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EXTENDED RADIO SOURCES AND ELLIPTICAL GALAXIES.
V. OPTICAL POSITIONS FOR 40 IDENTIFIED SOURCES

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ABSTRACT

Optical positions generally accurate to ~0.4 arcsec are given for the centers of 40 radio galaxies; the positions have been obtained by the method described in Paper III of this series (Goodson *et al.* 1979). Small-diameter radio cores in extended radio structures coincide with 18 of these galaxy centers, so the identifications of the extended structures with these galaxies are essentially unambiguous. We have examined the distribution of angular offsets of the radio cores from the centroids of the extended structures for all such unambiguous identifications made in Papers I to V of this series. The distribution confirms the result of Paper I (Bridle and Fomalont 1978a) that >90% of the identifications of clearly bifurcated radio structures are within 0.15 (LAS) of their radio centroids. The reliability of the optical identification is examined for the 22 extended sources in this group which do not have detectable radio cores.

I. INTRODUCTION

Paper III of this series (Goodson *et al.* 1979) gave optical positions for the centers of 87 radio galaxies drawn from a large sample of sources which in 1973 were identified with elliptical or S0 galaxies. This paper presents optical positions, accurate to $\lesssim 0.4$ arcsec, for the centers of 40 further radio galaxies. Most of these optical positions were measured to confirm the identifications of sources that were encountered (but not necessarily finally used) in a study of the relative orientations of extended radio structures and their associated elliptical galaxies (Palimaka *et al.* 1979).

The radio structures of these sources have been observed with the NRAO 4-element interferometer, as described in Paper I (Bridle and Fomalont 1978a), or with antennas of the VLA (Paper II—Fomalont and Bridle 1978). Maps of those whose structures had no adequate high-resolution representations in the literature were shown in Paper IV (Fomalont *et al.* 1980) (preceding paper).

The candidates for optical position measurement were chosen on the basis of proximity of the galaxy to (a) the position of a small-diameter component in the radio structure or to (b) the centroid of the extended radio emission. Section III of this paper considers the reliability of the resulting identifications in light of criteria developed in the earlier papers of this series.

II. THE OPTICAL POSITIONS

The x-y positions of the identification candidates and those of six to eight AGK3 reference stars were measured from the Palomar Sky Atlas prints using a two-coordinate measuring engine. The x-y coordinates of the reference stars were fitted with an equatorial frame using Schlesinger's method of dependencies as described by Smart (1962). The position of the identification candidate was then obtained from its x-y coordinates by use of this "standard" frame. Details of the measurement procedure and of the methods of internal and external error estimation are described in Paper III and by Bridle and Goodson (1977).

Table I presents the derived positions of the geometrical centers of the Sky Atlas images of 40 galaxies which we consider to be secure identifications of radio sources on the basis of our measurements. The upper line in column 1 gives the radio source name in the IAU convention and the lower line gives a common name from a radio source catalog, nomenclature as in Kesteven and Bridle (1977).

Columns 2 and 3 list the optical coordinates (epoch 1950.0) for the center of each galaxy; the standard errors in R.A. and Decl. are given below each position in seconds of time for R.A. and in arcseconds for Decl. Column 4 codifies the color sensitivity of the Palomar Sky Atlas print from which the measurement was made (E = red, O = blue).

Column 5 gives an estimate of the apparent visual magnitude of the identification made from the Sky Atlas prints as described in Paper I (these estimates are un-

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TABLE I. Optical positions of radio galaxy centers.

NAME	R.A. (1950.0)	DEC.	PRINT	m_V	SIZE	TYPE(OFFSET)	REFS.	NOTES
0055+265 B20055+26	$00^{h}55^{m}40^{s}.71$ 0.03	$+26^{\circ}35'44''.7$ 0.4	O	13.7	22x14	C(10.1)	Fan77 Col75	1
0059+144 3C30	00 59 27.46 0.02	+14 27 18.8 0.4	O	17.2	4x3	C(11.2)	unpub Mer69	
0108-142 PK0108-142	01 08 40.30 0.10	-14 13 35.8 0.4	O	13.9	13x13	C(8.5)	Fom80 Bol67	2
0110+152 PK0110+15	01 10 20.20 0.02	+15 13 35.3 0.3	O	14.8	9x7	C(2.8)	unpub Mer72	2,3,4
0124+189 PK0124+18	01 24 12.24 0.02	+18 57 19.1 0.4	O	14.4	12x11	C(2.1)	Fom80 Sha78	
0153+053 PK0153+05	01 53 44.31 0.04	+05 23 05.4 0.4	O	12.3	30x25	C(5.1)	Fom80 Pal80	2
0238+085 PK0238+08	02 38 25.85 0.02	+08 31 29.0 0.4	O	13.9	13x11	S(0.7)	Fom80 Pal80	2,5
0305+039 3CR78	03 05 49.08 0.04	+03 55 13.2 0.6	O	13.8	14x12	S(0.3)	Fom80 Mal63	6
0325+023 3CR88	03 25 18.19 0.02	+02 23 20.3 0.4	O	14.0	11x9	S(0.6)	Fom80 Wyn66	7
0602+477 WK124	06 02 35.05 0.03	+47 47 55.2 0.6	E	19.1	5x3	C(1.8)	Fom80 Pal80	2
0704+351 4C35.16A	07 04 24.40 0.02	+35 08 23.6 0.4	O	15.4	7x6	S(0.5)	Fom80 Rud77	2,8
0734+805 3CR184.1	07 34 25.05 0.08	+80 33 24.1 0.4	O	17.2	5x4	S(0.5)	Ril75 Wyn66	2
0800+248 B20800+24	08 00 16.24 0.02	+24 49 03.9 0.4	E	14.8	14x10	S(3.0)	Fan77 Col75	9
0838+325 B20838+32A	08 38 06.75 0.04	+32 35 43.7 0.4	O	14.9	10x9	C(28.9)	unpub Pal80	2,10
0858+292 3CR213.1	08 58 05.15 0.03	+29 13 33.8 0.3	O	18.1	4x3	S(1.3)	unpub Wyn66	3,11
0922+366 4C36.14	09 22 34.20 0.04	+36 40 04.6 0.4	E	15.6	10x9	S(0.4)	Rud79 Rud79	12
0932+254 4C25.26	09 32 40.07 0.03	+25 24 09.5 0.4	E	17.1	5x4	C(20.8)	unpub Ols70	13
1005+007 PK1005+007	10 05 37.34 0.03	+00 44 42.0 0.7	O	15.4	7x6	S(0.5)	Fom80 Mer70	2
1033+003 PK1033+003	10 33 31.93 0.04	+00 21 41.1 0.4	O	15.2	8x6	C(14.4)	Fom80 Mer70	2,14
1127+012 PK1127+012	11 27 47.51 0.02	+01 14 56.6 0.4	O	16.7	5x4	C(13.4)	Fom80 Mer70	
1130-037 PK1130-037	11 30 31.85 0.02	-03 44 14.3 0.5	O	14.3	10x8	S(3.2)	Fom80 Mer70	2
1137+123 PK1137+12	11 37 52.64 0.02	+12 19 46.0 0.4	O	14.8	9x7	C(6.0)	Fom80 Cla66	

1980AJ.....85..995P

TABLE I. (continued)

NAME	R.A. (1950.0)	DEC.	PRINT	m_V	SIZE	TYPE(OFFSET)	REFS.	NOTES
1150+227 4C22.32	$11^h50^m34^s.50$ 0.05	$+22^\circ45'54''.2$ 0.4	E	17.3	5x4	C(22.7)	unpub Ols70	2,15
1154-038 PK1154-038	11 54 14.73 0.02	-03 48 58.9 1.1	O	14.3	12x10	S(0.8)	Fom80 Mer70	2
1247+503 WK301	12 47 01.68 0.04	+50 21 09.0 0.4	E	18.6	4x4	C(4.1)	Fom80 Pal80	4,16
1250-102 PK1250-10	12 50 30.64 0.02	-10 13 21.7 1.4	O	13.4	20x19	S(1.5)	Fom80 Mer69	
1256+281 B21256+28	12 56 58.52 0.04	+28 10 51.1 0.4	O	13.7	15x15	C(18.3)	Owe77 Col75	17
1303+366 B21303+36B	13 03 31.83 0.02	+36 38 56.1 0.4	E	19.0	4x3	C(2.3)	Fom80 Kat78	18
1414+110 3CR296	14 14 26.37 0.03	+11 02 19.3 0.4	O	12.5	24x20	S(0.7)	Fom80 Wyn66	2,19
1422+268 B21422+26	14 22 26.50 0.03	+26 51 01.8 0.4	O	13.9	11x10	S(0.5)	Fom80 Col75	
1435+038 PK1435+038	14 35 50.86 0.02	+03 53 09.6 0.4	E	18.2	6x5	C(5.6)	unpub Mer70	20
1443+178 4C17.60	14 43 38.10 0.02	+17 51 02.7 0.4	O	14.9	9x7	C(13.8)	unpub Wil69	
1514+004 PK1514+00	15 14 06.73 0.02	+00 26 01.5 0.4	O	14.8	10x8	S(0.5)	Fom80 Bol68	2,21
1710+156 MLO1710+156	17 10 11.52 0.02	+15 39 39.2 0.4	E	16.7	7x4	C(17.6)	Fom80 Hos72	22
1726+318 3CR357	17 26 27.31 0.02	+31 48 24.6 0.6	O	16.7	6x5	C(1.3)	unpub Gru72	23
1940+504 3CR402S	19 40 25.57 0.05	+50 28 38.2 0.4	O	14.1	17x15	S(0.8)	Bri78 Lon75	2,24
2103+124 PK2103+12	21 03 47.73 0.04	+12 27 52.1 0.9	O	16.2	5x5	S(0.5)	Fom80 Cla66	
2117+605 3CR430	21 17 02.73 0.03	+60 35 27.1 0.4	O	16.9	3x3	S(0.7)	Ril75 Wyn66	2
2342+294 4C29.70	23 42 33.04 0.02	+29 26 05.5 0.3	O	17.3	5x4	C(22.0)	unpub Ols70	25
2354+471 4C47.63	23 54 57.50 0.06	+47 09 39.8 0.4	O	14.1	12x11	C(3.0)	Fom80 Ver71	

References to Table I: Bo167 = Bolton and Ekers 1967; Bo168 = Bolton *et al.* 1968; Bri78 = Bridle and Fomalont 1978a (Paper I); Cla66 = Clarke *et al.* 1966; Co175 = Colla *et al.* 1975; Fan77 = Fanti *et al.* 1977; Fom80 = Fomalont *et al.* 1980 (Paper IV); Gru72 = Grueff and Vigotti 1972; Hos72 = Hoskins *et al.* 1972; Kat78 = Katgert 1978; Lon75 = Longair and Gunn 1975; Ma163 = Maltby *et al.* 1963; Mer69 = Merkelijn 1969; Mer70 = Merkelijn and Wall 1970; Mer72 = Merkelijn 1972; Ols70 = Olsen 1970; Owe77 = Owen *et al.* 1977; Pa180 = this paper, Fig. 1; Ril75 = Riley and Pooley 1975; Rud77 = Rudnick and Owen 1977; Rud79 = Rudnick and Adams 1979; Sha78 = Shaffer 1978; unpub = radio position from our (unpublished) NRAO data; Ver71 = Véron 1971; Wil69 = Wills and Bolton 1969; Wyn66 = Wyndham 1966.

Notes to Table I

1. Guthrie (1979) classified this identification as a db galaxy based on its appearance on the Palomar Sky Survey plates.
2. Another optical object lies within or near the radio structure; see Table II.
3. The optical position is the mean of two measurements.
4. The quoted optical position is that of the brighter nucleus of a db system; see Table II for the position of the other nucleus.
5. The radio core is extended ~4 arcsec in diameter (see Paper IV,

Notes to Table I. (continued)

notes to Table II). The position offset in column 7 has been calculated with respect to the peak of a possibly unresolved component on our 8.1-GHz map at $02^{h}38^{m}25\overset{s}{.}89\pm0\overset{s}{.}04$, $+08°31'28\overset{''}{.}6\pm0\overset{''}{.}6$. Clarke *et al.* (1966) classify the identification as a db galaxy; see Table II for the position of the companion.

6. An optical position is also given by Griffin (1963).
7. An optical position is also given by Véron (1966).
8. Rudnick and Owen (1977) suggest that the field contains two head-tail radio sources. They detected a small-diameter 8.1-GHz component at $07^{h}04^{m}24\overset{s}{.}41\pm0\overset{s}{.}02$, $+35°08'23\overset{''}{.}7\pm0\overset{''}{.}3$, which is consistent with the position of our radio core. The optical position given here is for object 1 on their finding chart. The position of the galaxy suggested as the identification for the other head-tail source in the field is given in Table II.
9. A confusing source (40 mJy at 1.4 GHz, 18 mJy at 5 GHz) is shown at $08^{h}00^{m}07\overset{s}{.}0$, $+24°46'20''$ in the maps by Fanti *et al.* (1977). According to the 5-GHz source count relation used in Paper II, the probability of finding a source of this intensity or brighter within this radius of 0800+248 by chance is $\gtrsim 3\%$. It is therefore unclear whether the confusing source is associated with the emission near the identification.
10. The optical field is documented in Fig. 1(f); see Sec. II.
11. An optical position is also given by Wills *et al.* (1973). The position quoted here is the mean of two positions measured on adjacent, overlapping prints. The position of the radio core is $08^{h}58^{m}5\overset{s}{.}21\pm0\overset{s}{.}02$, $29°13'32\overset{''}{.}8\pm0\overset{''}{.}2$, but the errors may be underestimated owing to confusion with structure on a scale ~1 arcsec.
12. The identification is object 2 on the finding chart shown by Rudnick and Adams (1979). The position of object 1 is given in Table II.
13. A confusing component (100 mJy at 2.7 GHz) is seen at $9^{h}32^{m}37\overset{s}{.}04$,$+25°22'07\overset{''}{.}1$. From the 2.7-GHz source count of Fomalont *et al.* (1974), the probability of finding a source of this intensity or brighter in the field by chance is <1%, so it is possible that the two components in this field are associated. The centroid position used in calculating the offset given in column 7 of the table is, however, for the Northern component only. There is no image significantly brighter than the print limit under the Southern component.
14. The source contains an extended central component ~5 arcsec in diameter which is apparently resolved into two subcomponents at 8.1 GHz. The centroid of this core is at $10^{h}33^{m}31\overset{s}{.}89$, $+00°21'38\overset{''}{.}5$ (see Paper IV, notes to Table I). There is an offset between this position and the optical position but we consider the identification to be reliable under criterion (c) (see Sec. III), since the offset from the source centroid is formally less than 0.15 (LAS).
15. There is a weak radio component (8±5 mJy) near the galaxy position on the 8.1-GHz map.
16. A 15±7-mJy radio core is seen at 8.1 GHz at $12^{h}47^{m}1\overset{s}{.}65\pm0\overset{s}{.}05$, $+50°21'11\overset{''}{.}8\pm1\overset{''}{.}4$, but it is not separable from the larger-scale emission at 2.7 GHz (see Paper IV, notes to Table I). The core is midway between two nuclei of what may be a db system.
17. The optical position is the mean of three measurements by different observers.
18. The faint ($19\overset{m}{.}3$) image on the O print suggests a close db system. This field is on the finding chart marked 1303+36W3 in Katgert (1978).
19. The optical position given by Véron (1966) disagrees with our position by 6.0 arcsec in R.A. and 4.2 arcsec in Decl. Our optical position is in good agreement with that of the small-diameter radio component.
20. The identification is more than 2^{m} brighter on the E print than on the O and appears to be the brightest member of a compact cluster.
21. Bolton and Kinman (1966) and Clarke *et al.* (1966) identified this source with a UV-excess QSO on the basis of an incorrect Parkes catalog right ascension (Bolton *et al.* 1968). Caswell and Wills (1967), Bolton *et al.* (1968), and Fomalont (1971) proposed identification with the galaxy documented here. The QSO lies within the search area defined by the source LAS, but we consider the identification with the galaxy to be secure on the evidence of coincidence with the small-diameter radio core reported in Paper IV.
22. An optical position is also given by Hoskins *et al.* (1972). The identification is of neutral color but its image is elongated and slightly diffuse on both prints. The source is almost entirely within the image of the galaxy.
23. Paper II gives a 3-mJy upper limit to any 5-GHz emission at the position of the galaxy. Table II gives the positions of other objects marked on the map by Rudnick and Adams (1979).
24. The identification is the Southern galaxy marked with cross-hairs on the finding chart by Longair and Gunn (1975). The position of the galaxy in the Northern structure of the source 3C402 is given in Table II. Paper IV (Fig. 7) shows a map of the structure most likely to be associated with the galaxy whose position is given in Table I.
25. Our NRAO interferometer data show that the 2.7-GHz centroid of this slightly resolved source is at $23^{h}42^{m}33\overset{s}{.}08\pm0\overset{s}{.}01$, $29°26'05\overset{''}{.}9\pm0\overset{''}{.}2$. The core was also observed by us with seven VLA antennas at 14.8 GHz, as described by Bridle and Fomalont (1978b). These observations show it to be ~1 arcsec in diameter in the North-South direction, but the detailed morphology is uncertain. Hazard *et al.* (1970) classify the identification as a spiral with a blue nucleus. It appears to us to be an asymmetric galaxy with a compact blue nucleus but with little evidence of spiral structure. The radio source is entirely within the image of the galaxy.

corrected for galactic extinction). Column 6 gives an estimate of the angular dimensions, in arcseconds, of the most heavily exposed part of the galaxy image.

Column 7 codifies the type of identification. "S" denotes that the identification is based on the coincidence of the galaxy with a small-diameter radio component, in which case the number in parentheses is the offset between the radio and optical positions, in arcseconds. "C" denotes that the identification is based on the proximity of the galaxy to the source centroid, in which case the number in parentheses is the offset between the optical and radio centroid positions expressed as a percentage of the largest angular size (LAS) of the source (see Paper III, Sec. III).

Column 8 codifies the reference to the radio position (upper line), most commonly Paper IV, and the reference to a finding chart (lower line). Column 9 refers to numbered explanatory notes following the table.

Table II gives our optical positions, approximate apparent magnitudes, and brief descriptions of other objects in the radio fields. Figures 1(a)–1(d) show finding charts for galaxies which have not been clearly documented in the literature. Figure 1(e) is a finding chart for the identification of the source 1743+666, whose position is given in Paper III. Figure 1(f) documents the field of 0838+325, which has several optical objects near the position of the radio source. The identification is the brightest object indicated and its reliability is not in doubt since the radio source lies almost entirely within the optical boundaries of this image. A close companion and two objects to the South-West are indicated in Fig. 1(f) and their positions are given in Table II.

III. RELIABILITY OF THE IDENTIFICATIONS

We consider all identifications whose positions are given in Table I to be reliable under one of the following criteria:

(a) A small-diameter ($\lesssim$4-arcsec) radio core coin-

1980AJ.....85..995P

TABLE II. Optical positions of other objects in radio fields.

FIELD	R.A. (1950.0)	DEC.	m_V	REMARKS
0108-142	$01^h08^m42^s.63$ ±$0^s.10$	-14°14′21″.7 ±0″.4	16.5	galaxy to SE of source
0110+152	01 10 20.03 ±0.02	+15 13 47.8 ±0.3	18.5	faint object near identification
	01 10 20.77 ±0.02	+15 13 38.2 ±0.3	15.5	other nucleus of db
	01 10 20.88 ±0.02	+15 13 28.8 ±0.3	17.5	faint object near identification
0153+053	01 53 47.30 ±0.04	+05 22 57.8 ±0.4	15.0	galaxy immediately East of source
0238+085	02 38 22.74 ±0.02	+08 32 01.1 ±0.4	15.0	galaxy on edge of bridge of emission
	02 38 26.92 ±0.02	+08 31 39.1 ±0.4	15.0	companion or other member of db system?
	02 38 32.57 ±0.02	+08 30 22.0 ±0.4	14.0	galaxy to NE of Sf lobe
0602+477	06 02 33.35 ±0.03	+47 47 47.4 ±0.6	19.0	galaxy to West of Sp lobe
	06 02 35.95 ±0.03	+47 47 35.9 ±0.6	18.5	galaxy to SE of Sp lobe
0704+351	07 04 21.94 ±0.02	+35 08 23.6 ±0.4	15.5	galaxy identified with Np radio emission
	07 04 22.89 ±0.02	+35 08 16.3 ±0.4	15.0	galaxy in Sp radio structure
0734+805	07 34 29.00 ±0.07	+80 32 26.8 ±0.1	17.5	galaxy in Southern radio structure
0838+325	08 38 06.41 ±0.04	+32 35 38.6 ±0.4	16.0	other nucleus of db?
	08 38 07.24 ±0.04	+32 35 33.4 ±0.4	16.5	object near identification
	08 38 07.77 ±0.04	+32 35 22.1 ±0.4	17.0	object near identification
0922+366	09 22 34.07 ±0.02	+36 39 31.1 ±0.4	18.0	galaxy near identification
1005+007	10 05 34.69 ±0.03	+00 45 00.5 ±0.7	16.0	galaxy? to NW of source
1033+003	10 33 28.44 ±0.04	+00 21 42.4 ±0.4	16.5	galaxy on W edge of radio structure
1130-037	11 30 32.34 ±0.02	-03 44 24.3 ±0.5	17.5	galaxy? near identification
	11 30 33.44 ±0.02	-03 44 11.7 ±0.5	18.0	galaxy? in field
1137+123	11 37 51.88 ±0.02	+12 18 56.0 ±0.4	17.5	galaxy in Southern radio structure
	11 37 55.85 ±0.02	+12 19 29.3 ±0.4	16.5	galaxy to East of source
1150+227	11 50 33.63 ±0.05	+22 46 12.0 ±0.4	17.0	stellar? object to N of preceding lobe
	11 50 36.63 ±0.05	+22 46 06.5 ±0.4	19.5	blue object on E edge of radio structure
1154-038	11 54 09.35 ±0.02	-03 50 39.4 ±1.1	15.5	galaxy to SE of Np lobe
1247+503	12 47 01.67 ±0.04	+50 21 14.3 ±0.4	19.5	other nucleus of db?
1414+110	14 14 26.87 ±0.03	+11 01 45.8 ±0.4	14.5	galaxy to South of identification
1514+004	15 14 07.40 ±0.02	+00 25 52.3 ±0.4	17.0	stellar? object in radio structure
1726+318	17 26 25.49 ±0.02	+31 48 27.5 ±0.6	18.5	blue object in radio structure
	17 26 28.13 ±0.02	+31 48 30.5 ±0.6	17.5	galaxy? in radio structure
	17 26 29.33 ±0.02	+31 48 11.8 ±0.6	18.0	stellar? object in radio strucure
1940+504	19 40 21.87 ±0.05	+50 30 49.4 ±0.4	13.0	brightest galaxy in the field of 3C402
	19 40 24.23 ±0.05	+50 30 08.0 ±0.4	14.5	galaxy NW of structure shown in paper IV
2117+605	21 16 58.29 ±0.03	+60 35 07.9 ±0.4	16.5	galaxy to NW of Sp lobe
	21 17 00.09 ±0.03	+60 35 12.7 ±0.4	18.0	galaxy? in structure to NE of Sp lobe
	21 17 00.69 ±0.03	+60 35 30.0 ±0.4	16.3	stellar? object to W of source

cides with the proposed identification, and radio source counts show that the core has a small (<1%) *a priori* probability (as in Paper I, Sec. IV b) of lying within the circular "search area" whose diameter is defined by the LAS of the source.

(b) The identification cannot be confirmed by coincidence with a radio core but both of the following conditions are met: first, the identification is sufficiently bright that there is a <1% *a priori* probability, based on galaxy counts at high galactic latitudes (Allen 1973), that it is within the search area by chance; and second, there is no other galaxy in the radio structure whose apparent magnitude is within 2^m of that of the proposed identification.

(c) As in (b) the identification has a low probability of being in the search area by chance, but the subsidiary

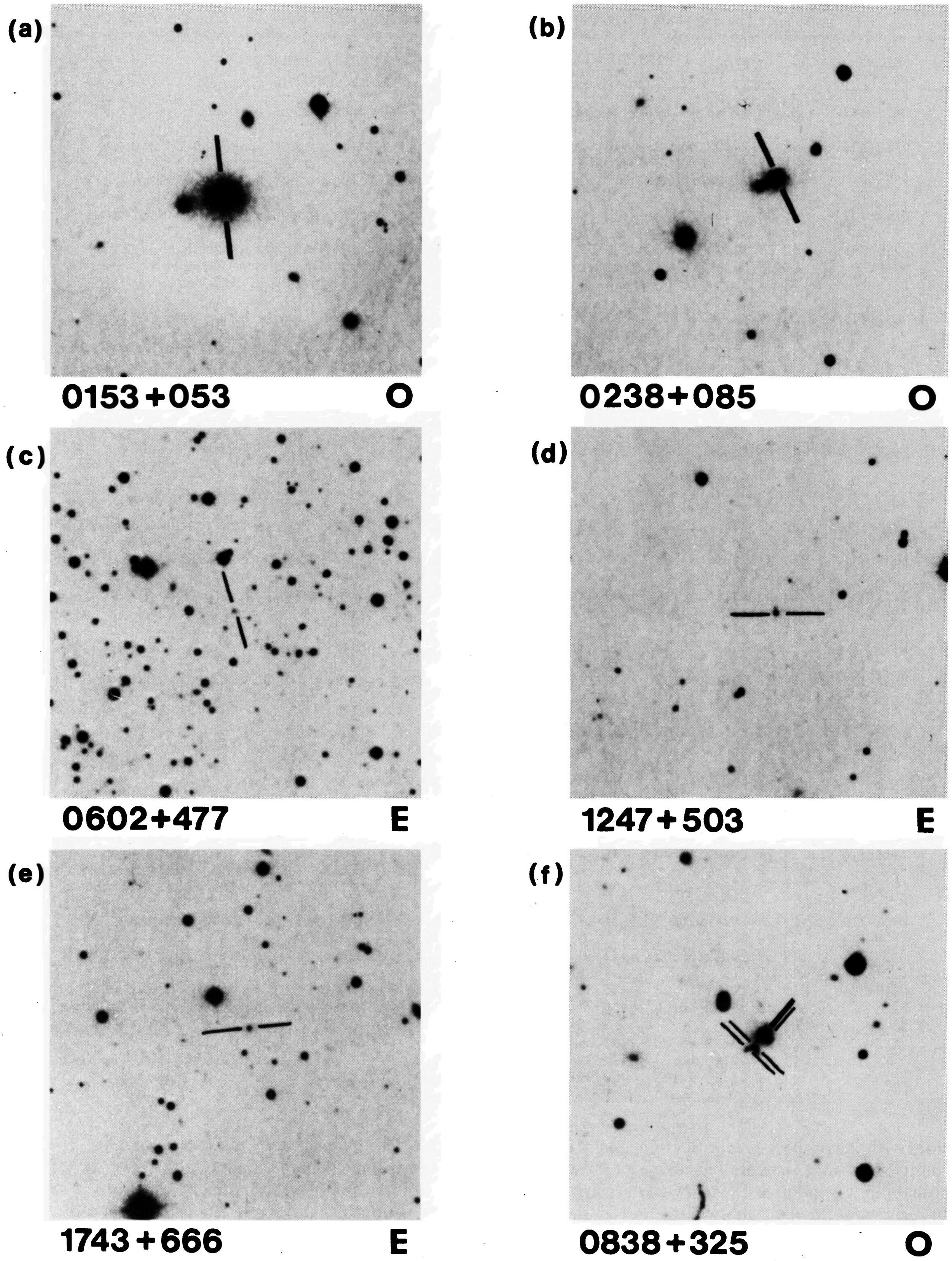

FIG. 1. Finding charts, reproduced from the Palomar Sky Atlas, for six galaxies whose positions are given in this paper (a–d) or in Paper III (e). The finding charts are 7 arcmin on a side. (f) documents the field 0838+325 and is 4.8 arcmin on a side. Letter codes denote color sensitivity of print (E = red, O = blue). © Copyright National Geographic Society–Palomar Observatory Sky Survey, reproduced courtesy of Hale Observatories.

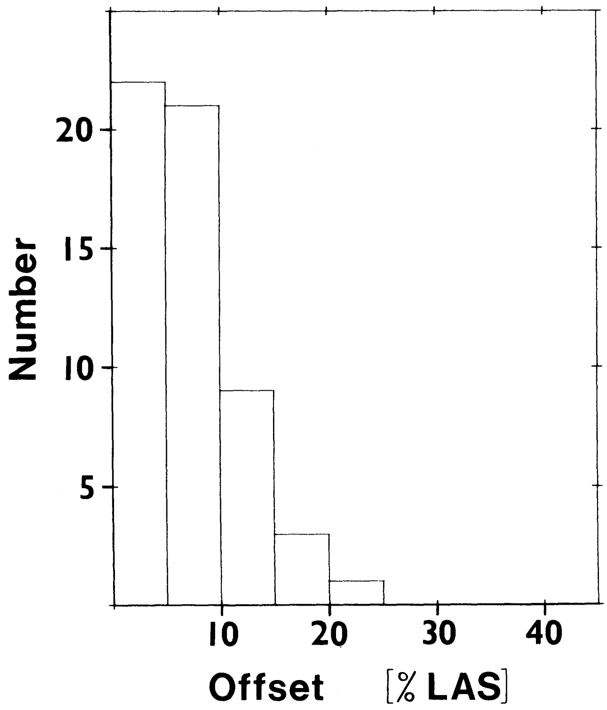

FIG. 2. Frequency histogram of angular offsets between radio core components and radio (usually 2.7-GHz) centroids of bifurcated structures, expressed as percentages of the source LAS.

conditions are: first, that the proposed identification is the brightest galaxy within 0.15 (LAS) of the centroid of the extended structure; and second, that the source is clearly bifurcated. The validity of this secondary criterion was established empirically in Paper I and is reexamined below.

When applying criterion (a), we consider the core to be coincident with the optical identification if the position offsets in R.A. and Decl. are both <1.5 arcsec. This "acceptable offset" is larger than the normal values of the combined formal position errors in our data to allow for possible systematic errors in the optical positions due to large or asymmetric galaxy images. We emphasize also that the optical positions are those of the geometrical centers of the Sky Atlas images; it is to be expected that these may not precisely coincide with the radio core positions, which are the best available estimates of the locations of the active nuclear regions of the galaxies. The optical positions for the identifications of 0800+248 and 1130−037 have offsets from their radio core positions that are greater than 1.5 arcsec in at least one coordinate direction. Both identifications however, satisfy the reliability criteria outlined in (b).

The radio cores detected in the sources 0734+805, 0922+366, and 1154−038 have probabilities >1% of being found by chance within the generous circular search area defined by the source LAS in criterion (a). All three cores have probabilities <1% of being within the more physically realistic rectangular search areas whose lengths are defined by the LAS of the source and whose widths are defined by the widths, to the outer contours, of the radio lobes perpendicular to the source axis.

In the case of double-nucleus or double galaxy systems without detectable radio cores, which are identified using criterion (b), the overall identification is with the pair of nuclei. In these cases the position of the brighter nucleus is given in Table I and that of the fainter in Table II. The fainter nucleus is ignored when comparing the magnitude of the identification to that of other optical objects which may be in the radio structure.

The identifications which do not satisfy the reliability criteria (a) or (b) divide into two groups: (1) sources with nonstellar objects within their radio structures whose apparent magnitudes are within 2^m of that of the proposed identification (0110+152, 1033+003, and 1726+318) and (2) sources with faint identifications such that a galaxy $<2^m$ fainter than the identification could be within the radio structure below the $\sim 20^m$ Sky Atlas print limit (0602+477, 1247+503, 1303+366, and 1435+038). All of these identifications are considered to be reliable under criterion (c).

Figure 2 displays the statistics of radio centroid versus radio core position offsets expressed as percentages of the LAS for clearly bifurcated sources, using sources from all papers of this series whose identifications are based on coincidence with radio cores. These identifications are essentially unambiguous under criterion (a). The distribution should illustrate the intrinsic distribution of offsets of the central energy producers from the centroids of the extended structures for sources with bifurcated structures, assuming that sources with radio cores have the same range of morphology as those without. Figure 2 shows that over 90% of these unambiguous identifications are within 0.15 (LAS) of their source centroids. This strengthens the conclusions of Paper I, Sec. VI a and further supports use of our criterion (c) for identifying coreless bifurcated radio sources with the brightest galaxies within 0.15 (LAS) of their radio centroids.

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