HIGH RESOLUTION SPECTROSCOPY OF ABSORPTION LINES 
IN THE $z = 1.7$ BL LAC OBJECT 0215+015 *

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We describe the various absorption systems in 0215+015, and present results from 
our new, high-resolution studies at 10 km/sec (FWHM).

1. THE ABSORPTION SYSTEMS IN 0215+015

The radio source 0215+015 was shown by Gaskell (1982) to be a highly variable 
BL Lac object with absorption systems at $z = 1.345, 1.549, \text{ and } 1.649$. Subsequent 
work has found 7 separate absorption systems in the optical spectrum of the object 
as well as a weak Lyman $\alpha$ forest (Blades et al. 1985).

The system at $z = 1.345$ exhibits a strong, mixed-ionization spectrum and 
is one of the richest found in any QSO—hence it is of considerable interest. We 
have detected 5 neutral species, H, C, N, O and Mg; 8 singly ionized species, C, 
Mg, Al, Si, Ca, Mn, Fe and Zn; as well as the higher ionization species, Al III, 
Si III, C IV and Si IV. This is the first time that Zn II has been found in any 
QSO absorption system. The ion column densities allows us to deduce depletions 
of factors between 10 and 4 relative to solar values for Mg, Al, Si and Fe, similar 
to the gas phase abundances of these elements in local, low-density, interstellar 
clouds. The Zn strength implies it has solar abundance (Pettini, 1985). In Blades 
et al. (1985) we attributed this absorption system to an intervening galaxy, with 
the sight line intercepting both halo and disc material. Indeed, judging by the 
strength and complexity of the lines, the intercept probably passes through the 
inner region of the intervening system.

The other six absorption systems in 0215+015 are of higher ionization, with 
species, C III, C IV, and S IV dominating (Blades et al. 1985; Bergeron & 
d’Odorico, 1985). When observed at high resolution, the $z = 1.549$ and 1.649 
systems reveal highly complex C IV absorption, the latter showing at least nine 
distinct components over a velocity range of 910 km/sec. The origin of such com-
plex absorption is not at all clear. In Pettini et al. (1983) we postulated two, rich 
clusters of galaxies at redshifts of 1.549 and 1.649, with the complex absorption 
occurring in overlapping halos and extended disks of individual galaxies in the 
sight line to 0215+015.

* Discussion on p. 577
2. THE IMPORTANCE OF HIGH RESOLUTION OBSERVATIONS

In order to disentangle the complex absorption in 0215+015 we have found it necessary to use the highest possible spectroscopic resolution. Such observations yield detailed information on the overall velocity structure and give well-determined values for \( N \) and \( b \). For this purpose we have been studying selected absorption lines in 0215+015 at 10 km/sec resolution, and we describe here our first results.

The adjacent figure compares the Fe II lines at 10 km/sec resolution (lower profiles) with an earlier observation of the \( \lambda 2600 \) line at \( \sim 25 \) km/sec resolution. Even at the higher resolution we have not satisfactorily resolved the overall complex.

Nevertheless, our detailed model fit to the Fe II pair shows that there are at least 12 different velocity components over the 250 km/sec range, with individual values of the column density \( N \sim 1 - 2 \times 10^{13} \text{ cm}^{-2} \) and \( b \) values in the range \( 4 - 6 \) km/sec.

For the case of the \( z = 1.549 \) C IV system, our new data show that some of the components that make up this redshift complex are exceedingly narrow, with \( b \)-values around \( \sim 5 \) km/sec, indicating that the lines must originate in gas with \( T \sim 10^4 \) K. This implies that photoionization is the principal mechanism for production of C IV, and is consistent with models of our own galactic halo that propose photoionization as the major means of producing highly-ionized species (see York 1982; Hartquist, Pettini & Tallant 1983).

REFERENCES