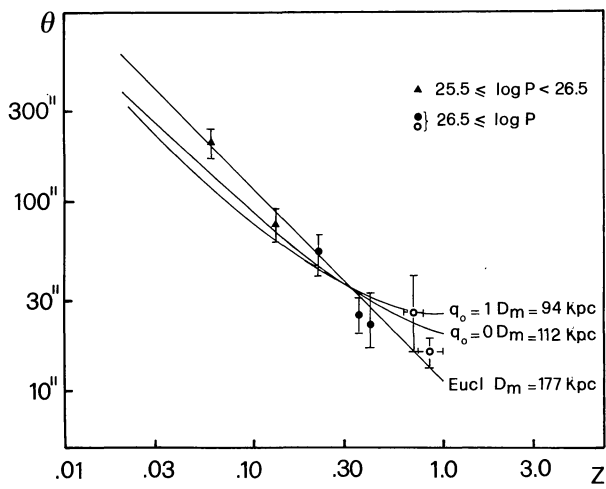


FIGURE 9. — The θ - z relation for radio galaxies in the extended sample that have $\log P_{408} > 25.5$. Entered also are *a*) the point derived from the data of Laing *et al.* (1978) ($z = 0.7$, $\theta_{\text{med}} = 25''$ arc), *b*) the point derived from the Empty Fields (see text, $z = 0.85$, $\theta_{\text{med}} = 16''$ arc). Best-fit relations obtained from galaxies with $z < 0.6$ are indicated for various geometries.

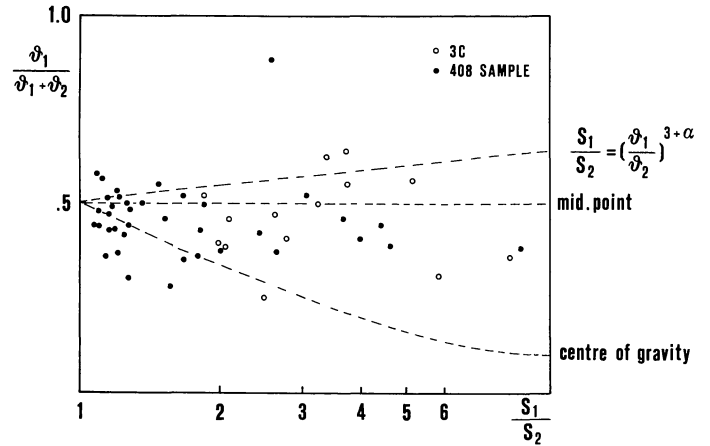


FIGURE 10. — The distribution of relative positions of identifications with flux ratio. Indicated are the expected relative positions if *a*) the optical object is to be found in the center of gravity, *b*) the optical object is to be found in the center of a symmetric radio source without flux density evolution observed under a random angle (i.e. relativistic effects come into play).

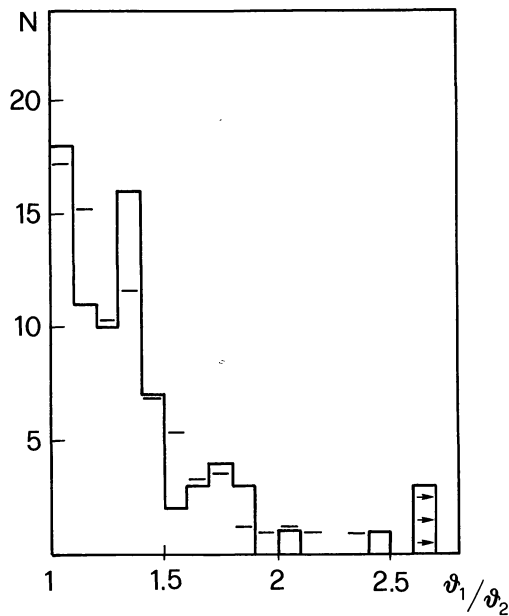


FIGURE 11. — The histogram gives the observed distribution of θ_1/θ_2 for a 408 MHz-178 MHz sample (as described in text). The short horizontal bars give the expected distribution for a distribution of separation velocities with a peak value of v/c of 0.24, a dispersion of 0.12 and a lower limit of 0.1.

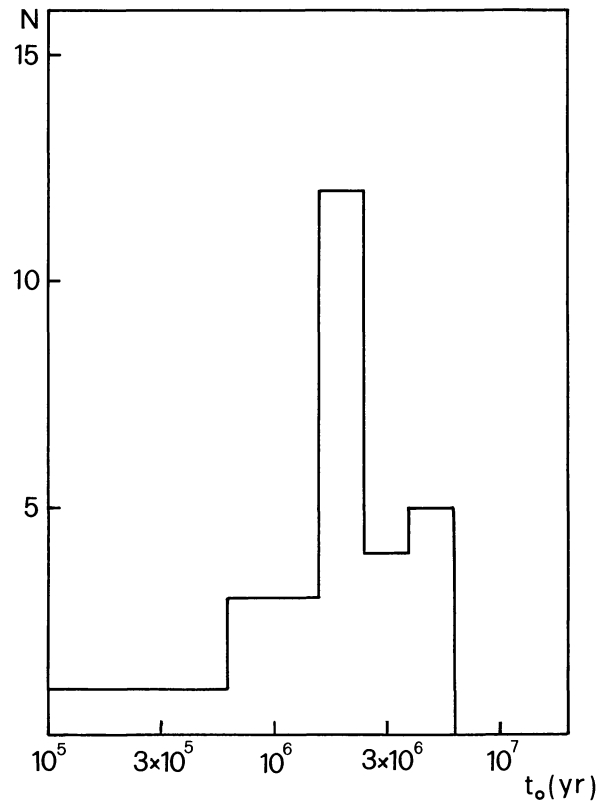


FIGURE 12. — The distribution of estimated ages of the radio sources in the 408 MHz sample, derived by combining the results of sections 5*b* and 5*c*.