with $\nu_2 = 10^{11}$ c/s, $\nu_1 = 10^7$ c/s, and the values on S_ν and the spectral index, n, given in the Parkes Catalogue. The cosmological correction has been applied in the same way as done by Matthews, Morgan, and Schmidt (1964).

The value of M_B is typical for radio galaxies and the value on L places 05 21−36 among the strong radio sources. Its maximum diameter and its surface brightness (σ) are similar to those for some other compact galaxies (cf. Zwicky 1965*b*).

It is of interest to compare 05 21−36 with the objects discussed by Arp (1965). We find that 05 21−36 falls almost on the line in the luminosity-diameter diagram which separates "observed galaxies" from "stellar." Obviously 05 21−36 may be classified as either a high-luminosity compact galaxy or a low-luminosity QSS. In the latter case it

TABLE 4

DIMENSIONS AND CALCULATED DATA FOR 05 21−36

$$D_{\max} = 4\overset{''}{.}3 = 3750 \text{ pc}$$
$$V_S = 18300 \text{ km/sec}$$
$$R = 1.8 \times 10^8 \text{ pc (with } H = 100 \text{ km/sec/Mpc)}$$
$$M_B = -21.2 \text{ mag.}$$
$$\sigma_B = 18.0 \text{ mag/sq sec of arc}$$
$$L = 5 \times 10^{42} \text{ ergs/sec}$$
$$L_B = 4 \times 10^{10}\, L_\odot (M_{B,\odot} = +5.4)$$

would represent the low-luminosity end, so far observed, of the QSS's. However, it appears likely that other objects of this type may be found among radio sources identified as QSS(?) or N from low-scale photographs.

B. E. WESTERLUND
N. R. STOKES

April, 7, 1966
MOUNT STROMLO OBSERVATORY
AUSTRALIAN NATIONAL UNIVERSITY
CANBERRA

REFERENCES

Arp, H. C. 1965, *Ap. J.*, **142**, 402.
Bolton, J. G., Clarke, M. E., and Ekers, R. D. 1965, *Australian J. Phys.*, **18**, 627.
Bolton, J. G., Gardner, F. F., and Mackey, M. B. 1964, *Australian J. Phys.*, **17**, 340.
Matthews, T. A., Morgan, W. W., and Schmidt, M. 1964, *Ap. J.*, **140**, 35.
Sandage, A. 1965, *Ap. J.*, **141**, 1560.
Zwicky, F. 1965*a*, *Ap. J.*, **142**, 1293.
———. 1965*b*, *ibid.*, **143**, 192.

QUASI-STELLAR OBJECTS WITH SMALL REDSHIFTS 1217+02, 3C 249.1, AND 3C 263*

Spectra of the quasi-stellar objects 1217+02, 3C 249.1, and 3C 263 have been obtained with the Kitt Peak 84-inch telescope and the Perkins 72-inch telescope of the Ohio State and Ohio Wesleyan Universities at Lowell Observatory. Identifications and V magnitudes were taken from Bolton, Clarke, Sandage, and Véron (1965), and Sandage, Véron, and Wyndham (1965). An RCA cascaded image intensifier was used on the DTM spectrograph. A record of observations is given in Table 1.

For the object 1217+02, a redshift of $\Delta\lambda/\lambda = 0.240$ is determined from six strong emission lines. The measurements are listed in Table 2. An absorption feature is meas-

* *Contributions from the Kitt Peak National Observatory*, No. 166.

ured at 4887 Å on the 25-min plate, a plate which has a well-exposed continuum in this region. The absorption is also seen weakly at this position on the 17-min plate. On the spectrum at 175 Å/mm, the absorption is measured at wavelengths of 4885 and 4875 Å. With a redshift of $\Delta\lambda/\lambda = 0.240$, this absorption is identified as the K-line of Ca II λ 3934 Å.

A search of *A Multiplet Table of Astrophysical Interest* (Moore 1959) in the range λλ 3929–3939 revealed no other lines to which this absorption could confidently be attributed. The only possibilities, O IV λ 3931, Ar II λ 3933, S II λ 3933, N III λ 3936, and C IV λ 3936, all seem less likely than the Ca II identification. The absorption is clearly associated with the object, for we do not see an absorption at this wavelength in the spectra of other objects and there are no night-sky absorption lines at the measured wavelength (Goldberg 1954). While the H-line of Ca II cannot be seen with certainty, this is not unexpected, for the Balmer Hε in emission would make it difficult to observe the blend with Ca II H at this dispersion.

TABLE 1

OBSERVATIONS

Object	V	Date (1966)	Telescope	Dispersion (Å/mm)	Exposure Time (min)	Wavelength Region (Å)
1217+02	16 53	Jan. 25	84-inch	440	25	4200–8200
		Jan. 25	84-inch	440	17	4200–8200
		Jan 25	84-inch	440	5	4200–8200
		Mar. 20	72-inch	350; 1st order	45, widened	4900–7300
				175; 2d order		4800–5400
3C 249 1 .	15 72	Mar. 22	72-inch	350	45	4900–7300
		Mar. 22	72-inch	350	90	4900–7300
3C 263 .	16 32	Jan. 25	84-inch	440	15	4200–8200
		Jan. 25	84-inch	440	14	4200–8200
		Jan 25	84-inch	440	20, widened	4200–8200
		Jan 25	84-inch	440	5	4200–8200
		Mar. 18	72-inch	350	30	4900–7300
		Mar. 20	72-inch	350	30	4900–7300

In Figure 1 the upper spectrum (*a*) is a reproduction of the 45-min widened spectrum of 1217+02, showing the emission lines of [O III] λλ 5007, 4959, Hβ, Hγ, and Hδ. The spectrum (*b*) is the 25-min exposure, with the absorption break at 4887 Å seen clearly on the microphotometer tracing (*c*).

The spectrum of 3C 249.1 resembles that of 1217+02, with strong emission lines of [O III] λλ 5007, 4959, and Balmer lines of hydrogen. However, Hα is shifted too far to the red to be observed. The observed wavelengths are listed in Table 2, and a reproduction of the 90-min spectrum is shown in Figure 1 (*d*). A redshift of $\Delta\lambda/\lambda = 0.311$ is determined. The plates of 3C 249.1 were taken in poor seeing; the continua are not well enough exposed to detect the presence of absorption lines.

The spectrum of 3C 263 is difficult to interpret. There is a very strong continuum, with one prominent broad feature at 4619 Å. On the two plates (15- and 14-min) well exposed in the blue, additional emission lines are also seen. These are narrow and only slightly more intense than the continuum. On the assumption that the broad feature is Mg II λ 2798, the weaker lines are identified with lines found in quasi-stellar objects and tabulated by Schmidt (1965*b*) and by Lynds, Stockton, and Livingston (1965); the redshift is $\Delta\lambda = 0.652$. Additional confirmation of this redshift comes from two sharp absorption lines measured at 6516 and 6568 Å on the best (15-min) plate. With the adopted redshift, these correspond to the H- and K-lines of Ca II. There is some

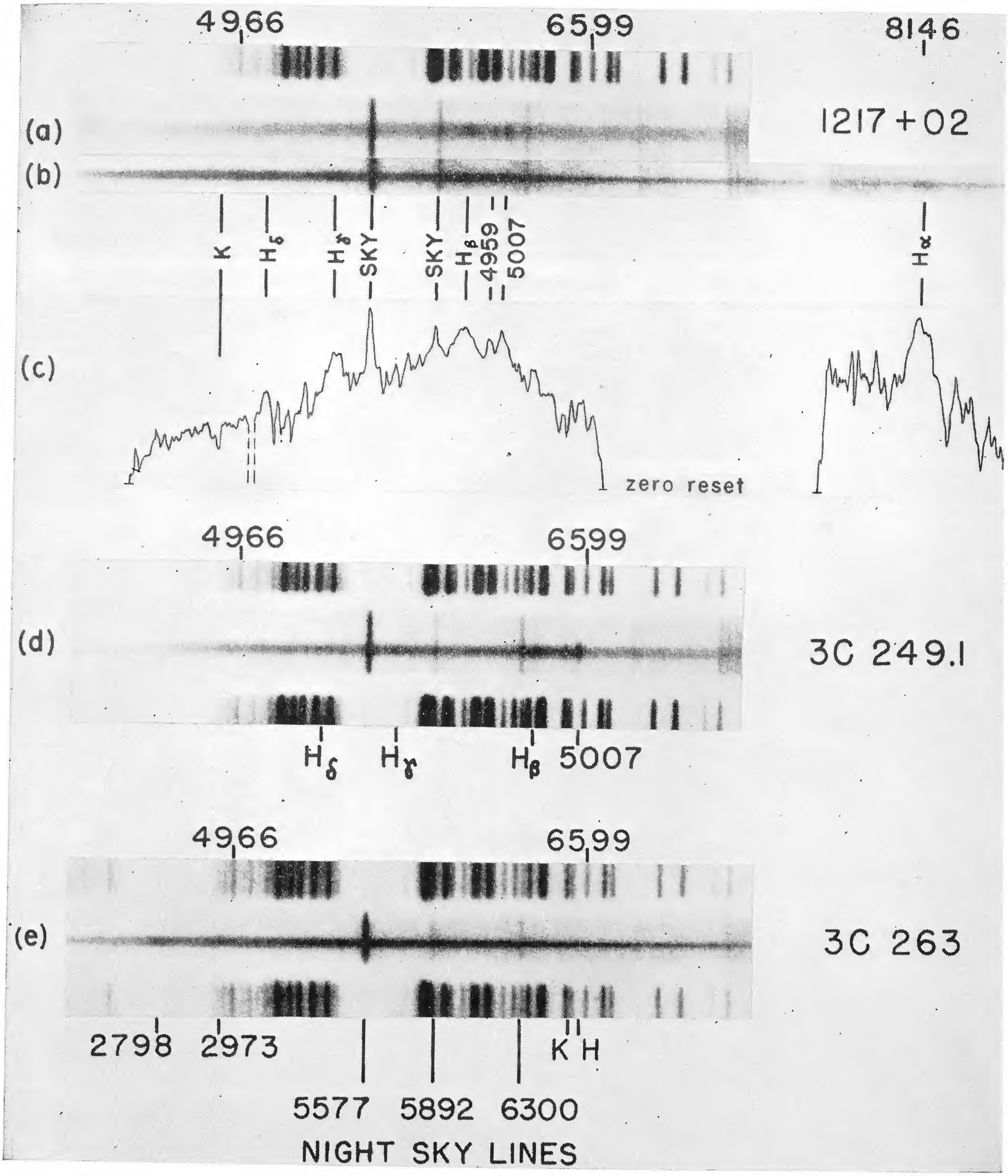

FIG. 1.—Spectra of three quasi-stellar objects, original dispersions 350 Å/mm or 440 Å/mm, comparison spectrum hollow cathode Fe-Ne lamp. Wavelengths of some comparison lines are marked on upper edge of spectra. Some prominent night sky features are also marked. (*a*) and (*b*): Light and dense exposures of 1217+02. (*c*): Microphotometer tracing (arbitrary scale) of dense exposure, showing absorption feature corresponding to the redshifted Ca II K-line, and showing the redshifted Hα-line. Tracing of a lighter exposure in the region from 5050 to 6600 Å. (*d*): Spectrum of 3C 249.1. (*e*): Spectrum of 3C 263; redshifted H- and K-lines are marked.

evidence for both absorption lines on other plates, but, in general, the continua are not well enough exposed to confirm the observation. The observed wavelengths and identifications are listed in Table 2. It must be emphasized that the adopted redshift rests principally on the identification of the broad feature as Mg II λ 2798; the weight which should be assigned to the weaker features is difficult to assess. A reproduction of the 15-min plate is shown in Figure 1 (*e*).

Absorption lines of H and K are observed in Seyfert galaxies (Seyfert 1943; Burbidge, Burbidge, and Prendergast 1959); in pygmy galaxies (Zwicky 1964); in radio galaxies with weak emission, but not generally in radio galaxies with strong emission lines (Schmidt 1965*a*). By analogy with galaxies with absorption features, the quasi-

TABLE 2

MEASURED WAVELENGTHS, IDENTIFICATIONS, AND REDSHIFTS

Observed Mean Wavelength (Å)	Identification		Δλ/λ
	1217+02		
4882*	Ca II λ 3934 (K)		(0 241)
5084	Hδ λ 4102		239
5397	Hγ λ 4340; [O III] λ 4363		244; 0 237
6027	Hβ λ 4861		240
6150	[O III] λ 4959		240
6206	[O III] λ 5007		239
8146	Hα		0 241
		Mean	0 240
	3C 249 1		
4898:	[O II] λ 3727		0 314:
5079	[Ne III] λ 3869		313
5371	Hδ λ 4102		309
5688	Hγ λ 4340		311
6365	Hβ λ 4861		309
6504	[O III] λ 4959		312
6566	[O III] λ 5007		0 311
		Mean	0 311
	3C 263		
4619.	Mg II λ 2798		0 651
4731†	[Ar IV] λλ 2854, 2869†		653
4911	[Ne V] λ 2973		.652
6159	[O II] λ 3727		653
6786.	Hδ λ 4102		654
6516*	Ca II λ 3934 (K)		(656)
6568*	Ca II λ 3968 (H)		(0 655)
		Adopted	0 652

* Absorption

† On two plates, the doublet is resolved.

stellar objects, 1217+02 and 3C 263, in which we have seen Ca II H- and K-lines, are likely to have stellar constituents from which the H- and K-lines arise. On the Palomar atlas prints, both 1217+02 and 3C 263 look stellar, with no evidence for outer structure. If the redshift is to be interpreted as a velocity shift, the agreement between the redshift of the absorption lines and the emission lines implies that there is no large-scale difference between the motion of the stellar population and the excited gas.

Finally, it is of interest to determine the absolute magnitudes, M, of these objects. If the redshifts are assumed to be cosmological, for 1217+02, $M = -23$; for 3C 249.1, $M = -24$; for 3C 263, $M = -25$; where only the non-selective term in the K-correction (Sandage 1965) has been included. A corresponding value for 3C 273 is $M = -26$. Hence 1217+02, with small redshift but $V = 16.53$, is a "dwarf" quasi-stellar object.

An alternative interpretation, which cannot yet be ruled out, is suggested by the proximity of 3C 273 and 1217+02 to the Virgo Cluster. Curiously, 3C 273 ($\alpha_{1950} = 12^h26^m33\overset{s}{.}7$; $\delta_{1950} = +2°19'43''$) and 1217+02 ($\alpha_{1950} = 12^h17^m38\overset{s}{.}35$; $\delta_{1950} = +2°20'20\overset{''}{.}9$) are separated by only 2° on the sky. Also their redshifts are the smallest known for quasi-stellar objects: $\Delta\lambda/\lambda = 0.158$ for 3C 273 (Schmidt 1963) and 0.240 for 1217+02. If we assume that these are fast-moving objects at the distance of the Virgo Cluster, $d = 11 \times 10^6$ pc, then their respective absolute magnitudes are $M = -18$ and $M = -14$, magnitudes in the range of galaxies and dwarf galaxies. At the distance of the Virgo Cluster, a transverse motion of the order of the radial velocity, 0.2 c, would result in a proper motion of $0\overset{''}{.}001$/yr which is too small to be detected. Luyten (1963) and Jefferys (1965) have found no proper motion for 3C 273. A blink of two Lowell Observatory proper-motion plates, separated by 28 years, was made for 1217+02 by Norman Thomas of Lowell Observatory, and no proper motion was detected. It is estimated that a motion as small as $0\overset{''}{.}05$/yr could be noted.

We wish to thank Dr. John S. Hall, director of the Lowell Observatory, and Dr. N. U. Mayall, director of the Kitt Peak Observatory, for providing us with observing time. We also thank Mr. Norman Thomas for blinking the proper-motion plates and Dr. W. A. Baum for assisting with the March observations.

W. KENT FORD, JR.*
VERA C. RUBIN*

April 22, 1966
DEPARTMENT OF TERRESTRIAL MAGNETISM
CARNEGIE INSTITUTION OF WASHINGTON
WASHINGTON, D.C.

REFERENCES

Bolton, J. G., Clarke, M. E., Sandage, A., and Véron, P. 1965, *Ap. J.*, **142**, 1289.
Burbidge, E. M., Burbidge, G. R., and Prendergast, K. H. 1959, *Ap. J.*, **130**, 26.
Goldberg, L. 1954, *The Earth as a Planet*, ed. G. P. Kuiper (Chicago: University of Chicago Press), p. 434.
Jefferys, W. H. 1965, *Quasi-stellar Sources and Gravitational Collapse*, ed. I. Robinson, A. Schild, and E. L. Schucking (Chicago: University of Chicago Press), p. 219.
Luyten, W. J. 1963, *Pub. Astr. Obs. Minnesota III*, No. 13.
Lynds, C. R., Stockton, A. N., and Livingston, W. C. 1965, *Ap. J.*, **142**, 1667.
Moore, C. E. 1959, *A Multiplet Table of Astrophysical Interest* (Natl. Bur. Std. Tech. Note No. 36).
Sandage, A. 1965, *Ap. J.*, **141**, 1560.
Sandage, A., Véron, P., and Wyndham, J. D. 1965, *Ap. J.*, **142**, 1307.
Schmidt, M. 1963, *Nature*, **197**, 1040.
———. 1965*a*, *Ap. J.*, **141**, 1.
———. 1965*b*, *ibid.*, p 1295.
Seyfert, C. K. 1943, *Ap. J.* **97**, 28.
Zwicky, F. 1964, *Ap. J.*, **140**, 1467.

* Visiting astronomer, 1965–1966, Kitt Peak National Observatory (operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation).