NON-LTE SCATTERING RESONANCE POLARIZATION IN

SOLAR SPECTRAL LINES

GARY JOSEPH SALIBA

The physics of the production of non-LTE resonance line polarization
is studied in the case of a two-level atom in the absence of magnetic
fields. Previous studies have considered the line core and wings
separately. Here we couple these two regimes using a model incorporating
scattering with partial frequency redistribution. The properties of this
model are first investigated in the example of scattering in an optically
thin prominence.

We then present a heuristic derivation of the transfer equations for
polarized light which are solved in finite and semi-infinite atmospheres.
The calculations are performed for both complete and partial frequency
redistribution models. We find that the emergent percentage polarization
profile for a partial redistribution calculation, in a semi-infinite
atmosphere, is characterised by a core and wing maxima. This is in good
qualitative agreement with observations of strong solar resonance lines.

In order to investigate the physical processes which give rise to
the polarization profile, the properties of the source function for the

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Q Stokes parameter are investigated in simple model atmospheres (isothermal or with a "chromospheric" temperature rise specified through an analytic representation of the Planck function). Indeed, by writing the Q source function in the equivalent two-level atom representation (that is, a scattering term and a source term) we show formally that the source of polarization is proportional to the product of two terms. The first is the mean radiation field while the second is a factor which describes the departure of the radiation field from isotropy.

The insight gained into the physics of the line formation process in these atmospheres is then applied to the interpretation of the polarization profiles computed in a grid of solar models. We consider models of the formation of the solar $CaIIK$ $(3934Å)$ resonance line. In this work a number of simplifications and assumptions concerning the atomic and line formation models have been made so a detailed quantitative comparison with data is precluded. Despite this, the models adopted are sufficiently accurate to provide good qualitative fits with data. The response of the intensity, percentage polarization and Q Stokes parameter to changes in the calcium abundance, van der Waals damping parameter and atmospheric models is discussed. Furthermore, we investigate the diagnostic potential of scattering polarization as a probe of atmospheric structure.

24 Carrington Avenue,
Strathfield, 2135
New South Wales,
Australia.