A Westerbork survey of rich clusters of galaxies. XI - Observations of the Cancer Cluster at 610 MHz

Perola, G.C.; Tarenghi, M.; Valentijn, E.A.

Citation

Perola, G. C., Tarenghi, M., & Valentijn, E. A. (1980). A Westerbork survey of rich clusters of galaxies. XI - Observations of the Cancer Cluster at 610 MHz. *Astronomy And Astrophysics*, *84*, 245-250. Retrieved from https://hdl.handle.net/1887/7467

Astron. Astrophys. 84, 245–250 (1980)

ASTRONOMY
AND
ASTROPHYSICS

A Westerbork Survey of Rich Clusters of Galaxies

XI. Observations of the Cancer Cluster at 610 MHz

G. C. Perola[1], M. Tarenghi[2], and E. A. Valentijn[3]

[1] Istituto di Scienze Fisiche dell'Università, via Celoria 16, I-20133 Milano, Italy
[2] European Southern Observatory, Telescope Project Div., c/o CERN, CH-1211 Geneva 23, Switzerland
[3] Sterrewacht Leiden, P.O. Box 9513, 2300 RA Leiden, The Netherlands

Received June 26, 1979

Summary. An area of $1\overset{\circ}{.}6$ in radius about the centre of the Cancer Cluster has been surveyed at 610 MHz with the Westerbork telescope. The minimum detectable flux in the full synthesis map obtained is 2.5 mJy (4 r.m.s. noise), which at the distance of 46 Mpc corresponds to $P=6\ 10^{20}$ WHz^{-1}. Two (E+SO) galaxies and seven (S+I) galaxies belonging to the cluster have been detected, and these are used to construct the Radio Luminosity Function of this cluster. The results for both the ellipticals and the spirals are in agreement with those obtained for galaxies of the same type outside rich clusters. The reasonable statistics achieved in the optical interval $-18 \geqq M_x > -19$ show that still about 50% of the spirals and irregulars have radio power below $6\ 10^{20}$ WHz^{-1}. The peculiar S galaxy Zw 119–55 studied by Tifft et al. (1973) is the strongest radio source in this cluster, $P=1.3\ 10^{22}$ WHz^{-1}.

Key words: clusters of galaxies – radio galaxies – luminosity function

I. Introduction

The previous papers of this series were devoted to observations with the Westerbork Synthesis Radio Telescope (WSRT) at 1415 and 610 MHz of several Abell Clusters: Coma, Hercules, A 2197, A 2199, A 1367. One of the aims of these observations is that of studying the radio properties of elliptical and spiral galaxies in statistically well defined samples to look for differences from one cluster to the other and between clusters and "field" galaxies (see in particular Jaffe and Perola, 1976; Jaffe et al., 1976; Perola and Valentijn, 1979; Gavazzi, 1979).

In this paper we add to the sample of the Abell clusters with richness class ≧1 studied so far the Cancer Cluster, a rather loose aggregation of moderate richness not included in the Abell catalogue. It contains a high percentage (~55%) of spiral and irregular type galaxies within $1\overset{\circ}{.}6$ from its centre. This region is in the field N° 119 of the catalogue by Zwicky and Herzog (1963) and extends a little in the neighbouring fields N° 88 and 89. A partial spectroscopic investigation by Tifft et al. (1973) yields a distance of 46 Mpc (adopting $H_0=100$ km s^{-1}Mpc^{-1}). A more detailed optical study is being prepared by Tifft and Tarenghi.

We have obtained a 610 MHz map of the central region, within a radius of $1\overset{\circ}{.}6$, with a limiting map flux of 2.5 mJy (four times the r.m.s. noise). The total number of sources counted above this limit is 253. In this paper we present the results of the identification program concerning the Zwicky galaxies. The reason for not including identifications with fainter galaxies is that the limiting magnitude in the Zwicky catalogue ($m_p=15.7$) corresponds to an absolute magnitude of -17.9 at the distance of the Cancer Cluster, (including a correction of $0\overset{\mathrm{m}}{.}3$ for galactic extinction). This is approximately the limit we have generally adopted for the other clusters studied so far. The results are then presented as a survey of the galaxies in the Zwicky catalogue in Sect. III, while the statistical analysis (the Radio Luminosity Function) for those belonging to the cluster is given in Sect. IV.

II. Observations and Data Reduction

The observations of the Cancer Cluster were done with the "old" configuration of the WSRT, i.e. with ten fixed and two movable telescopes. The operations of the WSRT are described in general in Högbom and Brouw (1974). The specifications of the observations are given in Table 1. The instrument was calibrated by periodic observations of 3 C 48 and 3 C 380.

Observations and calibrations were of very high quality and yielded an extremely good dynamic range. We therefore spent a more than normal amount of computer time to clean the grating rings from the map, by means of three Fourier transforms done in succession. The first one served to determine the position and the map flux of the five brightest sources in the field. After subtraction of these sources from the observations, a second transform yielded a map without grating residuals above approximately 1 mJy/beam. This map was used to determine the parameters of 131 sources with a map flux greater than 5 mJy/beam, which were in turn subtracted from the observations before producing a third transform. Finally this transform was cleaned and restored down to a

Table 1. Observation specifications

Field centre (1950.0)	R.A.= $8^{\mathrm{h}}17^{\mathrm{m}}30\overset{\mathrm{s}}{.}0$ Dec.=$21°14'\ 0\overset{''}{.}0$
Observing date	September–December 1976
Observing time	4×12 h
Baseline coverage	54(18)1422 m
Number of interferometers	80
Frequency	609.5 MHz
Dynamic range	~29 dB
r.m.s. noise (final)	0.63 mJy
FWHM synthesized beam	$51'' \times 141''$

Send offprint requests to: G. C. Perola

★ On leave from Laboratorio di Fisica Cosmica e Tecnologie Relative, Milano, Italy

Table 2. The Zwicky galaxies in the radio field

	α(1950.0)			δ(1950.0)			M.T.	R(deg)	S(mJy)	m_p	m_p^c	Mem	
Zw119-16	8^h	11^m	$18^s.4$	21°	30'	27"	Sb(r)	1.44	< 76.0	13.2	12.6	no	N2545
-19	8	12	25.6	21	42	44	S	1.26	< 31.0	15.7	14.4	?	
-24	8	13	38.3	21	33	52	SO/E	0.97	< 10.5	15.0	14.7	yes	I2253
-27	8	14	03.0	20	40	03	Sa	0.99	< 11.2	15.5	15.0	no	
-28	8	14	30.2	21	19	09	Sa	0.70	< 5.1	15.5	14.7	no	
-29	8	14	30.0	21	50	28	Sb/c	0.92	15.6	14.5	14.2	no	
-30	8	14	32.8	21	20	11	E?	0.68	< 5.0	15.7	15.4	no	
-31	8	14	40.0	21	03	31	SO	0.67	< 4.9	15.0	14.7	yes	N2553
-34	8	14	57.2	21	15	59	I	0.58	< 4.1	15.6	15.2	no	
-35	8	15	0.2	22	35	32	S	1.47	< 87.3	15.4	14.6	?	
-40	8	15	31.0	20	56	39	SO/a	0.54	< 3.8	15.6	15.3-15.1	yes	
-41	8	15	34.7	20	55	05	SO	0.53	5.6	15.3	15.0	yes	
-43	8	15	53.9	21	22	31	Sa/b	0.37	5.3	15.5	14.4	yes	
-44	8	15	54.0	22	16	22	S/I	1.09	< 15.5	15.7	15.4	?	
-45	8	16	06.0	21	05	38	SO	0.34	< 3.0	15.5	15.2	yes	N2556
-46	8	16	06.7	21	20	34	Sc	0.32	13.4	15.0	14.7	yes	
-47	8	16	09.2	21	56	54	Sa	0.78	19.0	15.2	14.9	yes	
-48	8	16	15.2	21	35	34	SO	0.46	< 3.4	14.6	14.3	yes	N2557
-50	8	16	18.4	20	40	04	Sb	0.62	< 4.5	14.6	14.2	yes	N2558
-51	8	16	18.3	20	54	52	Sb	0.41	< 3.2	15.5	15.1	yes	
-53	8	16	24.8	21	12	59	I	0.23	10.7	15.5	15.0	yes	
-54	8	16	36.7	21	33	06	SBa	0.37	< 3.0	15.2	14.9	yes	I2293
-55	8	16	43.0	21	16	20	Spec	0.17	56.2	15.5	14.4	yes	
-56	8	16	45.3	22	11	59	S/I	0.98	< 10.7	15.5	14.9	no	
-57	8	16	52.2	22	11	22	Sb(r)	0.96	< 10.3	13.8	12.9	no	N2565
-58	8	16	57.0	21	08	34	SO	0.15	< 2.6	14.9	14.6	yes	N2560
-59	8	17	03.9	21	13	28	S	0.09	3.3	15.7	14.6	yes	
-61	8	17	15.8	21	13	37	Sb	0.05	< 2.5	15.5	15.2	yes	
-62	8	17	21.8	21	01	60	Sc	0.20	3.0	15.5	15.2	yes	
-63	8	17	28.5	21	17	25	SO	0.05	< 2.5	14.0	13.7	yes	N2562
-65	8	17	40.7	21	13	36	E	0.05	2.5	13.7	13.4	yes	N2563
-66	8	17	54.9	22	48	56	Sa	1.59	< 138	14.9	14.3	?	
-67	8	18	26.4	21	01	37	E	0.31	< 2.9	15.3	15.0	yes	N2569
-68	8	18	27.2	21	04	14	Sa?	0.49	3.6	15.4	14.9	no	N2570
-69	8	18	31.4	21	17	25	E	0.26	< 2.8	15.7	15.4	yes	
-70	8	18	57.9	22	48	06	Sb	1.60	< 138	15.6	14.2	?	
-71	8	19	06.3	21	30	09	SBa	0.46	< 3.4	15.7	15.4	no	
-72	8	19	21.3	21	15	10	SO	0.44	< 3.3	15.5	15.2	no	
-74	8	19	47.0	22	42	51	SO/E	1.58	< 135	13.8	13.5	?	N2577
-77	8	19	58.2	21	14	20	SO	0.58	< 4.1	15.4	15.1	yes	
-80W	8	20	37.5	21	29	58	S/I	0.78	13.6	14.7	15.2	yes	I2339
-80E	8	20	39.3	21	30	35	S	0.78	6.9		14.3	yes	I2338
-81	8	20	46.2	21	35	48	E/SO	0.85	< 7.4	14.9	14.6	yes	I2341
-82	8	21	0.6	21	08	15	SBa	0.82	< 6.9	15.6	15.3	yes	
-83	8	21	6.9	21	11	23	Sb	0.84	< 7.3	14.8	13.5	yes	
-85	8	21	26.1	20	41	43	Sb	1.08	< 15.2	15.6	14.7	?	I2348
-86	8	21	34.3	21	12	25	E?	0.93	< 9.3	15.7	15.4	no	
-91	8	22	18.2	20	29	53	SBa	1.36	< 50.2	14.3	14.0	?	N2583=I2359
-92	8	23	12.5	21	37	15	Sb	1.38	< 55.1	15.5	14.4	?	
-93	8	23	10.3	21	49	56	Sb/c	1.46	< 83.4	15.7	14.4	?	
Zw88-58+	8	15.2		20	07		SO	1.24	< 28.2	15.4	15.1	?	
-60+	8	16.8		20	04		SO	1.18	< 21.9	15.5	15.2	?	

+ Positions from Zwicky and Herzog (1963)

Table 3. Galaxies detected in radio

	α_R(1950.0)	δ_R(1950)	S_{map} (mJy)	S_{sky} (mJy)	$\alpha_o-\alpha_R$ (arcsec)	$\delta_o-\delta_R$ (arcsec)	Pos.err. (arcsec)^2	IC	log P (WHz^{-1})	M_p	
Zw119-29	8^h 14^m $30^s.10$ ±.42	21° 50' 59".2 ±16.1	4.5	15.6 ±3.2	-1.4	-31.2	6.2x16.2	I	21.33	-18.5	Rad. vel. = 3520 Km sec^{-1}
-41	8 15 34.33 .50	20 55 53.6 20.1	3.70	5.6 1.2	5.6	-48.6	7.3x20.2	I	21.13	-18.3	
-43	8 15 53.83 .44	21 23 23.7 17.1	4.25	5.3 1.1	-1.4	-52.7	6.5x17.2	III	21.10	-18.9	
-46	8 16 06.68 .24	21 20 38.2 9.1	11.5	13.4 1.9	0	- 4.2	3.9x9.3	II	21.51	-18.6	Ext. 60" = 14 Kpc E-W
-47	8 16 09.47 .26	21 56 59.4 9.8	7.70	19.0 3.2	-4.2	- 5.4	4.1x10.0	I	21.66	-18.4	
-53	8 16 24.68 .30	21 13 02.2 11.6	9.95	10.7 1.5	1.4	- 3.2	4.6x11.8	II	21.41	-18.3	Ext. 80" = 18 Kpc S-W
-55	8 16 42.73 .09	21 16 20.4 3.3	54.15	56.2 7.0	4.2	- 0.4	2.3x3.9	II	22.13	-18.9	Ext. 40" = 9 Kpc to E
-59	8 17 04.43 .55	21 13 09.5 21.4	3.35	3.3 .7	-7.0	18.5	8.0x21.5	I	20.90	-18.7	
-62	8 17 22.24 .64	21 01 52.0 25.1	2.80	3.0 .8	-5.6	8.0	9.2x25.2	I	20.86	-18.1	
-65	8 17 41.20 .71	21 13 54.8 28.0	2.50	2.5 .7	-7.0	-18.8	10x28	I	20.78	-19.9	
-68	8 18 26.61 .56	21 04 09.8 21.8	3.30	3.6 .8	8.4	4.2	8.0x21.9	I	21.24	-19.2	Rad.vel. = 6490 Km sec^{-1}
-80W	8 20 38.44 .35	21 30 08.6 13.5	5.50	13.6 2.5	-12.6	-10.6	5.3x13.6	I	21.51	-18.1	
-80E	8 20 41.60 .64	21 31 33.3 24.5	2.80	6.9 1.8	-32.1	-58.3	9.2x24.6	III	21.22	-19.0	

level of 1.5 mJy using the standard cleaning procedure. The cleaning removed artifacts due to grating ring superpositions. The r.m.s. noise on the final map is very close to that determined on a circular polarization map of the same observations and is estimated to be 0.63 mJy/beam. The variation of the zero level never exceeds 0.25 mJy. This map was used to complete the source list with other 117 sources with map flux between 2.5 and 5 mJy/beam, and to estimate structure and extension of the sources brighter than 5 mJy/beam. Altogether a sample of 253 sources complete down to 2.5 mJy ($=4\sigma$) was obtained.

In this paper the radio data are presented only for sources identified with galaxies brighter than $m_p=15.7$ in the Zwicky and Herzog (1963) catalogue. The source count based on the full sample will be presented separately (Valentijn, in prep.).

III. Radio and Optical Data

All the galaxies in the Zwicky catalogue (Zwicky and Herzog, 1963) which are in the surveyed field are listed in Table 2. In Col. 1 they are given the sequential number in the catalogue fields N^o 119 and 88. (The NGC and IC numbers are given on the right side of the Table). The optical positions (Col. 2, 3) were measured on a glass copy of the Palomar Sky Survey, with an accuracy of about 2". The morphological types (Col. 4) were estimated on 10× enlargements of the red and blue PSS plates, and a colour criterion was used in classifying as spiral or irregular the few doubtful cases with a definitely blue colour. The distance R in degrees from the radio field centre is given in Col. 5 and the corresponding minimum flux detectable in this survey in Col. 6. This was obtained from the survey radio limit and the primary beam attenuation factor reproduced in Jaffe et al. (1976), and can be considered an upper limit to the radio flux from each galaxy. For those which have been detected the measured flux is given instead (see also Table 3). In Col. 7 and 8 we give the Zwicky photographic magnitude and a corrected value. The latter was obtained applying two corrections, one for the extinction in our own galaxy, taken to be $0^m.3$ ($A_p \simeq 0.25$ (cosec 28°−1)), the other for the internal absorption as a function of inclination in the case of the S galaxies. This correction was derived using its relationship (Holmberg, 1958) with the apparent axial ratio, which we measured on the Palomar Sky Survey. Such a correction, although very uncertain, is introduced in order to derive the bivariate radio luminosity function for the cluster spirals, as in the previous papers of this series. In one case, where the morphological classification is uncertain between SO and Sa, we report two values of m_p^c, one without the internal absorption correction.

In the last column it is stated whether the galaxy can be considered a member of the Cancer Cluster or not, on the basis of redshift measurements which will be published in a separate paper (Tifft and Tarenghi, in prep.). The full range of radial velocities goes from 2000 to 10,000 kn s^{-1}, and in order to avoid contamination by background and foreground objects, we have restricted the membership to the range 4000 to 5500 km s^{-1}, where the great majority of the galaxies are grouped with a fairly smooth redshift distribution. For about 20% of the galaxies however the redshift measurement is not yet available, and these are indicated by a question mark.

The finding charts of the Zwicky Galaxies detected in this survey are shown in Fig. 1 and the radio data are given in detail in Table 3. The position of the radio source, the map flux, S_{map}, and the flux corrected for the primary beam attenuation, S_{sky}, are given in Col. 2–5. The position error was derived from the relation with S_{map} given in Jaffe et al. (1976); note that $\sigma_\delta=\sigma_\alpha$ cosec δ. The error in S_{sky} was obtained combining the error in S_{map} (which is taken equal to the r.m.s. noise plus a 10% error in the absolute scale) and the error in the attenuation factor (10 R%, with R in degrees). In Col. 6 and 7 we give the difference in R.A. and Dec between the optical and the radio position, and in Col. 8 the

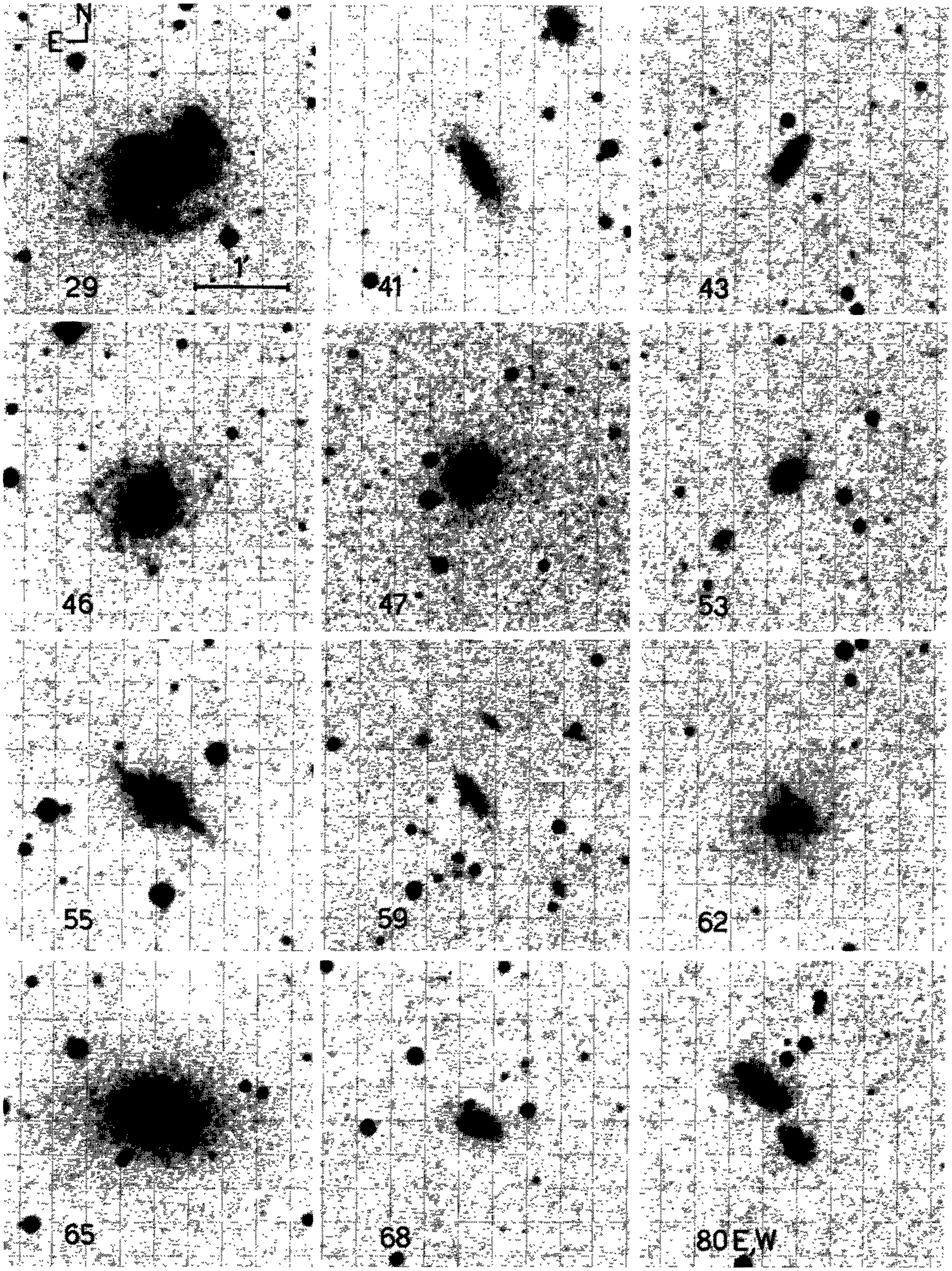

Fig. 1. Finding charts of the galaxies in Table 3. Reproductions are courtesy of Palomar Sky Survey-National Geographic Society

Table 4. Radio Luminosity Functions

	(E+SO)		(S+I)	
$\log P_{610}$ (WHz^{-1})	$-17.9 \geq M_p > -19$	$-19 \geq M_p > -20$	$-17.9 \geq M_p > -19$	$-19 \geq M_p > -20$
20.78 - 20.90	0/4	1/3	1/9	0/0
20.90 - 21.10	0/8	0/3	1/10	0/1
21.10 - 21.30	1/9	0/3	0/13	0/3
21.30 - 21.50	0/10	0/3	1/13	0/3
21.50 - 21.70	0/10	0/3	3/15	0/3
21.70 - 21.90	0/12	0/3	0/16	0/3
21.90 - 22.10	0/12	0/3	0/16	0/4
22.10 - 22.30	0/12	0/3	1/18	0/4
22.30 - 22.50	0/12	0/4	0/19	0/4
		$\log P > 20.8$	0.54±0.1	
		$\log P > 21.1$	0.33±0.1	<0.5
		field (a)	0.33±0.1	0.6±0.1
		field (b)	0.50±0.1	0.3±0.1

combined radio-optical position error. On the basis of these quantities the optical identification is established: as in the previous papers of this series, the identification is considered reliable if the optical position lies within the 3σ ellipse around the radio position. Then we call an identification Class I or II depending on whether the radio source is unresolved or resolved (Col. 9). There are also two identifications of Class III, which do not satisfy the above criterion, and are less reliable than the others: one is with the galaxy Zw 119–43, which lies just outside the 3σ ellipse, the other is with the galaxy Zw 119–80 E, which lies outside the 4σ ellipse, but has been retained because of a possible association with the double system of galaxies. Neither of these Class III identifications will be used in the construction of the Radio Luminosity Function.

Using the position errors of all the radio sources detected in the field we estimated the probability that some of the Cl. I and II identifications are due to a chance coincidence, and this turned out to be negligibly small.

In Col. 10 and 11 we give the radio power and the absolute magnitude (from m_p^c), adopting a distance of 46 Mpc for the galaxies reported as cluster members in Table 2, and a distance corresponding to the radial velocity reported in Col. 12 for Zw 119–29 and 68 (from Tifft and Tarenghi, in prep.).

Three of the sources in Table 3 are barely resolved and in Col. 12 we give a rough estimate of the extension and the general direction in which it is found. In the case of the Sc galaxy Zw 119–46 the extension indicates emission from the disk. The galaxy Zw 119–55 has a very peculiar appearence, and is described in detail in Tifft et al. (1973). We note that the extension is roughly in the direction of the major axis of the "elliptical-shaped amorphous component" which constitutes the main body of this galaxy and which displays strong emission lines (Tifft et al., 1973). Its power exceeds that of any other galaxy in this cluster. Finally, Zw 119–53, which we classify as an irregular due to its blue colour and which is rather compact, is remarkable in radio because it appears rather more extended than the other two resolved sources. This galaxy also shows emission lines in its spectrum (Tifft et al., 1973).

IV. The Radio Luminosity Function of the Cancer Cluster Galaxies

The 9 cluster galaxies detected in this survey (identification class I and II) are now used to derive the radio luminosity function (RLF) in the Cancer Cluster, i.e. the fraction of galaxies which are found to emit per interval of radio power. This is obtained in the bivariate form, that is per interval of optical magnitude, to allow for the dependence of the probability of radio emission on the optical luminosity. The method is described in the previous papers of this series, see for instance Jaffe et al. (1976). The RLF is obtained separately for the elliptical and SO, (E + SO), galaxies and the spiral and irregular, (S + I), galaxies, and is given in fractional form in Table 4. In the denominators we provisionally counted as cluster members also the 12 galaxies in Table 2 whose membership is still doubtful. Since they all lie rather far from the field centre, they contribute to the galaxy counts only above $\log P = 21.5$. The galaxy Zw 119–40, classified as SO/*a*, has been counted twice, both among the SO's and the spirals.

Compared to the other (Abell) clusters studied in this survey, the Cancer Cluster is the poorest, and in fact is the only one which does not contain galaxies brighter than -20: the statistical weight of its RLF is correspondingly low, especially for the (E + SO) class.

In the previous papers it was found that the RLF of the (E + SO) galaxies is not significantly different from one cluster to the other and from that of a larger sample including galaxies outside rich clusters (see Auriemma et al., 1977). In this cluster there are no strong radio galaxies, but the number of weak radio sources detected are close to the expectations based on the integral RLF above $\log P = 20.8$ in Auriemma et al. (1977), which amount to about 10% in the interval (-18, -19), and to about 30% in the interval (-19, -20).

Concerning the spiral galaxies, comparisons of the 610 MHz RLF of the Coma Cluster (Jaffe et al., 1976), A 2151 and A 2147 (in the Hercules supercluster, Perola and Valentijn, 1979) and A 1367 (Gavazzi, 1979) with each other and with the RLF of the "field" galaxies derived from a survey at 408 MHz by Cameron (1971), show significant differences. With respect to the "field", Coma has an excess of radioemitters in the faint optical interval (-18, -19), while the other three clusters all show a deficiency of radioemission among the optically brightest galaxies ($M_p \leqq -20$). Unfortunately the Cancer Cluster does not contain galaxies brighter than -20. For the other two intervals, the integral values obtained in this survey can be compared above $\log P = 21.10$ with those derived from Cameron's survey for the "field" and given at the bottom of Table 4. The derivation of the "field" RLF is described in Jaffe et al. (1976). We refer to this paper for the difference between entries (a) and (b), the first obtained with a magnitude correction which is believed to be more consistent with the Zwicky magnitude scale. We note that with either choice the agreement is fairly good in both magnitude intervals.

Thanks to the relative closeness of this cluster and to the low r.m.s. noise of the observations, we could decrease by a factor of two the minimum power detectable compared to the Cameron survey, and by a factor of three compared to the Coma survey (Jaffe et al., 1976). This progress can only be exploited in the (-18, -19) range, where still 10 galaxies were detectable in the interval $20.8 < \log P < 21.1$. As can be seen from Table 4, the small number of detections in this interval demonstrates that the RLF is still far from saturation, that is about 50% of the (-18, -19) spirals and irregulars have radio power less than $P = 6\,10^{20}$ WHz^{-1}.

In the Coma Cluster (Jaffe et al., 1976) it was found that 90% of the (S + I) galaxies detected have emission lines in their spectra, compared to about 60% of all galaxies of the same type in that cluster. The same trend was confirmed, although on the basis of incomplete optical information, in the other clusters surveyed (see Gavazzi, 1979; Perola and Valentijn, 1979). On the basis of preliminary data (Tifft and Tarenghi, in prep.), the percentage of emission lines in the (S + I) galaxies detected in this cluster is about 80%, which apparently conforms to the general trend.

V. Conclusions

The Cancer Cluster has been surveyed at 610 MHz down to a minimum power $6\,10^{20}$ WHz^{-1}. Among the (E+SO) galaxies we detect two objects, among the (S+I) galaxies we detect seven objects. Concerning the (E+SO) class, the number of detections is close to the expectations from studies of larger samples both inside and outside rich clusters. Concerning the (S+I) class, this cluster is unfortunately poor in very bright objects and therefore the deficiency of radio emission, compared to the "field", found in bright spirals belonging to Abell clusters in previous papers of this series could not be checked. On the other hand, the statistics in the interval (−18, −19) are good, and here agreement is found with the RLF of the "field" spirals. Moreover we can say that at least in this interval still about 50% of spirals and irregulars have radio powers below $6\,10^{20}$ WHz^{-1}.

Finally we draw attention to the fact that the peculiar *S* galaxy Zw 119–55, studied by Tifft et al. (1973), is the strongest radio source in this cluster, $P = 1.3\,10^{22}$ WHz^{-1}.

Acknowledgments. We thank the Westerbork Telescope Group and the Reduction Group for their work on the observations, and the photographic department of ESO, Geneva, for the help with the photographic material. E.A.V. acknowledges financial support from the Netherlands Organization for Pure Research (Z.W.O.). G.C.P. acknowledges the Sterrewacht Leiden and in particular prof. H. van der Laan for hospitality. The Westerbork Radio Observatory and the Reduction Group are administered by the Netherlands Foundation for Radio Astronomy (S.R.Z.M.) with the financial support of Z.W.O.

References

Auriemma, C., Perola, G.C., Ekers, R., Fanti, R., Lari, C., Jaffe, W.J., Ulrich, M.H.: 1977, *Astron. Astrophys.* **57**, 41

Cameron, M.J.: 1971, *Monthly Notices Roy. Astron. Soc.* **152**, 403 and 429

Gavazzi, G.: 1979, *Astron. Astrophys.* **72**, 1

Högbom, J.A., Brouw, W.N.: 1974, *Astron. Astrophys.* **33**, 289

Holmberg, E.: 1958, *Medd. Lund. Astron. Ser.* II, n°136

Jaffe, W.J., Perola, G.C.: 1976, *Astron. Astrophys.* **46**, 275

Jaffe, W.J., Perola, G.C., Valentijn, E.A.: 1976, *Astron. Astrophys.* **49**, 179

Perola, G.C., Valentijn, E.A.: 1979, *Astron. Astrophys.* **73**, 54

Tifft, W.G., Jewsbury, C.P., Sargent, T.A.: 1973, *Astrophys. J.* **185**, 115

Zwicky, F., Herzog, E.: 1963, Catalogue of Galaxies and Clusters of Galaxies, Vol. 2, Calif. Inst. of Technology, Pasadena