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OPTICAL IDENTIFICATION OF RADIO SOURCES IN THE 3C REVISED CATALOGUE

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ABSTRACT

Radio positions with a mean error of $\pm 12''$ in both coordinates have been used in a search for optical identifications for small-diameter sources in the 3C Revised Catalogue The search has been carried out on the prints and plates which comprise the National Geographic Society–Palomar Observatory Sky Survey Many new identifications are presented together with the previously published material of other workers. More than 50 per cent of the extragalactic sources in the catalogue are now identified, while for sources with $b^{II} > 15°$ the figure is upward of 69 per cent. About 30 per cent of all the identified extragalactic sources are of the quasi-stellar type.

I. INTRODUCTION

Optical identification of a sample of radio sources complete to some given flux level is important for several reasons. Besides providing an increased number of objects for detailed optical study, particularly important in the case of the little-understood quasi-stellar radio sources, it is of interest to determine the distribution of the sources among the various types of optical objects. When such a sample of identified sources is available, it should be possible in many cases to determine, by means of optical spectra, the distances and hence absolute luminosities of the sources. The radio luminosity function for the sources can then be determined with more reliability than has been possible with the limited number of identifications available to date.

The 3C Revised Catalogue of radio sources (Bennett 1962) was designed to include all small-diameter sources with flux density greater than 9×10^{-26} W m^{-2} (c/s)$^{-1}$ at 178 Mc/s north of declination $-05°$, with the exception of some areas near the galactic plane. Several workers (notably Dewhirst, Bolton, Mills, and Minkowski) have made systematic attempts to identify these and other sources with some success but have been hampered by the low accuracy of the radio positions then available for the small-diameter radio sources. More recent attempts with greater positional accuracy (Wyndham 1965; Longair 1965) have yielded an increased number of identifications, while a combination of accurate radio positions and the ultraviolet excess technique employed by Sandage (Ryle and Sandage 1964; Sandage and Wyndham 1965; Sandage, Véron, and Wyndham 1965) has led to a large increase in the number of confirmed quasi-stellar radio sources. The lunar occultation method for the accurate determination of radio source positions and structure has also yielded some important results (Hazard, Mackey, and Nicholson 1964).

In the present paper radio positions with a mean error of $\pm 12''$ in both coordinates obtained with the Owens Valley Radio Observatory two-element interferometer have

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been used in a search for optical identifications for all the unidentified small-diameter sources (with a few exceptions) in the 3C Revised Catalogue (3C R). Some of the radio positions have been published already (Read 1963; Fomalont, Matthews, Morris, and Wyndham 1964; Wyndham and Read 1965). The remainder of the radio positions on which the identifications in this paper are based will be published separately (Fomalont, Wyndham, and Bartlett 1965).

In order to give as complete a description as possible of the optical objects associated with the 3C R sources, previously published material has been included in Table 1, which summarizes the results. References to published material are given in the notes to individual sources but no attempt has been made to assign credit for the initial identification. Some of the new identifications were made independently by T. A. Matthews and E. B. Fomalont (Owens Valley Radio Observatory). Many of the new identifications have been made independently by P. Véron (using a variety of published and unpublished radio positions) during the course of a program for measuring the optical positions of identified radio sources with an accuracy of $\pm 1''$ (Véron, private communication).

Finding charts are given for all identified sources where these have not been published previously. Finding charts have also been provided for those sources whose identification may be possible with radio positions of greater accuracy or through the use of optical telescopes capable of reaching a fainter limiting magnitude than that attained by the Sky Survey plates (limiting magnitudes for Sky Survey plates are 21.1 [blue plates] and 20.0 [red plates] [Minkowski and Abell 1963]).

II. METHOD OF IDENTIFICATION

The search for identifications was carried out using the blue- and red-sensitive plates and prints which comprise the National Geographic Society–Palomar Observatory Sky Survey made with the 48-inch Schmidt telescope. The radio positions were first located on the prints using a method very similar to that described by Longair (1965). A computing program, utilizing the AGK2 catalogue star positions on magnetic tape, was developed in order to perform the necessary calculations. The radio positions were fed into the computer which then searched through the AGK2 catalogue to find all stars which lay within $\pm 45'$ of the radio position in both right ascension and declination. The positions of these stars relative to the radio position were then calculated in millimeters on the scale of the Sky Survey prints. The radio position and the positions of at least six nearby AGK2 stars were plotted on tracing paper by hand and the transparent overlay fitted to the stars on the print. The radio position was located on the print by this means with an accuracy $\pm 5''$ in most cases.

Objects in the vicinity (usually within $30''$) of the radio source position were examined both on the prints and the Survey plates. The latter were indispensable in classifying some of the fainter objects and in determining the galaxy types. Some of the brighter N galaxies were indistinguishable from stars on the Survey prints but were clearly seen to be galaxies when examined on the plates.

III. EXPLANATION OF TABLE 1

Column 1 gives the catalogue number of the radio source, and Column 2 describes the optical object suggested as the identification. The notation used here is largely that of Matthews, Morgan, and Schmidt (1964):

Qs: Starlike object suggested as a quasi-stellar radio source (a few of these appear to be very slightly diffuse). Colors of these objects as determined from the Sky Survey plates are blue (exceptions are 3C 2 and 3C 298). A marked ultraviolet excess relative to normal stars is evident from *UBV* photometry (Matthews and Sandage 1963; Sandage 1965). Radio diameters are small.

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N: Galaxies with brilliant starlike nuclei and a small and faint nebulous envelope. Most of these are red in color and are clearly seen to be galaxies when examined on the Survey plates. An exception is 3C 445 whose spectrum is that of a galaxy (Schmidt 1965*a*) but whose plate image is barely distinguishable from that of a star. *UBV* photometry of five N galaxies by Sandage (1965) shows these objects to lie to the right of the quasi-stellar sources on the *UBV* color diagram, above the black-body line at values of $B - V \sim 0.9$.

The N galaxies are probably related to the compact galaxies discovered by Zwicky (1963*a*, *b*). Many of the latter, however, unlike the N galaxies, have bright extensive envelopes. One exception is the N galaxy identified with 3C 287.1 which has a stellar nucleus surrounded by an extensive outer envelope.

G: Galaxy. For galaxies brighter than 18.0 (visual magnitude) a type has been assigned wherever possible and is inclosed in parentheses. The type notation used here is that of Matthews *et al.* (1964), whose published results have been incorporated into column 2 and a reference given in the notes. Most of these galaxies have D-galaxy characteristics, i.e., elliptical-like nuclei surrounded by extensive envelopes. The letters "cl" indicate a cluster. The prefix "c" denotes a supergiant D galaxy in a cluster.

SNR: Galactic source, supernova remnant.

H II: Galactic source, H II emission region.

Where an optical type has been inclosed in square brackets, the classification should be regarded as doubtful. For a few sources where several optical objects occur close together, two possible identifications have been suggested. For unidentified sources, column 2 is left blank and a description of the field given in the notes.

Column 3 contains an estimate of the visual magnitude of the optical object. These were made from a 5× enlarged Polaroid print of the object made from the red Survey print. Magnitudes of galaxies were estimated by comparison with a sequence of photovisual magnitudes of galaxies identified with radio sources (A. R. Sandage, private communication). Magnitudes of stellar objects were estimated by comparison with photovisual magnitudes of stars in Selected Area 57 (*Mount Wilson Catalogue of Selected Areas*, 1930) made by Stebbins, Whitford, and Johnson (1950) and by W. A. Baum (private communication). These estimates suffer for the reason that the red Sky Survey plate sensitivity peaks at a wavelength of 6500 Å, while the comparison sequences relate to wavelengths of 5500 Å (galaxies) and 5240 Å (stars) and errors of some fraction of a magnitude are to be expected depending upon the color of the object. Plate differences will also introduce errors. The estimates for galaxies should be accurate to ±0.5 mag. in many cases. Comparison with the photometry of Sandage for some of the quasi-stellar objects indicates that estimates for stellar objects are as accurate as ±0.3 mag. for many objects, though there are some cases of marked disagreement.

Columns 4 and 5 contain an optical position as marked on the finding chart. No positions are given for unidentified sources with field class I (galactic obscuration, no galaxies visible). Column 6 contains the galactic latitude of the radio source.

Column 7 is a reference to the positions in columns 4 and 5:

1, Position of optical identification with mean accuracy ±7″.
2, Mean position of radio source as marked on finding chart with accuracy ∼±7″.
3, Optical position by Griffin (1963).
4, Optical positions by Véron (1965) and Sandage *et al.* (1965).
5, Optical positions published by Schmidt (1965*a*).
6, Hazard *et al.* (1964).
7, Published California Institute of Technology radio positions.
8, 3C R position.

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TABLE 1

OPTICAL DATA FOR 3C REVISED SOURCES

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 2	Qs	20.0	$00^h03^m48^s.70$	$-00^\circ21'06''.6$	-61°	4	a1
3C 6.1			00 13 37.5	79 00 03	17	2	II
3C 9	Qs	18.8	00 17 49.83	15 24 16.5	-47	4	a1
3C 10	SNR		00 22 28.1	63 51 53	1	7	1
3C 11.1					1		I
3C 13			00 31 33.3	39 07 43	-23	2	IV
3C 14	G	20.0	00 33 29.0	18 21 37	-44	1	a3
3C 14.1					- 3		I
3C 15	G(D1)	15.5	00 34 29.8	-01 25 38	-64	1	a2
3C 16			00 35 07.6	13 03 34	-50	2	III
3C 17	N	18.5	00 35 46.6	-02 23 58	-65	1	a1
3C 19			00 38 13.5	32 53 38	-30	2	IV
3C 18	G	18.5	00 38 14.5	09 46 58	-53	1	a2
3C 20			00 40 17.8	51 47 02	-11	2	II
3C 21.1					5		I
3C 22			00 48 04.5	50 55 42	-12	2	II
3C 27					6		I
3C 28	G cl	17.5	00 53 08.86	26 08 25	-37	5	b1
3C 29	G(ED2)	13.0	00 55 01.3	-01 39 40	-64	1	b2
3C 31	G(DE3)cl	12.0	01 04 38.4	32 08 38	-30	1	d2
3C 33	G(DE4)	15.0	01 06 14.537	13 04 14.75	-49	3	d1
3C 33.1			01 05 57.0	72 56 02	10	2	II
3C 33.2					7		I
3C 34			01 07 33.3	31 31 00	-31	2	III
3C 35	G(D3)	14.5	01 09 05.0	49 12 41	-13	1	d3
3C 36	[Qs]	19.0	01 15 03.3	45 20 35	-17	1	a4
3C 40	G(cD4)	12.0	01 23 25.999	-01 35 59.53	-63	3	d1
		12.3	27.484	36 17.19	-63	3	d1
3C 41			01 23 55.5	32 57 43	-29	2	III
3C 42			01 25 42.6	28 47 36	-33	2	III
3C 43	Qs	20.0	01 27 15.18	23 22 52.0	-39	4	a1
3C 44			01 28 46.5	06 08 13	-55	2	IV
3C 46	G	19.5	01 32 34.5	37 38 46	-24	1	a3
3C 47	Qs	17.6	01 33 40.3	20 42 16.0	-41	4	b1
3C 48	Qs	16.6	01 34 49.817	32 54 20.22	-29	3	a1
3C 49			01 38 28.7	13 38 22	-47	2	IV

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 52	G cl	18.5	$01^h45^m14^s.7$	53°17'31"	- 8°	1	b4
	G cl	18.5	14.3	18 04	- 8	1	b4
3C 54			01 52 26.8	43 31 12	-18	2	III
3C 55			01 54 19.0	28 37 03	-32	2	III
3C 58					3		I
3C 61.1	G cl	18.5	02 11 03.6	86 05 20	24	1	b3
3C 63	G	18.5	02 18 22.0	-02 10 32	-57	1	a2
3C 66	G(ED2)d	12.3	02 20 01.778	42 45 54.63	-17	3	d1
3C 65			02 20 36.9	39 47 13	-20	2	III
3C 67	G	18.0	02 21 18.2	27 36 37	-31	1	a3
3C 68.1	[G]	19.5	02 29 28.2	34 10 56	-24	1	b4
3C 68.2	[Qs]	15.3	02 31 24.2	31 21 25	-26	1	c3
	[Qs]	15.0	22.6	03	-26	1	c4
3C 69					- 1		I
3C 71	G(gS2p)	10.8	02 40 07.097	-00 13 31.47	-52	3	a1
3C 75	G(db)cl	13.0	02 55 02.951	05 49 37.02	-45	3	a1
		13.0	03.009	20.74	-45	3	c1
3C 76.1	G(DE3)	14.0	03 00 27.1	16 14 41	-36	1	a2
3C 78	G(DE3)	13.2	03 05 49.067	03 55 13.08	-45	3	a1
3C 79	G	18.0	03 07 11.0	16 54 29	-35	5	a1
3C 83.1	G(ED3-4)cl	12.5	03 14 57.1	41 40 39	-13	1	d1
3C 84	G(ED2)cl	12.0	03 16 30	41 20	-13	1	a1
3C 86					- 1		I
3C 88	G(D4)	13.0	03 25 18.8	02 23 21	-42	5	b1
3C 89	G(ED2)cl	15.5	03 31 44.0	-01 21 18	-43	1	b2
	G cl	16.0	43.6	20 46	-43	1	b4
3C 91			03 34 03.8	50 35 54	- 4	2	II
3C 93	Qs	19.2	03 40 51.47	04 48 21.6	-38	4	a1
3C 93.1	G cl	19.0	03 45 35.9	33 44 03	-16	1	b3
3C 98	G(ED3)	14.0	03 56 10.214	10 17 31.70	-31	3	c1
3C 99	G	18.0	03 58 32.7	00 28 38	-37	1	a2
3C 103			04 04 35.7	42 52 16	- 7	2	II
3C 105			04 04 45.0	03 33 18	-34	2	IV
3C 107	[N]	16.2	04 09 49.7	-01 06 41	-35	1	a3
3C 109	N	15.7	04 10 54.3	11 04 49	-28	1	b2
3C 111					- 9		I
3C 114	G cl	18.5	04 17 28.6	17 46 18	-22	1	b4
3C 119	Qs	>20.0	04 29 07.84	41 32 08.7	- 4	4	a1
3C 123	G	19.5	04 33 55.1	29 34 11	-12	1	a3

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 124	G cl	18.5	$04^h39^m23^s.8$	01°14'54"	-28°	1	b3
3C 125					- 4		I
3C 129	G	19.0	04 45 21.2	44 56 45	0	1	b3
3C 129.1					0		II
3C 130	G(DE2)	16.5	04 48 56.9	51 59 56	5	1	a2
3C 131					- 8		I
3C 132	G cl	18.5	04 53 42.1	22 44 42	-13	1	a2
3C 133					-10		I
3C 134					- 2		I
3C 135	G(DE:)cl	16.5	05 11 33.7	00 53 15	-21	1	a2
3C 136.1	G(D5:)	17.0	05 12 58.8	24 55 15	- 8	1	c3
3C 137			05 15 37.9	50 51 30	8	2	II
3C 138	Qs	18.5	05 18 16.51	16 35 26.2	-11	4	a1
3C 139.1	HII		05 19 20	33 22	- 1	1	2
3C 139.2					- 4		I
3C 141					- 1		I
3C 142.1			05 28 48.2	06 28 19	-15	2	II
3C 144	SNR		05 31 30	21 59 00	- 6	1	a1
3C 147	Qs	18.0	05 38 43.531	49 49 43.11	10	3	a1
3C 147.1					-16		I
3C 152					- 1		I
3C 153	G cl	18.0	06 05 44.4	48 04 59	13	1	a2
3C 153.1	HII		06 06 54	20 30 40	1	1	3
3C 154			06 10 42.8	26 05 27	4	2	II
3C 157	SNR		06 14 36	22 43	3	8	1
3C 158			06 18 50.1	14 33 40	0	2	II
3C 165			06 40 05.0	23 22 15	9	2	II
3C 166	G	19.5	06 42 24.1	21 25 10	8	1	a2
3C 169.1			06 47 36.7	45 13 01	19	2	III
3C 171	G	18.8	06 51 11.2	54 12 47	22	5	a1
3C 173	[N]	18.0	06 58 55.1	38 01 43	18	1	a3
3C 172	Qs	17.2	06 59 04.5	25 17 36	13	1	a3
3C 173.1	G cl	18.5	07 02 47.4	74 54 34	27	1	a2
3C 175	Qs	17.5	07 10 15.3	11 51 30	10	1	a3
3C 175.1	Qs	18.0	07 11 14.3	14 41 33	12	1	a2
3C 177	N1	15.5	07 21 35.0	15 18 42	14	1	b3
3C 180	G	19.0	07 24 33.4	-01 58 25	7	1	a2
3C 181	Qs	19.4	07 25 20.36	14 43 47.2	15	4	a1
3C 184			07 34 02.3	70 29 59	30	2	IV
3C 184.1	G(D)cl	17.0	07 34 28.2	80 33 32	29	1	b2

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 186	Qs	17.8	$07^h40^m56^s.67$	$38^\circ00'31''.9$	26°	4	a1
3C 187	[G]	19.5	07 42 28.0	02 07 48	13	1	a4
3C 190			07 58 45.2	14 23 11	22	2	III
3C 191	Qs	18.5	08 02 03.78	10 23 58.1	21	4	a1
3C 192	G(DE1)cl	15.0	08 02 35.4	24 18 21	26	1	b2
3C 194			08 06 38.7	42 37 02	32	2	III
3C 196	Qs	16.9	08 09 59.385	48 22 08.03	33	3	a1
3C 196.1	G	17.5	08 12 57.2	-02 59 13	17	1	a2
3C 197.1	G(DE1)cl	16.5	08 18 00.1	47 12 09	35	1	b2
3C 198	G(D4)cl	17.0	08 19 52.4	06 06 50	23	1	b2
3C 200	G	20.0	08 24 21.5	29 28 49	33	1	b2
3C 204	Qs	18.0	08 33 18.23	65 24 05.9	36	4	a1
3C 205	Qs	17.8	08 35 10.6	58 04 46	37	1	a2
3C 207	Qs	17.5	08 38 01.73	13 23 05.4	30	4	a1
3C 208	Qs	17.0	08 50 22.79	14 03 58.3	33	4	a1
3C 208.1			08 51 54.6	14 17 17	34	2	III
3C 210	G cl	20.0	08 55 12.2	28 02 28	39	1	a3
3C 212	N	19.0	08 55 55.7	14 21 26	35	6	a2
3C 213.1	G cl	19.0	08 58 05.1	29 13 31	40	1	a2
3C 215	Qs	18.4	09 03 44.15	16 58 15.7	37	4	a1
3C 217			09 05 41.0	38 00 27	43	2	IV
3C 216	Qs	18.3	09 06 17.26	43 05 59.0	43	4	a1
3C 219	G(cD5)	17.5	09 17 50.655	45 51 43.94	45	3	a1
3C 220.1	G	19.5	09 26 30.9	79 19 19	33	1	a4
3C 220.2	[G]	18.2	09 27 29.8	36 14 28	47	1	a3
3C 220.3	G	18.5	09 31 13.3	83 28 39	31	1	a2
3C 222	G	20.0	09 33 53.7	04 35 46	38	1	a3
3C 223	G(D2)cl	16.5	09 36 50.5	36 07 34	49	1	b2
3C 223.1	G(DE4)	16.0	09 38 18.8	39 58 22	49	1	a2
3C 225			09 39 31.2	14 00 00	44	2	III
3C 226	G	19.5	09 41 37.0	10 00 11	43	1	b2
3C 227	N1	14.5	09 45 06.3	07 39 17	42	1	b1
3C 228			09 47 27.9	14 34 06	46	2	III
3C 230	Qs	17.5	09 49 25.5	00 12 57	39	1	a3
3C 231	G(I)		09 51 43	69 55	40	1	a1
3C 234	N1	17.5	09 58 57.415	29 01 37.38	53	3	a1
3C 236	G(DE4)	15.0	10 03 06.0	35 08 49	54	1	b2
3C 237			10 05 22.0	07 44 53	47	2	III
3C 238			10 08 24.1	06 39 18	47	2	IV
3C 239	Qs	17.5	10 08 37.5	46 43 15	53	1	b3

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 241			$10^h19^m09^s.6$	22°14'18"	56°	2	IV
3C 244.1	G cl	19.0	10 30 18.8	58 30 04	51	1	a2
3C 245	Qs	17.5	10 40 06.11	12 19 15.1	56	4	a1
3C 247	Qs	18.4	10 56 08.93	43 17 35.4	62	4	a1
3C 249			10 59 31.0	-01 00 11	51	2	IV
3C 249.1	Qs	14.8	11 00 30.56	77 15 08.1	38	4	a1
3C 250			11 06 11.4	25 16 48	67	2	III
3C 252			11 08 48.7	35 57 03	67	2	III
3C 254	Qs	17.5	11 11 53.35	40 53 42.0	66	3	a1
3C 255			11 16 52.7	-02 46 27	53	2	III
3C 256	G(D:)cl	17.0	11 18 03.0	23 44 19	69	1	b2
3C 257			11 20 34.0	05 46 51	60	2	IV
3C 258	G cl	19.5	11 22 06.3	19 35 55	69	1	a3
3C 263	Qs	15.8	11 37 09.38	66 04 25.9	50	4	a1
3C 263.1	G	20.0	11 40 48.7	22 23 28	74	1	a3
3C 264	G(DE1)	13.0	11 42 29.7	19 53 03	73	5	d1
3C 265	[G]	20.0	11 42 53.1	31 50 28	75	1	a4
3C 266	[N]	18.4	11 43 07.0	50 02 53	64	1	b3
3C 267			11 47 22.0	13 04 08	70	2	III
3C 268.1			11 57 48.2	17 17 34	44	2	III
3C 268.2	G	19.0	11 58 24.8	31 50 02	78	1	a2
3C 268.3			12 03 54.4	64 30 13	52	2	III
3C 268.4	Qs	18.0	12 06 41.7	43 56 05	71	1	a3
3C 270	G(ED3)cl	11.7	12 16 50.024	06 06 08.50	67	3	c1
3C 270.1	Qs	18.4	12 18 04.00	33 59 50.0	81	4	a1
3C 272			12 22 01.5	42 22 49	74	2	III
3C 272.1	G(E2)cl	11.3	12 22 32	13 10	74	1	a1
3C 273	Qs	12.8	12 26 33.35	02 19 42.0	64	6	a1
3C 274	G(E2)cl	10.8	12 28 17	12 40	75	1	a1
3C 274.1	G	20.0	12 32 57.1	21 37 18	83	1	a4
3C 275			12 39 45.0	-04 29 46	58	2	III
3C 275.1	Qs	20.0	12 41 27.68	16 39 18.7	79	4	a1
3C 277			12 49 27.1	50 50 36	67	2	III
3C 277.1	Qs	18.0	12 50 15.31	56 50 37.0	60	4	a1
3C 277.2			12 51 04.1	15 58 46	78	2	IV
3C 277.3	G(D2)	15.5	12 51 46.294	27 53 49.49	89	3	a1
3C 280			12 54 40.1	47 36 12	70	2	IV
3C 280.1	Qs	19.7	12 58 14.15	40 25 15.4	77	4	a1
3C 284	G cl	18.5	13 08 41.1	27 44 09	86	1	a2
3C 285	G(D:)	15.5	13 19 05.3	42 50 47	73	1	a2

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 287	Qs	17.5	$13^h28^m16^s.12$	$25^\circ24'37''.1$	81°	4	a1
3C 286	Qs	17.4	13 28 49.74	30 45 59.3	81	4	a1
3C 287.1	N	18.5	13 30 21.1	02 16 11	63	1	a2
3C 288	G(D4)cl	16.5	13 36 38.4	39 06 26	75	1	a2
3C 288.1	Qs	18.2	13 40 30.4	60 36 55	56	1	a2
3C 289	[Qs]	17.5	13 43 28.6	50 01 16	65	1	c4
3C 293	G(D5)	13.0	13 50 02.7	31 41 31	76	1	a2
3C 293.1	G	19.0	13 52 15.7	16 29 30	72	1	a3
3C 294			14 04 34.1	34 25 41	72	2	III
3C 295	G(cD:)	20.0	14 09 33.436	52 26 13.61	61	3	a1
3C 296	G(ED4)	12.0	14 14 25.8	11 02 22	62	1	c2
3C 297			14 14 47.7	-03 46 35	52	2	IV
3C 298	Qs	15.8	14 16 38.5	06 42 21	61	1	a1
3C 299	G cl	20.0	14 19 05.6	41 58 30	67	1	a3
3C 300	G	18.0	14 20 39.6	19 49 17	68	1	a2
3C 300.1	G cl	19.0	14 25 57.4	-01 10 47	53	1	b3
3C 303	G(DE)cl	16.0	14 41 25.5	52 14 26	58	1	a2
	[G]	20.0	23.2	26	58	1	a3
3C 303.1	G	18.0	14 43 56.2	77 20 00	38	1	b3
3C 305	G(D4)	13.5	14 48 15.9	63 28 32	49	1	a2
3C 305.1			14 47 50.4	77 08 39	39	2	III
3C 306.1	G cl	19.0	14 52 24.5	-04 08 47	47	1	a3
3C 309.1	Qs	16.8	14 58 57.6	71 52 19	41	1	a2
3C 310	G(db)	14.5	15 02 46.939	26 12 34.68	60	3	b1
		14.5	48.142	27.03	60	3	a1
3C 313	[G]	19.0	15 08 32.8	08 02 59	52	1	a4
3C 314.1	D cl	17.0	15 10 09.3	70 57 18	42	1	a2
3C 315	G(db)cl	16.6	15 11 30.825	26 18 38.96	58	3	a1
		16.2	30.782	32.11	58	3	a1
3C 317	G(cD4)	12.5	15 14 17.004	07 12 16.70	50	3	b1
3C 318	G cl	19.5	15 17 50	20 26 55	55	1	a2
3C 318.1					49		III
3C 319	G cl	18.5	15 22 44.5	54 38 45	51	1	c3
3C 320	G cl	18.0	15 29 29.6	35 43 52	55	1	a2
3C 321			15 29 39.0	24 13 10	54	2	III
3C 322	G	19.0	15 33 47.7	55 46 34	49	1	b3
3C 323	[G]	18.5	15 40 49.3	60 25 16	46	1	a4
3C 323.1	Qs	15.8	15 45 31.2	21 01 34	49	1	a3
	[Qs]	18.5	32.3	51	49	1	b4

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 324			$15^h47^m37^s.9$	21°34'36"	49°	2	IV
3C 325			15 49 16.7	62 50 18	44	2	III
3C 326	G cl	18.5	15 50 13.3	20 14 34	48	1	b2
3C 326.1			15 53 57.8	20 12 41	47	2	III
3C 327	G(DE3-4)cl	15.0	15 59 55.665	02 06 12.29	38	3	a1
3C 327.1	[G]	18.5	16 02 13.4	01 26 02	37	1	a4
3C 330			16 09 15.1	66 04 46	41	2	III
3C 332	G(DE3)cl	16.0	16 15 46.6	32 29 42	45	1	a2
3C 334	Qs	15.9	16 18 07.40	17 43 30.5	41	4	a1
3C 336	Qs	18.5	16 22 32.45	23 52 00.7	42	4	a1
3C 341	G	19.5	16 26 02.6	27 48 25	42	1	a4
3C 338	G(cD4)	12.0	16 26 55.377	39 39 36.58	44	3	a1
3C 337			16 27 19.9	44 25 36	44	2	III
3C 340			16 27 29.8	23 26 51	41	2	III
3C 343			16 34 03.0	62 51 46	39	2	III
3C 343.1			16 37 54.9	62 40 34	39	2	III
3C 345	Qs	15.0	16 41 17.70	39 54 11.10	41	4	a1
3C 346	G	16.0	16 41 34.7	17 21 22	36	1	a2
3C 348	G(cD4:)	18.0	16 48 48.00	05 04 35.5	29	3	d1
3C 349	G	19.0	16 58 04.1	47 07 24	38	1	a2
3C 351	Qs	15.0	17 04 03.1	60 48 37	36	1	b3
3C 352			17 09 18.0	46 04 54	36	2	IV
3C 353	G(D2)	15.0	17 17 53.288	-00 55 49.49	20	3	d1
3C 356	[N]	15.3	17 23 06.7	51 00 02	34	1	a4
3C 357	G(ED4)cl	15.5	17 26 27.3	31 48 35	31	1	a2
3C 363.1					16		III
3C 368			18 02 46.3	11 01 20	15	2	II
3C 371	N1	14.2	18 07 19.0	69 49 03	29	1	b1
3C 372.1					6		I
3C 379.1	G	18.0	18 25 55.7	74 19 09	28	1	a3
	Qs	18.4	26 01.0	19	28	1	b4
3C 380	Qs	17.7	18 28 13.38	48 42 39.3	24	4	a1
3C 381	G(ND:)	17.0	18 32 24.2	47 24 50	23	1	c3
3C 382	G(D3:)	14.5	18 33 11.9	32 39 18	17	5	b1
3C 386	G(DE2)	13.0	18 36 12.849	17 09 06.73	11	3	a1
3C 388	G(cD3:)	14.5	18 42 35.438	45 30 21.66	20	3	a1
3C 390					6		I
3C 389					0		I
3C 390.1					4		I
3C 390.2					- 1		I
3C 390.3	N1	13.8	18 45 38.7	79 43 10	27	1	b1

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 391					0°		I
3C 392	[SNR]				0		I
3C 394					4		I
3C 396					0		I
3C 396.1					- 5		I
3C 397					0		I
3C 398					0		I
3C 399.1					9		I
3C 399.2					- 1		I
3C 400					0		I
3C 400.1					9		II
3C 400.2					- 2		I
3C 401	G cl	18.0	$19^h39^m39^s.0$	60°34'32"	18	1	b3
3C 402			19 40 22.5	50 29 29	13	2	III
3C 403	G(DE3-4)	14.5	19 49 44.6	02 22 38	-12	1	d3
3C 403.1	G(ED2)cl	16.2	19 49 55.4	-01 25 12	-14	1	d3
3C 403.2					2		I
3C 405	G(cD3)	15.0	19 57 44.348	40 35 46.67	6	3	a1
			44.515	45.76	6	3	a1
3C 409					- 6		I
3C 409.1					5		I
3C 410					- 4		I
3C 410.1					2		I
3C 411			20 19 44.3	09 52 01	-15	2	III
3C 415.1					2		I
3C 415.2			20 31 24.5	53 35 37	8	2	II
3C 416.1					4		I
3C 416.2					1		I
3C 418			20 37 06.6	51 08 35	6	2	II
3C 419.1					0		I
3C 424	G cl	18.0	20 45 44.4	06 50 08	-22	1	a2
3C 427.1	[Qs]	18.5	21 04 48.9	76 21 30	19	1	b4
3C 428					1		I
3C 430	G(ED4:)	15.0	21 17 01.9	60 35 33	8	1	a1
3C 431					0		I
3C 432	Qs	17.8	21 20 25.4	16 51 56	-23	1	a2
3C 433	G(D4:)	16.0	21 21 30.499	24 51 33.00	-18	3	c3
3C 434			21 20 53.0	15 35 12	-24	2	III
3C 434.1					1		I
3C 435	Qs	19.5	21 26 37.6	07 19 49	-30	1	a3
3C 435.1	Qs	16.8	21 34 04.7	83 44 56	24	1	c4

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TABLE 1--Continued

Source	Optical Object	m_v	α 1950.0	δ 1950.0	b_{II}	Ref. to Position	Quality
3C 436	G	19.0	$21^h41^m57^s.0$	27°56'31"	-19	5	a1
3C 437			21 45 00.0	15 06 27	-28	2	III
3C 437.1					-30		III
3C 438			21 53 45.8	37 46 05	-13	2	III
3C 441	[G]	19.4	22 03 49.7	29 14 58	-21	1	b4
3C 442	G(D)	13.0	22 12 20.396	13 35 31.02	-34	3	a1
3C 445	N	15.3	22 21 14.763	-02 21 26.09	-47	3	b1
3C 449	G(cDE4)	12.5	22 29 06.3	39 06 11	-16	1	a2
3C 452	G(ED1)	16.0	22 43 32.3	39 25 31	-17	1	a1
3C 454	Qs	18.4	22 49 07.6	18 32 51	-36	1	a2
3C 454.1			22 48 58.0	71 13 22	11	2	II
3C 454.2					5		I
3C 454.3	Qs	18.0	22 51 29.3	15 53 04	-39	1	a3
3C 455	G(D4)	13.3	22 52 35.1	12 57 18	-41	1	b2
3C 456	G	19.0	23 09 56.2	09 03 13	-46	1	a2
3C 458	G	20.0	23 10 19.3	05 00 43	-50	1	a2
3C 459	N	17.7	23 14 02.4	03 49 00	-51	1	a1
3C 460			23 18 58.3	23 30 36	-35	2	III
3C 461	SNR		23 21 06.8	58 32 47	- 2	7	1
3C 465	G(c?D4)	12.2	23 35 59.0	26 45 16	-33	5	a1
3C 468.1					3		I
3C 469.1			23 52 58.2	79 38 35	18	2	III
3C 470	G	19.5	23 56 02.7	43 47 59	-18	1	a3

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NOTES TO TABLE 1

3C 2: Sandage *et al.* (1965). Optical variable. Visible on red Sky Survey plate only.

3C 6.1: Some obscuration, but galaxies are visible. Object 28″ W., 7″ N., $m_v \sim 17.5$ is slightly diffuse, very red, could be an N galaxy. There are two galaxies ~28″ W. 28″ N. (*a*) red, $m_v \sim 18.5$, (*b*) blue, $m_v \sim 19.5$.

3C 9: Ryle and Sandage (1964). Redshift by Schmidt (1965*b*).

3C 10: Galactic source Tycho's supernova, 1572.

3C 11.1: Crowded field, patches of high obscuration. Several red stellar objects at radio position.

3C 13: Blank at radio position. Stellar object ~30″ W. 5″ S. is equally blue-red, $m_v \sim 15.0$.

3C 14: Object marked is very faint, nebulous, visible only on red plate. Field at radio position is otherwise blank. Many galaxies in region.

3C 14.1: Much obscuration, red stellar objects at radio position

3C 15: Hazard *et al.* (1964). Finding chart given by Hazard (1965). This source is identified with a galaxy in a small group. Nucleus is small and sharp on blue plate, much larger on red.

3C 16: Nothing at radio position. Several faint ($m_v \sim 19.0$) nearby objects, ~30″ to N. and E., are probably galaxies in a cluster.

3C 17: Identified by Moffet, spectrum by Schmidt (1965*a*). Object is only slightly diffuse, spectrum that of a galaxy.

3C 19: Blank at radio position except for some very faint objects visible on red plate only.

3C 18: Faint galaxy, blue, diffuse on red plate, almost stellar on blue. Independent identification by Matthews (1965). Another galaxy is ~30″ SE., $m_v \sim 19.0$.

3C 20: Fairly crowded field, obscuration, some galaxies visible. There are several faint, red stellar objects near the radio position.

3C 21.1: In patch of obscuration. Several red stellar objects near radio position.

3C 22: Two faint objects 3″ and 13″ E. of radio position are stellar, $m_v \sim 19.0$, slightly red. (Objects (*a*) of Longair 1965.) Object ~20″ E. is stellar, slightly blue, $m_v \sim 16.8$.

3C 27: Obscured. There are some faint red stellar objects near the radio position.

3C 28: Identified by Matthews, spectrum by Schmidt (1965*a*). Galaxy is red, in cluster.

3C 29: Galaxy, slightly red, no cluster.

3C 31: NGC 383, DE3 plus companion, $m_v \sim 13$. Brightest in small cluster. The radio source shows N.S. structure.

3C 33: Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*). See also Maltby *et al.* (1963).

3C 33 1: Crowded field, obscuration, but some galaxies visible A double object 13″ E. 20″ N. of the radio position (object (*a*) of Longair 1965) appears slightly diffuse, $m_v \sim 17.5$, 18 5. All other nearby objects are stellar.

3C 33 2: Crowded field, obscuration.

3C 34: Nothing at radio position. A faint red stellar object is ~11″ E., $m_v \sim 19$ 5.

3C 35: Galaxy, very red, in group. Just north is a blue stellar object, $m_v \sim 17.1$. Another galaxy is ~30″ NW., $m_v \sim 15$ 7. Slight obscuration. Large N S. radio size (double source?).

3C 36: Object suggested as Qs is slightly blue, stellar in appearance. There are some other faint objects near the radio position.

3C 40: NGC 545–547. Description by Matthews *et al.* (1964). See also Maltby *et al.* (1963).

3C 41: Nothing at radio position. Object ~23″ NW. is stellar, red, $m_v \sim 15.7$.

3C 42: Nothing at radio position. 10″ E 25″ N. is a blue stellar object, $m_v \sim 15.7$. 5″ W. 20″ S. is a faint galaxy, $m_v \sim 20$.

3C 43: Sandage *et al* (1965). Optical variable.

3C 44: Blank at radio position.

3C 46: Object marked is a faint red galaxy. Other faint objects nearby may be cluster members. A red stellar object is ~15″ N., $m_v \sim 18$ 0

3C 47: Schmidt and Matthews (1964).

3C 48: Matthews and Sandage (1963). Optical variable (Sandage 1964*a*) Redshift by Greenstein and Matthews (1963).

3C 49: Blank at radio position. There is a faint red object ~30″ to NW.

3C 52: Object marked is a galaxy, red, in cluster at position $01^h45^m14^s.7$, +53°17′31″. Another galaxy lies to N at $01^h45^m14^s.3$, +53°18′04″. The radio position is intermediate between these two. Many other galaxies are visible on this plate, together with galactic emission regions.

3C 54: Blank at radio position. Some nearby objects are (*a*) 10″ E. 30″ N., neutral in color, slightly diffuse, galaxy (?), $m_v \sim 17$ 4; (*b*) 30″ E. 27″ S., slightly blue stellar object, $m_v \sim 15$ 7; (*c*) 17″ W. 22″ S , red stellar object, $m_v \sim 19.1$ (object (*a*) of Longair 1965); and (*d*) 30″ W. 37″ S., very red stellar object, $m_v \sim 16.8$

3C 55: Blank at radio position. 10″ W. 25″ N. is a red stellar object, $m_v \sim 14.8$. Two very red stellar objects are 30″ E 22″ S., 9″ E. 42″ S., $m_v \sim 18.4$ and 19.0, respectively.

3C 61.1: There is a cluster of galaxies in immediate vicinity of the radio source. Galaxy marked is very red, ~15″ N. of mean radio position and is one of the brighter members of the cluster. Another galaxy, blue, $m_v \sim 19$ 0 is 8″ E. of the suggested identification

3C 63: Galaxy, color neutral, more diffuse on blue plate. Object (*a*) of Longair (1965).

3C 66: Description by Maltby *et al.* (1963) and Matthews *et al.* (1964).

3C 65: Object 7″ E. 10″ S. is neutral in color, probably a star, $m_v \sim 18.6$.

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3C 67: Object marked is red, slightly diffuse on the red plate. On blue plate it appears to be a double object

3C 68 1: Faint object marked may be a galaxy, neutral in color. There are two faint red objects ~20″ SE. and ~30″ SW , both with $m_v \sim 19.5$

3C 68.2: Two blue stellar objects lie N. and W of the radio position Object marked is at $02^h31^m24^s.2$, +31°21′25″, probable identification (Qs).

3C 69: Much obscuration Faint red stellar objects at radio position.

3C 71: NGC 1068 Seyfert galaxy Description by Maltby *et al.* (1963) and by Matthews *et al.* (1964). Also Burbidge (1964)

3C 75: Description by Maltby *et al.* (1963) and Matthews *et al.* (1964). Radio source centroid and optical object displaced.

3C 76 1: Galaxy, red. (Independently identified by Bolton [1965] and by Fomalont [1965]) Object 22″ S. is not quite stellar, color neutral, $m_v \sim 14\ 3$.

3C 78: NGC 1218 Description by Maltby *et al.* (1963) and Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 79: Galaxy, very red, probably in cluster Another similar galaxy is 50″ E 25″ S., $m_v \sim 18\ 4$. (Object (*a*) of Longair 1965?) Identified by Matthews, spectrum by Schmidt (1965*a*).

3C 83 1: NGC 1265 Description by Matthews *et al.* (1964). Source shows N S radio structure, giving poor agreement in declination between radio source position and optical object.

3C 84: NGC 1275. Seyfert galaxy. Description by Matthews *et al.* (1964), Burbidge (1964).

3C 86: Obscured. Red stellar objects near radio position.

3C 88: Description by Matthews *et al* (1964) Spectrum by Schmidt (1965*a*).

3C 89: Galaxy marked is at $03^h31^m44^s.0$, −01°21′18″, brightest in cluster. Very red. Very diffuse on blue plate. A second galaxy at $03^h31^m43^s.6$, −01°20′46″, might be associated with the radio source. (Objects (*b*) and (*a*) of Longair 1965) Independently identified by Matthews (1965).

3C 91: Crowded field, obscuration, a few galaxies visible. Objects at radio position are red and stellar.

3C 93: Sandage and Wyndham (1965).

3C 93 1: Object marked is a galaxy, very red, probably brightest in a cluster. Stellar object ~13″ W. 5″ N. is equally blue-red, $m_v \sim 17\ 5$. Diffuse objects nearby are probably cluster members.

3C 98: Description by Maltby *et al.* (1963) and Matthews *et al* (1964) Spectrum by Schmidt (1965*a*).

3C 99: Galaxy, very red. Another galaxy is 25″ W , 17″ N , $m_v \sim 19\ 5$.

3C 103: Crowded field, some obscuration. Objects at radio position are red and stellar.

3C 105: Blank at radio position.

3C 107: Object marked is slightly red and not quite stellar, especially on the blue plate. It may be an N galaxy.

3C 109: Identified by Longair (1965) Object marked is very red, stellar on the red plate, slightly diffuse on the blue plate, almost certainly an N galaxy. (Very many objects on this plate have a similar appearance, however) (*UBV* photometry by Sandage 1965)

3C 111: Heavily obscured.

3C 114: Galaxy, very red, slightly diffuse. Another galaxy is 25″ W. 20″ N , $m_v \sim 19\ 0$, also very red. Probably members of a cluster.

3C 119: Field partially obscured but some galaxies visible. Qs suggested by Sandage *et al.* (1965), not visible on Sky Survey plates.

3C 123: Object marked is extended, almost certainly a galaxy. Plate shows obscuration, but a number of galaxies are visible Identified by Matthews (1965) and noted by Longair (1965)

3C 124: Galaxy, red, brightest in cluster 27″ SW. is another galaxy, red, $m_v \sim 19.5$.

3C 125: Obscured Red stellar object at radio position

3C 129: Faint galaxy, red, probably in a cluster. Some other nearby objects are red and stellar. Plate shows obscuration, but some other galaxies are visible. 105″ E. 80″ S. is another galaxy, very red, $m_v \sim 16\ 0$ The radio source has E W. structure.

3C 129 1: Not observed.

3C 130: Galaxy, very red, in obscured region. Some other galaxies are visible in this region.

3C 131: Obscured.

3C 132: Galaxy, red, very close to stellar object which is slightly red and 5″ E., $m_v \sim 16.7$. Some nearby objects may be cluster members.

3C 133: Heavily obscured.

3C 134: Obscured.

3C 135: Galaxy, very red, brightest in cluster, plus companion to SW. There are slightly blue stellar objects 17″ E 33″ N , $m_v \sim 15\ 7$, and 13″ S , $m_v \sim 17.9$.

3C 136 1: Galaxy, red, asymmetrical, very diffuse on red plate. Some faint nearby objects may be cluster members.

3C 137: Crowded field, some obscuration. Objects in vicinity of radio source are red or neutral and stellar in appearance

3C 138: Sandage *et al.* (1965).

3C 139.1: Not observed At 3C R position is a roughly circular H II region, diameter $\gtrsim$ 30′, with a central knot of high obscuration, position $05^h19^m20^s$, +33°22′.

3C 139.2 and 3C 141: Obscured.

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3C 142.1.: Absorption-emission regions. A few galaxies visible. Several faint objects to NE. (∼20″) of radio position may be galaxies, $m_v \sim 19\ 5$.

3C 144: Galactic source, supernova remnant (Crab Nebula).

3C 147: Schmidt and Matthews (1964).

3C 147.1: Not observed in declination. Using 3C R δ, radio source lies near a knot of dense obscuration in an emission region. Large radio size.

3C 152: Obscured.

3C 153: Object marked is a galaxy, red, in cluster. Independently identified by Matthews (1965). Fairly crowded field, several starlike objects in immediate vicinity are red. Stellar object 8″ W. of galaxy is neutral in color, $m_v \sim 13.8$.

3C 153.1: Large H II region. Object marked is knot of high emission which agrees well with radio position (and may not be connected with the main H II region). At center of this knot is a stellar object.

3C 154: Obscuration but some galaxies visible. Objects near radio position are red and stellar.

3C 157: Galactic source. Supernova remnant (IC 443).

3C 158: Many faint red stellar objects at radio position. Obscuration, but a few galaxies visible.

3C 165: Crowded field, very few galaxies visible. Stellar objects near radio position are neutral to red in color. An object 18″ W. 25″ S. is red, probably a galaxy, $m_v \sim 19.0$.

3C 166: Faint galaxy, red, in cluster, in fairly crowded field. Independently identified by Matthews (1965).

3C 169.1: Some very faint objects 20″ NW. of radio position at plate limit may be galaxies. Otherwise blank at radio position.

3C 171: Galaxy, red. Identified by Bolton (1960). Spectrum by Schmidt (1965*a*).

3C 173: Object marked is very red, stellar (?), probably an N galaxy. 5″ E. 27″ S. is a blue stellar object, $m_v \sim 18.3$. Stellar objects 13″ E. 23″ N. ($m_v \sim 12.6$) and 20″ W. 10″ N. ($m_v \sim 15.7$) are neutral and red, respectively.

3C 172: Object marked is stellar and blue. Two stellar objects 22″ NE. ($m_v \sim 17.7$) and 18″ NW. ($m_v \sim 17.2$) are red. There are some faint stellar objects south of the suggested identification.

3C 173.1: Galaxy, red, brightest in faint cluster.

3C 175: Object suggested as the identification is stellar and blue. It is the SW. member of a triangle of three stellar objects. The other two have $m_v \sim 15.4$ (10″ NE.) and 17.5 (5″ E.) and are neutral in color.

3C 175.1: Object marked is stellar and blue. Stellar objects 25″ SW. ($m_v \sim 13.8$), 20″ NW. ($m_v \sim 16.6$) and 33″ E. ($m_v \sim 16.1$) are neutral to red in color.

3C 177: Galaxy, very red and compact.

3C 180: Galaxy, red, probably partially obscured. Two other galaxies nearby (cluster?). Independently identified by Matthews (1965).

3C 181: Sandage *et al.* (1965).

3C 184: Blank field at radio position.

3C 184.1: Galaxy, brightest in cluster, color neutral, has extended envelope visible on blue plate, no envelope on red.

3C 186: Sandage *et al.* (1965).

3C 187: Faint red galaxy (?) in fairly crowded field. Nearby objects are red and starlike. Stellar object ∼18″ N. is red, $m_v \sim 11.7$.

3C 190: At the radio position is a very faint object visible on both plates 25″ W. is a blue, stellar object, $m_v \sim 18.1$. 63″ S. and 70″ S. are a pair of galaxies, $m_v \sim 17.0$ and 17.5, respectively, noted by Longair (1965).

3C 191: Sandage *et al.* (1965).

3C 192: Galaxy, red, in cluster, with asymmetrical envelope. Stellar object ∼13″ SE. is neutral in color, $m_v \sim 14.4$. Another galaxy lies 70″ W. 13″ N , $m_v \sim 15.0$ and is red. Identified by Longair (1965).

3C 194: Blank at radio position. Two very faint red stellar objects are 20″ S.

3C 196: Matthews and Sandage (1963).

3C 196 1: Galaxy, red and diffuse. There is a faint blue stellar object ∼20″ NE. $m_v \sim 19.6$.

3C 197.1: Galaxy, red, brightest in cluster. Nucleus is blue.

3C 198: Galaxy is small cluster, color neutral. Maltby *et al.* (1963). Spectrum by Schmidt (1965*a*). A faint object 17″ W. 3″ N. is a galaxy, $m_v \sim 19.5$. Stellar object ∼16″ SW. is slightly blue, $m_v \sim 18.0$.

3C 200: Galaxy, red. Appears to have a jet in the SW. direction, visible on the red plate.

3C 204: Sandage *et al.* (1965).

3C 205: Suggested identification is blue, stellar in appearance. Object 21″ S. is red, very slightly diffuse, $m_v \sim 18.2$ (object (*a*) of Longair, 1965).

3C 207: Sandage *et al.* (1965).

3C 208: Sandage and Wyndham (1965).

3C 208.1: There are some very faint objects at the plate limit near the radio position. Confused by 3C 208.

3C 210: Very faint object marked is red, probably a galaxy. Two nearby objects 30″ E. 10″ N. ($m_v \sim 19.5$) and 40″ W. 15″ S. ($m_v \sim 19.0$) are galaxies, red, probably cluster members.

3C 212: Hazard (1964). N. galaxy, starlike image. (*UBV* photometry by Sandage, 1965.)

3C 213.1: Galaxy, red, on edge of small cluster. It is the second brightest cluster member on red plate (brightest member is ∼1′ W., $m_v \sim 18.5$), equally bright as brightest member on blue plate.

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3C 215: Sandage *et al.* (1965). The Qs is blue, slightly diffuse. A stellar object ~11″ SE., $m_v \sim 17.0$, is red. There are many faint galaxies in this region.

3C 217: Blank at radio position. 25″ E. 14″ N. is a faint red diffuse object. 35″ E. 40″ N. is a blue stellar object, $m_v \sim 18.4$.

3C 216: Ryle and Sandage (1964).

3C 219: Description by Maltby *et al.* (1963), Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 220.1: Object marked is red, may be a galaxy.

3C 220.2: Object at radio position is slightly blue, and very slightly diffuse. It could be a Qs or N galaxy.

3C 220.3: Galaxy, red plus companion ~22″ SE., $m_v \sim 19.0$. Object 10″ E. 33″ N. is slightly red and non-stellar in appearance on the red plate, $m_v \sim 14.8$.

3C 222: Object marked is probably a galaxy, red. An object 17″ W., neutral in color, is also probably a galaxy, $m_v \sim 19.0$. Object 25″ E. 15″ N. is a galaxy, red, $m_v \sim 19.5$.

3C 223: Galaxy, red, brightest in fairly rich cluster. Identified by Longair (1965).

3C 223.1: Galaxy, red, asymmetrical envelope. Several faint objects to south may be cluster members.

3C 225: Finding chart made from blue Sky Survey print. Differences between declinations measured at various interferometer spacings indicate N.S. radio structure. There is a small-diameter component (Hewish, Scott, and Wills 1964; Anderson, Donaldson, Palmer, and Rowson 1965; ~1″.0). Mean position of radio source has been taken as $09^h39^m31^s.2$, +14°00′00″. 18″ W. 18″ N is a blue stellar object, $m_v \sim 17.2$. There are three galaxies nearby: (*a*) 27″ W. 30″ N., $m_v \sim 18.0$, red; (*b*) 35″ W., $m_v \sim 19\ 0$, blue; and (*c*) 25″ W. 33″ S., $m_v \sim 19.5$, red.

3C 226: Faint red galaxy. Field is otherwise blank at the radio position.

3C 227: N galaxy, red. Description by Matthews *et al.* (1964). This object is very compact, but definitely diffuse on both plates.

3C 228: Object suggested earlier as a Qs by Sandage and Wyndham (1965) is a misidentification. At the radio position is a very faint object at plate limit, brighter on the blue plate.

3C 230: Probable identification is blue, stellar on the red plate, diffuse on the blue. Stellar object ~17″ SW. is also blue, $m_v \sim 13\ 8$, and could possibly be the radio source.

3C 231: M82. Irregular galaxy Lynds (1961), Lynds and Sandage (1963).

3C 234: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*). N galaxy, compact, very slightly diffuse, blue. In cluster of fairly compact galaxies, all red except for one which is blue. (*UBV* photometry by Sandage, 1965.)

3C 236: Galaxy, red, strong central nucleus on blue plate. Several diffuse objects to north may be cluster members.

3C 237: Nothing at radio position except for a very faint object (galaxy?). Object 22″ E. 13″ S., $m_v \sim 16.9$, is slightly elongated and diffuse, especially on the red plate. Color very red and could be a galaxy.

3C 238: Blank at position. Two objects ~50″ to SE. are (*a*) stellar (?), red, $m_v \sim 16\ 0$; (*b*) galaxy, red, $m_v \sim 19.5$.

3C 239: Probable identification is blue stellar object. 62″ E. 25″ N is a galaxy, $m_v \sim 16\ 0$, neutral in color, plus other faint objects (cluster members?).

3C 241: Blank field. Nearest object is 13″ E. 40″ S. of radio position, very red, stellar (but slightly elongated), $m_v \sim 18.0$.

3C 244 1: Galaxy, red, brightest in cluster (object (*a*) of Longair 1965) Some of the cluster members are slightly blue to neutral in color. Another galaxy of nearly equal brightness is 15″ W. 15″ N.

3C 245: Ryle and Sandage (1964). Hazard *et al.* (1964). Redshift by Schmidt (1965*b*).

3C 247: Qs (Sandage *et al.* 1965). The identification is blue and stellar. Three faint galaxies, $m_v \sim 19.5$, one of which is blue, lie within 25″ of Qs.

3C 249: Blank field.

3C 249.1: Qs, Sandage *et al.* (1965). First suggested by Longair (1965). The object is blue, stellar, and lies in a cluster of galaxies, the brightest of which is compact, very red, 60″ W 8″ S. of Qs, $m_v \sim 17\ 1$.

3C 250: At radio position is a very faint object, visible only on the red plate. Many objects in vicinity appear to be galaxies. A blue galaxy is 11″ W. 55″ S., $m_v \sim 19\ 0$

3C 252: Blank at radio position except for some very faint objects at plate limit.

3C 254: Qs, identified by Adgie (1964). Photometry by Sandage (Sandage *et al.* 1965). Redshift by Schmidt (1965*b*). There is a red galaxy, $m_v \sim 18\ 0$, 20″ NE., previously thought to be the radio source.

3C 255: Nothing at radio position. 20″ SW. is a red object at plate limit.

3C 256: Galaxy, red, brightest in group or cluster. Object (*a*) of Longair (1965).

3C 257: Blank field. Nearest object is stellar, red, 40″ E. 23″ S., $m_v \sim 16.9$.

3C 258: Galaxy, blue, in fairly rich cluster. Brightest in cluster on blue plate. Galaxy 17″ E. 5″ N. is slightly red, $m_v \sim 19.0$.

3C 263: Qs (Sandage *et al.* 165). Some nearby objects are diffuse on red, stellar on blue plate (probably a plate effect).

3C 263.1: A faint object at the radio position, at plate limit, is probably a galaxy, and the radio source.

3C 264: NGC 3862. Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

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3C 265: Faint double object, both components appear stellar or slightly diffuse. They could be galaxies.

3C 266: Object marked is very red, stellar on red, slightly diffuse on blue plate, may be an N galaxy.

3C 267: At the radio position is a faint red object at plate limit. 30″ W. 33″ S. is a very blue galaxy, $m_v \sim 18.5$.

3C 268.1: Nothing at radio position. 25″ E. 5″ N. is a red galaxy, $m_v \sim 18.5$. 10″ W. 20″ N. is another galaxy, red, $m_v \sim 19.5$. 20″ E. 40″ N. and 28″ W. 25″ S. are two blue stellar objects, $m_v \sim 17.5$ and 12.3, respectively.

3C 268.2: Position of suggested Qs of Sandage *et al.* (1965) does not agree with the radio position. At the radio position is a red galaxy in group or small cluster. (The object suggested by Sandage *et al.* is blue, and diffuse on the red plate, 33″ NE. of identification suggested here.)

3C 268.3: A group of three or more faint red objects at plate limit lies at the radio position.

3C 268.4: Object suggested as Qs is slightly blue and stellar. It is surrounded by many faint galaxies.

3C 270: NGC 4261. Description by Maltby *et al.* (1963) and Matthews *et al.* (1964).

3C 270.1: Qs, Sandage *et al.* (1965). The object is blue and stellar. There is another blue, stellar object 13″ W. 43″ N., $m_v \sim 18.5$.

3C 272: There is a very faint smudge at the radio position, visible on the blue plate only, $m_{pg} \sim 21$. Otherwise blank. Stellar object 30″ W. 30″ N. is red, $m_v \sim 11.7$.

3C 272 1: M84, NGC 4374. Description by Matthews *et al.* (1964).

3C 273: Hazard, Markey, and Shimmons (1963). Redshift by Schmidt (1963). Finding chart by Smith (1965).

3C 274: Bolton, Stanley, and Slee (1949). M87. Description by Maltby *et al.* (1963) and Matthews *et al.* (1964); also Burbidge (1964).

3C 274.1: Object marked is a red galaxy. Object 30″ W. 20″ N. is stellar, slightly blue, $m_v \sim 18.9$.

3C 275: Nothing at radio position. See Wyndham (1965).

3C 275.1: Sandage *et al.* (1965).

3C 277: At radio position are some very faint stellar objects. 5″ W. 25″ N. is a very red stellar object, $m_v \sim 18.5$. Stellar object 5″ W. 37″ S. is slightly red, $m_v \sim 15.3$.

3C 277.1: Qs, Sandage *et al.* (1965). Object is blue and stellar.

3C 277.2: Blank field. There is a galaxy 10″ E. 33″ S , $m_v \sim 19.5$.

3C 277.3: Coma A. Identified by Moffet, spectrum by Schmidt (1965*a*).

3C 280: Blank field. See Wyndham (1965).

3C 280.1: Qs, Sandage *et al.* (1965). Object is blue, stellar. Two objects ~20″ SW. are probably galaxies. There are several other very faint objects close by. 47″ E. 25″ S. is a galaxy, color neutral, $m_v \sim 18.5$.

3C 284: Galaxy, red, brightest in cluster. Stellar object 30″ E. is blue, $m_v \sim 16.6$.

3C 285: D galaxy with asymmetrical envelope, brightest in cluster of NDs (~1′ NW.). Red.

3C 287: Sandage and Wyndham (1965). Redshift by Schmidt (1965*b*).

3C 286: Matthews and Sandage (1963). Redshift by Oke (1965).

3C 287.1: Galaxy, neutral in color. On red plate it has an extensive outer envelope plus stellar nucleus. On the blue plate it is stellar in appearance. Possibly in cluster, though not the brightest member. Photometry by Sandage (1965) gives values of *UBV* similar to N galaxies.

3C 288: Galaxy plus companion 7″ NW. ($m_v \sim 19.5$), red, brightest in cluster. Stellar object 30″ SE. is red, $m_v \sim 10.0$.

3C 288.1: Blue stellar object. 45″ W. is a galaxy, red, $m_v \sim 16\ 5$.

3C 289: Object marked is neutral to blue, slightly diffuse on the red plate, stellar on the blue. There is a very faint object ~14″ to NE., at plate limit.

3C 293: Wyndham (1965). Galaxy with absorption lane.

3C 293.1: Faint red galaxy, not visible on blue plate. There are many galaxies nearby.

3C 294: Object at radio position is an F-type star, hydrogen lines barely visible, large negative velocity ~250 km/sec (spectrum by Zwicky 1965); $m_v \sim 11.8$.

3C 295: Minkowski (1960). Description by Maltby *et al.* (1963) and Matthews *et al.* (1964).

3C 296: IC 5532. Companion galaxy to S. has $m_v \sim 13.5$. Both galaxies are red, in poor cluster.

3C 297: Blank field.

3C 298: Adgie (1964). Photometry given by Sandage *et al.* (1965).

3C 299: Faint galaxy in cluster. No cluster members visible on blue plate.

3C 300: Galaxy, very red, plus some faint companions ~15″ N. Nearby stellar objects are neutral in color. Independently identified by Bolton (1965).

3C 300.1: Galaxy, red, in cluster. Wyndham (1965).

3C 303: Finding chart was made from blue print. The radio position lies between two objects: (*a*) a very blue object, stellar on the red plate, slightly diffuse on the blue, $m_{pg} \sim 19.0$, $14^h41^m23^s.2$, $+52°14'26''$, which may be a galaxy; and (*b*) a galaxy, red, brightest in cluster, position $14^h41^m25^s.5$, $+52°14'26''$ (marked on finding chart). An object 14″ W. 17″ N. of (*b*) is a galaxy, red, cluster member with $m_v \sim 18.5$.

3C 303.1: Galaxy, red, asymmetrical envelope, plus red companion galaxy 15″ NW., $m_v \sim 17.8$. Stellar object 25″ to SW. is blue, $m_v \sim 18.3$.

3C 305: Galaxy, color neutral, with asymmetrical envelope and distinct spherical nucleus. Noted by Sandage (1964*b*). Also identified by Longair (1965).

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3C 305.1: Nothing at position. Three red stellar objects are 10″ W. 10″ N. ($m_v \sim 19.4$), 22″ W. 5″ S. ($m_v \sim 17.5$) and 38″ W. 10″ S. ($m_v \sim 15.8$).

3C 306.1: Galaxy, red, in cluster. There is a blue stellar object 20″ S., $m_v \sim 16.8$.

3C 309.1: Object at radio position is stellar and very blue. There is a galaxy ~36″ E., $m_v \sim 16.5$, red.

3C 310: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 313: Object marked is very red, stellar (?) on red plate, could be a galaxy. See description by Wyndham (1965).

3C 314.1: Galaxy, very red in group or cluster. Many faint objects at plate limit may be cluster members.

3C 315 and 3C 317: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 318: Very faint cluster of galaxies. Wyndham (1965).

3C 318.1: Not observed.

3C 319: Galaxy, red, brightest in cluster. Wyndham (1965).

3C 320: Galaxy, red, in cluster. Companion 12″ N., $m_v \sim 19.5$. A blue galaxy is ~28″ SE., $m_v \sim 19.5$ A very red stellar (?) object ~27″ W., $m_v \sim 16.7$, could be a compact galaxy.

3C 321: No identification. Wyndham (1965).

3C 322: Galaxy, red. There are some other very faint objects nearby.

3C 323: Object marked is red to very red, could be a galaxy. 7″ SW. is a very faint diffuse object. No other objects are visible near the radio source position.

3C 323.1: Two objects, one of which may be Qs. Object marked is stellar and very blue, position $15^h45^m31^s.2$, +21°01′34″. 23″ NE. is a second object, diffuse on red plate, stellar on the blue, very blue, position $15^h45^m32^s.3$, +21°01′51″. Surrounding these two objects are many faint, diffuse, red galaxies.

3C 324: See Wyndham (1965). No identification suggested.

3C 325: 8″ E. 9″ S. of radio position is a very faint red object at plate limit.

3C 326: Galaxy, color neutral, in a very large cluster of galaxies, area ~100 square min. of arc. Three nearby stellar objects are red to very red. 32″ W. ($m_v \sim 16.6$), 17″ W. 10″ S. ($m_v \sim 18.1$), and 17″ E. 36″ S. ($m_v \sim 17.5$).

3C 326.1: Very faint red objects only near radio position.

3C 327: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 327.1: Wyndham (1965). Object at radio position could be a galaxy.

3C 330: No identification. Wyndham (1965).

3C 332: Galaxy, red, brightest in cluster, with companion to SW. Wyndham (1965).

3C 334: Wyndham (1965). Photometry given by Sandage *et al.* (1965).

3C 336: Sandage *et al.* (1965). Object is blue, slightly diffuse on the red plate, stellar on the blue.

3C 341: Possible identification is a faint galaxy, color neutral. 44″ W. 20″ N. is a blue galaxy, $m_v \sim 19.5$.

3C 338: NGC 6166. Description by Matthews *et al.* (1964), Burbidge (1964).

3C 337: A faint red object 8″ E. 18″ N. of the radio position is probably a galaxy, $m_v \sim 20.0$.

3C 340: 8″ E. 5″ N. is a red stellar object, $m_v \sim 18.7$. Other stellar objects nearby.

3C 343: Nothing at radio position. There are some faint red stellar objects ~30″ NW. Blue object 33″ E. 19″ N., $m_v \sim 17.0$, is a star. Schmidt (1965*c*).

3C 343.1: At radio position is a faint object visible only on the red plate. Field is otherwise blank.

3C 345: Sandage and Wyndham (1965).

3C 346: Galaxy, red, plus companion ~10″ SW. ($m_v \sim 19.5$). Object 18″ NW. is stellar, neutral, $m_v \sim 17.5$. Many nearby diffuse objects may be cluster members. Independent identification by Bolton (1965).

3C 348: Williams, Dewhirst, and Leslie (1961). Hercules A. Description by Maltby *et al.* (1963) and Matthews *et al.* (1964).

3C 349: Wyndham (1965). There is a very faint blue, stellar object ~5″ W. of galaxy suggested as the identification.

3C 351: Probable identification (Qs) is blue and stellar. 17″ N. is a faint stellar object, neutral in color, $m_v \sim 20.0$.

3C 352: Nothing at radio position. Stellar object 20″ N., $m_v \sim 16.0$, is an F-type star. Schmidt (1965*c*).

3C 353: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 356: Object marked is stellar, neutral to slightly blue. May be an N galaxy.

3C 357: Galaxy, red, brightest in cluster.

3C 368: Crowded field, obscuration but some galaxies visible. Radio source lies in a patch of obscuration.

3C 371: Compact red galaxy. Starlike with fuzzy halo, especially on the red plate. A 103a-F spectrum at the 200-inch telescope by Zwicky (1965) is largely featureless with possible faint emission lines.

3C 379.1: Object 23″ NE. is blue and stellar, position $18^h26^m01^s.0$, +74°19′19″, possibly the radio source. A galaxy, red, $m_v \sim 17.8$, marked at $18^h25^m55^s.7$, +74°19′09″, is a probable identification. The radio position lies between these two objects.

3C 380: Sandage and Wyndham (1965).

3C 381: Crowded field. Object marked is galaxy plus companion in group. W. member of pair is almost stellar on the red plate. Red. A stellar object 30″ S. is neutral in color, $m_v \sim 18.0$, agrees well in declination with the radio source position.

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3C 382, 3C 386, and 3C 388: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 390 and 3C 389: Obscured. Very crowded field.

3C 390.3: N galaxy, red, with small faint envelope on red plate, starlike nucleus. Very compact—just discernible as extended with the 200-inch telescope. A 103a-F spectrum by Zwicky (1965) shows prominent emission lines including Hα, giving a redshift velocity ~17000 km/sec. 33″ E. 60″ N. is another galaxy, $m_v \sim 15.5$, object (*a*) of Longair (1965).

3C 391: Crowded field, dense obscuration.

3C 392: Probably a supernova remnant—see Leslie (1960).

3C 394: Obscured. Very crowded field.

3C 396: Obscured.

3C 397, 3C 398: Obscured. Thermal spectrum (Conway, Kellermann, and Long 1963) indicates galactic origin.

3C 399.1: Obscured.

3C 401: Diffuse red galaxy, brightest in cluster, plus companion 12″ NW., $m_v \sim 19.0$. Wyndham (1965).

3C 402: Wyndham (1965). Radio source lies between two bright galaxies, $m_v \sim 12\ 5$ and 13.0. Several other galaxies near radio position.

3C 403: Crowded field. Probable identification is galaxy, red, probably in cluster (Wyndham 1965). Object suggested as Qs by Sandage and Wyndham (1965) is almost certainly a misidentification, since radio size is not small.

3C 403.1: Crowded field. Red galaxy, in cluster. No interferometer position available. Radio position using primary antenna beam at 21 cm gives agreement with optical position ~1′.

3C 405: Cygnus A. Baade and Minkowski (1954).

3C 409 and 3C 410: Obscured.

3C 411: Crowded field. Second measurement of the declination brings radio source ~20″ S. of position given by Wyndham (1965) into relatively blank region.

3C 415.2: Crowded field, very few galaxies visible. Objects at radio position are faint, stellar, some neutral in color.

3C 418: Crowded field, obscuration plus emission regions. Galaxies visible. Red stellar objects at radio position.

3C 424: Galaxy, red, in cluster (though not brightest member). Wyndham (1965). A close pair of galaxies, brightest in cluster is 30″ W. 17″ S., $m_v \sim 16.0$.

3C 427.1: Possible identification is blue and stellar (object (*b*) of Longair 1965). A stellar object 42″ N is also blue, $m_v \sim 19.4$. Stellar objects 22″ E. 8″ N. ($m_v \sim 18.6$) and 11″ W. 22″ S. ($m_v \sim 17.6$) are red.

3C 428: Obscured.

3C 430: Description by Matthews *et al.* (1964).

3C 431: Obscuration, plus emission regions.

3C 432: Object marked is very blue and stellar. Nearby objects are also stellar in appearance.

3C 433: Radio position disagrees in declination with probable identification (Wyndham 1965). Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 434: At radio position is a very faint blue stellar object, $m_v \sim 19.8$. Another blue stellar object is 22″ W., $m_v \sim 19.0$.

3C 435: Object marked is blue, $m_{pg} \sim 19.6$, diffuse (?) on blue plate, at plate limit on red. 10″ W. is a very faint red object. A stellar object ~15″ SW. is red, $m_v \sim 18\ 1$.

3C 435.1: Suggested object is northernmost member of a close pair of stellar objects. Blue to very blue. Object 7″ S. is red, $m_v \sim 18.2$. 20″ W. 10″ N. is a red stellar object, $m_v \sim 12\ 6$.

3C 436: Identified by Matthews, spectrum by Schmidt (1965*a*). Crowded field, a few other fainter galaxies nearby.

3C 437 and 3C 438: Wyndham (1965).

3C 441: Object at radio position is faint, stellar on red, not visible on the blue plate (Wyndham 1965).

3C 442: NGC 7237 (Wyndham 1965). Description by Matthews *et al.* (1964). Discussed by Greenstein (1962).

3C 445: Description by Matthews *et al.* (1964) N galaxy, neutral color. Stellar appearance. Spectrum by Schmidt (1965*a*).

3C 449: Bright galaxy, with companion, $m_v \sim 14\ 0$, to N. Both galaxies are red, in cluster.

3C 452: Galaxy, red, probably in cluster. Type ED1 or DN1. Identified by Matthews, spectrum by Schmidt (1965*a*).

3C 454: Blue, stellar object. (30″ N. is another stellar object, neutral, $m_v \sim 18.4$)

3C 454.1: Nothing at radio position. 13″ W. 5″ N. is a diffuse (?) object, neutral in color, $m_v \sim 20\ 0$, which is probably a galaxy. 27″ W. 5″ N is a blue stellar object, $m_v \sim 18.3$. A red stellar object, $m_v \sim 16.5$ lies 7″ W. 13″ S.

3C 454 2: Obscured.

3C 454.3: Suggested identification is a blue stellar object. 10″ E. and 17″ S. are two bright stellar objects, red to neutral in color, $m_v \sim 13.5$ and 14.0, respectively. A very red object 11″ E. 42″ S., $m_v \sim 17.5$, is not quite stellar, probably a galaxy.

3C 455: Galaxy, red, asymmetrical envelope to E., spherical nucleus; not in a cluster (Wyndham 1965).

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NOTES TO TABLE 1—*Continued*

3C 456: Galaxy, red. Spectrum by Schmidt (1965*a*). Two other galaxies of similar magnitude are 36″ NW. (red) and 40″ S. (blue).

3C 458: Very faint, red, galaxy—diffuse and extended. No other objects nearby.

3C 459: N galaxy. Spectrum by Schmidt (1965*a*). *UBV* photometry by Sandage (1965). Identified by Matthews, and by Longair (1965), object (*a*).

3C 460: Nothing at radio position. 25″ E. 17″ S. is a galaxy, red, $m_v \sim 18.5$. 13″ W. 25″ N. is a red stellar object, $m_v \sim 16.9$, which is slightly diffuse on the blue plate.

3C 461: Cas A. Supernova remnant.

3C 465: Description by Matthews *et al.* (1964). Spectrum by Schmidt (1965*a*).

3C 468.1: Obscured.

3C 469.1: Stellar object 18″ NE. of radio position is neutral in color, $m_v \sim 14.0$. There is a very faint object at the radio position.

3C 470: Object marked is diffuse and red, galaxy. Stellar object ~17″ N. is slightly blue, $m_v \sim 18.4$.

The following large-diameter sources, all of which are probably galactic, were not observed: 3C 363.1, 3C 372.1, 3C 390.1, 3C 390.2, 3C 396.1, 3C 399.2, 3C 400, 3C 400.1, 3C 400.2, 3C 403.2, 3C 409.1, 3C 410.1, 3C 415.1, 3C 416.1, 3C 416.2, 3C 419.1, 3C 434.1, and 3C 437.1.

Column 8 gives the quality of an identification and, in cases where no identification is suggested, a field classification. For small-diameter identified sources the radio-optical position agreement is given:

Radio-optical Position Agreement: *a*, less than 10″; *b*, 10″–20″; *c*, 20″–30″; and *d*, greater than 30″.

Quality of Identification:

1, Certain (optical confirmation, spectra, *UBV* colors, etc.);
2, Highly probable (but no optical confirmation to date);
3, Probable;
4, Possible.

Qualities 2–4 are subjective estimates based on the appearance of the object on the Survey plates, the radio-optical position agreement, etc. In general, quality 2 has only been assigned to those objects whose appearance definitely places it in one of the categories Qs, N, or G, and where the radio-optical position agreement is within 10″.

Field Classification for Unidentified Sources:[1]

I: Highly obscured region, no galaxies visible; identification with an extragalactic object very unlikely;
II: Obscuration, but some galaxies visible; field usually crowded;
III: No obscuration; there are objects within 30″ of the radio source position;
IV: Blank field; no obscuration, no objects within 30″ of the radio position.

For sources not observed in the radio position program, a field classification has been assigned on the basis of the 3C R position.

IV. NOTES TO INDIVIDUAL SOURCES

The Notes provide information in addition to that given in Table 1. Colors are given for most objects ranging from very blue through neutral to very red and have been estimated by comparison of the blue and red magnitudes of the objects and also by comparison with the blue and red magnitudes of nearby objects. Positions of objects described in the Notes are relative either to the suggested identification or to the radio position as marked on the finding chart, i.e., relative to the position in Table 1.

V. THE FINDING CHARTS

Finding charts are provided for all identified extragalactic sources and for all unidentified sources with field classifications II–IV unless these have been published elsewhere.

[1] Sources for which identification with an extragalactic object has been suggested have field classification II or III.

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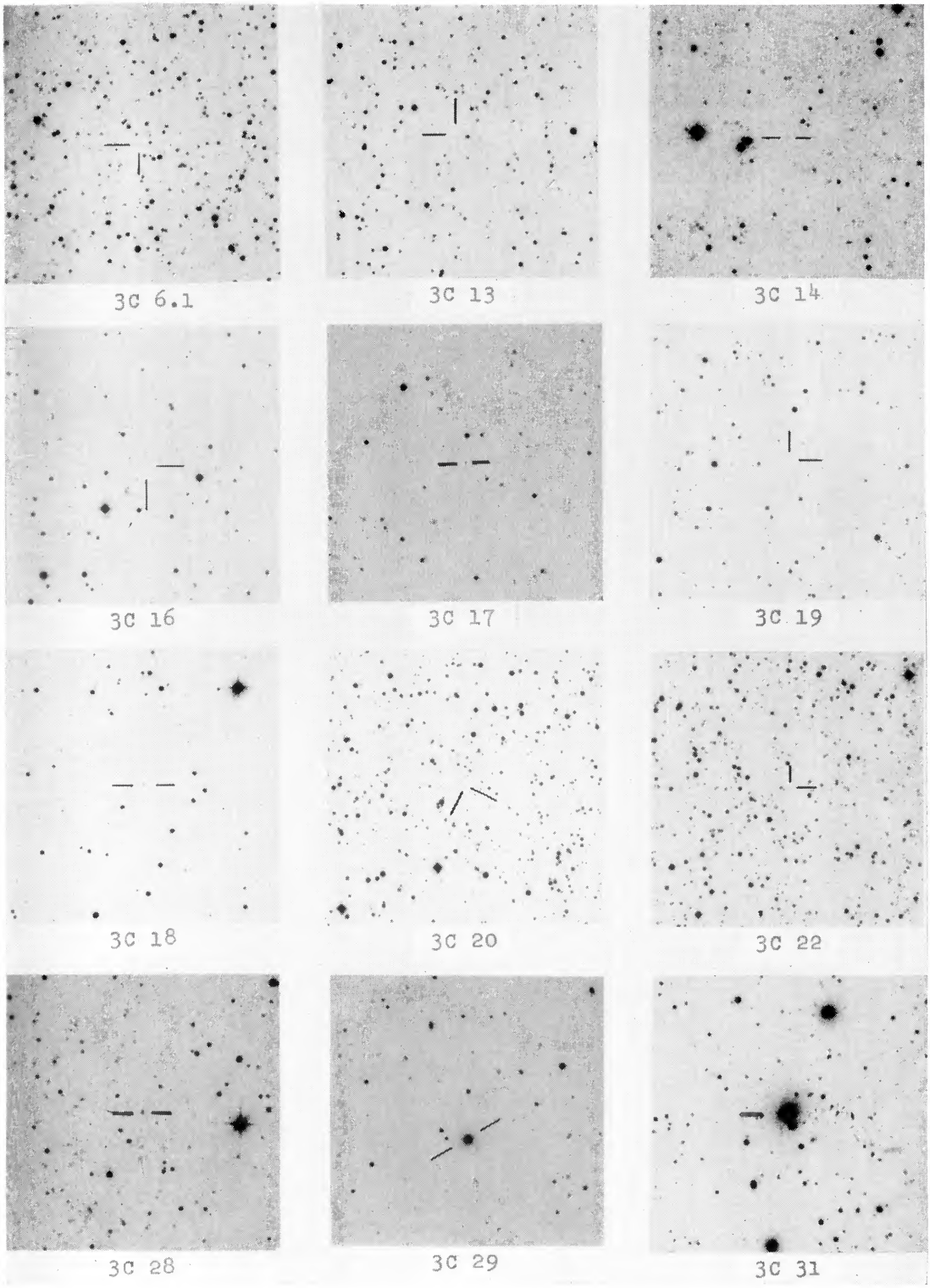

FIG. 1.—Finding charts for 191 sources. North is at the top and east is to the left. Each chart is a square of side 10′.3.

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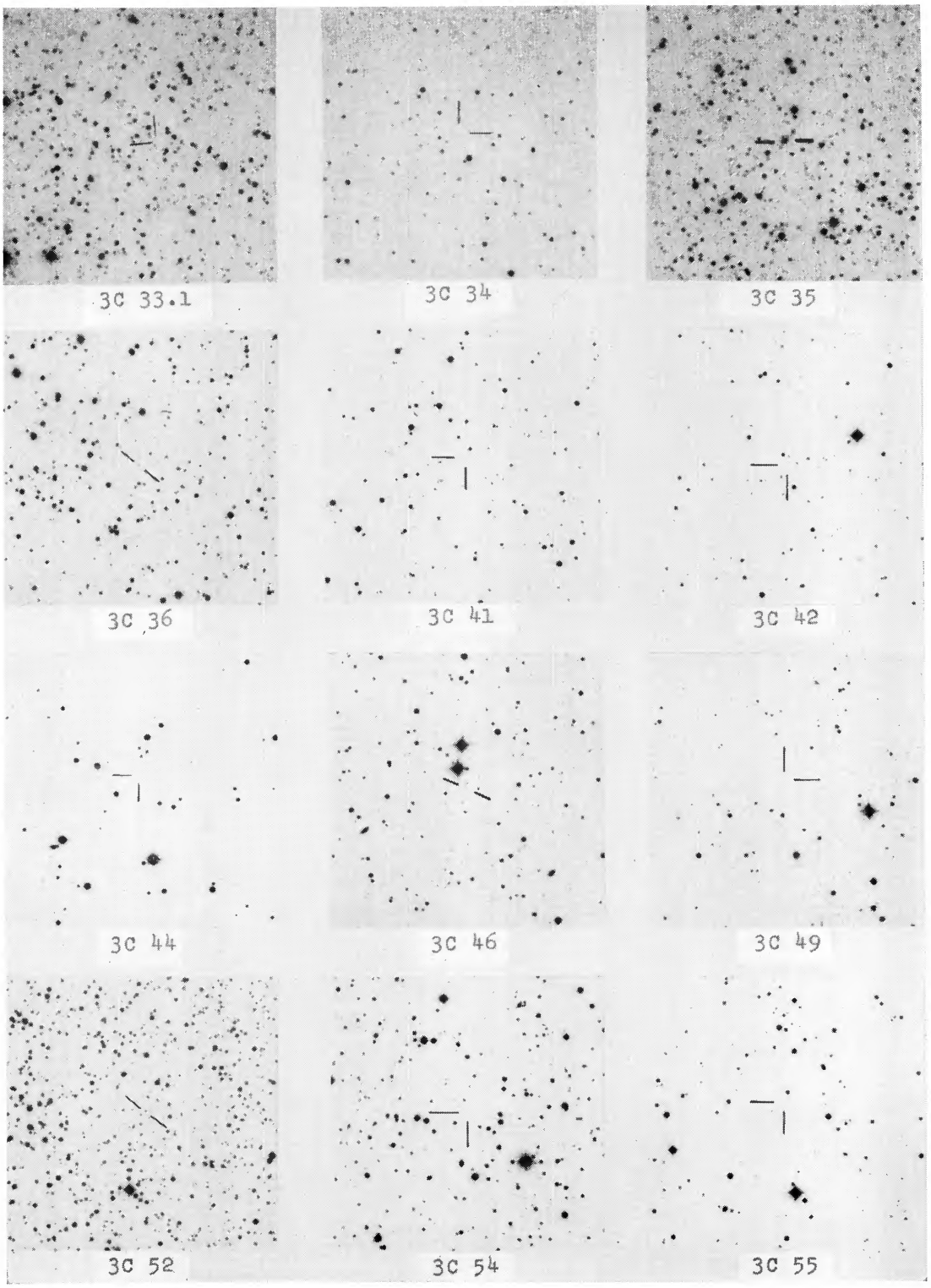

FIG. 1—*Continued*

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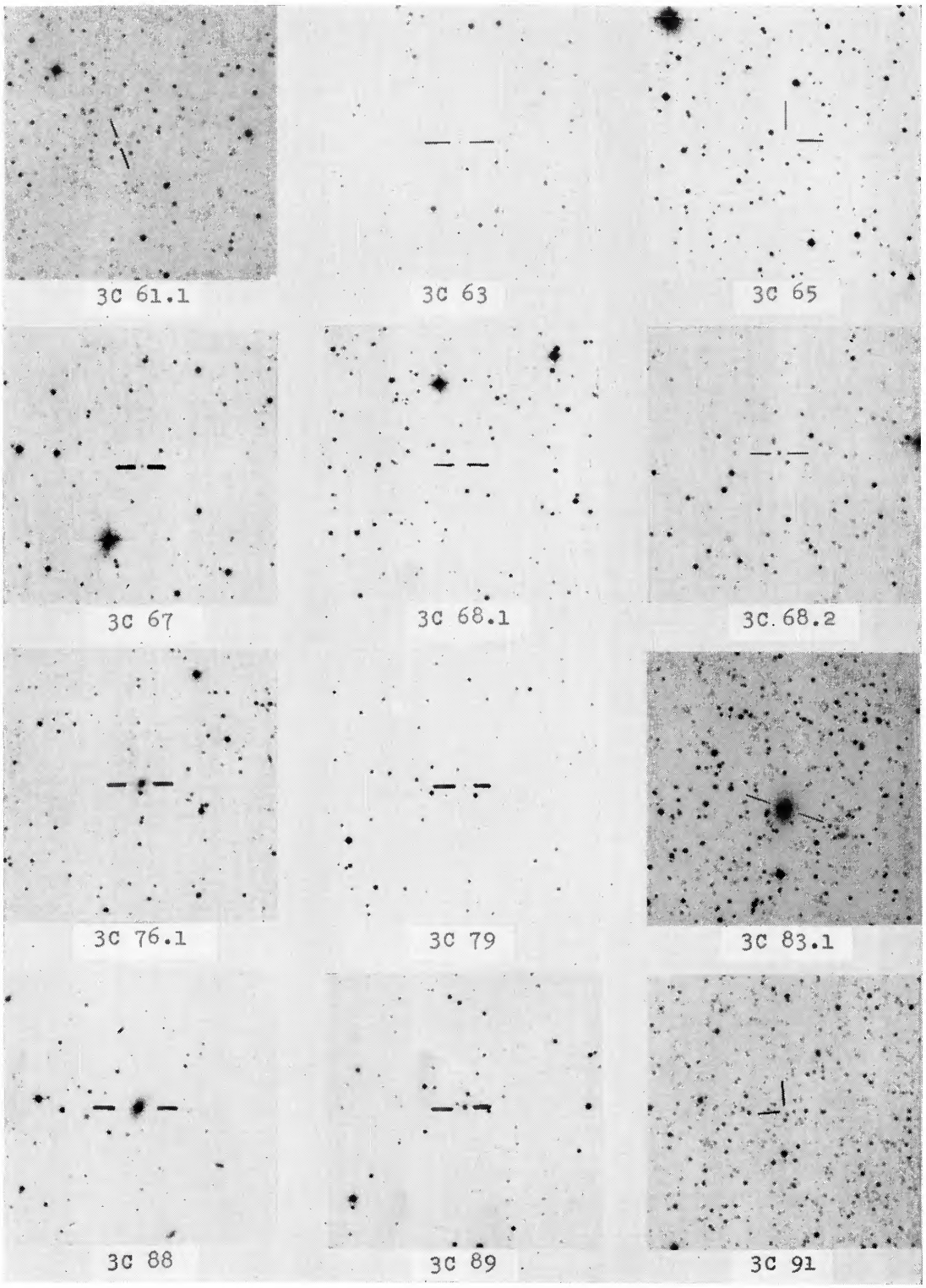

FIG. 1—*Continued*

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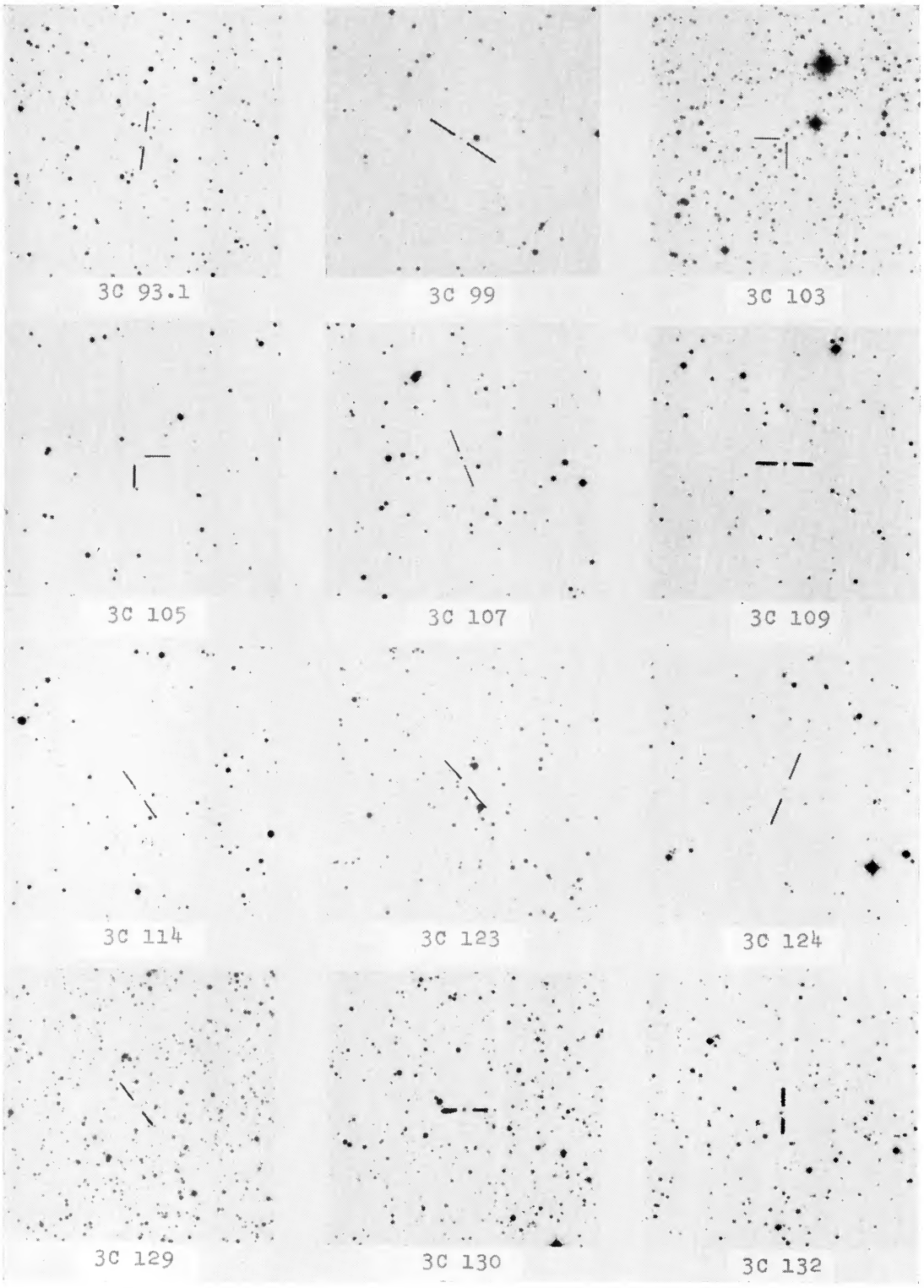

FIG. 1—*Continued*

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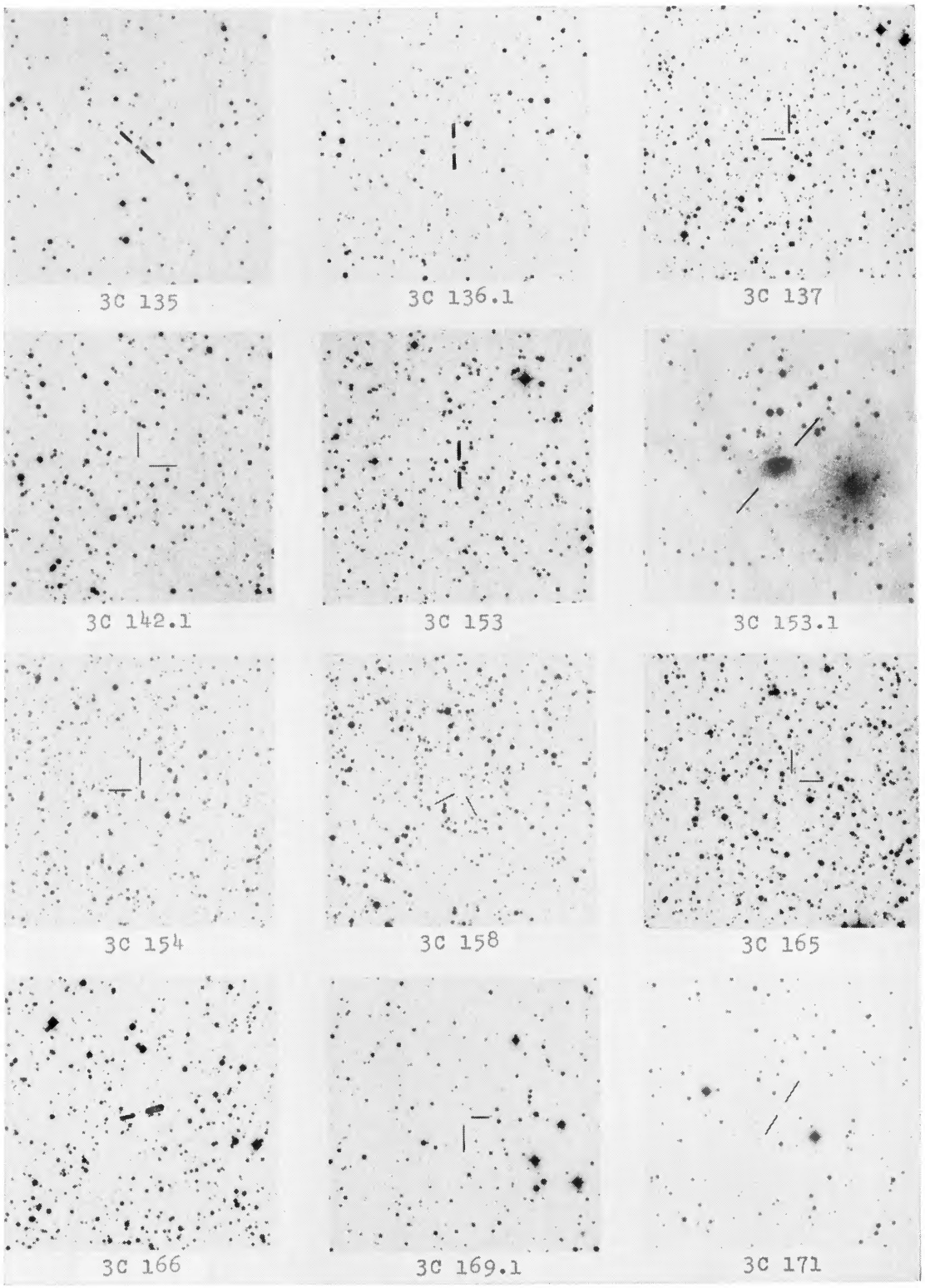

FIG. 1—*Continued*

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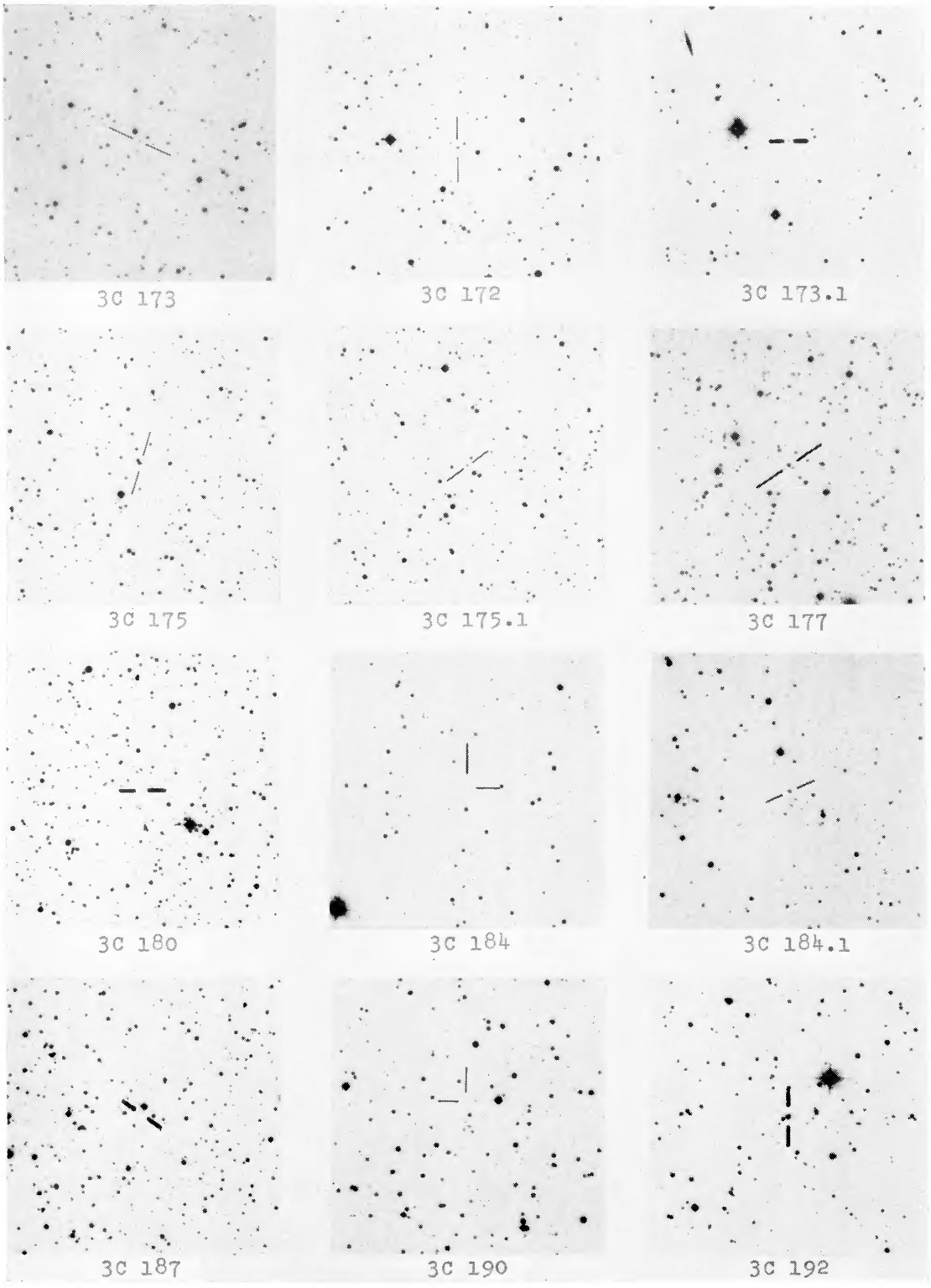

FIG. 1—*Continued*

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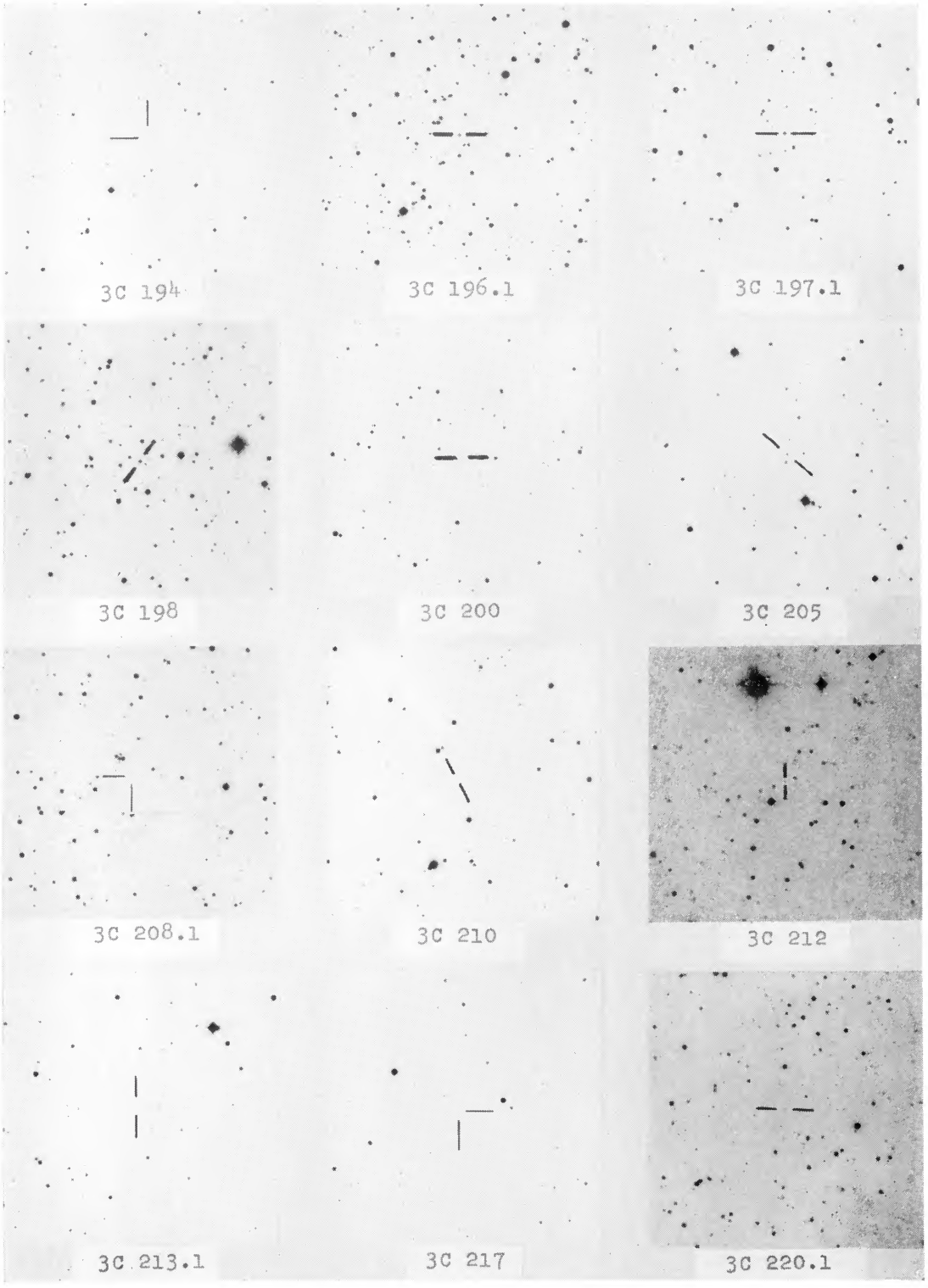

FIG. 1—*Continued*

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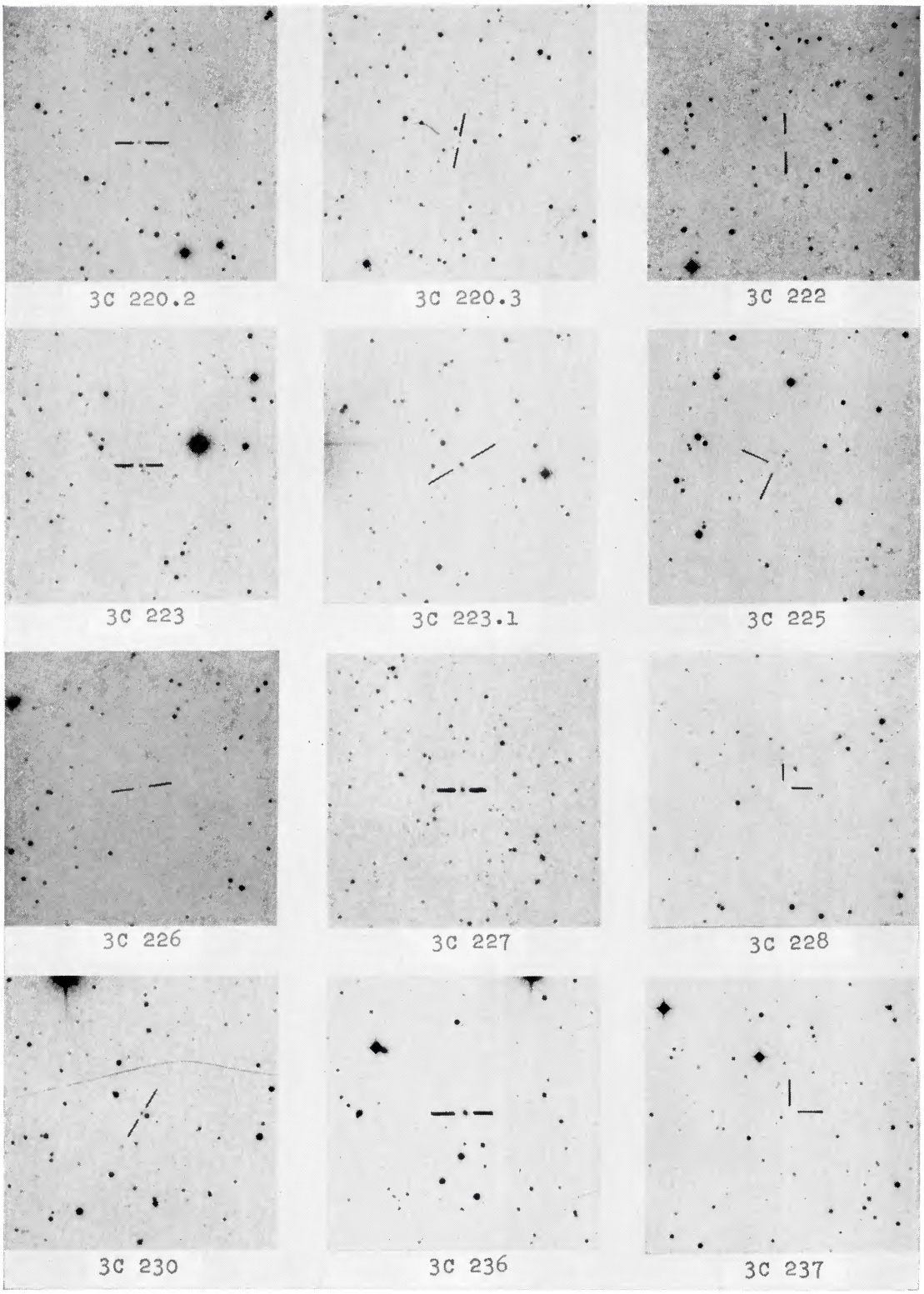

FIG. 1—*Continued*

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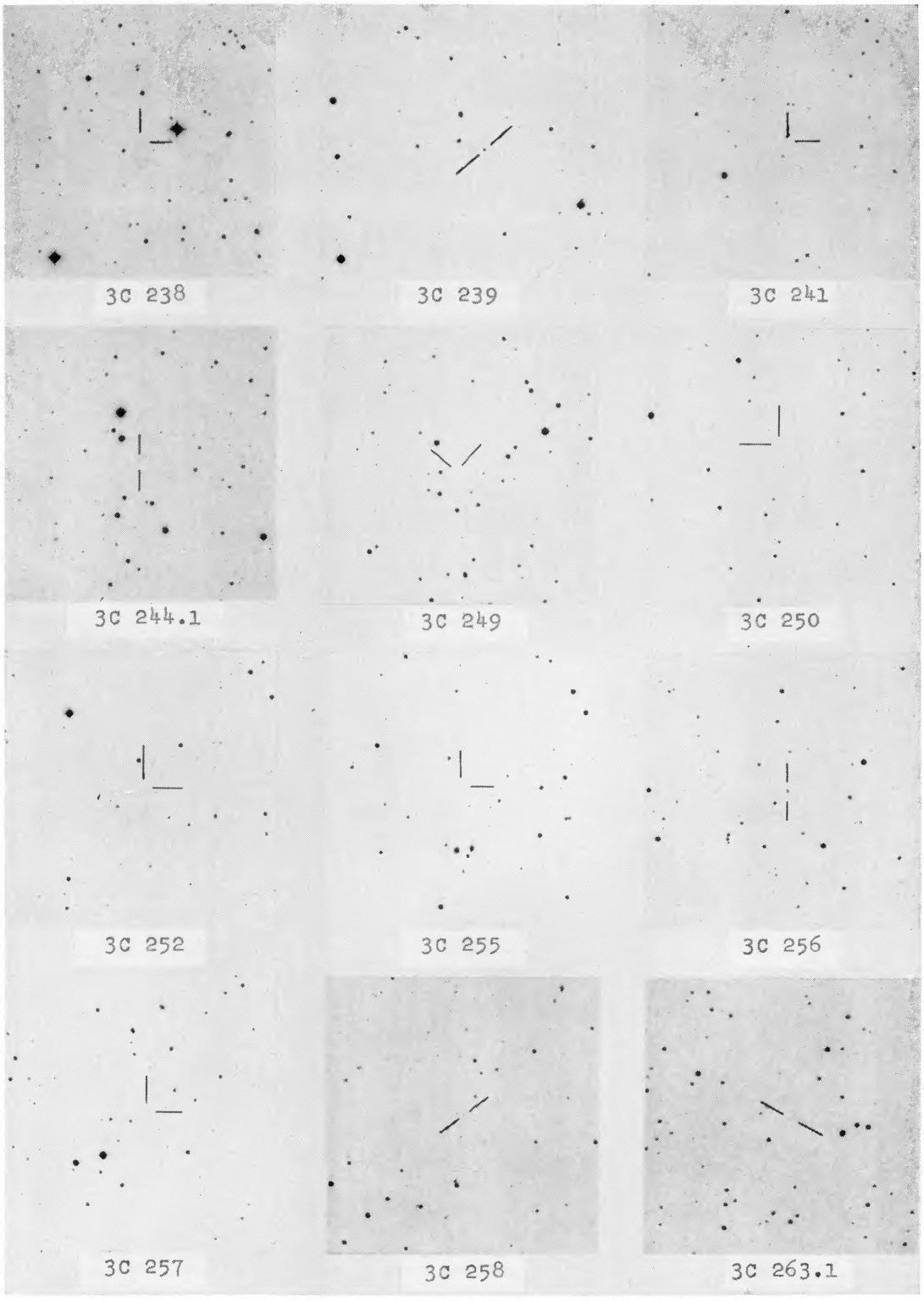

FIG. 1—*Continued*

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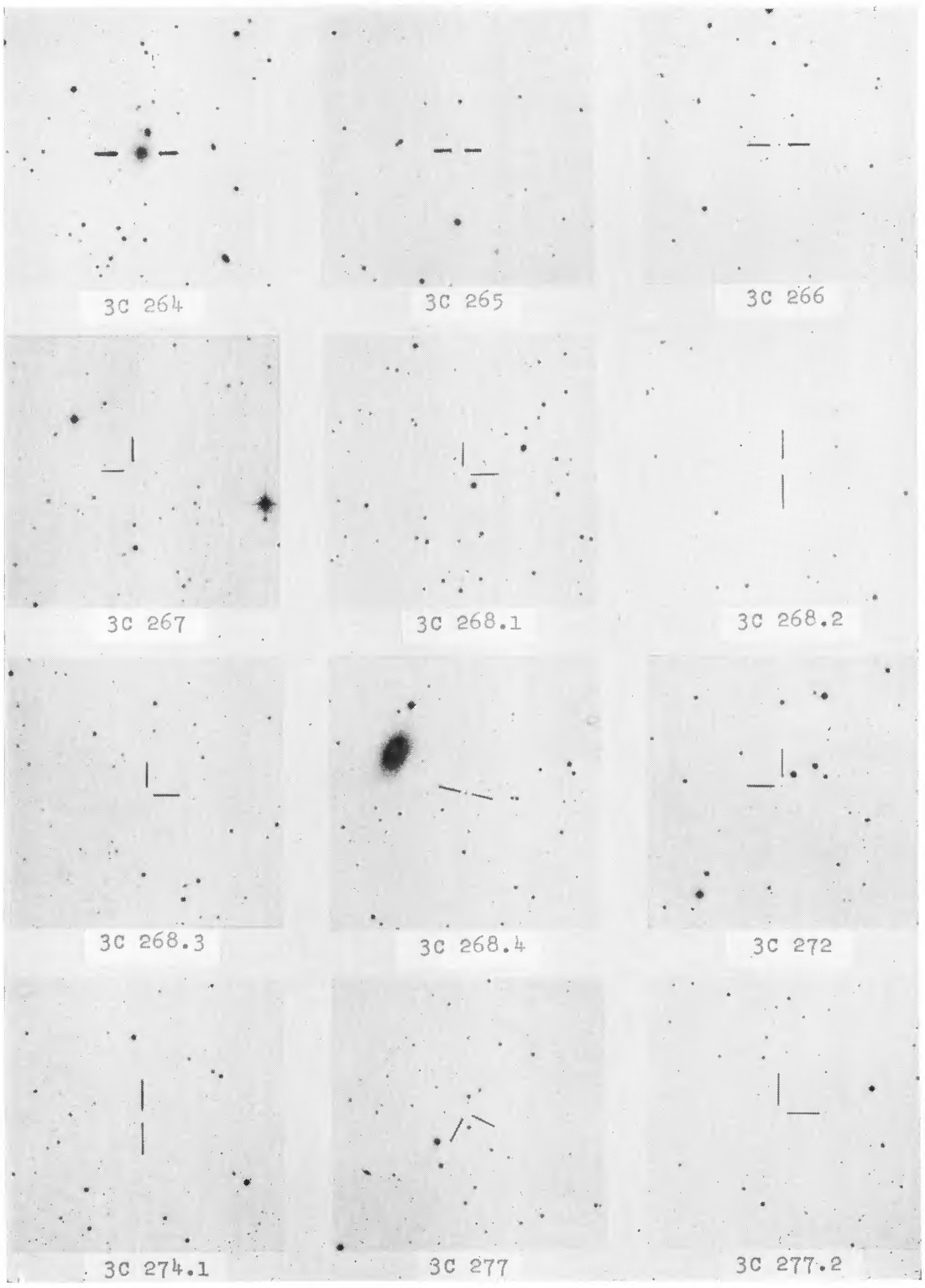

FIG. 1—*Continued*

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1966ApJ...144..459W

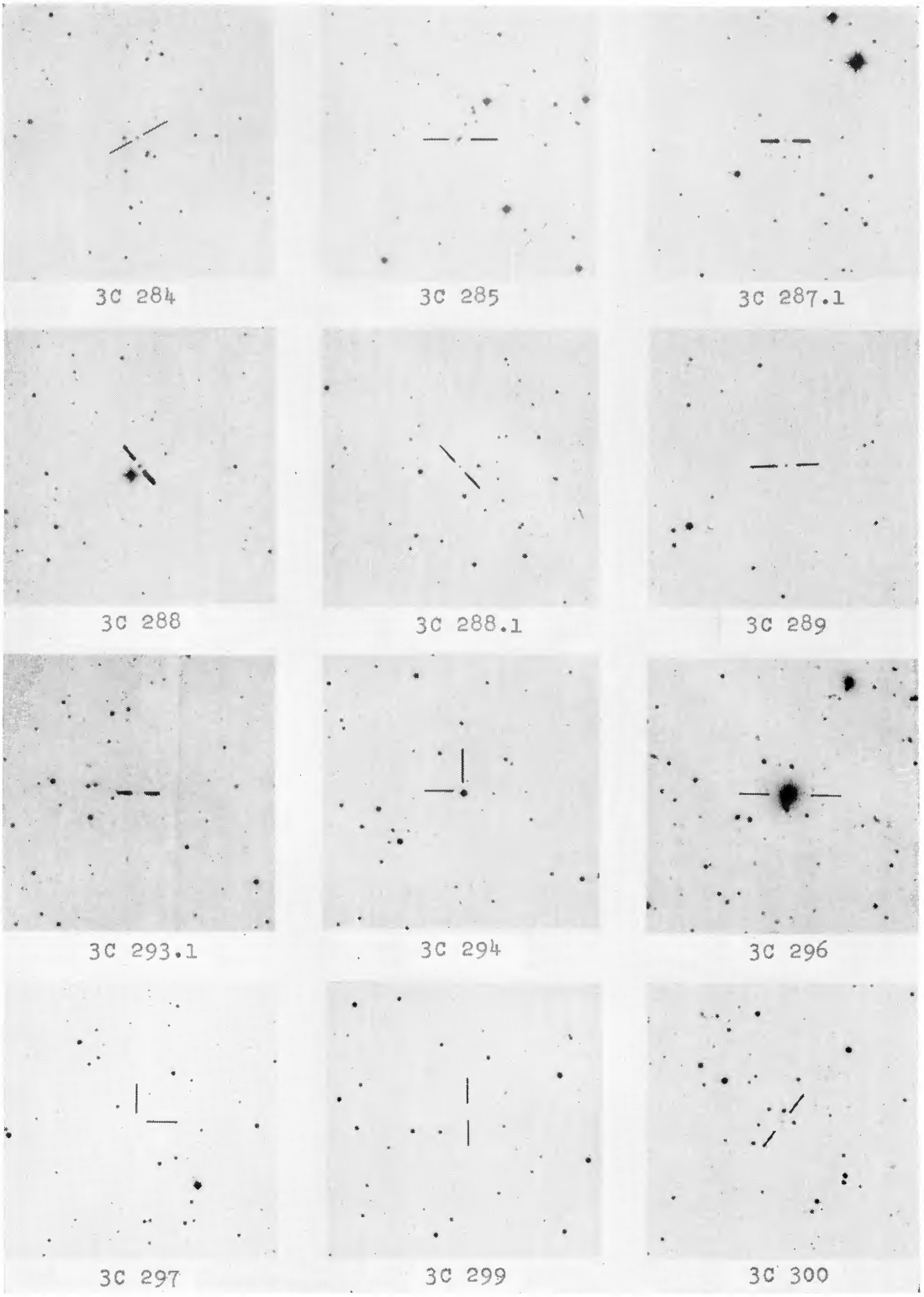

FIG. 1—*Continued*

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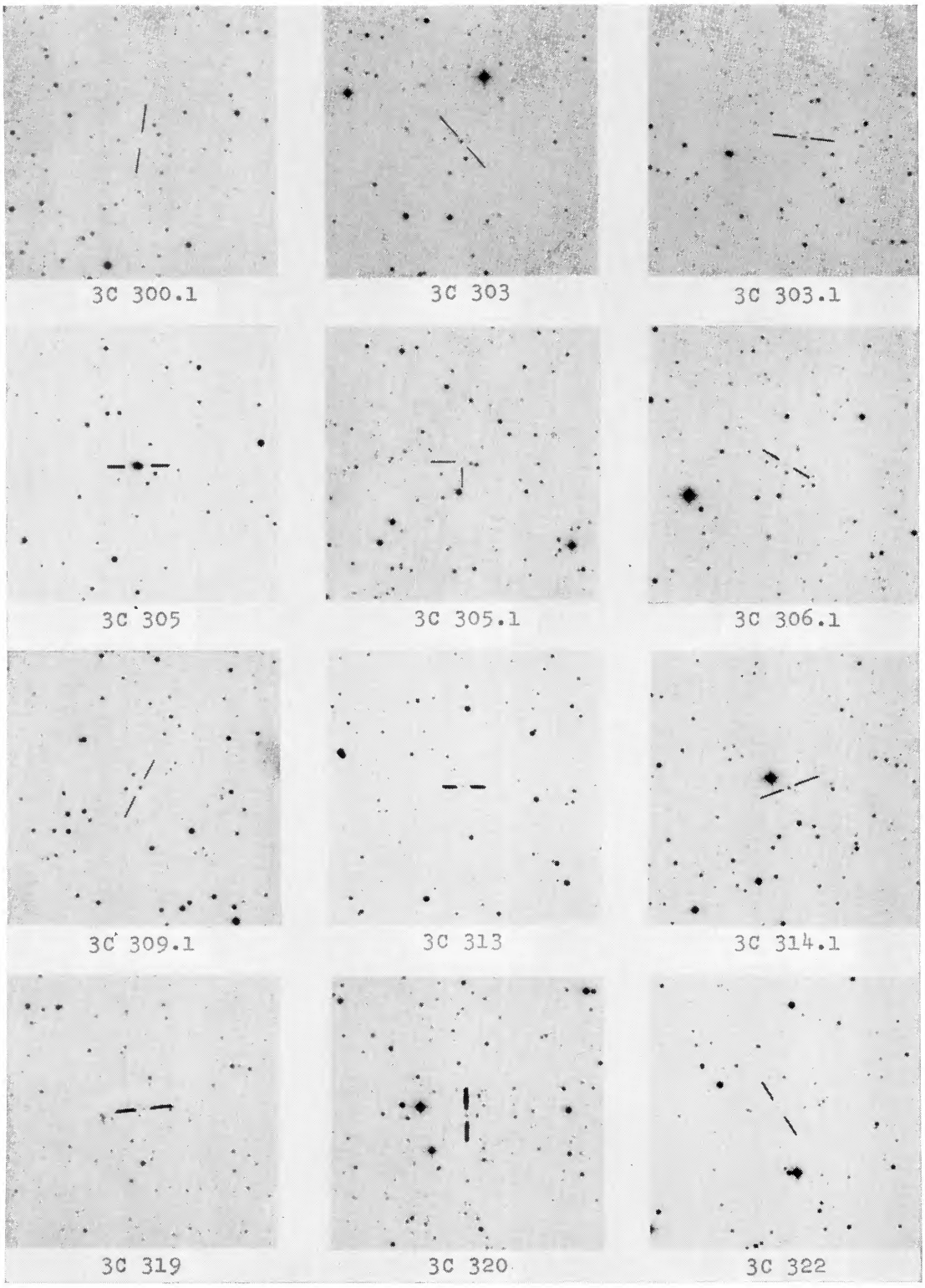

FIG. 1—*Continued*

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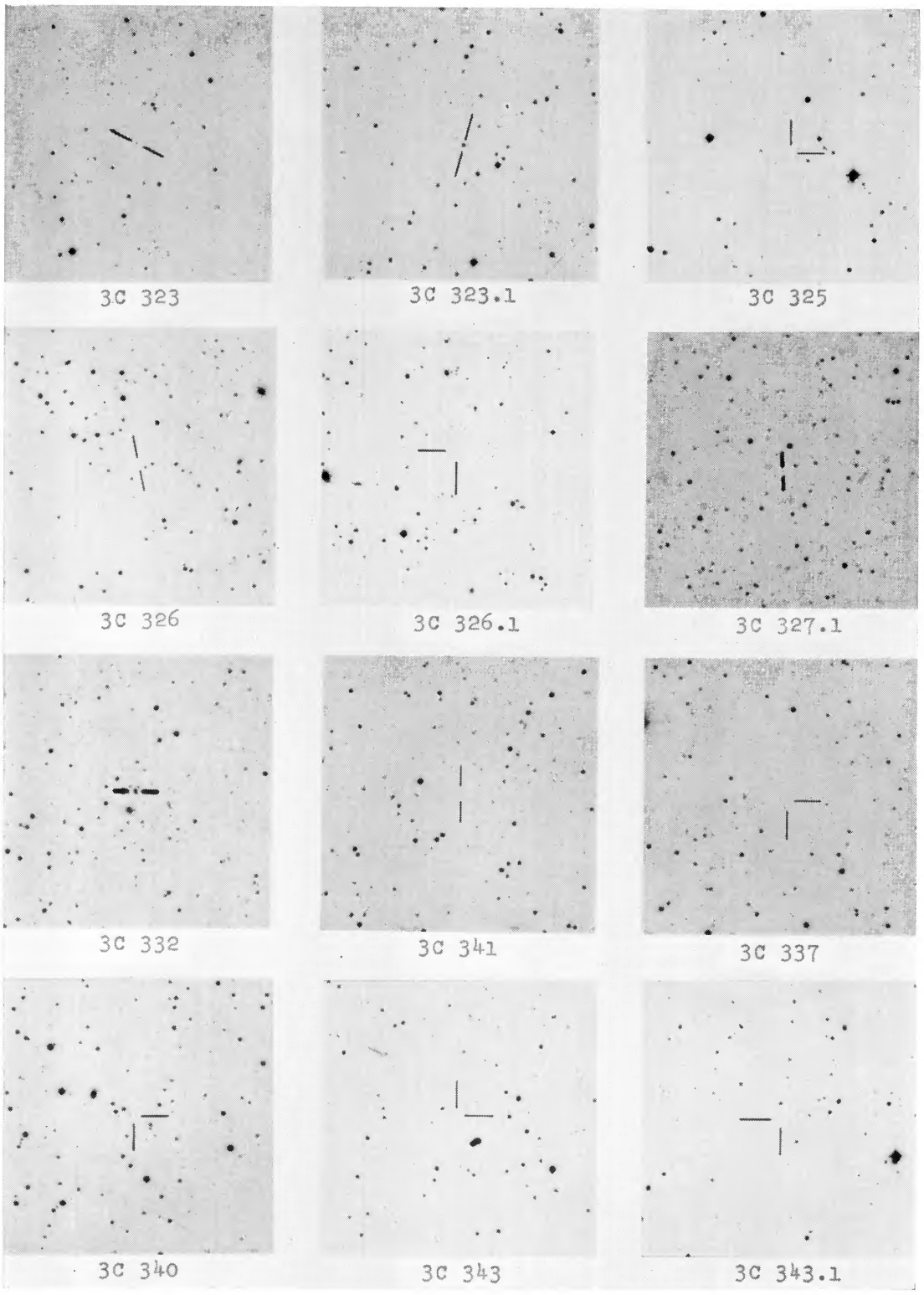

FIG. 1—*Continued*

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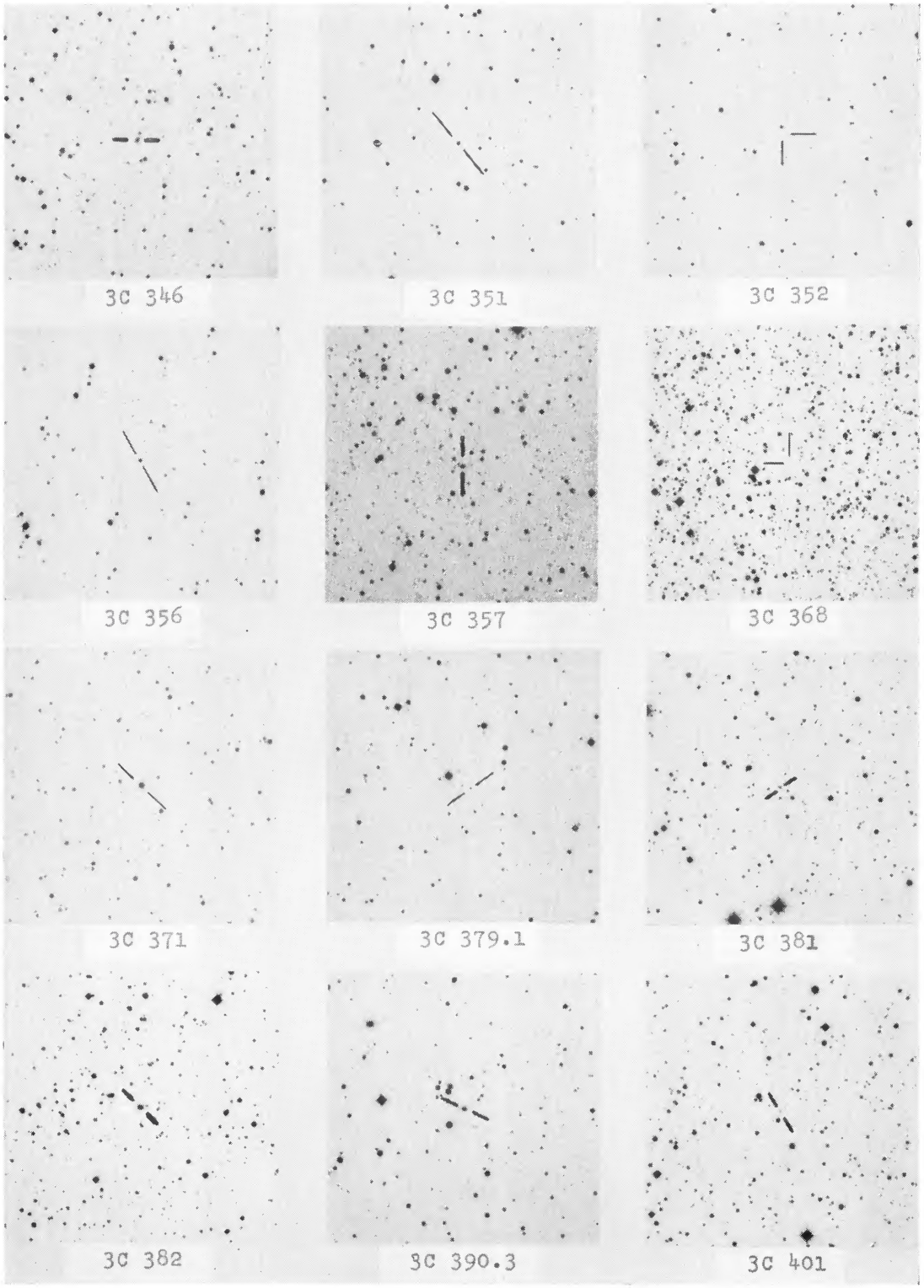

FIG. 1—*Continued*

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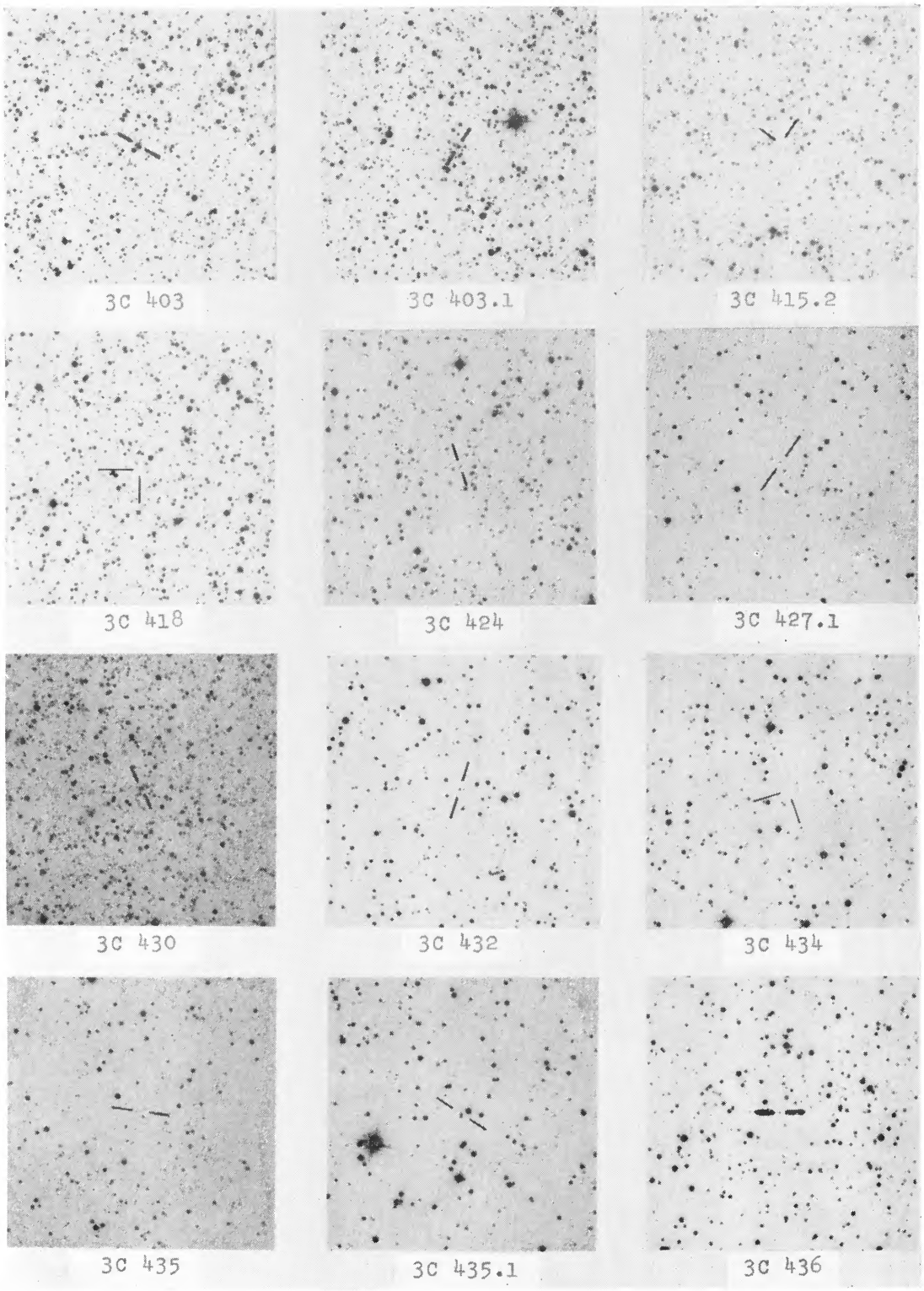

FIG. 1—*Continued*

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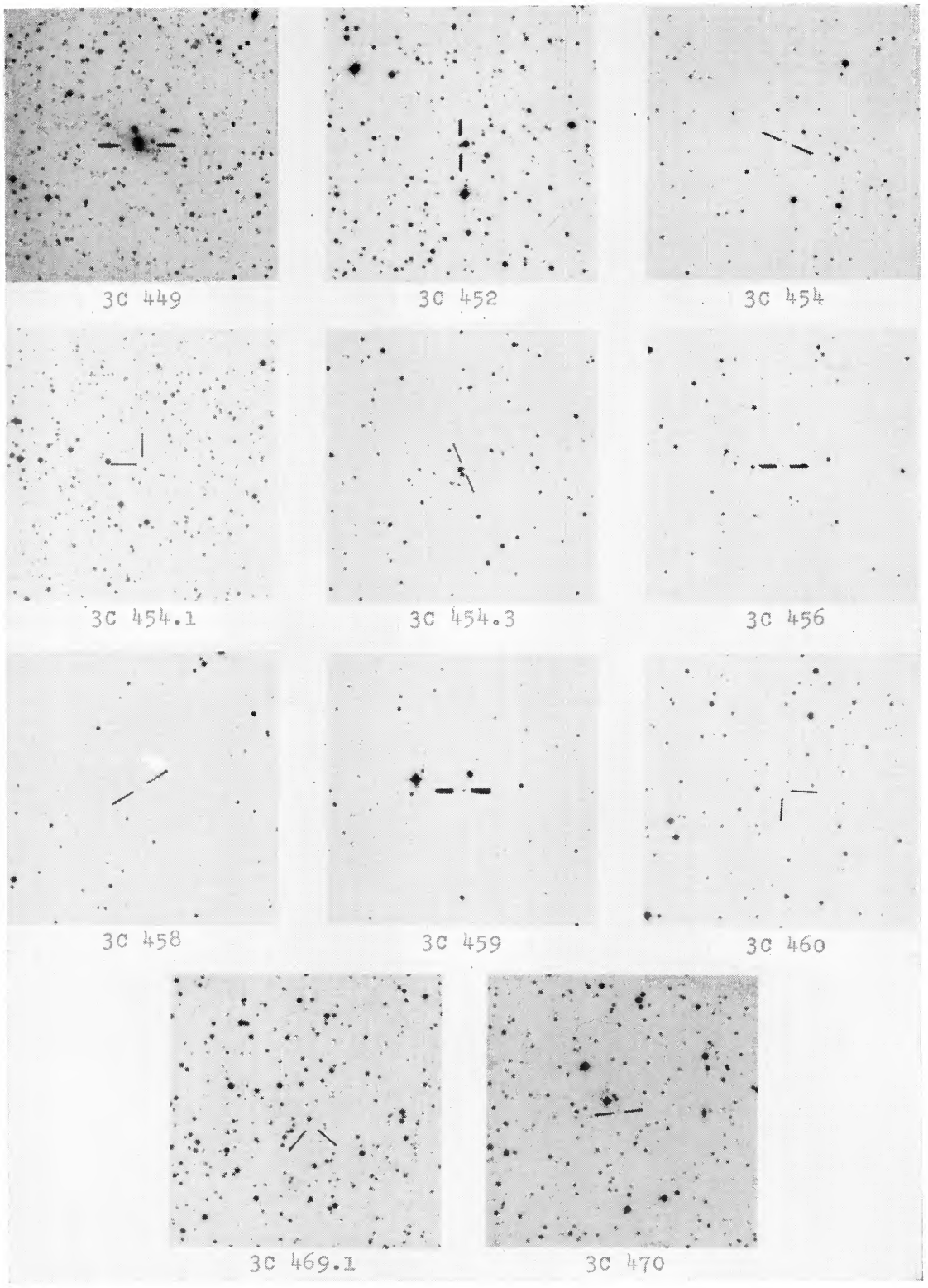

FIG. 1—*Continued*

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Charts for many of the older identified sources have been published by Griffin (1963) and by Maltby, Matthews, and Moffet (1963). A number of charts published by Longair during the preparation of this paper have been included. Each chart is a square of side 10′.3 with north at the top and east on the left and is a reproduction of a Polaroid print from the red Survey print (except for 3C 225 and 3C 303, whose charts were made from the blue prints). Objects suggested as the radio source identification are indicated by two parallel straight lines, while for unidentified sources the mean radio position given in Table 1 lies at the intersection of the two perpendicular straight lines.

VI. PROBABILITY OF MISIDENTIFICATION

For most of the new identifications in Table 1, optical confirmation in the form of spectra, *UBV* colors, is at present lacking. It is therefore important to consider the limitations of the present search regarding the probability of misidentification through chance coincidence. Some of the factors involved in making an identification are the radio position errors, radio structure, the appearance of the object (starlike or diffuse), color, and the nature of the optical field (whether obscured, crowded, etc.). In addition, a limit to the brightness of the objects suggested as identifications $\sim 20\ m_{pg}$ (blue) and $19\ m_v$ (red) (1 mag. brighter than objects at the plate limit) was dictated mainly by the

TABLE 2

PROBABILITY OF MISIDENTIFICATION WITH STARS

Source	Probability for Stars (Per Cent)	Probability for Blue Stars (Per Cent)	b^{II}
3C 432	25	10 5	−23
3C 309 1	8	1 5	+41
3C 288 1	5 6	1 2	+56

accuracy of the radio positions and the difficulty in classifying objects of this and fainter magnitudes. In some uncrowded fields on plates of high quality and for high positional accuracy, this magnitude limit was restricted only by the ability of the Schmidt telescope to record very faint objects.

The probability of a galaxy of some given magnitude lying by chance in a given error rectangle can be calculated on the basis of number-magnitude counts for galaxies (see, e.g., Dewhirst 1963). Values ~5 per cent are derived for the probability of a galaxy with $m_{pg} \leq 20$ lying by chance in an error rectangle of $\pm 12''$ in both coordinates (the mean error rectangle relevant to the present search) from the number counts of Hubble (Minkowski 1961). This probability decreases by a factor of 4 per 1 mag. increase in limiting brightness. Since most of the galaxies identified are significantly brighter than 20 m_{pg}, not more than a few chance associations are to be expected.

For stellar objects the situation is less favorable, especially near the galactic plane where highly crowded star fields render identification difficult. Out of the plane ($b^{II} = 90°$) values tabulated by Dewhirst give a 5 per cent probability that a star of $m_{pg} \leq 20$ will lie by chance in the average error rectangle of $\pm 12''$, the probability decreasing by a factor of less than 2 per 1 mag. increase in limiting brightness. In the case of the quasi-stellar objects, these statistics are improved somewhat when their blue color is taken into account. To obtain an idea of the statistics involved, counts of stars and blue stars with $m_{pg} \leq 20$ were made in areas of 125 square minutes of arc centered on the sources 3C 288.1, 3C 309.1, and 3C 432, all of which are identified with blue stellar objects. From these counts the probability of a stellar object and a blue stellar object with $m_{pg} \leq 20$ lying by chance in an error rectangle of $\pm 12''$ was calculated (Table 2).

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For the present limited sample of radio sources, the chances of misidentification with a blue stellar object in high galactic latitude are small, while even in a moderately crowded field such as that of 3C 432, only one object in ten will be misidentified. These values are of course upper limits since most identified objects are brighter than 20 m_{pg}.

VII. DISCUSSION

Of the 328 sources listed in the 3C R catalogue, about 9 per cent are definitely of galactic origin. These include identified galactic sources together with large-diameter sources near the galactic plane (e.g., in the Cyg X region) and also a few sources of moderate diameters with thermal spectra. A further 4 per cent of the sources with moderate diameters close to the galactic plane may be of galactic origin. However, for the purpose of discussing the extragalactic sources only the 9 per cent which are definitely galactic will be excluded.

TABLE 3

STATISTICS OF IDENTIFICATION FOR EXTRAGALACTIC SOURCES

Quality of Identifications	Total Extragalactic Sources (Per Cent)	Sources with $b^{II} \leq 15°$ (Per Cent)	Sources with $b^{II} > 15°$ (Per Cent)
1 and 2	46	22	54
1–3	61	35	69

TABLE 4

STATISTICS OF EXTRAGALACTIC IDENTIFIED SOURCES

Quality of Identification	Per Cent		
	Qs	N	G
1 and 2	30	7	63
1–3	28	8	64

Table 3 gives the percentage of extragalactic sources identified with respect to the total number of extragalactic sources (300) and also with respect to the number of extragalactic sources in two regions of galactic latitude (72 with $b^{II} \leq 15°$, 228 with $b^{II} > 15°$). Table 4 gives the distribution of the extragalactic sources among the various optical types. Percentages are given for identifications of qualities 1 and 2 (certain and highly probable identifications comprising a total of 139 sources) and for identifications of qualities 1–3 (certain, highly probable, and probable identifications comprising a total of 182 sources).

Table 3 illustrates the effects of galactic obscuration and indicates that 69 per cent of the sources in high galactic latitude down to a flux level of 9 units at 178 Mc/s can probably be identified within the limits of optical magnitude imposed by the present method of search. This is a very encouraging figure compared with earlier estimates based on an inadequate knowledge of the radio luminosity function. If we furthermore consider those sources with $b^{II} > 15°$ which are definitely felt to be not identified (sources

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with field classification IV and with classification III where the radio position is so well defined as to exclude nearby objects as the identification), we obtain a percentage of the order of 17.5 for unidentified sources. Thus the final figure for identifications with the above limits of galactic latitude, radio flux, and optical magnitude may well lie between 70 and 80 per cent.

Almost a third of the extragalactic identified sources in the 3C R catalogue are seen to be quasi-stellar, their number being probably greater than 50. The N galaxies which comprise 7–8 per cent of the total may prove capable of subdivision into two classes depending, among other things, on the stellar quality of their appearance. The remaining 64 per cent of identified sources are galaxies, many in distant clusters, whose predominant characteristic is that of the D galaxy.

Two limitations of the present search are (*a*) the lack of adequate knowledge of the radio structure for many of the sources and (*b*) the difficulty in identifying extragalactic objects which are completely stellar in appearance and neutral to red in color and which could either be Qs or N galaxies. Objects in this category will require study with large telescopes to achieve a reliable identification.

The aim of this paper has been to present the basic optical data from the search on the Sky Survey prints and plates. The results and their interpretation in terms of the radio luminosity function will be discussed more fully in a separate paper.

I would like to express my gratitude to E. B. Fomalont, who was responsible for identifying a number of sources during this program, and to T. A. Matthews for helpful discussions on the classification of radio galaxies. Thanks are due to F. Zwicky, who observed some of the objects (stars near 3C 294, 3C 371, and 3C 390.3) at the 200-inch telescope and provided information on their spectra, and to M. Schmidt, whose spectra of two objects near 3C 343 and 3C 352 showed these to be stars. Permission to use unpublished photoelectric magnitudes of galaxies (A. R. Sandage) and of stars (W. A. Baum) in making magnitude estimates is gratefully acknowledged.

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