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Lawrence Livermore National Laboratory

Development and Study of a Method Adaptive in Angle Variables for Solving 2D Transport Equation

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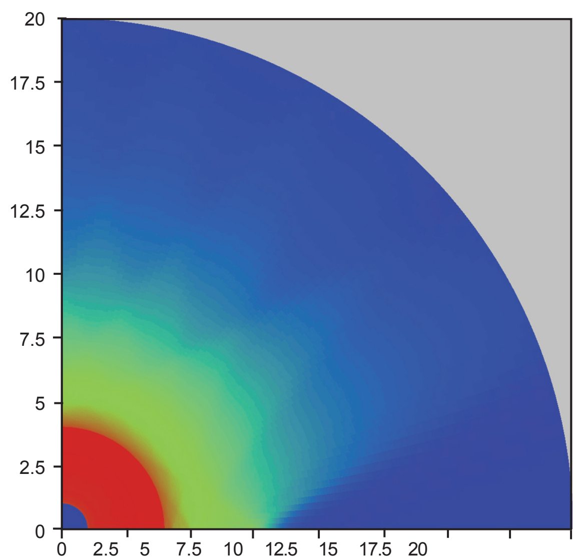
Project Description

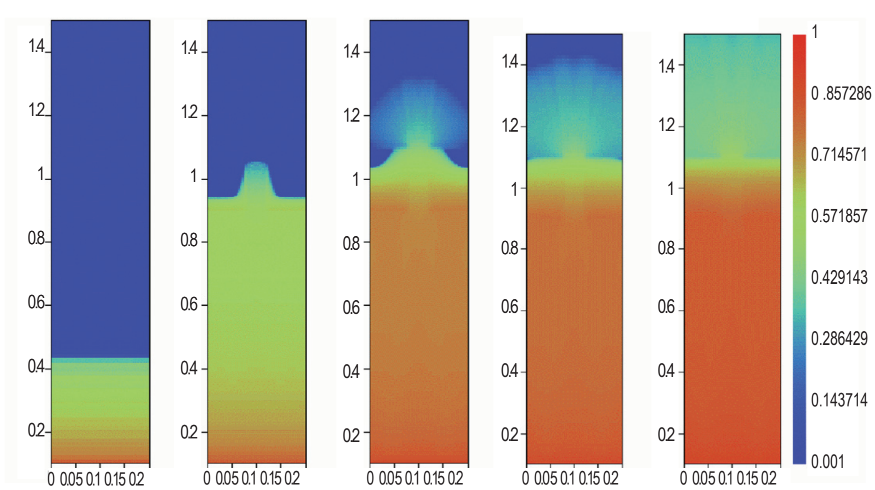
The objective of this project is to develop and demonstrate more efficient methods for solving radiation transport equations using adaptivity in angle variables. Conventional angular discretization methods require that the angular finite-difference grid be fine enough in any region. If the grid is too coarse, well-known "ray effects" appear. In addition, subdomains appear with a highly anisotropic particle flux distribution over directions where a very fine angular difference grid must be used, as well as subdomains where the distribution is nearly isotropic. In view of this, a promising approach to multidimensional transport solution efficiency enhancement using finite-difference approximations is one employing adaptive grids. Such adaptive methods are expected to resolve the "ray effect" problem in a cost-efficient manner.

The algorithm for solving the radiation transport equation using an angle-adaptive method with dynamic criteria for constructing the grid was evaluated using a set of benchmark test problems (pipe, slit, vacuum, and spherical).



The spatial distribution of radiation temperature, showing that geometric divergence is not accurately modeled by angular discretization in S_N transport algorithms, resulting in "ray effects."

Below: The radiation temperature distribution at five times. Radiation transport through a slit displays significant angular variations, including unphysical "ray effects."



Technical Purpose and Benefits

The simulation of multidimensional transport processes is an area of great interest. Deterministic methods, combined with improved discretization and acceleration techniques, hold the promise of accurate simulation of a variety of transport processes in complex geometries. However, the realization of this promise has proven to be very difficult, and further advances in algorithms are needed. One of the primary difficulties is that the number of variables required to model a given system can be extremely large, as the transport requires a description in six-dimensional phase space. Reduced dimensionality, using spatial symmetries, diffusive transport, or energy-averaged variables, is usually invoked to minimize the computational requirements, but each of these approximations has limited applicability. It remains true that resolved transport simulations of many physical systems remain beyond the reach of our most powerful computers. More efficient algorithms, such as the one demonstrated in this project, are needed. This adaptive approach may be contrasted to a complementary energy-adaptive approach investigated in project B541415.

ВНИИ
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