Some Polarized Radiation Diagnostics for Measuring the Magnetic Fields of the Outer Solar Atmosphere

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ABSTRACT: 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 energy levels. The degree of this radiatively-induced atomic level polarization, which via the Hanle effect 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 Astrophysics is that the outer layers of stellar atmospheres, such as the chromosphere and corona of the Sun, are indeed optically-pumped vapors and that the linear 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 easily measurable Zeeman polarization signals. In this talk we review several radiative transfer investigations of the polarization produced by optical pumping in selected IR, FUV and EUV allowed spectral lines, showing that their sensitivity mainly 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.

This IAU talk provided a quick overview of the research described with more detail in the following publications (see also http://arxiv.org/abs/0903.4372):


