LETTERS TO NATURE

PHYSICAL SCIENCES

Multiple Redshifts in QSOs

FOUR QSOs (PHL 957, Ton 1530, Parkes 0237−23, and 4C 05.34) are now known with complex absorption spectra; these have been interpreted[1-5] as objects with multiple redshifts. It is disturbing that even with the use of up to 10 redshifts per object, 20% or more of the absorption lines which are definitely present with strength 2 or greater remain unidentified.

Several possibilities may apply to these lines. Lynds[5] has suggested that the unidentified features to the blue of the Ly α emission represent redshift systems where just Ly α appears. Lowrance *et al.*[1] propose that these are redshift systems with several lines in each system, where Ly α is not present or is very weak. This is possible if, for example, the temperature is so high that CIV is the dominant C ion, but H is so completely ionized that Ly α is unobservable. Using collisional ionization calculations[6,7], which may not be strictly applicable, the ratio of the optical depth of λ1549 Å (CIV) to that of Ly α changes by a factor of 10^3 when T increases from 30,000 K to 60,000 K. Redshift systems with Ly α in the observed wavelength range, but very weak or absent, have been automatically rejected in previous studies.

A third possibility is that these lines belong to the redshift systems that have already been found, but that the lines have not been identified. Bahcall's list[8] of expected QSO absorption lines is used in the computer programs of each of the groups which have worked on the identification of absorption lines in complex QSO absorption spectra; this raises the suspicion that perhaps the problem is that this identification list of expected lines is incomplete.

To investigate this hypothesis, I have taken each observed wavelength of the unidentified lines of strength 2 or greater in the 4 QSOs cited above, and derived the corresponding set of values of the wavelength at the source, λ_0, for each redshift system observed in the particular QSO. This produces, for each QSO, an array of wavelengths of dimension (number of unidentified lines) × (number of redshift systems in the QSO). For each member of this array, I have looked for a line λ_0, in another redshift system, either in the same or in a different object, which has $|\lambda_0 - \lambda_0'| \leq 1$ Å. Because these are wavelengths at the source, $\Delta\lambda = 1$ Å is equivalent to $\Delta\lambda = 2.5$ to 4 Å in the observers' frame. I found 19 such pairs (and 2 triplets) for the 150 values of λ_0 from the 20 most certain redshift systems and the 27 unidentified lines of the 4 QSOs. This is no larger than the number of pairs expected on the basis of rough probabilistic arguments, and in fact 25 pairs are found with $1\ \text{Å} < |\lambda_0 - \lambda_0'| \leq 2$ Å. It seems therefore that the 19 pairs observed are mostly coincidences.

I conclude that the unidentified absorption features in QSO spectra cannot be explained by adding lines to the basic identification list of Bahcall; additional redshifts must be present in the objects. Analysis of the unidentified lines of more QSOs with complex absorption spectra would strengthen this conclusion. I further suggest that the standard requirement for an acceptable redshift system, that Ly α be present if in the accessible wavelength region, should be eliminated.

JUDITH G. COHEN

Department of Astronomy,
University of California,
Berkeley, California

Received March 10, 1972.

1 Lowrance, J. L., Morton, D. C., Zucchino, P., Oke, J. B., and Schmidt, M., *Astrophys. J.*, **171**, 233 (1972).
2 Bahcall, J. N., and Goldsmith, S., *Astrophys. J.*, **170**, 17 (1971).
3 Bahcall, J. N., Greenstein, J. L., and Sargent, W. L. W., *Astrophys. J.*, **153**, 689 (1968).
4 Bahcall, J. N., Osmer, P. S., and Schmidt, M., *Astrophys. J. Lett.*, **156**, L1 (1969).
5 Lynds, R., *Astrophys. J. Lett.*, **164**, L73 (1971).
6 Weymann, R., *Astrophys. J.*, **147**, 887 (1967).
7 Allen, J. W., and Dupree, A. K., *Astrophys. J.*, **155**, 27 (1969).
8 Bahcall, J. N., *Astrophys. J.*, **153**, 679 (1968).

Search for Optical Counterpart of GX3+1

AN accurate determination of the position of the X-ray source GX3+1 has been reported by Janes *et al.*[1], who used the results of lunar occultations of the source during two rocket flights. The intersecting positions of the lunar limb, as seen from the rocket, occur near the centre of the previous best position of the source determined by Schnopper *et al.*[2]. Slitless spectra of stars in the spectral range 5600 to 8000 Å in the field of the occultation position were obtained by Kunkel *et al.*[3] who found no emission features in an angular field of 7.5×2 arc min. Following a comparison of the occultation position with a Royal Observatory, Cape Town, direct photographic plate, Janes *et al.* concluded that either GX3+1 is star 14 of Kunkel *et al.*, or it is optically fainter than 18 mag. and lies between stars 14 and 15, or it is fainter than 21 mag. and lies in the occultation error box.

I have obtained two spectra with the 74-inch at Mount

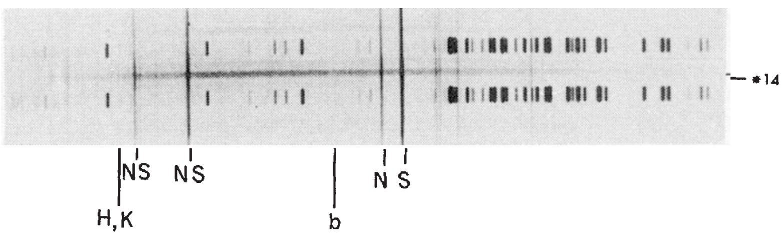

Fig. 1 The spectrum of star 14 in the wavelength range 3500 Å to 6800 Å; original dispersion 200 Å mm^{-1}. Several night-sky lines (NS), some from city lights, are marked together with the strongest stellar absorption features, Ca II K and H and Mg I b.