From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution
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The temperature scale of metal-poor dwarfs: lithium and oxygen abundances

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Abstract. We employ a new Infrared Flux Method (IRFM) temperature scale (Ramírez & Meléndez 2005a,b) in order to determine Li, O, and Fe NLTE abundances in a sample of relatively unevolved (dwarfs, turn-off, subgiants) metal-poor stars. We show that the analysis of the permitted OI triplet and FeII lines leads to a plateau in [OI/FeII] over the broad metallicity range $-3.2 < [Fe/H] < -0.7$, independent of temperature and metallicity, and with a star-to-star scatter of only 0.1 dex. The Li abundance in halo stars is also found to be independent of temperature and metallicity (Spite plateau), with a star-to-star scatter of just 0.06 dex over the metallicity range $-3.4 < [Fe/H] < -1$. Our Li abundance (Meléndez & Ramírez 2004) is higher than previously reported values, but still lower than the primordial abundance suggested by WMAP data and BBN.

Keywords. Stars: fundamental parameters, stars: abundances, stars: halo

1. New IRFM Temperature Scale

Recently, Ramírez & Meléndez (2005b, hereafter RM05b) have derived a new IRFM T_{eff} scale, which is based on a homogeneous analysis of more than one thousand stars for which IRFM temperatures were obtained employing updated atmospheric parameters (Ramírez & Meléndez 2005a, hereafter RM05a). The main improvements compared with previous works are a better coverage of the atmospheric parameters space (T_{eff} , log g, [Fe/H]), the use of up-to-date metallicities, and the fit of any trend in the residuals (eliminating in this way spurious trends in the T_{eff} :color:[Fe/H] relations). The use of updated metallicities and the good coverage of the atmospheric parameters space were crucial to derive reliable T_{eff} calibrations, greatly helping to distinguish noise from real trends with metallicity.

The new IRFM T_{eff} scale (RM05a,b) is in rough agreement with the scale by Alonso *et al.* (1996), except for very metal-poor F and early G dwarfs, for which we have obtained T_{eff} calibrations based on a larger sample. According to the new IRFM T_{eff} scale, the temperature of metal-poor stars close to the turn-off is highly dependent on metallicity. Even though a large dependence of T_{eff} with metallicity in F/G halo dwarfs has been criticized in the literature (Ryan *et al.* 1999), we must remember from stellar evolution that the turn-off of metal-poor stars becomes hotter as metallicity decreases (see early works by I. Iben, Jr. and collaborators). This is a non-negligible effect that accounts for an increase of 600-700 K in the T_{eff} of the turn-off for a decrease in metallicity from $[Fe/H] = -1$ to -3 (Meléndez *et al.* 2005).

2. Impact on Lithium Abundances

Meléndez & Ramírez (2004) have recently determined the Li abundance in halo stars employing high quality ($W_\lambda/\sigma \geqslant 10$) literature data, the new IRFM T_{eff} scale (RM05a,b), and NLTE corrections by Carlsson *et al.* (1994). The Li Spite plateau metal-poor stars (those with $T_{eff} > 6000$ K) have Li abundances independent of metallicity and temperature, with a mean abundance A(Li) = 2.37 and a star-to-star scatter of only 0.06 dex over the broad metallicity range $-3.4 <$ [Fe/H] < -1. The plateau is extremely flat, with essentially zero slope within the uncertainties (Meléndez & Ramírez 2004).

On the other hand, Ryan *et al.* (1999) found a trend of Li abundance with metallicity, and extrapolating to zero metals they found A(Li) = 2.0, which is much lower than the primordial Li abundance derived from WMAP data and Big Bang Nucleosynthesis (A(Li) $\approx$ 2.6). The very low Li abundance determined by Ryan *et al.* (1999) is due to the much lower T_{eff} adopted by them. Even though the use of the hotter T_{eff} scale of RM05a,b helps to alleviate the difference between the Li stellar abundances and the WMAP+BBN prediction, a discrepancy still remains.

3. Impact on Oxygen Abundances from the OI triplet

We have applied the new IRFM T_{eff} scale to 31 unevolved halo stars close to the turn-off, employing recent high S/N literature data of the OI triplet and FeII lines.

The analysis has been performed in LTE and NLTE, employing the code NATAJA (Shchukina & Trujillo Bueno 2001; Shchukina *et al.* 2003, 2005). We have used up-to-date atomic data for the oscillator strengths and damping constants of the OI triplet and FeII lines. The list of FeII lines has been updated from the one used by Meléndez & Barbuy (2002), including the latest laboratory works.

Unlike most previous works in the literature based on the OI triplet, we have obtained a constant [O/Fe] $\approx +0.5$ dex over the broad metallicity range $-3.2 <$ [Fe/H] < -0.7, with a small star-to-star scatter of about 0.1 dex. The flat [O/Fe] ratio is essentially due to the use of the new T_{eff} scale by RM05a,b. Details will be presented shortly in Meléndez *et al.* (2005).

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