

## The Effect of Turbulent Electric Fields on the Scattering Polarization of Hydrogen Lines

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**Abstract.** We reviewed the polarization properties of hydrogen lines in the presence of electric and magnetic fields. We first considered the case of completely depolarized hydrogen atoms. Under this assumption, the hydrogen lines manifest complex polarization signatures due to the combined Stark and Zeeman effect (Casini & Landi Degl’Innocenti 1993). One can derive convenient analytic expressions for the 1st and 2nd-order moments of the Stokes profile, which nicely summarize the fundamental properties of hydrogen polarization for both cases of deterministic and micro-turbulent electric and magnetic fields (Casini & Landi Degl’Innocenti 1994, 1995; Casini 1997). In particular, it is demonstrated the “additivity” of the Stark and Zeeman effects on such integral properties of the line polarization emitted by a gas of depolarized hydrogen atoms. We then generalized the problem to include the possibility of atomic polarization induced in the hydrogen atoms by anisotropic excitation mechanisms (e.g., in chromospheric and coronal plasmas). The complexity of the problem makes it intractable by analytic means, and one must resort to numerical tools. The results show that, in the presence of atomic polarization, the “additivity” of the electric and magnetic effects is lost, and an intricate interplay of the two effects occurs (Casini 2005). In particular, we considered two hydrogen lines of diagnostic relevance—Ly $\alpha$  and H $\alpha$ —formed in a magnetized plasma, and demonstrated the modifications of the scattering polarization that are induced by the additional presence of turbulent, electric microfields of various strengths (typically, the normal field strength of the Holtsmark theory, for various electron densities of the plasma). We showed that the additional presence of these electric microfields can significantly enhance the amount of net circular polarization (NCP) of the H $\alpha$  line for a given magnetic strength, which can be produced by the so-called alignment-to-orientation transfer mechanism (e.g., Landi Degl’Innocenti 1982; Kemp, Macek, & Nehring 1984; Landi Degl’Innocenti & Landolfi 2004), even if the electric microfield distribution is perfectly isotropic (see Fig. 1; Casini & Manso Sainz 2006). We argued that this mechanism could explain the large levels of NCP that have recently been detected in several quiescent prominences (López Ariste et al. 2005), and discussed the implications of this study for the diagnostics of magnetic fields in the solar atmosphere using hydrogen lines.

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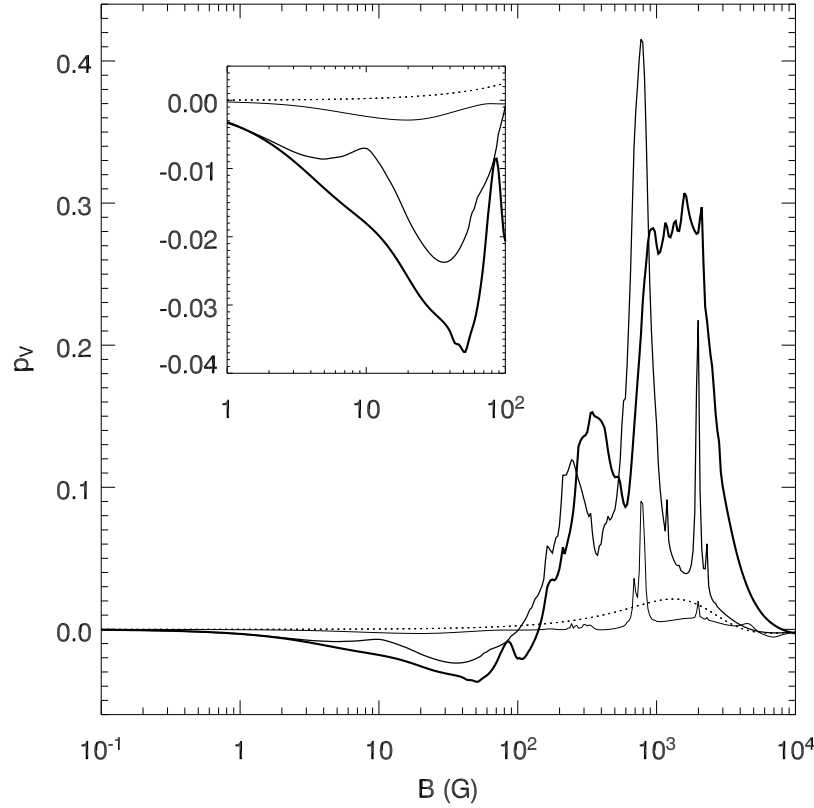


Figure 1. Net circular polarization (NCP) of the 90°-scattered radiation of the H $\alpha$  line, as a function of the strength of a horizontal magnetic field (i.e., perpendicular to the direction of incident radiation) and directed towards the observer (dotted line). The NCP is significantly modified in the additional presence of an isotropic distribution of microturbulent electric fields: 1 V cm $^{-1}$  (thin line); 10 V cm $^{-1}$  (medium line); 100 V cm $^{-1}$  (thick line). The many resonances visible at different magnetic field strengths, and for different intensities of the microturbulent electric fields, are determined by level anti-crossings determined by the simultaneous action of the two fields. The insert shows an enlargement of the same plot for magnetic strengths in a range typical of quiescent prominences. (From Casini & Manso Sainz 2006.)

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