HIGH-REDSHIFT UNIVERSE

Whence metal-free clouds?

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An intergalactic cloud at a redshift of $z \approx 4.4$ is composed of nothing other than hydrogen and helium, report Frédéric Robert and collaborators. High-resolution spectra obtained towards a background quasar show no hints of metal absorption lines, implying that the cloud has a metallicity of less than one ten-thousandth of the Sun's. The origin of the cloud is unclear, but it may result from the collected ejecta of low-energy, low-mass population III supernovae, or it may have fortunately remained in a condition unsullied by stellar debris since the Big Bang.

The cloud under study (LLS1723) is an example of a Lyman limit system (LLS), meaning that it has a sufficient column density of neutral hydrogen to make the cloud optically thick bluewards of the Lyman limit at 912 Å. Three other high-redshift LLSs are known, at lower redshifts just beyond $z = 3$, and two of these similarly do not exhibit any metal lines. Keck HIRES spectra of LLS1723 over ~4,800–9,200 Å reveal many hydrogen lines (that constrain the column density to $\log_{10}(N_{\mathrm{H\,I}}/\mathrm{cm}^{-2}) =$ 17.9–18.3), but strong transitions of O I, C IV, Si II and Si IV are absent, and weak C II features at 1,334 Å (rest frame) are likely to be telluric.

There are two main origin scenarios for the very metal-poor LLSs: they are pristine, cold streams of accreting gas (as seen in cosmological simulations) that are present in the circumgalactic medium, or they populate the intergalactic medium. A simple discriminant would be to map the Lyα-emitting environment around these LLSs using optical integral field spectroscopy to look for nearby galaxies.

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