

Keck constraints on a varying fine-structure constant: wavelength calibration errors

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Abstract. The Keck telescope's High Resolution Spectrograph (HIRES) has previously provided evidence for a smaller fine-structure constant, α , compared to the current laboratory value, in a sample of 143 quasar absorption systems: $\Delta\alpha/\alpha = (-0.57 \pm 0.11) \times 10^{-5}$. The analysis was based on a variety of metal-ion transitions which, if α varies, experience different relative velocity shifts. This result is yet to be robustly contradicted, or confirmed, by measurements on other telescopes and spectrographs; it remains crucial to do so. It is also important to consider new possible instrumental systematic effects which may explain the Keck/HIRES results. Griest et al. (2009) recently identified distortions in the echelle order wavelength scales of HIRES with typical amplitudes $\pm 250 \text{ m s}^{-1}$. Here we investigate the effect such distortions may have had on the Keck/HIRES varying α results. Using a simple model of these intra-order distortions, we demonstrate that they cause a random effect on $\Delta\alpha/\alpha$ from absorber to absorber because the systems are at different redshifts, placing the relevant absorption lines at different positions in different echelle orders. The typical magnitude of the effect on $\Delta\alpha/\alpha$ is $\sim 0.4 \times 10^{-5}$ for individual absorbers which, compared to the median error on $\Delta\alpha/\alpha$ in the sample, $\sim 1.9 \times 10^{-5}$, is relatively small. Consequently, the weighted mean value changes by less than 0.05×10^{-5} if the corrections we calculate are applied. Unsurprisingly, with corrections this small, we do not find direct evidence that applying them is actually warranted. Nevertheless, we urge caution, particularly for analyses aiming to achieve high precision $\Delta\alpha/\alpha$ measurements on individual systems or small samples, that a much more detailed understanding of such intra-order distortions and their dependence on observational parameters is important if they are to be avoided or modelled reliably.

Keywords. Instrumentation: spectrographs – Techniques: spectroscopic – Cosmology: observations - Quasars: absorption lines – Line: profiles

References

Griest, K., Whitmore, J. B., Wolfe, A. M., Prochaska, J. X., Howk, J. C., & Marcy, G. W. 2009, *ApJ*, submitted, arXiv:0904.4725v1