CHANGES IN THE HI ABSORPTION LINE SPECTRUM OF AO 0235+164

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The BL Lac object AO 0235+164 is an extreme example of a QSO containing a compact, non-thermal energy source which is violently variable. In 1975 it brightened simultaneously at optical and radio frequencies, with a hundred-fold increase in optical brightness on a time scale of a few weeks (Rieke et al. 1976; Ledden, Aller and Dent 1976). During the outburst 0235 was among the most luminous objects in the universe. It exhibits longer term variations at meter wavelengths (Condon and Dennison 1978), and has experienced repeated optical and short wavelength radio outbursts since 1975 (Pica, Smith and Pollock 1979). Very long baseline interferometry shows it to be the most compact known extragalactic radio source.

The optical spectrum has two well-defined redshift systems, at z = 0.852 and z = 0.524 (Rieke et al. 1976; Burbidge et al. 1976). The lower optical redshift has also been detected in 21 cm absorption (Roberts et al. 1976). A faint nebulosity 2" SW of the BL Lac exhibits emission lines at the z = 0.524 redshift (Smith, Burbidge and Junkkarinen 1978). A plausible case can be made that this absorber is a spiral galaxy with an HI disk, and has a cosmological redshift z = 0.524. However, the nebulosity is unusual in having emission line luminosities at least ten times greater than the most luminous spiral galaxies, so that the hypothesis of chance alignment of the nebulosity with the BL Lac object must be treated with some caution. The question arises, whether AO 0235+164 is cosmologically distant from the nebulosity, at or beyond a distance corresponding to z = 0.852, or whether the two objects are physically co-located, with the redshift difference attributable perhaps to an ejection velocity.

If the two objects lie near each other, the 21 cm continuum flux will compete with collisions in determining the hyperfine level populations of the hydrogen ground state. In this case we might expect to detect a decrease in the HI optical depth following an increase in the continuum flux density. On the basis of this expectation, we instituted a monitoring program to search for variation in the HI profile, using the Arecibo telescope at 932 MHz.

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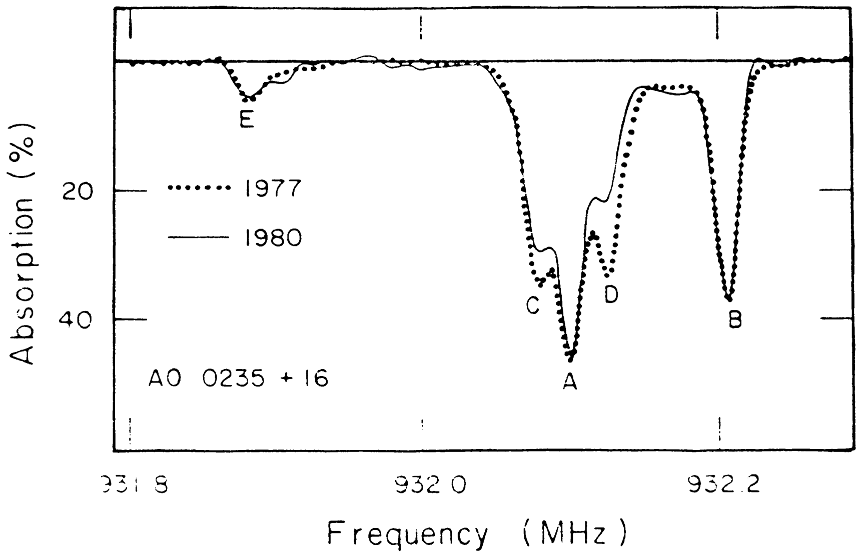

Figure 1. Sample of the observed variation in the HI profile.

The results of the monitoring program were somewhat unexpected. In spite of a nearly constant continuum flux density, we have seen highly significant variations in the absorption profile. Since early 1980, the profile has returned to its earlier shape, but monthly monitoring has revealed smaller but significant variations in the line depths, on a time scale of a few months. An upper limit of 0.7 km/s can be set on the variation in component velocities, but there are systematic trends in the residuals of order 0.2 km/s which are probably real rather than instrumental. In addition, a recent VLBI observation showed what may be a real change in the fringe phase of component B (Frank Briggs, private communication). In the following paper we assess the significance of these results.

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