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SELF-CONSISTENT POLARIZED RADIATIVE TRANSFER: CONNECTING THEORY AND OBSERVATIONS

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Astrophysical objects are rarely observed with sufficient spatial resolution. Consequently, the detected spectra originate in different parts of these objects under different physical conditions and it is, in general, impossible to infer a finite set of thermodynamical quantities (temperature, pressure, ...) defining the system. Such a correspondence would typically be impossible even if observations with infinite spatial resolution were available because (1) the matter is often out of local thermodynamical equilibrium, and (2) the observed spectrum is a superposition of radiation emitted by atoms along the line of sight, which is sampling various physical conditions. Even though direct inversion of the physical quantities is often mathematically ill defined, comparison of the observations with sufficiently realistic models may provide suitable diagnostics. Multiple processes contribute to creation and modification of emergent spectral line polarization (anisotropic illumination, collisions, magnetic fields, ...). Moreover, the state of matter at different points of the plasmas is non-linearly coupled by radiation transfer. Resonance scattering polarization, which is sensitive to departures from local thermal equilibrium and to the anisotropies present in the system, carries an information on such processes encoded in the four Stokes parameters. The modeling and simulations provide a connection between the theory and observations: from the knowledge of elementary physical processes it is used for interpretation of the observational data from spatially complex plasma structures. The aim of polarized radiative transfer calculations is to find additional constrains to the models of such systems and to disentangle the above mentioned processes. I will briefly review the processes involved in non-LTE polarized radiative transfer problem and I will show how the self-consistent solutions do provide a clue for quantitative plasma diagnostics.