Absorption Spectra of Q 0000-263 and Q 1442+101

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Studying the Lyman-α forest allows us to trace the cosmological distribution of matter through time, and may reveal insights into important questions such as the onset of galaxy formation. The number of Lyman-α absorption lines per redshift per rest equivalent in the Lyman-α forest can be written as

$$\frac{\partial^2 N}{\partial z \partial W} = \frac{A}{W^*}(1+z)^\gamma e^{-W/W^*} \tag{1}$$

For a nonevolving population of clouds γ=1 for q_0=0, and γ=0.5 for q_0=0.5 (See Murdoch *et al.* 1986 and references therein).

By the inception of this project the evolution parameters γ and A_0 of Eq. (1) had been determined out to z = 3.78 (Hunstead *et al.* 1986). We present here a detailed study of the Lyman-α forests of Q 1442 +101 at z_{em}=3.54 and Q 0000–263 at z_{em}=4.11. The spectra were obtained at high signal-to-noise and moderate resolution rather than moderate signal-to-noise and high resolution to determine whether profile fitting yielded results consistent with high resolution data. Two different researchers de-blended the Lyman-α forest components by fitting Gaussian profiles of FWHM=2.0 pixels, or 1.1 Å, the results of which were very similar. The aim was to find the minimum number of components, as required by χ^2, to produce an acceptable fit. For Q 0000–263, the Lyman-β spectrum was used as a constraint for the Lyman-α data, assuming b=25.6 km/s.

In order to determine the parameters γ and W^* we include our two new Lyman-α line lists in a sample of echelle spectra compiled by Rauch *et al.* (1991; hereafter ECH). We determined $\gamma = 2.59 \pm 0.49$. The K–S probability that our fits for Q 0000–263 and Q 1442+101 are drawn from this redshift distribution is 0.30 and 0.93 respectively. The equivalent width distribution of the Lyman-α forest absorption lines is described by $p(W) \propto \frac{1}{W^*}e^{-W/W^*}$. The W^* from our two objects, $W^* = 0.084 \pm 0.008$Å, was lower than that derived for the whole ECH sample, $W^* = 0.179 \pm 0.010$ Å, and lower than that derived from equivalent width limited samples (see Figures 1 and 2). This indicated that line blending and the techniques used were affecting the equivalent width distributions.

The column density distribution derived from Voigt profile fitting of high resolution data is described by $p(N_{HI}) \propto N_{HI}^{-\beta}$. The characteristic equivalent width W^* from equivalent width limited samples is $W^* \approx 0.2 - 0.3$, corresponding to $\beta \approx 1.4 - 1.5$, is not consistent with the column density distribution samples with $\beta = 1.7$ (Barcons and Webb *et al.* 1991; Jenkins *et al.* 1992). However, our values $W^* = 0.179$ corresponds to $\beta = 1.7$ and $W^* = 0.084$ corresponds to $\beta = 1.9$ (all for b=25.6 km/s). We stress that the column density distribution expected of equivalent width-limited samples such as this one provides a poor match to our observations. A steeper value of β is required, which is consistent with echelle results. Thus via profile fitting we find that our intermediate resolution but high signal-to-noise observations can be compared to high resolution data.

References.

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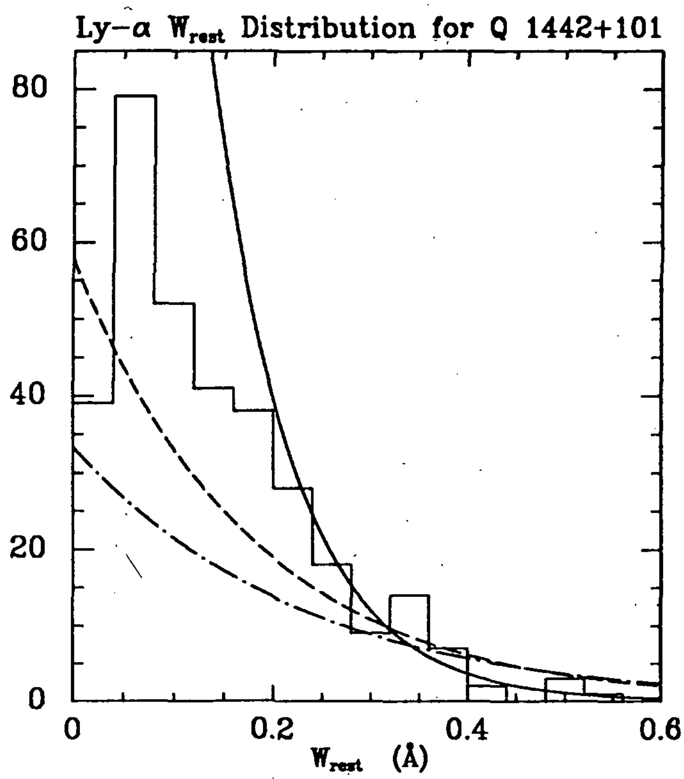

Figure 1.
The observed equivalent width distribution for Q 1442+101 with the normalized equivalent width distributions e^{-W/W^*} using $W^* = 0.114$ (solid line), $W^* = 0.179$ (dashed line) and $W^* = 0.227$ (dot-dashed line).

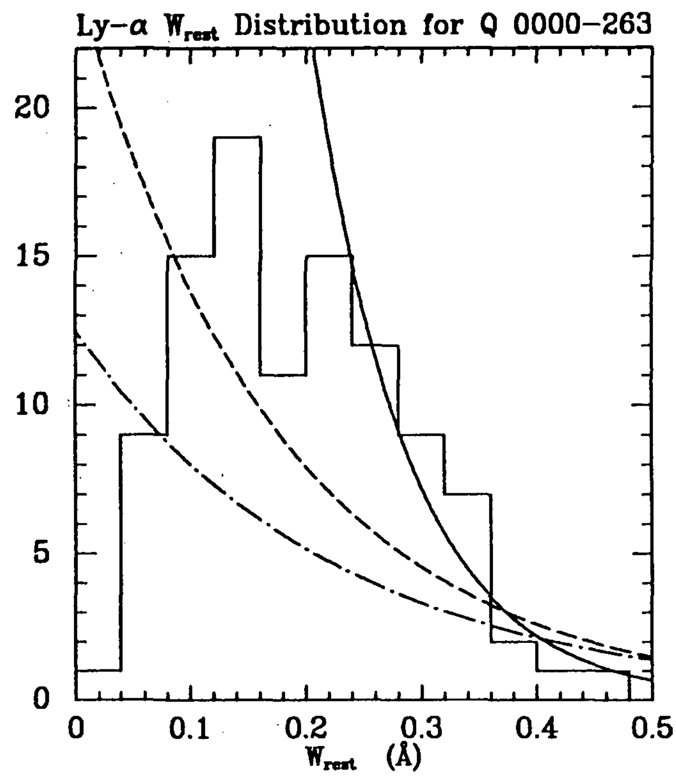

Figure 2.
The observed equivalent width distribution for Q 0000-263 with the normalized equivalent width distributions e^{-W/W^*} using $W^* = 0.131$ (solid line), $W^* = 0.179$ (dashed line), and $W^* = 0.227$ (dot-dashed line).