Session 3

Suitability of the CRD approximation for the RIII redistribution matrix in the RT modeling of scattering polarization

S. Riva[1], N. Guerreiro[2], P. Benedusi[3], L. Belluzzi[2]
[1] USI, [2] IRSOL, [3] Simula

The correct modeling of the scattering polarization signals observed in several strong resonance lines of the solar spectrum requires taking partial frequency redistribution (PRD) effects into account. These effects are conveniently described through the formalism of the redistribution matrix. For a resonance line, this is given by the sum of two terms, RII and RIII, which describe coherent and completely incoherent scattering processes in the atomic reference frame, respectively. The expressions of RII and RIII become particularly involved in the observer's reference frame, where the Doppler effect introduces a strong coupling between the frequency and propagation direction of the incident and scattered radiation, making the problem very demanding from a computational standpoint.

For simplicity's sake, approximate versions of RII and RIII are often applied. Complete frequency redistribution (CRD) has been widely used to approximate RIII in the observer's frame. This approximation proved very successful for modeling the intensity spectrum, but its suitability for scattering polarization has been questioned. Sampoorna et al. (2017) studied this approximation through radiative transfer (RT) calculations in an isothermal medium, demonstrating its applicability for modeling scattering polarization, particularly in optically thick media.

Here we generalize their work, and we analyze the suitability of the CRD approximation for RIII in 1D models that better represent the solar atmosphere, accounting for both magnetic and bulk velocity fields. Our results, based on the modeling of both photospheric (SrI 4607 A) and chromospheric (CaI 4227A) lines, firmly confirm the applicability of this approximation in the RT modeling of scattering polarization.