

The metal–poor end of the Spite plateau: gravity sensitivity of the H α wings fitting.

L. Sbordone^{1,2,3}, P. Bonifacio^{1,2,4}, E. Caffau², H.-G. Ludwig^{1,2},
N. Behara^{1,2}, J. I. Gonzalez-Hernandez^{1,2,5}, M. Steffen⁶, R. Cayrel²,
B. Freytag⁷, C. Van't Veer², P. Molaro⁴, B. Plez⁸, T. Sivarani⁹,
M. Spite², F. Spite², T. C. Beers¹⁰, N. Christlieb¹¹, P. François²,
and V. Hill^{2,12}

¹CIFIST Marie Curie Excellence Team,

²GEPI – Observatoire de Paris – France

³Max-Planck Institut für Astrophysik, Garching – Germany

⁴INAF – Osservatorio Astronomico di Trieste – Italy

⁵Universidad Complutense de Madrid – Spain

⁶Astrophysikalische Institut Potsdam – Germany

⁷Centre de Recherche Astrophisique de Lyon, UMR 5574 – France

⁸Université Montpellier 2 – France

⁹Indian Institute of Astrophysics, Bangalore – India

¹⁰Michigan State University and JINA, Lansing, MI – USA

¹¹Landessternwarte Heidelberg – Germany

¹²Cassiopee, Observatoire de la Cote d'Azur, Nice – France

Abstract. We recently presented (Sbordone *et al.*, 2009a) the largest sample to date of lithium abundances in extremely metal-poor (EMP) Halo dwarf and Turn-Off (TO) stars. One of the most crucial aspects in estimating Li abundances is the T_{eff} determination, since the Li I 670.8 nm doublet is highly temperature sensitive. In this short contribution we concentrate on the T_{eff} determination based on H α wings fitting, and on its sensitivity to the chosen stellar gravity.

Keywords. Nuclear reactions, nucleosynthesis – Galaxy: halo – stars: abundances, Population II

1. Introduction

In Sbordone *et al.* (2009a) we present lithium abundances for a sample of 28 stars in the $-3.6 < [\text{Fe}/\text{H}] < -2.4$ range, 10 of which have $[\text{Fe}/\text{H}] \leq -3.0$. We derived four different T_{eff} scales: H α wings fitting against a grid of synthetic profiles from 1D models using Barklem *et al.* (2000) or Ali & Griem (1966) self-broadening theories (BA and ALI scales); H α fitting against a 3D-hydrodynamical grid based on CO⁵BOLD models (Freytag *et al.* 2002; Wedemeyer *et al.* 2004) with Barklem *et al.* (2000) self-broadening (3D scale); InfraRed Flux method (IRFM, González Hernández & Bonifacio 2009).

2. The H α gravity sensitivity

Effective temperature (T_{eff}) is the most crucial stellar atmosphere parameter influencing Li abundance determination: Li abundances derived from the Li I 670.75nm line are sensitive to T_{eff} at a level of about 0.03 dex for each 50 K variation in T_{eff} . Being mostly temperature sensitive, the H α wings are also influenced by the adopted surface gravity, to a level which might be significant in the present scope. In this short contribution we

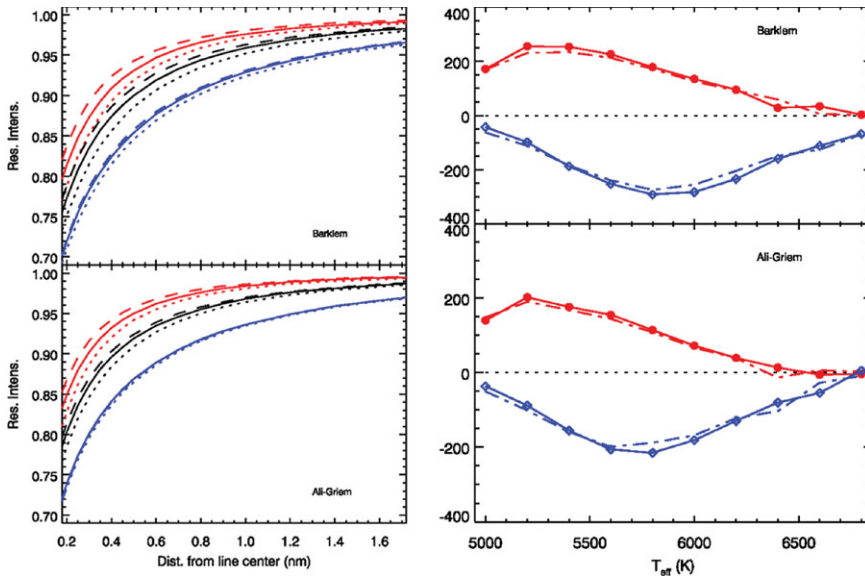


Figure 1. Left panel, for BA and ALI scales, 1D synthetic profiles of the H α red wing are plotted for $T_{\text{eff}} = 5400$ K, 6000 K, and 6600 K (red, black and blue respectively). Line type identify gravity, dashed for $\log g = 3.5$, solid for $\log g = 4.0$, dotted for $\log g = 4.5$. In the right panel, the effect of gravity offsets on T_{eff} estimate are shown. Theoretical profiles computed with $\log g = 4.0$ have been fitted with $\log g = 3.5$ profiles (red lines, filled circles) and $\log g = 4.5$ profiles (blue lines, open diamonds). The temperature difference (recovered-real) is plotted against the real temperature. Solid lines refer to $[\text{Fe}/\text{H}] = -3$, dotted to $[\text{Fe}/\text{H}] = -2.5$.

concentrate on this effect. Barklem *et al.* (2002) already reported estimates of such a sensitivity down to $[\text{Fe}/\text{H}] = -2$. The effect is always in the sense of higher gravity leading to broader profiles, and appears generally stronger at lower metallicities, and for the BA profiles compared to the ALI profiles. The effect is shown in Fig. 1, where we show both the shape of the H α red line wing and the temperature offset deriving from adopting the wrong gravity estimate in measuring effective temperature. As it can be seen, in the temperature range 6000-6500K, most significant for Li measurement in EMP TO and dwarf stars, significant (>100 K) offsets can arise from neglecting the gravity dependence in fitting H α profiles, which can appreciably skew the results when Li abundances are measured over a fairly broad temperature range (see Sbordone *et al.* 2009b).

References

- Ali, A. W. & Griem, H. R. 1966, *Physical Review*, 144, 366
 Barklem, P. S., Stempels, H. C., Allende Prieto, C., Kochukhov, O. P., Piskunov, N., & O'Mara, B. J. 2002, *A&A*, 385, 951
 Barklem, P. S., Piskunov, N., & O'Mara, B. J. 2000, *A&A (Letters)*, 355, 5
 Freytag, B., Steffen, M., & Dorch, B. 2002, *Astronomische Nachrichten*, 323, 213
 González Hernández, J. I., & Bonifacio, P. 2009, *A&A*, 497, 497
 Sbordone, L., *et al.* 2009a, proceedings of IAU Symposium 265 "Chemical Abundances in the Universe: Connecting First Stars to Planets", K. Cunha, M. Spite & B. Barbuy, eds., in press.
 Sbordone, L., *et al.* 2009b, *A&A*, submitted
 Wedemeyer, S., Freytag, B., Steffen, M., Ludwig, H.-G., & Holweger, H., 2004, *A&A*, 414, 1121