

SCIENCE NEWS

COSMOLOGICAL SIGNIFICANCE OF GHRS OBSERVATIONS OF D/H TOWARDS CAPELLA

The ease with which deuterium can be destroyed in nuclear reactions implies that essentially all of the deuterium now present in the Universe was created in the first few minutes of the Big Bang. In April 1991, Jeffrey Linsky and colleagues on the GHRS Team obtained GTO observations intended to measure the deuterium/hydrogen ratio in the local region of our Galaxy. The goal was to infer

the primordial ratio and densities at a very early stage of the Universe, before the deuterium was destroyed by nuclear reactions in stars.

Using the Echelle-A grating of the GHRS, the GHRS Team observed the nearby (12.5 pc) bright star Capella (α Aurigae). Absorption by interstellar hydrogen and deuterium Lyman α lines,

which are separated by an amount corresponding to 80 km/s, can clearly be seen as a broad feature and a narrow feature 0.33 Å to the left, respectively, in the spectrum at the left.

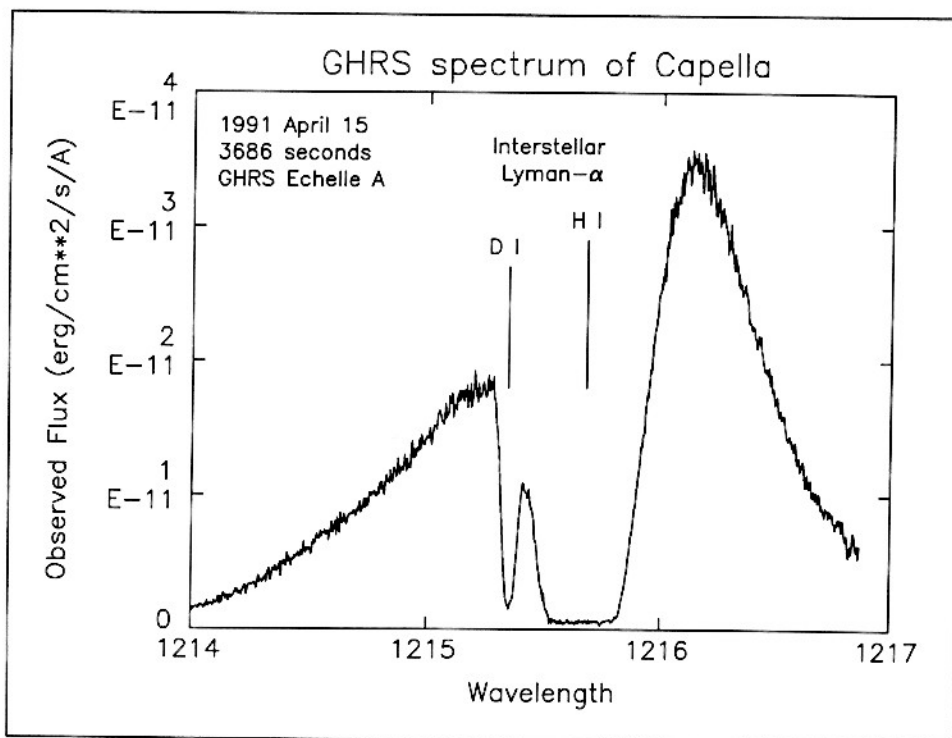
The broad chromospheric Lyman α emission line from Capella is the background light source for this experiment. Analysis of this spectrum and the Echelle-B spectra of the interstellar MgII and FeII lines provide extremely accurate measurements of the interstellar temperature, $T = 7150 \pm 150$ K, and turbulent velocity, $\xi = 1.63 \pm 0.03$ km/s, for this apparently simple line of sight.

The measured hydrogen and deuterium column densities are $N_{\text{HI}} = 1.80 \pm 0.2 \times 10^{18}$ cm⁻² and $N_{\text{DI}} = 3.00 \pm 0.03 \times 10^{13}$ cm⁻². This means the atomic deuterium/hydrogen ratio is $D/H = 1.65 (\pm 10\%) \times 10^{-5}$ for this line of sight.

This ratio lies at the mean of all of the previous IUE and Copernicus measurements, but is far more precise than previous work for the Capella and other lines of sight. The new data suggest that the local

region of the Galaxy is well mixed, but further observations for other lines of sight are needed to confirm or modify this tentative result.

The measured local D/H ratio places a hard upper limit on $\Omega_{\text{baryon}} < 0.12$ (for $H_0 = 50$) or < 0.03 (for $H_0 = 100$). If the primordial D/H ratio is three times the local value, as suggested by published Galactic evolution models that include astration and infall of primordial or partially astrated material from the Galactic halo, the ratio of the density to closure density is $\Omega_{\text{baryon}} < 0.06$ or 0.015 for $H_0 = 50$ or 100, respectively. Unless the assumptions in the standard



The GHRS spectrum of the nearby star Capella shows broad Lyman α absorption by interstellar hydrogen and narrow deuterium Lyman α absorption, separated by 80 km/s.

(Courtesy of J. Linsky.)

Highlights of this Issue

- Results of Cycle 2 Proposal Review
- Parallel Observations Implemented
- COSTAR Passes Critical Design Review
- New Science Results

