

SPECTROSCOPIC AND PHOTOMETRIC OBSERVATIONS OF THE QUASAR 4C 31.63

K. P. Tritton, S. N. Henbest and M. V. Penston

(Received 1973 March 29)

SUMMARY

Spectra have been obtained of Olsen's suggested identifications of 4C 31.63 and 4C 24.6. These show that the former is a quasar but the latter is a foreground star. Photoelectric *UBVRI* magnitudes place the quasar among the 10 brightest known.

In his paper on optical identifications from the 4C radio source catalogue, Olsen (1970) suggested a stellar object as candidate identification for 4C 31.63 (= B2 2201 + 31A). A finding chart is published in that paper. He obtained the following coordinates from the Palomar Sky Survey prints: $\alpha = 22^{\text{h}} 01^{\text{m}} 01^{\text{s}}.1$, $\delta = +31^{\circ} 31' 10''$ (1950.0). Medd *et al.* (1972) have found that the radio source has a peculiar radio spectrum and is a variable on a time scale of months at centimetre wavelengths. In this paper we report spectroscopic observations proving that the identification is a quasar, and photoelectric and photographic results on its colours and variability.

Spectra of the candidate were obtained in 1972 July and August using the image tube spectrograph of the 98-in. telescope at the Royal Greenwich Observatory, Herstmonceux. The spectra were taken at 210 \AA mm^{-1} using a McGee spectracon and cover the wavelength range 3200–5800 \AA . The most conspicuous feature on these spectra is a broad emission line at 3631 \AA . Identifying this with Mg II $\lambda 2798$ gives a redshift $z_{\text{em}} = 0.298$. A further spectrum covering the red region was obtained on the Steward Observatory 90-in. reflector. Though only a print of this was available to the authors, it clearly shows broad emission lines at approximately 5326, 5612 and 6310 \AA and a narrow emission line at 6482 \AA . The broad lines are identified as H_{δ} , H_{γ} and H_{β} and the narrow line as [O III] $\lambda 5007$. These identifications confirm the redshift 0.298 very well. In addition, narrow absorption lines appear to be present in the short wavelength wings of Mg II, H_{γ} and H_{β} , all near a redshift $z_{\text{abs}} = 0.282$. A summary of lines observed appears in Table I.

TABLE I

Observed wavelength λ_0	Identification λ_1	Plate or print	Redshift $\lambda_0/\lambda_1 - 1$	Breadth \AA
Emission lines				
3631	Mg II $\lambda 2798$	plate	0.298	80
5326	H_{δ} $\lambda 4102$	print	$\left\{ \begin{array}{l} 0.298 \\ 0.293 \\ 0.298 \\ 0.295 \end{array} \right.$	60
5612	H_{γ} $\lambda 4340$			80
6310	H_{β} $\lambda 4861$			80
6482	[O III] $\lambda 5007$			15
Absorption lines				
3587	Mg II $\lambda 2798$	plate	0.282	
5574	H_{γ} $\lambda 4340$	print	$\left\{ \begin{array}{l} 0.284 \\ 0.280 \end{array} \right.$	
6223	H_{β} $\lambda 4861$			

Short Communications

TABLE II

Photoelectric results

	<i>U</i>	<i>B</i>	<i>V</i>	<i>R</i>	<i>I</i>
4C 31.63	15.14 ± 0.11	15.50	15.47	15.03	14.45 ± 0.07
Star A		14.90	13.92		
B		15.18	13.98		
C		16.16 ± 0.07	15.37		
D		17.27 ± 0.17	16.47 ± 0.14		

The errors, based on eye estimates from pen recorder tracings, are less than $0^m.05$ unless otherwise quoted in the table. Errors in colours are likely to be less than this.

TABLE III

Fluxes (f_ν) in $\text{W m}^{-2} \text{Hz}^{-1}$

$$\begin{aligned} \log f_\nu &= -28.79 (U) \\ &= -28.56 (B) \\ &= -28.61 (V) \\ &= -28.55 (R) \\ &= -28.43 (I) \end{aligned}$$

Photoelectric *UBVRI* magnitudes of the quasar were obtained using the Imperial College of Science and Technology 60-in. flux collector at Izaña, Tenerife. At the same time photoelectric *B* and *V* magnitudes were obtained for four comparison stars in the same field, for which a finding chart is given in Fig. 1. The observations used the 'People's photometer' (Bingham, in preparation) operating in single-channel mode. One observation was made of each star in each waveband, on 1972 November 10–11. The magnitudes are on the system of Johnson *et al.* (1966).

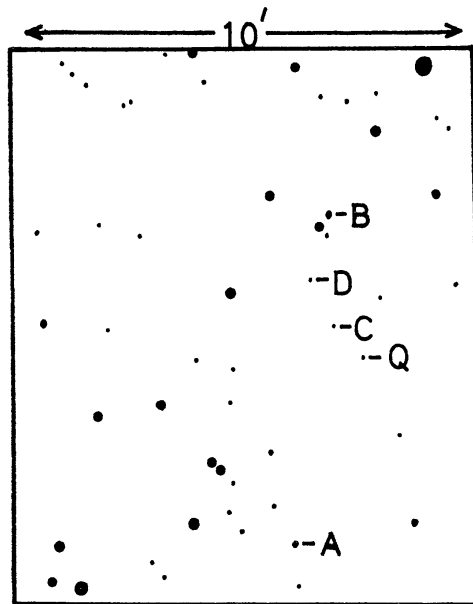


FIG. 1. Finding chart for the stars measured photoelectrically. The quasar is marked *Q*. North-east is at the top left-hand corner.

TABLE IV
Photographic results

1972	B magnitude	Standard error	Julian Date
Aug. 10-11	15.61	0.04	2441540.53
11-12	15.66	0.03	541.57
11-12	15.59	0.04	541.58
11-12	15.76	0.03	541.60
30-31	15.68	0.05	560.49
Sep. 5-6	15.66	0.05	566.40
10-11	15.58	0.02	571.48
Oct. 4-5	15.67	0.03	595.39
6-7	15.71	0.04	597.45
Dec. 3-4	15.61	0.02	655.36

The photoelectric results are summarized in Tables II and III. These show that the quasar is among the 10 brightest known. It has a typically flat spectrum. If confirmed, a possible small excess in the B band places the quasar fairly low in the region of the $U-B$, $B-V$ two-colour diagram occupied by the quasars.

The four comparison stars form the basis of a magnitude sequence that was used to calibrate a series of photographic observations made over the period 1972 August–December. IIaO plates were obtained on the 26-in. refractor at Herstmonceux, giving magnitudes close to the B system (see e.g. Penston & Cannon

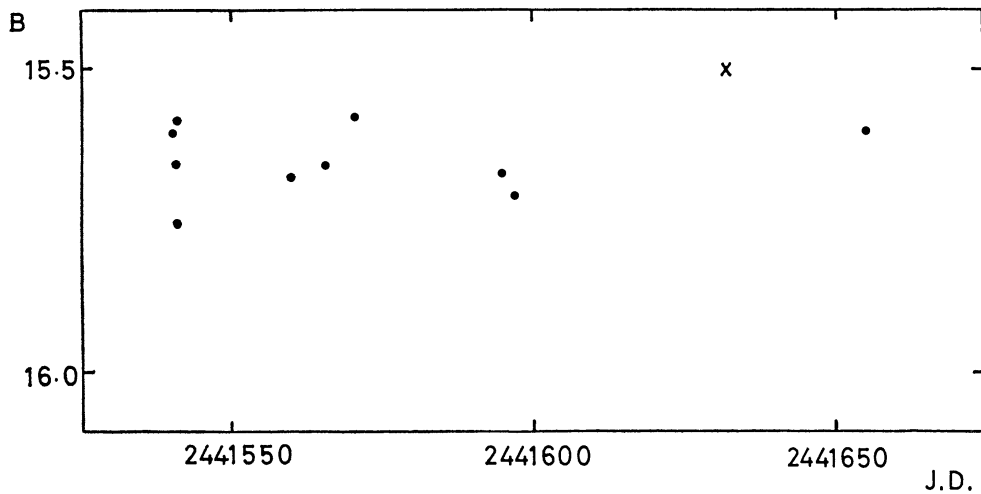


FIG. 2. Light curve of 4C 31.63 during 1972 August–December, taken from Table IV. One photoelectric observation is plotted as a cross.

1970). The calibrated photographic results are shown in Table IV and Fig. 2. These indicate that the quasar is probably a variable without any signs of violent activity.

A spectrum was also obtained of Olsen's suggested identification of 4C 24.6. This proves to be a foreground star.

ACKNOWLEDGMENTS

The authors are very grateful to Drs P. A. Strittmatter and R. J. Dickens for obtaining some of the spectroscopic material, and Drs R. G. Bingham and G. B.

Wellgate for help with the photoelectric measurements. The observers thank the relevant authorities for telescope time allocated.

Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex

S. N. Henbest is now at *Mullard Radio Astronomy Observatory, Cavendish Laboratory, Cambridge*

REFERENCES

- Johnson, H. L., Mitchell, R. I., Iriarte, B. & Wiśniewsky, W. Z., 1966. *Comm. Lunar Planet. Lab.*, **4**, 99.
Medd, W. J., Andrew, B. H., Harvey, G. A. & Locke, J. L., 1972. *Mem. R. astr. Soc.*, **77**, 109.
Olsen, E. T., 1970. *Astr. J.*, **75**, 764.
Penston, M. V. & Cannon, R. D., 1970. *R. Obs. Bull.*, **159**.