Session 3

(Invited) Multi-fidelity preconditioning of Krylov solvers for linear transfer problems of polarized radiation

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The modeling of the transfer of polarized radiation gives rise to a large class of problems, which can be reframed as linear systems. Depending on the considered physical assumptions, these problems can be relatively lightweight from the computational point of view, or extremely complex and challenging for state-of-the-art iterative methods.
We propose a multifidelity approach, which leverages the strengths of different modeling assumptions and strategies, of variable accuracy and computational cost: we design efficient preconditioners, based on lightweight simplified (low-fidelity) models, tailored to obtain accurate and fast solutions of specific computationally expensive (high-fidelity) problems.
We first apply a multifidelity preconditioned matrix-free GMRES iterative method to the radiative transfer modeling of intensity and polarization of the solar CaI 4227A spectral line, considering a two-level atom in a 1D atmospheric model, taking angle-dependent PRD effects into account. The proposed strategy shows near-optimal strong and weak scaling and converges in a few iterations, thus suggesting its suitability for realistic 3D applications. Subsequently, we apply and analyze the performance of the same solution strategy to model the Mg II h & k lines by considering a two-term atom.