THE GRAVITATIONAL LENS CANDIDATE HE 1104–1805 AND THE SIZE OF ABSORPTION SYSTEMS

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Abstract. We obtained 1.2 Å resolution spectra over the range 3175 - 7575 Å for the two components of the gravitational lens candidate HE 1104–1805 ($z = 2.31$, $m_B = 16.7$ and 18.6, separation = 3.0 arcsec; *cf.* Wisotzki et al. 1993), with the aim of setting limits on the sizes of the clouds producing the Ly-α, C IV, and Mg II absorption systems. We refer to Smette et al. (1995) for a detailed account of this study.

1. Results

The Ly-α absorption lines are strongly correlated in equivalent width, suggesting that the two lines of sight pass through the same clouds in all cases, and there are no significant differences in velocities to within $\simeq 10$ km s^{-1} between corresponding pairs of lines (the separation of the Ly-α clouds ranges from 0 to $6 - 25\ h_{50}^{-1}$ kpc, depending on the lens redshift). From the 72 Lyα lines with $W_{\rm rest} > 0.085$ Å (and $\lambda > 3395$ Å) detected at 5σ in A

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and 3σ in B we statistically derive a 2σ lower limit of 100 h_{50}^{-1} kpc for the diameter of spherical Ly-α clouds, assuming that the lens redshift $z_L > 1$, $H_0 = 50\ h_{50}$ km s^{-1} Mpc^{-1}, $q_0 = 0.5$, and $\Lambda = 0$. Similarly, 2σ lower limits of 100, 60 and 20 h_{50}^{-1} kpc are obtained for the region inside the clouds giving rise to lines with $W_{\rm rest} > 0.17$, 0.32 and 0.60 Å respectively. The inferred sizes are within an order of magnitude of the maximum size that avoids overlap of the Ly-α clouds. These values and the strong correlation between Ly-α cloud line equivalent widths are hardly compatible with the spherical mini-halo model.

For the systems causing the C IV and Mg II absorption lines, we find 2σ lower limits of 28 and 22 h_{50}^{-1} kpc respectively for $W_{\rm rest} > 0.3$ Å. Again the equivalent widths of corresponding lines are correlated, although some lines are not seen in both spectra. The redshift differences between corresponding pairs of lines are small.

A damped Ly-α system is present in one spectrum (A) but not in the other (B), indicating a typical size on the order of the separation of the two lines of sight at that redshift, $\sim 8 - 25 h_{50}^{-1}$ kpc at $z_{\rm abs} = 1.6616$, depending on the actual geometry of the system. Some high-ionization lines in this system have similar characteristics in both spectra, while all low-ionization lines are much weaker in the spectrum of B. This suggests that, while the region causing the low-ionization lines may be similar in size to the damped Ly-α region, the region causing some of the high-ionization lines must be considerably larger.

These spectra present further evidence for the gravitationally lensed nature of HE 1104–1805. An investigation of the continuum in the two images suggests the possibility that the quasar continuum source in A is microlensed, in which case its size generally increases with wavelength, but is relatively constant between 970 and 1215 Å (rest wavelengths). The equivalent widths of the C IV absorption lines in A and in B are similar near the quasar redshift, but differ for smaller redshifts, as expected in a gravitational lens geometry. The Ly-α cloud size that we derive assuming that HE 1104–1805 is not a lens greatly exceeds the separation between the lines-of-sight for the quasar pair UM 680/681 (Shaver & Robertson 1983) for which no significant correlation was observed.

References

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