Polarized Radiation Diagnostics for Measuring the Magnetic Field of the Outer Solar Atmosphere

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The basic idea of optical pumping, for which Alfred Kastler received the 1966 Nobel Prize in physics, is that the absorption and scattering of light that is near-resonant with an optical transition can produce large population imbalances among the magnetic sublevels of atomic ground states as well as in excited states. The degree of this radiatively-induced atomic level polarization, which is very sensitive to the presence of magnetic fields, can be determined by observing the polarization of the scattered or transmitted spectral line radiation. Probably, the most important point for solar physics is that the outer solar atmosphere is indeed an optically pumped vapor and that the polarization of the emergent spectral line radiation can be exploited for detecting magnetic fields that are too weak and/or too tangled so as to produce measurable Zeeman polarization signals. In this talk we review some recent radiative transfer simulations of the polarization produced by optical pumping in selected IR, FUV and EUV spectral lines, showing that their sensitivity to the Hanle effect is very suitable for magnetic field measurements in the outer solar atmosphere. We argue that solar magnetometry using the spectral lines of optically pumped atoms in the chromosphere, transition region and corona should be a high-priority goal for large aperture solar telescopes, such as ATST, EST and SOLAR-C.