From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution
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Looking at the Spite plateau from a different perspective

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Abstract. Thanks to the accurate determination of the baryon density of the Universe by the recent cosmic microwave background experiments, updated predictions of the standard model of Big Bang nucleosynthesis yield the initial abundances of the primordial light elements with an unprecedented precision (Bennet *et al.* 2003; Spergel *et al.* 2003; Coc *et al.* 2004; Cyburt 2004). In the case of ^{7}Li, the CMB+SBBN value is significantly higher than the generally reported abundances for Pop II stars along the Spite plateau. Here, we report on the very recent results we obtained by revisiting a large sample of literature Li data in halo stars that we assembled following some strict criteria on the quality of the original analyses published from the early 90s onwards.

Keywords. Stars: abundances, stars: Population II, stars: evolution, Galaxy: halo, cosmology: early Universe

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1. The Project

In view of the crucial importance of the abovementioned disagreement (i.e. between the CMB+SBBN ^{7}Li value and the one observed in metal-poor halo field stars) which has cosmological, galactic and stellar implications, we decided to tackle the most critical issues of the problem: temperature scale and evolutionary status.

We explored in great detail the temperature scale issue with special emphasis on reddening, with the aim of deriving a homogeneous set of values for the largest sample of stars ever analysed in a consistent way. We found that the accounting for the reddening is very critical, and if not treated in a consistent way, can lead to a distorted view of the lithium plateau (especially in terms of dispersion, cf Figs. 12 and 13 of Charbonnel & Primas 2005).

We then used the HIPPARCOS trigonometric parallax measurements in order to locate precisely our sample stars in the HR diagram. Intrinsic absolute magnitudes M_v were derived from the m_v and the parallaxes given in the Hipparcos catalogue. We determined the bolometric corrections BC by using the relations between BC and V-I (taken from the Hipparcos catalogue) given by Lejeune *et al.* (1998). The resulting HR diagrams are shown in Fig. 16 of Charbonnel & Primas (2005) for our complete sample split in four metallicity bins. Post-main sequence stars can be easily located on the HRD as those stars with basically $\mathrm{Log}(L/L_\odot)$ higher than $\sim$0.4.

2. Results

Our final lithium abundances were derived using the arithmetic mean of the equivalent width and the 1σ uncertainty of the 670.7nm line as reported in the literature works from which we have assembled the sample. NLTE corrections were computed and applied to the LTE abundances.

Because of the extra piece of information we have in our hands, i.e. the evolutionary status of all our stars, we then looked at the derived A(Li) abundances, separating the dwarf stars from the post-main-sequence objects (see Figs. 17, 18 and 20 of Charbonnel & Primas 2005).

For all our dwarf stars with [Fe/H] $\leqslant -1.5$, the straight average value of the lithium abundance is :

$$\mathrm{A(Li)}_{NLTE} = 2.177(2.220) \pm 0.084(0.074)$$

where the first and second values (the latter given between parenthesis) correspond respectively to all stars with $\mathrm{T}_{eff} \geqslant 5700$ K or $\geqslant 6000$ K respectively. This is a factor of 2.48 to 2.54 lower (depending on the SBBN study we rely on, i.e., Coc *et al.* 2004 or Cyburt 2004) than the predictions for a standard Big Bang corresponding to the WMAP estimate of $\Omega_b h^2$ (Bennet *et al.* 2003; Spergel *et al.* 2003). We find no evidence of an intrinsic dispersion along the plateau.

For the post-turnoff stars with [Fe/H] $\leqslant -1.5$, instead, the straight average value of the lithium abundance is :

$$\mathrm{A(Li)}_{NLTE} = 2.252(2.235) \pm 0.099(0.077)$$

where the two values correspond to the same cut-off in effective temperature as in the case of the dwarfs.

3. Conclusions

Based on these findings, our conclusions can therefore be summarised as follows:
1) The relatively low Li abundance seen in metal-poor halo stars is a very robust result.
2) Assuming the correctness of the CMB constraint on the value of the baryon-to-photon ratio, we are left with the conclusion that the Li abundance seen at the surface of the halo stars is not the pristine one, but that these stars have undergone surface Li depletion at some point of their evolution.
3) The mean Li value as well as the dispersion appear to be lower for the dwarfs than for the post-turnoff stars. This result, together with the fact that all the stars with Li abnormalities (strong Li deficiency or high Li content) lie on or originate from the hot side of the plateau, lead us to suggest that the most massive of the plateau stars have had a slightly different Li histories than their less massive counterparts.

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