Solar Line Asymmetries

Modelling the Effect of Granulation on the Solar Spectrum

by

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"Why is everyone afraid to be enthusiastic about basic science? ... Do everything. Then when we need data for our project of the moment, they will already have been published."

R.L. Kurucz[1]

[1]As quoted by Bengt Gustafsson on pg 14 of Gustafsson, B. "The Future of Stellar Spectroscopy and its Dependence on YOU" *Physica Scripta* **T34**, pg 14-19 (1991).

The work presented in this thesis is, to the best of my knowledge and belief, original and my own work, except as acknowledged in the text, and the material has not been submitted, either in whole or in part, for a degree at The University of Queensland or any other university.

Timo Nieminen

Abstract

Solar Line Asymmetries
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A parametric model of granulation employing a small number of parameters was developed. Synthetic spectra calculated using this model closely match observed spectra and, in particular, reproduce the asymmetries observed in spectral lines. Both the microturbulent motions and the large-scale flow velocity decrease exponentially with a scale height of 368 km as the height within the photosphere increases. The model agrees with observations of the solar granulation (from which it was derived).

The horizontal motions associated with granulation were found and used to calculate spectra emergent away from disk centre. These calculated spectra were compared to observed spectra, with the agreement supporting the accuracy of the granular model.

Also in the course of this work, the Brueckner-O'Mara damping theory was found to predict damping constants accurately. The photospheric abundances of a number of elements were determined. The abundance obtained for iron agrees with the meteoric iron abundance. Astrophysical *f*-values for some lines were also determined.

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Note on Units

The astrophysically customary c.g.s. units are used in this work, with a few exceptions where appropriate. The major exceptions are wavelengths, which are usually given in Ångstroms, distances and velocities, which are mostly in km and kms^{-1}, and atomic energies, which are given in electron volts or cm^{-1}.

These units can be readily converted to the S.I. units that the reader may be more familiar with. Care must be taken with formulae, however, as c.g.s. electrical units are chosen so that $4\pi\varepsilon_o = 1$, the presence of which is not readily apparent in equations.