

Stars too old to be trusted? A possible Stellar Solution to the Cosmological Lithium Problem

August 9 2006

Analysing a set of stars in a globular cluster with ESO's Very Large Telescope, astronomers may have found the solution to a critical cosmological and stellar riddle. Until now, an embarrassing question was why the abundance of lithium produced in the Big Bang is a factor 2 to 3 times higher than the value measured in the atmospheres of old stars. The answer, the researchers say, lies in the fact that the abundances of elements measured in a star's atmosphere decrease with time.

"Such trends are predicted by models that take into account the diffusion of elements in a star", said Andreas Korn, lead-author of the paper reporting the results in this week's issue of the journal *Nature*. "But an observational confirmation was lacking. That is, until now."

Lithium is one of the very few elements to have been produced in the Big Bang. Once astronomers know the amount of ordinary matter present in the Universe, it is rather straightforward to derive how much lithium was created in the early Universe. Lithium can also be measured in the oldest, metal-poor stars, which formed from matter similar to the primordial material. But the cosmologically predicted value is too high to reconcile with the measurements made in the stars. Something is wrong, but what?

Diffusive processes altering the relative abundances of elements in stars are well known to play a role in certain classes of stars. Under the force

of gravity, heavy elements will tend to sink out of visibility into the star over the course of billions of years. "The effects of diffusion are expected to be more pronounced in old, very metal-poor stars", said Korn. "Given their greater age, diffusion has had more time to produce sizeable effects than in younger stars like the Sun."

The astronomers thus set up an observational campaign to test these model predictions, studying a variety of stars in different stages of evolution in the metal-poor globular cluster NGC 6397. Globular clusters are useful laboratories in this respect, as all the stars they contain have identical age and initial chemical composition. The diffusion effects are predicted to vary with evolutionary stage. Therefore, measured atmospheric abundance trends with evolutionary stage are a signature of diffusion.

Eighteen stars were observed for between 2 and 12 hours with the multi-object spectrograph FLAMES-UVES on ESO's Very Large Telescope. The FLAMES spectrograph is ideally suited as it allows astronomers to obtain spectra of many stars at a time. Even in a nearby globular cluster like NGC 6397, the unevolved stars are very faint and require rather long exposure times.

The observations clearly show systematic abundance trends along the evolutionary sequence of NGC 6397, as predicted by diffusion models with extra mixing. Thus, the abundances measured in the atmospheres of old stars are not, strictly speaking, representative of the gas the stars originally formed from.

"Once this effect is corrected for, the abundance of lithium measured in old, unevolved stars agrees with the cosmologically predicted value", said Korn. "The cosmological lithium discrepancy is thus largely removed."

"The ball is now in the camp of the theoreticians," he added. "They have to identify the physical mechanism that is at the origin of the extra mixing."

Source: ESO

Citation: Stars too old to be trusted? A possible Stellar Solution to the Cosmological Lithium Problem (2006, August 9) retrieved 23 April 2024 from <https://phys.org/news/2006-08-stars-stellar-solution-cosmological-lithium.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.