

SHORT COMMUNICATION

THE REDSHIFTS OF 27 RADIO GALAXIES*

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A series of spectroscopic observations of galaxies believed to be associated with radio sources was carried out with the 74 in. reflector of the Mt. Stromlo Observatory during the period September 1968 to September 1969. As a result, redshifts have been determined for 27 radio sources, the majority of which are located at southern declinations.

The spectra were obtained with a Cassegrain image-tube spectrograph on loan to the Observatory from the Carnegie Image Tube Committee. A combination of a 7 in. camera and a 300 lines mm^{-1} grating yielded a dispersion of 183 \AA mm^{-1} . With baked Eastman-Kodak IIa-o plates, the usable spectral range extended from 4500 to 6700 \AA . The maximum exposure times were 3 hr, since with longer exposures the plate density of the night-sky spectrum would have been too high. The wavelength calibrations for the plates were provided by neon-mercury comparison spectra, air-glow lines, and mercury lines from street lighting that had been scattered by the atmosphere. The redshift measurements were carried out either on a photoelectric setting device at Mt. Stromlo (Gollnow 1962) or on similar equipment at the Hoher List Observatory of Bonn University.

The main features that may be present in galactic spectra within the effective spectral range of the spectrograph have been listed by de Vaucouleurs and de Vaucouleurs (1967). They include the relevant Balmer lines of hydrogen in emission or absorption, emission lines of [OIII] ($\lambda 4959$, $\lambda 5007$), [OI] ($\lambda 6300$), [NII] ($\lambda 6548$, $\lambda 6584$), and [SII] ($\lambda 6717$, $\lambda 6731$), and absorption lines of the G band ($\lambda 4304$), Fe ($\lambda 4384$), MgI ($\lambda 5175$), MgH ($\lambda 5269$), and NaI ($\lambda 5893$). However, in the observed emission spectra the $H\alpha$, [NII], and [SII] lines were extensively blended and were not used in the redshift determinations.

The results are listed in Table 1. The first column contains the Parkes catalogue number (Ekers 1969); the source PKS1650+024 was obtained from the Parkes 2700 MHz survey (Wall, Shimmins, and Merkelijn 1971). The magnitude and type of galaxy is listed in column 2, while the reference number to the publication originally containing the identification is given in column 3. Several of the identifications at the most southern declinations are uncertain and require more accurate radio positions for confirmation. Column 4 contains the measured cosmological redshift $\Delta\lambda/\lambda_0$ and the associated probable error; in accordance with the practice of Humason, Mayall, and Sandage (1956) and others, a redshift of $0.0010 \sin^{1/2} i \cos b^2$ has been added to the observed redshift with respect to the Sun. The three values in parentheses are questionable because the spectral lines were extremely shallow and may have

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been misidentified. In another case, PKS 1514—24 (Bolton, Clarke, and Ekers 1965), the spectrum contained no obvious lines. The last column (5) lists the spectral features that were measured.

TABLE 1
REDSHIFTS OF RADIO GALAXIES

(1) PKS No.	(2) Identification	(3) Ref.*	(4) Redshift ($\Delta\lambda/\lambda_0$)	(5) Measured features
0023—33	16·7 ^m E	3	$0\cdot0497\pm0\cdot0002$	G, MgI, MgH, NaI
0043—42	18 ^m E	3	$0\cdot0526\pm0\cdot0013$	G, MgI, MgH
0108—14·2	15·8 ^m E	4	$0\cdot0518\pm0\cdot0006$	G, Fe, H β , MgI, NaI
0336—35	10·9 ^m E	6	$0\cdot0045\pm0\cdot0002$ $0\cdot0010\pm0\cdot0005$	MgI, MgH, NaI H β ?, NaI?
0431—13·5	16·3 ^m E	3	$0\cdot0360\pm0\cdot0009$	MgI, NaI
0449—17	13·7 ^m E	4,11	$0\cdot0313\pm0\cdot0002$	MgI, MgH, NaI
0453—20	14 ^m E	5	$0\cdot0339\pm0\cdot0004$	MgI, NaI
0618—37	16·6 ^m db	2	$0\cdot0313\pm0\cdot0002$	MgI, NaI
0843—33	12·3 ^m E3	2,11	$0\cdot0062\pm0\cdot0002$	H β , MgI, MgH, NaI
1123—35	13·9 ^m E3	2,11	$0\cdot0314\pm0\cdot0002$	MgI, MgH, NaI
1250—10	12 ^m E2	8	$0\cdot0138\pm0\cdot0005$	H β , MgI, MgH, NaI
1400—33	11·6 ^m E0	1,11	$0\cdot0129\pm0\cdot0004$	MgI, MgH, NaI
1610—60·8	12·8 ^m E3	7,11	$0\cdot0176\pm0\cdot0001$	MgI, MgH, NaI
1637—77	16 ^m D3	7	$0\cdot0423\pm0\cdot0005$	H β , MgI, MgH, NaI
1650+024	14 ^m Pec	9	$0\cdot0250\pm0\cdot0001$	H β (em), [OIII], [OI]
1655—77	17 ^m E0	10	$(0\cdot0663\pm0\cdot0007)$	G, MgH, NaI
1928—34	17 ^m E	6	$0\cdot0981\pm0\cdot0002$	G, Fe, H β , MgI
1954—55	16·3 ^m E	7	$(0\cdot0598\pm0\cdot0003)$	G, MgI, NaI
2006—56	16 ^m S0	7	$(0\cdot0426\pm0\cdot0009)$	G, Fe, MgH, MgI
2014—55	15·5 ^m E1	10	$0\cdot0605\pm0\cdot0001$	H β (em), [OIII], NaI
2040—26	13·5 ^m E	2,11	$0\cdot0406\pm0\cdot0002$	MgI, NaI
2048—57	13 ^m S0	6	$0\cdot0110\pm0\cdot0002$	H β (em), [OIII], MgI, MgH, NaI, [OI]
2058—28	14·8 ^m E	2,11	$0\cdot0394\pm0\cdot0003$	G, MgI, NaI
2059—13	15·2 ^m E3	3	$0\cdot0296\pm0\cdot0003$	MgI, MgH, NaI
2130—53	15 ^m E1	7	$0\cdot0781\pm0\cdot0003$	G, Fe, MgH
	14 ^m db	7	$0\cdot0763\pm0\cdot0006$	G, MgH, NaI
2354—35	14·4 ^m D	2,11	$0\cdot0487\pm0\cdot0001$	G, MgI, MgH, NaI
2356—61	16 ^m D	7	$0\cdot0959\pm0\cdot0001$	H β (em), [OIII]

* References to identifications are: 1, Bennett (1962); 2, Bolton, Clarke, and Ekers (1965); 3, Bolton and Ekers (1966); 4, Bolton and Ekers (1967); 5, Clarke, Bolton, and Shimmins (1966); 6, Ekers (1969); 7, Ekers (1967); 8, Merkelijn (1969); 9, Wall, Shimmins, and Merkelijn (1971); 10, Westerlund and Smith (1966); 11, Westerlund and Wall (1969).

The results for the double galaxies merit additional comment. The galaxy associated with PKS 0336—35 (NGC 1399) appears as a single bright object on Palomar Survey Extension prints. However, its nucleus is in fact double, with the fainter component located about 0'·25 arc north of the other. The spectrum of the fainter component differs from that of the main nucleus, and its considerably shallower absorption features yield a lower redshift (the second value listed in Table 1).

The NaI line is observable between the nuclei, and indicates a velocity that varies uniformly from one nucleus to the other. For PKS0618—37, the two components have similar spectra and a small angular separation, and their spectra were therefore measured simultaneously. The two galaxies that are listed with PKS2130—53 are separated by more than 4' arc, but are both situated between the two radio components. The similarity of their redshifts supports the suggestion of Ekers (1967) that the radio emission may be associated with both galaxies.

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