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Oxygen abundance and convection

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Abstract. The triplet IR lines of O I near 777 nm are computed with the Kurucz's code, modified to accept several convection models. The program has been run with the MLT algorithm, with l/H = 1.25 and 0.5, and with the Canuto-Mazzitelli and Canuto-Goldman-Mazzitelli approaches, on a metal-poor turnoff-star model atmosphere with Teff=6200 K, log g = 4.3, [Fe/H]= -1.5. The results show that the differences in equivalent widths for the 4 cases do not exceed 2 per cent (0.3 mA). The convection treatment is therefore not an issue for the oxygen abundance derived from the permitted lines.

Key words. abundance – convection – stellar atmosphere

1. Introduction

In a workshop held at the observatory Paris-Meudon (" Treatment of convection in stellar atmospheres" May 31 to June 2, 1999) the same authors had investigated the effect of the treatment of convection on several spectral features with the Kurucz's ATLAS9 code (Kurucz 1998). But they had limited their computations to models of solar metallicity. Francesca d'Antona suggested to them to extend their computations to metal-poor models adequate for representing turn-off (TO) stars as those observed in the ESO Large Programme lead by Raffaele Gratton on globular cluster stars. This programme has lead to the very important finding that the abundance "anomalies" in GCs, like the O-Na anticorrelation, well known in giants, extend down to unevolved stars, namely TO stars. We report in this note the results of our computations.

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2. The O I IR triplet lines with 4 different treatments of convection

In the Gratton's Large Programme the abundance of oxygen was derived from the O I IR triplet near 777 nm. We have therefore computed the strongest of these lines at 777.195 nm, for several treatments of convection. Thanks to a recent work (Heiter et al. 2002) we have been able to add to the MLT treatment with two values of the l/H_p ratio (mixing length over pressure scale-height) two other schemes, based on full spectrum turbulence convection models respectively by CM and by CGM (Canuto & Mazzitelli 1992; Canuto et al. 1996). The $(T_{eff}, \log(\tau))$ structure of these models are shown in fig. 1. Computation of the equivalent widths are given in table 1.

It is interesting to note that it was a natural, but a posteriori naive, expectation to think that the high excitation potential of the lines of the O I triplet (9.15 eV) would make them very

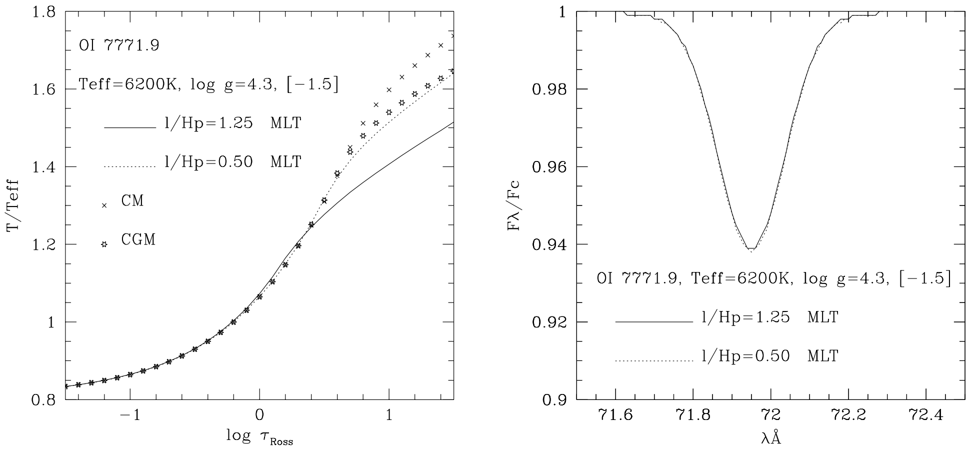

Fig. 1. Left panel: temperature structures for the 4 convection models. The right panel shows the line profile of the O I 777.195 line in the two extreme cases l/Hp = 1.25 and 0.5. The difference remains quite weak as shown both by the graph and by table 1 (only 2 per cent)

Table 1. Equivalent widths as a function of convection model. Model parameters: Teff= 6200 K log g= 4.3, [Fe/H]= -1.5, vmicro=2 km/s. [O/Fe]= 0.4

convection model	equiv. width of O I line (mA)
MLT l/H 1.25	13.7
MLT l/H 0.50	14.0
CM	13.9
CGM	14.0

sensitive to the temperature structure of the convective zone. The first point is that the temperature profiles separate only at depths deep enough so that the line are already formed. The second more subtle point, is that the sharp rise of the population of the lower level of the transition with increasing temperature is accompanied by a very similar rise of the continuous opacity due to the incoming ionization of hydrogen, having a strong effect on the population of the H minus ion. Actually, the ratio η of the line to continuous opacity has not a high temperature sensitivity.

3. Conclusion

The modelization of convection in 1-D stellar atmospheres has little effect on the derived abundance of oxygen. Similar computations for 3-D models including NLTE effects remain to be done.

References

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