THE LITHIUM ISOTOPE RATIO IN OLD STARS

P.E. NISSEN
Institute of Physics and Astronomy, University of Aarhus, DK-8000 Aarhus C, Denmark

The lithium isotope ratio in stars can be determined from high resolution observations of the profile of the Li I 6707 Å absorption line. Earlier studies of old F and G stars (Andersen et al. 1984, Maurice et al. 1984, Pilachowski et al. 1989) have led to upper limits of $^6Li/^7Li$ ranging from 0.05 to 0.10. Recently, Smith, Lambert & Nissen (1993) seem to have detected ^6Li in HD 84937 - a metal-poor turnoff star with $T_{\rm eff} \simeq 6200$ K and $[Fe/H] \simeq -2.4$. An isotope ratio $^6Li/^7Li = 0.05 \pm 0.02$ was determined (see Fig. 1). The detection has been confirmed by Hobbs & Thorburn (1994), who derived $^6Li/^7Li = 0.07 \pm 0.03$. The main contribution to the quoted (1σ) errors comes from the noise in the spectrum (S/N = 400) and possible errors in the Doppler broadening of the Li line (Nissen 1994). This broadening is due to stellar rotation and macro-turbulent motions in the stellar atmosphere and can be determined from the profiles of unblended metallic absorption lines.

As discussed in detail by Steigman et al. (1993) the presence of ^6Li in the atmosphere of HD 84937 is consistent with the measured Be abundance (Boesgaard & King 1993) within the context of *i)* Standard Big Bang nucleosynthesis, *ii)* Pop. II cosmic ray nucleosynthesis and *iii)* standard (non-rotating) models for Li depletion. In particular, Steigman et al. derive $D_6 > 0.2$, where D_6 is the depletion factor for ^6Li. As shown by Chaboyer (1994) standard stellar evolution models with new opacities predict $D_6 \simeq 0.4$ for turnoff stars and subgiants with $T_{\rm eff} > 5900$ K. The same models predict $D_7 \simeq 1.0$, i.e. no ^7Li depletion for main sequence stars as well as subgiants with $T_{\rm eff} \geq 5800$ K.

Non-standard models with rotational induced mixing predicting a strong degree of ^7Li depletion ($D_7 \simeq 0.1$) (Pinsonneault et al. 1992) seem to be excluded by the detection of ^6Li in HD 84937, because the same models predict a very severe ^6Li depletion ($D_6 < 0.01$). Hence, inhomogeneous Big Bang models predicting $\log \varepsilon(Li) \simeq 3.0$ can probably be excluded.

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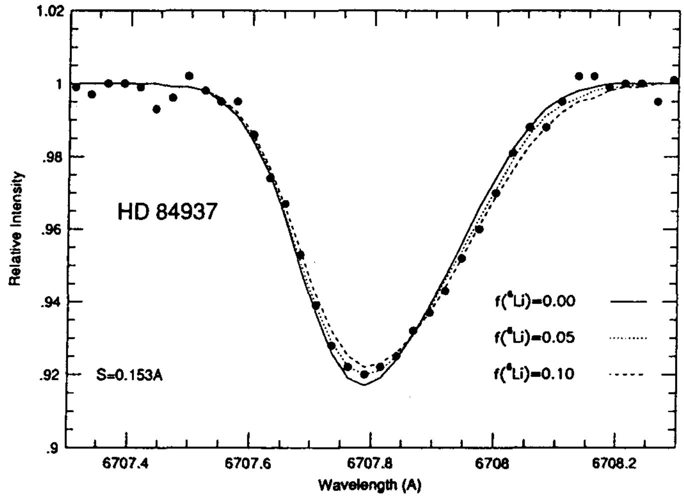

Figure 1. The observed profile (•) of the Li I line of HD 84937 compared with synthetic model atmosphere profiles for three ^{6}Li/^{7}Li ratios. S is the FWHM of the Gaussian smoothing function as determined from the observed profile of the Ca I 6162 Å line. See Smith, Lambert & Nissen (1993) for details.

A few other metal-poor stars were included in the works of Smith et al. (1993) and Hobbs & Thorburn (1994). In particular, one should note the upper limits $^6\mathrm{Li}/^7\mathrm{Li} \leq 0.02$ for HD 19445 - a dwarf star with $T_{\mathrm{eff}} \simeq 5800$ K, and $^6\mathrm{Li}/^7\mathrm{Li} \leq 0.03$ for HD 140283 - a subgiant with $T_{\mathrm{eff}} \simeq 5700$ K. Both results are consistent with the measured Be abundances and standard models for stellar depletion of ^{6}Li. Further studies of the Li isotope ratio in Pop. II stars are, however, needed to confirm that turnoff stars and the hottest subgiants do indeed have a small amount of ^{6}Li in their atmospheres. For this purpose very large telescopes equipped with high resolution ($R > 100\,000$) spectrometers are needed.

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