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Observers decipher more primordial helium to unravel the history of the early universe

Observations of helium give new clues as to how matter evolved in the early universe.

The primordial helium gas left over from the Big Bang is spread thinly through space between galaxies. NASA's Far Ultraviolet Spectroscopic Explorer (FUSE), which was launched in June 1999, observed the light from a distant quasar and measured the absorption of helium over 20 days.

Simultaneous observations using the Hubble Space Telescope measured the light at longer ultraviolet wavelengths, where the spectrum is unaffected by helium.

Measuring how the absorption varies across

the spectrum of the quasar reveals how the gas evolved as the universe got older.

This technique has been used many times before to study the intergalactic medium using the Lyman- α line of atomic hydrogen. The difficulty of using helium is that the absorption line occurs in the far-ultraviolet, where the Earth's atmosphere is opaque, hence the need for a space telescope.

The new observations trace the architecture of the universe back to very early times. The helium structure arose from small gravitational instabilities that were seeded in the chaos just after the Big Bang. The excellent

resolution of the results shows up the variations that existed in the young universe, when galaxies were forming and when quasars were at their most active.

The nuclei of helium atoms were formed in the first few minutes after the Big Bang. As the universe expanded, the nuclei captured electrons to form a cool gas of neutral atoms. This gas was then reheated and ionized by the radiation from the first energetic objects in the universe.

Reference

Science **293** 1112.

Are fundamental constants evolving?

Making a return appearance on the physics stage is a report of the possible evolution of the fine structure constant, α .

This constant, which governs fine structure in the emission and absorption spectra of atoms, is defined by other fundamental constants: the charge of the electron, the Planck constant and the speed of light. If α were to vary, then at least one of the other "constants" would have to change as well. If the speed of light were evolving, this would have important implications for recent cosmological observations, such as the apparent need for negative gravitational pressure and a cosmological constant.

The new results are based on the spectroscopy of gas clouds using light from distant quasars and then comparing the spectral lines with those observed in the laboratory today. The results suggest that α is evolving with time. The reported fractional change is minute, being -0.72×10^{-5} over the redshift range from $z = 0.5$ to 3.5 . However, even such a minute change would have tremendous significance. The researchers have not yet identified any systematic effects that could otherwise explain the results.

Reference

Phys. Rev. Lett. 2001 **87** 091301.

Picture of the month



This image of the Eagle nebula is made up of data from the European Space Agency's Infrared Space Observatory (ISO). It reveals the dust clouds that surround the star-forming region in the centre of the nebula. The dust, at around -100°C , can be seen as a bluish fog. ISO finished observing in May 1998, but new discoveries are still being made from the rich stock of accumulated data.