Experimental Testing of Scattering Polarization Models

W. Li[1], R. Casini[1], S. Tomczyk[1], E. Landi Degl'Innocenti[2] and B. Marsell[3]

[1]*High Altitude Observatory, National Center for Atmospheric Research**, *P.O. Box 3000, Boulder, CO 80307-3000, U.S.A.*

[2] *Dip. di Astronomia e Scienza dello Spazio, Università di Firenze, L.go E. Fermi 2, I-50125 Firenze, Italy*

[3] *Stetson University, 421 N Woodland Blvd, DeLand, FL 32723, U.S.A.*

We realized a laboratory experiment to study the scattering polarization of the Na1 D-doublet at 589.0 and 589.6 nm in the presence of a magnetic field. This work was stimulated by solar observations of that doublet, which have proven particularly challenging to explain through available models of polarized line formation, even to the point of casting doubts on our very understanding of the underlying physics [1,2]. The purpose of the experiment was to test a quantum theory for the polarized scattering of spectrally flat incident radiation [3], on which much of the current magnetic diagnostics of stellar atmospheres is based.

Figure 1 reports one set of measurements of the broadband fractional polarization of the two D lines (symbols with error bars). In the modeling, we have included the effect of elastic collisions, inelastic collisions and optic depth. The agreement between theory and experiment shown in Figure 1 demonstrates that the quantum-electrodynamic formalism on which our model of scattering polarization in the CRD limit is based[3] is completely adequate when the incident radiation is spectrally flat over the wavelength range of the atomic transition.

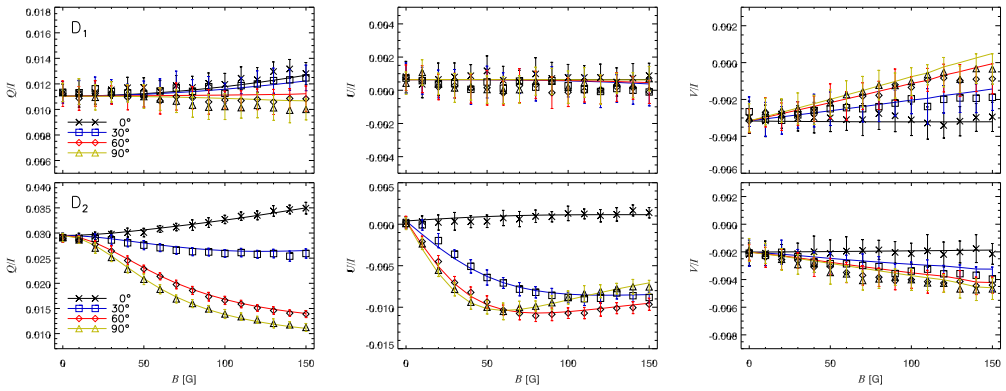

Figure 1: Broadband fractional polarization Q/I, U/I, and V/I (left to right) of the D_1 (top) and D_2 (bottom) lines as a function of magnetic field strength, for various geometries of the applied magnetic field. The measurements are represented by different symbols (with error bars) and colors, for different values of ϑ_B. The continuous curves of matching color represent the model.

[1] Stenflo, J. O. and Keller, C. U. 1996 *Nature*, **382**, 588

[2] Stenflo, J. O., Gandorfer, A. and Keller, C. U. 2000 *Astron. Astrophys.* , **355**, 781

[3] Landi Degl'Innocenti, E. and Landolfi, M. 2004 Polarization in Spectral Lines (Dordrecht: Kluwer)

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