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General Discussion I: At what stage is the abundance determination problem ?

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Abstract. This open session concentrates on the major problems of abundance determinations, and for this the effective temperature determination is discussed by Mike Bessell, the use of FeI and FeII lines and excitation and ionization equilibrium is discussed by Verne Smith. Roger Cayrel discusses the use of 1-D model atmospheres with different values of the mixing length parameter, and its impact on OI lines. Martin Asplund discusses the results of using 3-D model atmospheres and NLTE effects.

Key words. Stellar abundances

1. Introduction

A first order answer to the title of this session, as proposed by Francesca D'Antona, should be: effective temperatures are the major problem. The uncertainties are interrelated, but they can be discussed in terms of effective temperatures T_{eff}, gravity log g, atomic and molecular constants, NLTE effects and model atmospheres. I will briefly discuss these issues, as an introduction to the talks given in this session. Spectroscopic temperatures generally derived from FeI lines, are subject to NLTE effects (Thévenin & Idiart 1999), whereas FeII lines are reliable but they are not numerous enough in most cases. TiI and TiII lines are sometimes also used, however no NLTE calculations of Ti lines were carried out so far. See further discussion on this on Verne Smith's talk. On the other hand, photometric temperatures are in principle more reliable, and $V - K$ is considered to be a best T_{eff} indicator; we are presently facing an unexpected problem which is that JHK colours are available for the whole sky up to J $\sim$ 11 Strutskie et al. (1997, http://pegasus.phast.umas.edu/2mass.-html), but it is often the case that V is not available. As is shown in Mike Bessell's talk, in cases where the colours are known, the relations between colours and T_{eff} appear to be satisfactory. An intrinsic problem remains regarding T_{eff} from colours, residing in the reddening amount, as reminded by P. Nissen in this session.

Gravities are in general derived from ionization equilibrium of FeI and FeII lines. Due to NLTE effects on FeI lines, the result is that ionization equilibrium tends to give lower values relative to gravities derived from accurate parallax measurements, in particular from Hipparcos parallaxes, as shown in Nissen et al. (1997) and Allende et al. (1999).

The intensity of medium and strong lines is dependent on both the oscillator strength and the damping contant values. The damping constants for a good number of lines can now be computed accurately using the line-broadening cross-sections as described in Barklem et al. (1998) and references therein. This is a great improvement in the calculation of lines and derivation of abundances. A number of accurate laboratory and/or theoretical gf-values are also available for atomic lines, as well as for molecular lines. There are still, however, important lines for which gf-values are not yet satisfactory.

A check on classical mixing-length convection models on the formation of OI triplet lines in the near-infrared is presented by Roger Cayrel. NLTE effects and 3-D model atmospheres are discussed by Martin Asplund. The use of 3-D models shows that a number of element abundances are over-estimated when 1-D models are used. In a few cases, the introduction of non-LTE compensates the effect of 3-D models (Kiselman 1998; Cayrel & Steffen 2000; Asplund, this talk), as is the case of the Li I 671 nm line. Abundances derived from molecular lines are particularly affected by 3-D models, however it will take some years until we are able to compute non-LTE for molecules in order to check if this counterbalances the 3-D model effects, as is the case for Li I. One case should be mentioned, which is the Infrared OH lines: the calculations in 3-D give lower abundances than those in 1-D, but on the other hand the 1-D calculations give values only slightly higher than the [OI] 630nm line (Meléndez & Barbuy 2002), whereas the [OI] line is only slightly affected by the 3-D models (Nissen et al. 2002), indicating the 1-D calculations are not too far from reality (however the 3-D effects become increasingly important with decreasing metallicity).

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