Session 3

Scalable Matrix-free Solver for 3D Polarized Radiative Transfer in Stellar Atmospheres

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We present an efficient and massively parallel solution strategy for the transfer problem of polarized radiation. We consider a 3D medium out of local thermodynamic equilibrium, accounting for partial frequency redistribution effects in scattering processes. Such a setting results in one of the most challenging problems in radiative transfer modelling. The discrete ordinate method alongside an exponential integrator are used for discretization. Efficient solution is obtained with a Krylov method equipped with a tailored multi-fidelity preconditioner. A matrix-free approach results in a lightweight implementation, suited for tackling large problems. Near-optimal strong and weak scalability are obtained with two complementary decompositions of the computational domain. The presented approach made it possible to perform simulations with more than one billion of degrees of freedom in less than half an hour on massively parallel machines, always converging in a few iterations for the proposed tests.