
HyeongKae Park
**Multigrid preconditioning for Monte Carlo solution of
thermal radiative transfer problems**

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Thermal radiative transfer problems appear in many different physical applications such as combustion systems, inertial confinement fusion, and astrophysics. We are developing a moment-based scale-bridging algorithm, which utilizes the phase-space moments of the original transport equation to accelerate the convergence of isotropic physics, such as absorption-emission physics. In thermal radiative transfer problems, the resulting low-order (LO), continuum system consists of coupled hyperbolic equations and a ODE.

An efficient and accurate solver for the LO system is a key for successful application of the moment-based, scale-bridging algorithm. The LO system is solved using the Jacobian-free, Newton-Krylov (JFNK) method. JFNK together with nonlinear elimination of the radiation flux and material temperature equations, we can effectively reduce the LO system to a scalar PDE for the radiation energy density. This scalar PDE takes a form of an advection-diffusion equation that is amenable to effective multigrid preconditioning.

However, when a Monte Carlo method is used to solve a (simplified) high-order transport method, we encounter a difficulty due to the presence of a stochastic noise in an advection (consistency) term. The stochastic noise reduces the diagonal dominance of the preconditioning system, which may lead to an eventual failure of multigrid preconditioning. In this talk, we present effectiveness of multigrid preconditioning in Monte Carlo thermal radiative transfer problems and discuss a strength and weakness.