

REDSHIFTS OF NINE RADIO GALAXIES

ALLAN SANDAGE

Mount Wilson and Palomar Observatories, Carnegie Institution of Washington,
California Institute of Technology*Received October 16, 1967*

Redshifts of nine radio galaxies have been obtained as part of a continuing program of optical observation of objects in the 3C R catalogue (Bennett 1962). Previous lists of redshifts for radio galaxies have been given by Schmidt (1965), Sandage (1966), Wills (1967), and Burbidge (1967).

The procedure for the present observations is the same as previously reported (Sandage 1966). All spectra were taken with the prime-focus spectrograph at the 200-inch telescope using a grating dispersion of 400 Å/mm. The results are given in Table 1 where most of the column headings are self-explanatory. The galaxy type was estimated from the small-scale prints of the *National Geographic-Palomar Sky Survey*. For several objects such as 3C 285, plates taken with a larger scale would be useful to better establish the nature of the optical structure.

The column V_{25} of Table 1 lists the visual magnitude measured photoelectrically with the 100-inch and 200-inch telescopes, corrected for aperture effect to an isophote of about 25 mag/sq sec arc. Details of the photometry will be published elsewhere.

The correction to the redshifts for galactic rotation is $0.001 \sin l^{II} \cos b^{II}$ as adopted by Humason, Mayall, and Sandage (1956); a result which follows from a solar motion of 300 km/sec toward $l^{II} = 90^\circ$, $b^{II} = 0^\circ$.

The redshift of 3C 76.1 has been previously reported by Burbidge (1967) as $\Delta\lambda/\lambda_0 = 0.0324$, based on the H and K lines of Ca II in absorption. Our value of 0.0326 ± 0.0005 (A.D.), based on the same two lines plus the G band, is in excellent agreement. Redshifts for the other eight objects of Table 1 have not been previously reported and are believed to be new.

Finding charts for all galaxies of Table 1 have been published by Wyndham (1965, 1966). The identification for most of these objects was independently made by other workers, notably P. Véron, T. Matthews, and E. Fomalont, whose unpublished results were listed by Wyndham (1966) in his summary compilation.

Comments on the optical form and the spectral characteristics of each galaxy follow.

3C 29: E0; either isolated, or the brightest (non-central) member of the rich cluster of E galaxies named Abell 119 which is $1^m 14^s$ west and $7'$ north of 3C 29. A spectrogram of 150-min exposure shows only the absorption lines of H, K, and the G band. Photometry shows the expected $B - V$ color for normal elliptical galaxies at this redshift.

3C 76.1: E2; appears isolated. A well-exposed spectrogram shows only the H and K lines and the G band in absorption, as in normal ellipticals. The $B - V$ color is normal.

3C 135: Brightest of a small group, or cluster. A 2-hour exposure records only the emission lines N_1 , N_2 , and $\lambda 3727$. Peculiar measured colors of $B - V = +1.27$ and $U - B = +0.33$, and the bright emission lines are characteristic of N galaxies. The available direct plate material is not sufficient for a decision on the classification based on optical form alone.

3C 227: N; appears isolated. Emission lines of [O II] ($\lambda 3727$), [Ne III] ($\lambda 3869$), H β , and [O III] ($\lambda \lambda 4959, 5007$) are visible. The continuum is moderately well exposed, but no obvious stellar absorption lines are seen. Strong ultraviolet excess, characteristic of N types, is evident from the $B - V = 0.98$, $U - B = -0.36$ values.

3C 236: E3? Appears to be isolated. The redshift is based on a single emission line identified with $\lambda 3727$ measured on two plates. Absorption lines of H and K are visible on the most heavily exposed plate, but these were not measured.

3C 285: Brightest member of a small cluster of at least ten members. The image, on the scale of 48-inch Schmidt plates, appears to be elongated with ellipticity of about 5. The galaxy does not appear to be a normal elliptical. Larger-scale plates are needed to define the structure. The redshift is somewhat uncertain as it depends on measurement of a single emission feature marginally visible on each of two weakly exposed plates. The tabulated redshift should be checked. The notation S5 for the type listing in Table 1 means a possible non-E (i.e., a spiral) of ellipticity 5.

3C 381: E? A distant galaxy in a small group. The redshift is from five emission lines of [O II] ($\lambda 3727$), [Ne III] ($\lambda 3869$), [Ne III] ($\lambda 3968$), and [O III] ($\lambda \lambda 4959, 5007$).

TABLE 1
REDSHIFTS FOR NINE RADIO GALAXIES

Object	Type	$\alpha(1950)^*$	$\delta(1950)^*$	δ^{II}	V_{25}	$\Delta\lambda/\lambda_0^\dagger$ Reduced to Sun	$\Delta\lambda/\lambda_0$ Corrected for Gal- actic Ro- tation	Remarks
3C 29...	E0	00 ^h 55 ^m 01 ^s	-01°40'	-64°	14.1	0.0447 ± 0.0006	0.0450	Abs. H,K,G
76.1.	E2	03 00 27	+16 15	-36	14.8	.0326 ± .0005	.0328	Abs. H,K,G
135...	05 11 34	+00 53	-21	17.0	.1273 ± .0002	.1270	3 em. lines
227...	N	09 45 07	+07 39	+42	16.3	.0861 ± .0002	.0855	5 em. lines
236...	E3?	10 03 05	+35 09	+54	16.0	.0989 ± .0001	.0988	$\lambda 3727$, 2 plates
285...	E or S5	13 19 05	+42 51	+73	16.0	.0794	.0797	$\lambda 3727$
381...	E?	18 32 24	+47 25	+23	17.3	.1605 ± .0002	.1614	5 em. lines
449...	E2	22 29 08	+39 06	-16	13.2	.0171 ± .0005	.0181	Abs. H,K,G
455...	E4	22 52 34	+12 57	-41	14.0	0.0324 ± 0.0006	0.0331	Abs. H,K,G

* Optical positions from P. Véron, *Ap. J.*, **144**, 861 (1966).

† The quoted error is the average deviation of the lines from the mean redshift.

3C 449: E2; bright elliptical with several companions. A well-exposed spectrogram shows only H, K, and the G band in absorption.

3C 455: E5; an apparently isolated elliptical galaxy with a flattened envelope. The spectrum is similar to that of 3C 449. Both closely resemble the spectra of normal elliptical galaxies. Visual inspection of the galaxy at the Newtonian focus of the 100-inch reflector showed a bright central, pointlike nucleus. Photoelectric photometry gave no indication of a large ultraviolet excess for this nucleus. No emission lines are evident in the spectrum at a dispersion of 400 Å/mm.

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