Chapter 10

Conclusions

The study of the Ly α forest in the spectrum of the $z_{em} = 3.054$ quasar HE 0940–1050 has shown a number of interesting results. After the long reduction process needed to obtain a normalized spectrum for the echelle data, Voigt-profile fits yielded the redshift, column density and Doppler parameter for all of the Ly α lines lines between Ly α and Ly β emission above a $5\,\sigma$ detection limit of $N_{\rm HI} \approx 10^{12.5}$ cm^{-2}. During this process, six heavy-element systems were identified and the metal lines excluded from further consideration. The effects of limited S/N were taken into account, and the column-density distribution was examined in order to determine a completeness limit of $N_{\rm HI} = 10^{13.3}$ cm^{-2} for the final sample that was used to study the proximity effect.

Despite the poor statistics offered by a single quasar spectrum, the redshift distribution of the data shows that the Ly α forest models of Fardal, Giroux and Shull (1998) provide a good description for the full sample except in the very lowest and highest bins. The counts in the latter bin closest to the quasar can thus be explained in terms of the proximity effect, but the former appears to be a statistical overdensity of lines. Neither of these effects disappear when the bin boundaries of locations are chosen differently.

Comparison of the data to Monte Carlo simulations of the Ly α forest in the presence of a quasar seem to confirm the assertion by Bechtold and Dobrzycki (1991b) that the ionizing quasar radiation should appear to affect the weaker lines more drastically than the stronger ones. The drop in the number density is indeed greater for the lines with $\log N_{\rm HI} \leq 13.33$ than for the lines in the sample as a whole, while the stronger lines with $\log N_{\rm HI} \geq 14.0$ show no appreciable proximity effect at all. In fact, the fit of the Ly α forest models is also poor for these column densities, and this may be an indication that the statistics are simply too low here to draw any useful conclusions.

Model I of the intensity of the metagalactic UV background presented by Bajtlik, Duncan and Ostriker (1988) yielded acceptable χ^2 fits to the data, as did the simple assumption that the Lyman-limit flux J_ν is constant with redshift; so in order to obtain a better order-of-magnitude estimate of the UVB by means of the proximity effect, J_ν was varied to find the values that were most compatible with both the full sample and the subsample of weaker lines in the spectrum of HE 0940–1050. This simple test yielded $\log J_\nu = -21.0 \pm 0.7$ and $\log J_\nu = -21.3 \pm 0.7$ for the two samples, respectively. If—as may well be the case–the emission redshift of HE 0940–

1050 has been underestimated by 1000–2000 km s^{-1}, then the results for the Lyman-limit background intensity should be reduced by a factor of about 3 to 5.

Finally, a possible void of $3.2h^{-1}$ Mpc (for $\Omega_o = 1$) or $4.9h^{-1}$ Mpc (for $\Omega_o = 0.2$) was identified at $z \approx 2.580$ in the spectrum. Its statistical significance was evaluated by means of Monte Carlo methods. If the column-density cut-off is taken to be equal to the detection limit within the void, the estimated probability of obtaining such a ~ 30 Å redshift interval containing only three lines lies at $(2.0 \pm 0.3) \times 10^{-3}$. If only stronger lines are considered, then the probability of finding a gap of comparable size between two absorption lines rises to 5 or 6%. However, it is not clear whether such a high cut-off is warranted in this case, since line blanketing is not a factor within the void. Therefore it is still worthwhile to undertake a search for the possible foreground quasar, which would offer further evidence that the photoionization model is indeed the correct explanation for the proximity effect. A simple calculation shows that such a quasar would probably be found within a few minutes of arc from the line of sight to quasar HE 0940–1050.

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Parts of this research made use of the article and abstract services of NASA's Astrophysics Data System.