The Hanle effect of hydrogen Lyman-alpha line for CLASP and future polarimetric solar studies

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We have derived an analytical solution for the problem of the polarized hydrogen Lyman-alpha line in the solar atmosphere. The Stokes parameters obtained are ready to be used for the data analysis in CLASP (Chromospheric Lyman-Alpha SpectroPolarimeter) which is a joint project of Japan, USA, and Europe for the study of the magnetic field in the solar atmosphere [1] and will be realized in 2015.

Atoms in the solar atmosphere are excited by an anisotropic radiation field, which gives rise to unequal population distribution over the magnetic sublevels, the so-called atomic polarization, and the subsequent radiation is generally polarized. If there exists, at the same time, a magnetic field inclined from the direction normal to the solar surface, the polarization is relaxed to some extent by the Hanle effect. The CLASP project plans to measure the polarization characteristics of the Lyman-alpha line and determine the magnetic field vector in the chromosphere and the transition region by taking such collective effects of the atomic polarization and the Hanle effect into consideration.

A complete numerical simulation of the measurement has been demonstrated by Trujillo Bueno et al. [2] based on the method formulated by Degl'Innocenti and Landolfi [3]. Although the present intuitive method omits several cumbersome effects such as the quantum interaction among the fine structure states and the radiation transport, the results show satisfactory consistency with those of the complete simulation under the expected conditions, which ensures a validity of the analytical solution for a practical use in CLASP. Furthermore, since an analytical solution facilitates incorporation of the effect into any simulation model of the solar atmosphere, this result should have a general significance for future solar research projects such as SOLAR-C.

[1] M. Kubo et al. Solar Polarization 7, in press.
[2] J. Trujillo Bueno et al., ApJ **738** (2011) L11
[3] E. L. Degl'Innocenti and M. Landolfi, Polarization in Spectral Lines, Kluwer Academic Publishers, Dordrecht (2004)