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PRISM Seminar Series – Fall 2012

PURDUE UNIVERSITY Discovery Park

"A Parallel Coupled Ordinates Method for Rarefied Gas Dynamics Simulations"

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Friday, Oct. 19th, 2012
12:00 pm, BRK 2001

Abstract: Micron-scale devices frequently involve non-equilibrium rarefied flows. Such systems can be effectively modeled using the ellipsoidal statistical Bhatnagar-Gross-Krook (ESBGK) form of the Boltzmann kinetic equation. Numerical solutions of these equations are based on finite volume method (FVM) in physical space and the discrete ordinates method in velocity space. Existing solvers employ solution procedures where the distribution functions are implicitly coupled in physical space, but are solved sequentially in velocity space. This leads to explicit coupling of the distribution functions in velocity space, which often creates convergence problems in systems with low Knudsen numbers or in multiscale systems with a large range of Knudsen numbers. Furthermore, parallel implementation of these numerical schemes is inefficient, making simulation of real-life devices practically impossible. In this work, we extend the coupled ordinates method (COMET), previously developed to study radiative heat transfer in the presence of a participating medium, to solve the ESBGK equations. In this method, at each cell in the physical domain, the distribution functions for all velocity ordinates are solved simultaneously. This coupled solution is used as the relaxation sweep in a geometric multigrid method in the spatial domain. The methodology works well with arbitrary convex polyhedral meshes, and is shown to give significantly faster solutions than the conventional sequential solution procedure. COMET solver has also been parallelized, and it is shown to have excellent strong and weak scaling characteristics. Results found in this work indicate that COMET can become a computationally effective solution procedure for the simulation of systems with a wide range of Knudsen numbers.

Speaker Bio:
Shankhadeep Das is a PhD Candidate in the Mechanical Engineering Department at The University of Texas at Austin. He works with Dr. Jayathi Murthy and Dr. Sanjay Mathur in the areas of fluid-structure interactions in microstructures. He has previously done his Bachelors in Mechanical Engineering from the Indian Institute of Technology in Kharagpur in India, and his Masters in Mechanical Engineering from the University of Minnesota - Twin Cities.

Refreshments will be served. *For further information please contact Matthew Potrawski, mpotraws@purdue.edu*
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