Abstract

Radiative transfer systems find a wide range of applications, for example, in the inertial constrained fusion research and in astrophysics. The solution of a radiative transport system can cover both optical thin and optical thick regimes due to the large variation of photon's mean-free path and its interaction with the material. In the small mean free path limit, a nonlinear time-dependent radiative transfer system can converge to an equilibrium diffusion equation due to the intensive interaction among radiation and material. In the optical thin limit, the photon free transport mechanism will emerge. In this talk, we develope an asymptotic preserving unified gas kinetic scheme (AP-UGKS) for both grey and frequency-dependent radiative transfer systems, where the radiation transport equation is coupled with the material thermal energy equation. The newly developed scheme has the asymptotic preserving property in the optically thick regime to capture the diffusive solution without using a cell size being smaller than the photon's mean free path and time step being less than the photon collision time. Besides the diffusion limit, the scheme can capture the exact solution in the optical thin regime as well. Many numerical examples are included to validate the current

approach. Extensions to more complex systems, including the equations of radiation hydrodynamics, will be presented. Moreover, we shall show an approach to mitigate the ray effects of the usual discrete ordinate (SN) method for the angular discretization.