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PKS 2126−15: A BRIGHT QUASI-STELLAR OBJECT WITH NEUTRAL COLOR AND A REDSHIFT OF 3.27

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ABSTRACT

Scanner observations of the bright 17.3 mag neutral stellar object identified with the radio source PKS 2126−15 show it to be a QSO with an emission-line redshift of 3.27.

Subject headings: galaxies: redshifts — quasars — radio sources: general

I. INTRODUCTION

In our continuing program of low-dispersion spectroscopy of QSOs from the Parkes 2700 MHz survey (Peterson *et al.* 1976; Wright *et al.* 1977; Jauncey *et al.* 1978), we have found the neutral stellar object identified with the radio source PKS 2126−15 to have an emission-line redshift of 3.27. The identification with the 17.3 mag neutral or even slightly red stellar object is based on an accurate radio position measured with the NRAO three-element interferometer (Condon, Hicks, and Jauncey 1977). The positions, epoch 1950.0, are: radio, R.A. $21^h26^m26\overset{s}{.}76 \pm 0\overset{s}{.}09$, decl. $-15°51'49\overset{''}{.}9 \pm 2\overset{''}{.}2$; optical, R.A. $21^h26^m26\overset{s}{.}69 \pm 0\overset{s}{.}09$, decl. $-15°51'51\overset{''}{.}5 \pm 0\overset{''}{.}9$. A finding chart is given by Condon, Hicks, and Jauncey (1977). The radio source is unresolved at 8085 MHz on the longest (2.1 km) NRAO baseline, indicating an angular size of less than 2″. The radio source also shows fringes at 2295 MHz on a Tidbinbilla (Australia) to Goldstone (California) baseline, indicating an angular size of $\sim 0\overset{''}{.}001$ or less (Preston and Jauncey, unpublished data).

II. SPECTROSCOPIC RESULTS

The first spectrum of PKS 2126−15 was obtained by us on the night of 1976 June 27/28 with the image-tube dissector scanner (Robinson and Wampler 1972) at the f/15 Cassegrain focus of the 4 m Anglo-Australian telescope (see Wampler 1975). These observations were taken at a spectral resolution of ∼10 Å, and cover the wavelength range 3500 to 8000 Å. Clearly present on the spectrum were broad emission features near 5200 Å, 5290 Å, 5945 Å, and 6595 Å that were easily identified as Lα λ1216, N v λ1240, Si IV λ1396, and C IV λ1549, respectively, at a redshift close to 3.27 (Jauncey *et al.* 1978). At the short- and long-wavelength limits of the image-tube scan there was evidence of emission from Lβ λ1026 at around 4370 Å and for C III] λ1909 at 8170 Å. The spectrum shortward of the Lα emission at 5200 Å was rich in absorption features that were blended at 10 Å resolution.

Consequently the source was reobserved again in 1976 September at 4 Å resolution over the range 4100 to 7100 Å. The resultant 48 minute integration, corrected for the instrumental response, is shown in Figure 1. All of the emission features noted in the low-resolution data are confirmed in the higher-resolution scans, with the exception of the C III] λ1909 emission line, which was outside the wavelength range of the September spectrum. An additional emission line at 5590 Å was noted and identified as Si II λ1309 in the same $z = 3.27$ emission system. The emission feature near 4370 Å which was originally suggested as Lβ appears quite broad and may contain emission from Si II λ1024 as well. The presence of any O VI λ1034 is difficult to ascertain because of the deep absorption feature near 4410 Å. If higher-dispersion spectroscopy confirms the λ4370 feature as Lβ, it will provide clear evidence for a very low optical depth in neutral hydrogen for the emission region. The principal emission features from the September scans are listed in Table 1. Column (1) gives the observed wavelength, column (2) our suggested identification, and column (3) the resultant redshift. The close agreement among the individual redshifts in Table 1 established unequivocally the emission-line redshift of 3.270 ± 0.004.

It is clear from Figure 1 that PKS 2126−15 shows the very rich absorption-line spectrum common to such high-redshift QSOs (see Boksenberg 1977). Even at 4 Å resolution the absorption features shortward of Lα appear as blends, and so we will defer a more de-

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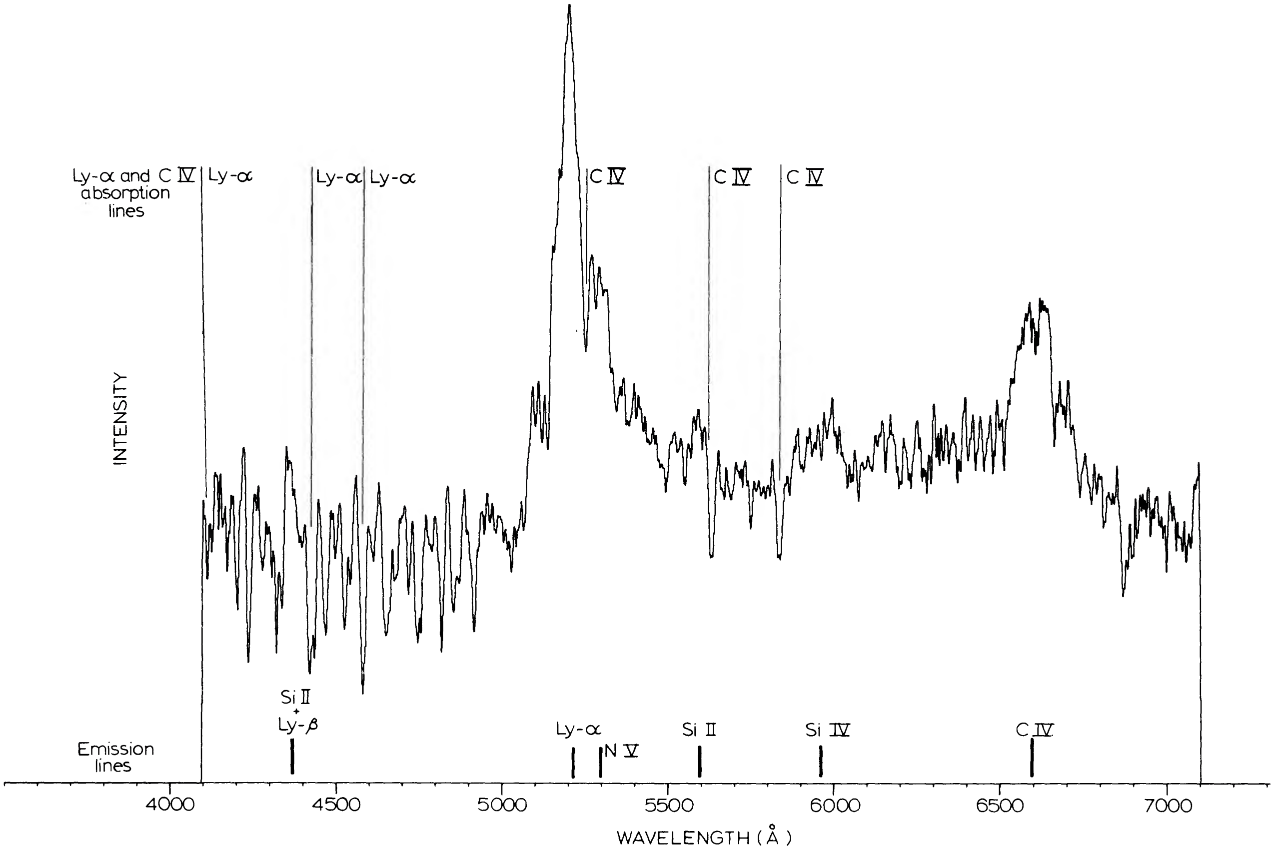

FIG. 1.—IDS scan of PKS 2126−15 taken at the f/15 Cassegrain focus of the AAO 4 m telescope in 1976 September at a resolution of 4 Å. The identifications of the principal emission features listed in Table 1 are indicated, as are the three Lα and C IV absorption-line systems.

TABLE 1

EMISSION-LINE DATA FOR PKS 2126−15

Observed Wavelength (Å) (1)	Identification (2)	Redshift (3)
5207.........	Lα 1216	3.283
5291.........	N V 1240	3.271
5590.........	Si II 1309	3.270
5946.........	Si IV 1394	3.266
6597.........	C IV 1549	3.259

tailed discussion of the absorption spectrum shortward of Lα to a later date. Longward of Lα, there are three broad absorption features at 5836 Å, 5613 Å, and 5254 Å. Because of their observed widths of ~15 Å, it is tempting to identify these as the C IV doublet λ1548.2 and λ1550.8 in absorption at three redshifts which are lower than the emission-line redshift. Examination of the short-wavelength absorption spectrum confirms this interpretation, since there appear to be three corresponding Lα absorption features, two deep lines at 4582 Å and 4420 Å, and a weaker absorption feature at 4125 Å. These yield wavelength ratios of 5836/4582 = 1.2737, 5631/4420 = 1.2740, and 5254/4125 = 1.2737, very close to the laboratory C IV/Lα ratio of 1.2738.

If this interpretation is correct, then the resultant C IV and Lα absorption redshifts are 2.768, 2.635, and 2.392. Any C IV absorption at redshifts of at most 2.36 would fall below the Lα emission line and be undetectable at the present resolution because of confusion with the many other absorption lines in this wavelength range.

III. SUMMARY

The 17.3 mag neutral stellar object identified with PKS 2126−15 has been found to have an emission redshift of 3.270 and a very rich absorption spectrum shortward of Lα. C IV/Lα absorption systems at redshifts of 2.768, 2.635, and 2.392 are seen even at 4 Å resolution.

With 1442+101 (Wampler *et al.* 1973), 0642+449 (Carswell and Strittmatter 1973), 0938+119 (Beaver *et al.* 1976), and PKS 1402+044 (Peterson *et al.* 1978), this brings to five the total of radio QSOs with emission redshifts greater than 3. Of these, PKS 2126−15 is the brightest and is one of the most intrinsically luminous QSOs known. Even at a much higher redshift it would easily have been discovered in the Parkes 2700 MHz survey and optically identified. Along with 0642+449, 0938+119, and PKS 1402+044, PKS 2126−15 appears neutral or red in color on the Palomar Sky Survey, while 1442+101 is only slightly blue. Consequently, such objects are not distinguished by their colors, and at present their identification requires both the radio and optical positions to be of high accuracy.

The neutral colors and flat radio spectra of these high-redshift QSOs are also characteristic of BL Lacertae objects. For BL Lacertae objects, the neutral colors are caused by a steep optical continuum spectrum (see Strittmatter *et al.* 1974). The neutral or red color of the high-redshift QSOs results from the redshifting of the deep and complex absorption spectrum shortward of Lα into the blue filter and the redshifting of strong C IV emission into the red filter. Searches for high-redshift radio QSOs based upon color have turned up many BL Lacertae objects which also have neutral colors. The discovery of PKS 2126−15 demonstrates that the search for high-redshift QSOs, using a neutral or red color criterion, is more rewarding than previously suggested (Strittmatter *et al.* 1974).

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