Seminar Notice  
October 20, 2006  
Bldg. 5700, D307 Conference Room  
10:00 – 11:00 a.m.

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*Methods for Coupling Radiation, Ion, and Electron Energies Using Implicit Monte Carlo*

The simulation of thermal radiation propagation ranks among the most difficult class of transport problems. These problems are highly nonlinear, and the fundamental unknown (the radiation intensity) can be a function of seven independent variables (in 3D). One of the most successful and widely used methods in thermal radiation transport is the Implicit Monte Carlo (IMC) method (Fleck and Cummings, 1971). This method is a two-temperature (2T) scheme that includes radiation and material coupling where the matter is represented by a single temperature.

A more accurate description of the radiation and material coupling represents the ions and electrons by distinct, separate temperatures. The resulting three-temperature (3T) equations for the time evolution of the radiation, electron, and ion energies include terms representing electron-ion coupling and conduction. Conventionally, this system of equations is solved using radiation diffusion with operator-split conduction and coupling, although fully nonlinear solution techniques have been investigated.

We present three methods for extending the Implicit Monte Carlo (IMC) method to treat the time-evolution of coupled radiation, electron, and ion energies. The first method splits the ion and electron coupling and conduction from the standard IMC radiation-transport process. The second method recasts the IMC equations such that part of the coupling is treated during the Monte Carlo calculation. The third method treats all of the coupling and conduction in the Monte Carlo simulation. Using Modified Equation Analysis (MEA), we show that the third method is theoretically the most accurate. We demonstrate the effectiveness of each method on a series of nonlinear benchmark problems where the accuracy of the third method is shown to be up to ten times greater than the other coupling methods for selected calculations.