Toward the Inversion of the Scattering Polarization and the Hanle Effect in the Hydrogen Lyα Line

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The chromosphere and the transition region of the Sun are the interface region between the cool photosphere of 10^4 K, where the ratio of gas to magnetic pressure $\beta > 1$, and the 10^6 K corona, where $\beta < 1$. In this region, it is believed that energy dissipation and energy transportation to the upper layers are taking place via the magnetic fields. Thus, magnetic field measurements in the upper chromosphere and above (i.e., low β region), are essential for understanding the thermal structure and dynamical activities of the solar atmosphere. However, the familiar Zeeman effect has the limited applicability since the magnetic field there is expected to be rather weak and the spectral lines originating from these atmospheric layers are broad. The Hanle effect, that magnetic field induces the modification of the linear polarization caused by the anisotropic radiation field (i.e., scattering polarization), is expected to be a suitable diagnostic tool. Indeed, recent developments in the theory and modeling of polarization in spectral lines have suggested that information on the magnetic field in low β region could be encoded in some UV lines via the Hanle effect [1], and motivated the development of the CLASP sounding rocket experiment, which aims to measure the linear polarization profiles at the hydrogen Lyα line ($\lambda = 121.6$ nm) for the first time [2,3,4].

In our work [5], we clarify the information that the Hanle effect can provide by applying a Stokes inversion technique by means of a database search in view of the CLASP experiment. The database contains all theoretical Lyα Q/I and U/I profiles for all possible values of the field strength, inclination, and azimuth, assuming a one-dimensional semi-empirical model of the quiet-sun atmosphere. We focus on understanding the sensitivity of the inversion results to the noise as well as the ambiguities inherent to the Hanle effect. We find that it is difficult to uniquely determine the magnetic parameters only from the CLASP observables (i.e., linear polarization profiles) (Fig. 1), and simultaneous measurements to constrain one of magnetic parameters are critically important. Our conclusion is that spectro-polarimetry with CLASP can be a suitable diagnostic tool for investigating the magnetism of the transition region, especially when complemented with the information on the azimuthal direction of the magnetic field that can be derived from other instruments.

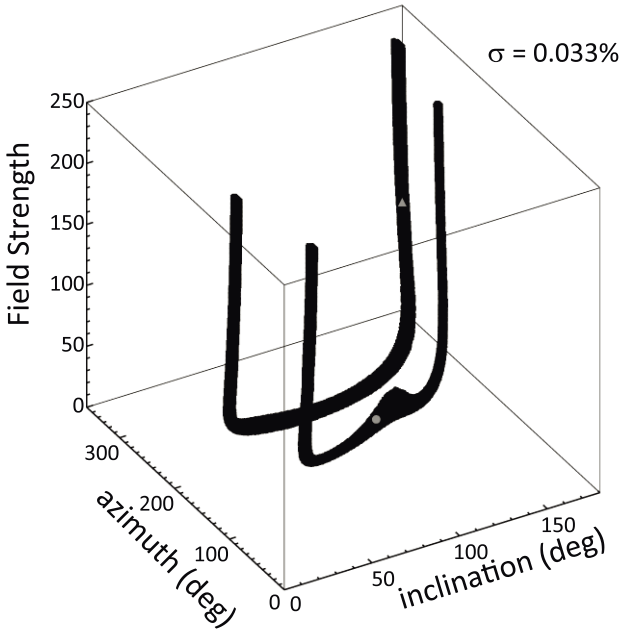

Figure 1: χ^2 map in the parameter space of field strength, inclination, and azimuth (magnetic parameters which are statistically accepted at one σ level as a result of inversion of a given simulated observable are shown with black) [5]. Noise expected for the CLASP experiment [3] is assumed.

References

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