**Implicit Monte Carlo Radiative Transfer in DRACO**

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### Abstract

Implicit Monte Carlo method is used to solve the coupled photon transport equation and plasma energy conservation equation with improved stability for large time steps. The essence is that a forward plasma temperature is estimated at the beginning of the time step in the transport equation using the so-called Fleck factor. We are developing an Implicit Monte Carlo code module in DRACO for parallel, two-dimensional, multi-group frequency radiation transfer. A simple equilibrium solution in an infinite medium is used as an analytical benchmark. In other test cases, analytical opacities, as in the Fleck and Cummings' paper, are applied to compare with their one-dimensional results using our two-dimensional code.

### Outline

1. Introduction of the Implicit Monte Carlo (IMC) method for radiation transport.
2. Simulation of radiation Marshak wave problem in 1D and 2D.
3. Comparison with diffusion results.
4. Summary and future work.

### Implicit Monte Carlo Radiation Transport

Photon transport and plasma energy equations:

\[
\frac{\partial u(\mathbf{r}, t)}{\partial t} + \nabla \cdot \mathbf{J}(\mathbf{r}, \mathbf{v}, t) = -\sigma_N \mathbf{u}(\mathbf{r}, \mathbf{v}, t) + \sigma_T \mathbf{u}(\mathbf{r}, \mathbf{v}, t) - \nabla \cdot \mathbf{c}(\mathbf{r})
\]

where \( \sigma_N \) is the cross-section.

### Comparison of 2D Simulation with the 1D Result

A slab heated by a 1 keV blackbody source from the right boundary.

The results from 2D IMC are averaged for lines to compare with the 1D results.

The 2D simulations agree with Fleck and Cummings results.

### Operator Splitting in Energy Source Coupling

1. Full thermal transport with real thermal conductivity.
2. Temperature is updated before plasma electron conduction in IMC splitting method.
3. In diffusion method, the radiation energy is a source term in the electron thermal transport equation.
4. The operator splitting method in IMC agrees with diffusion results.

### Summary and Future Work

We are implementing an Implicit Monte Carlo method for radiation transport into the multi-dimensional hydrodynamic code DRACO. Operator splitting techniques are used to couple with electron thermal transport. Simulations of radiation Marshak wave on a diffusive plasma show agreement with the diffusion results. In the future, continued testing on full target simulations will be performed on a massively parallel computer. Variance reduction methods will be introduced.

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