

REDSHIFTS FOR 51 GALAXIES IDENTIFIED WITH RADIO SOURCES IN THE 4C CATALOG

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ABSTRACT

Redshifts are given for 51 galaxies identified by Olsen and by Hazard and Jauncey with radio sources in the 4C catalog between $+20^\circ$ and $+40^\circ$ declination. These objects do not represent a complete sample.

Subject headings: galaxies — radio sources — redshifts

As part of a systematic program to measure the redshifts of radio galaxies I have begun to obtain spectra of the galaxies identified by Olsen (1970) in the declination range $+20^\circ$ to $+40^\circ$ of the 4C catalog (Pilkington and Scott 1965). Olsen identified 133 of the 4C sources in this declination range with galaxies or clusters of galaxies. Later a few more identifications were proposed by Hazard and Jauncey (1972). During the first season's work I obtained spectra of 101 galaxies, of which 51 have been measurable for the redshift. The ultimate aim is to obtain redshifts and photometry of a complete sample of 4C radio galaxies. The accomplishment of this aim will require improvements in equipment and, in any case, will take a considerable time. Since the incomplete results may be useful to workers studying problems (such as the physics of individual sources) which do not demand a complete sample, I have elected to publish the incomplete results from time to time as they become available. Readers are warned that great caution should be exercised in using these preliminary results for statistical purposes.

Spectrograms of the radio galaxies were obtained with the image-tube spectrograph at the Cassegrain focus of the Hale telescope. The spectrograms almost invariably had a dispersion of $190 \text{ \AA mm}^{-1}$ on the IIAO emulsion. Table 1 gives a list of redshifts for 51 galaxies. The objects are listed in order of increasing right ascension. The absorption or emission lines used to measure each redshift are listed in column (3) of the table. Columns (4) and (5) give the type and magnitude of the galaxy, and the source of the identification is given in column (6). O stands for Olsen (1970), and HJ for Hazard and Jauncey (1972). There are extensive footnotes to table 1; a key for them is given in column (7). In many cases further information is given in footnotes in Olsen's paper. Most of the redshifts listed in table 1 are new. However, in a few cases, identified in the footnotes, redshifts have been published by other observers. In general the agreement is good.

Analysis of the data given in table 1 is postponed until a more complete set of redshifts becomes available. However, we note that the range of redshift among these 4C radio galaxies is comparable with that encountered in the 3C radio galaxies so far studied. While there is a general positive correlation between optical magnitude and redshift for the data in table 1, the relation has considerable scatter. Experience at the telescope indicates that this is at least in part due to the low quality of the optical magnitude estimates. It is still quite possible that when accurate magnitudes are available, the relation between optical brightness and redshift for the 4C radio galaxies will be as tight as that found by Sandage (1972) for the 3C radio galaxies.

TABLE 1
REDSHIFTS FOR 51 4C RADIO GALAXIES

4C (1)	z (2)	Lines used (3)	Type (4)	m_p (5)	Ident. (6)	Notes (7)
23.01	0.1331	Abs. H, K. (Ca II)	E	17	HJ	1
26.03	0.0483	Abs. H, K.	cD	13	O, HJ	2
25.03	0.0784	Em. $\lambda 3727$. ([O II])	db	17	O, HJ	
25.04	0.0664	Abs. H, K.	E	16.5	HJ	3
31.04	0.0592	Em. $\lambda 3727$; Abs. H, K.	E	14	HJ	4
39.04	0.2107	Em. $\lambda 3727$.	D	18	O	
39.05	0.0717	Abs. H, K, G-band.	E	15	O	5
31.07	0.1747	Em. $\lambda 3727$, [OIII] $\lambda 5007$	E	18	HJ	
29.05	0.1482	Abs. H, K, Em. H γ	db	15.7	O, HJ	6
29.06	0.1090	Seyfert: Em.	E	16	O, HJ	7
35.03	0.0373	Abs. H, K.	D	13	O	8
34.09	0.0160	Em. $\lambda 3727$; Abs. H, K, G-band	Sc	14	O	9
35.06	0.0466	Abs. H, K.	G cl	13.5	O, HJ	10
26.23	0.0402	Abs. H, K.	E	15	HJ	11
23.18	0.0919	Abs. H, K.	D	15.7	O	12
28.18	0.0830	Abs. H, K.	E	16	HJ	13
31.32	0.0675	Abs. H, K.	E	13.5	O, HJ	14
36.14	0.1117	Abs. H, K.	cD	15.5	O	
25.26	0.2828	Em. $\lambda 3727$, [NeIII] $\lambda\lambda 3869, 3968$	E	17.5	O	
20.20	0.1675	Abs. H, K.	ED	16.5	O	
39.30	0.0596	Em. $\lambda 3727$	E	15.5	O	
37.29	0.3456	Em. $\lambda 3727$, [NeV] $\lambda 3425$	G	18.5	O	
29.41	0.0485	Abs. H, K.	ED cl	14	O	15
20.25	0.1316	Em. $\lambda 3727$	E	16	O	
36.19	0.1412	Em. $\lambda 3727$	ED cl	18	O	
22.32	0.1184	Em. $\lambda 3727$	N	17.7	O	
29.44	0.3292	Em. $\lambda 3727$, [NeIII] $\lambda\lambda 3869, 3968$	G cl	18	O	16
22.33	0.0655	Abs. H, K.	DE	14	O	
39.35	0.2435	Em. $\lambda 3727$	G	18.5	O	17
38.35	0.1261	Em. $\lambda 3727$	cD	18.5	O	18
29.47	0.0728	Abs. H, K.	ED	15	O	
36.23	0.0728	Abs. H, K.	E	17	O	
36.24	0.0175	Abs. H, K.	D	12.8	O	19
26.42	0.0630	Em. $\lambda 3727$, Abs. H, K.	cD	13.8	O	
25.46	0.0813	Abs. H, K.	E	15.6	O	
20.34	0.2540	Em. $\lambda 3727$, [NeIII] $\lambda 3869$	cD	17.8	O	
35.37	0.1565	Em. Seyfert	N	17.8	O	20
34.42	0.4018	Em. $\lambda 3727$; [NeV] $\lambda\lambda 3325, 3444$; [NeIII] $\lambda 3869$	G cl	18	O	21
30.29	0.1111	Abs. H, K.	E	16.5	O	
24.36	0.0318	Abs. H, K, G-band	cD	12	O	22
34.45	0.0801	Abs. H, K.	ED cl	15.5	O	23
22.45	0.2525	Em. $\lambda 3727$	G	18	O	
24.41	0.0871	Em. $\lambda 3727$	E	16.5	O	
39.50	0.0423	Abs. H, K.	D	15	O	
24.60	0.0905	Abs. H, K.	E	16.5	HJ	
36.47	0.0815	Em. $\lambda 3727$, H γ , H β , Abs. H, K.	E	16	O, HJ	
35.56	0.1178	Abs. H, K.	ED	15.8	O	
39.72	0.2061	Em. $\lambda 3727$, [NeV] $\lambda 3425$, [NeIII] $\lambda 3869$, [OIII] N1, N2.	E	17.8	O	
27.50	0.1188	Abs. H, K.	G cl	15.5	O, HJ	24
20.57	0.0554	Abs. H, K.	E	15.5	HJ	25
29.70	0.1306	Em. $\lambda 3727$; Abs. H, K.	ED	15.5	O	

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NOTES TO TABLE 1

In these notes, as in table 1, "HJ" denotes Hazard and Jauncey (1972) and "O" denotes Olsen (1970).

1. 4C 23.01. "Compact group of ellipticals" (HJ).
2. 4C 26.03 (NGC 326). There are two components separated by 5". The N component has $z = 0.0471$ and the S component $z = 0.0495$.
3. 4C 25.04. "Probably in cluster" (HJ).
4. 4C 31.04. "Brightest galaxy in cluster" (HJ). Burbidge and Strittmatter (1972) give $z = 0.0590$.
5. 4C 39.05. Note that on Olsen's chart N is to the left.
6. 4C 29.05. The object has a double nucleus, separation 4". The components have identical spectra and redshifts.
7. 4C 29.06. HJ suggest "alternative identification is with member of faint cluster N prec." In view of the Seyfert spectrum the object observed is almost certainly the correct identification. The spectrum has sharp forbidden and broad permitted emission lines.
8. 4C 35.03. "The asymmetrical D galaxy was identified by Caswell and Wills (1967) as VV 6-5-48" (O). Tritton (1972) measured $z = 0.0369$.
9. 4C 34.09 (NGC 1167). The stellar object referred to by O and within the main body of the galaxy is a galactic star, as is the blue stellar object 40" W and 54" N of the radio position.
10. 4C 35.06. Radio position is at center of very compact cluster Zw Cl 0257.8+3542.
11. 4C 26.23. Redshift is for object *a* of HJ.
12. 4C 23.18. Burbidge and Strittmatter (1972) give $z = 0.0905$.
13. 4C 28.18. HJ note "blue objects close by."
14. 4C 31.32 (NGC 2402). O notes an 18 mag blue stellar object appears 30" W and 17" N of the radio position.
15. 4C 29.41. Burbidge and Strittmatter (1972) give $z = 0.0481$.
16. 4C 29.44. In the field of the cluster Zw Cl 1151.6+2934, which, however, appears too bright on the prints for the quoted redshift.
17. 4C 39.35. O notes "the galaxy appears to have a distorted envelope."
18. 4C 38.35. O notes "the identification is with the brightest galaxy in the cluster." The slit was placed at P.A. 183° through both components of this double object. The redshift refers to the brighter (S) component.
19. 4C 36.24 (NGC 5141). Tritton (1972) gives $z = 0.0174$.
20. 4C 35.37. H β and H γ are broad emission lines. $\lambda 3727$ and [O III] N₁ and N₂ are sharp.
21. 4C 34.42. O notes "the identification appears to be the brightest galaxy in a cluster." The cluster, if present, is exceedingly faint.
22. 4C 24.36 (NGC 6051).
23. 4C 34.45. In Zw Cl 1707.9+3426.
24. 4C 27.50. O identifies with a widely separated pair of galaxies. HJ identify with the N prec. component. Both have the same redshift.
25. 4C 20.57. O does not identify. HJ and Wills (1967) identify with IC 5338. Member Zw Cl 2332.8+2027.

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