Mechanical Engineering Department Seminar

3:30pm January 25, 2012
1130 Mechanical Engineering

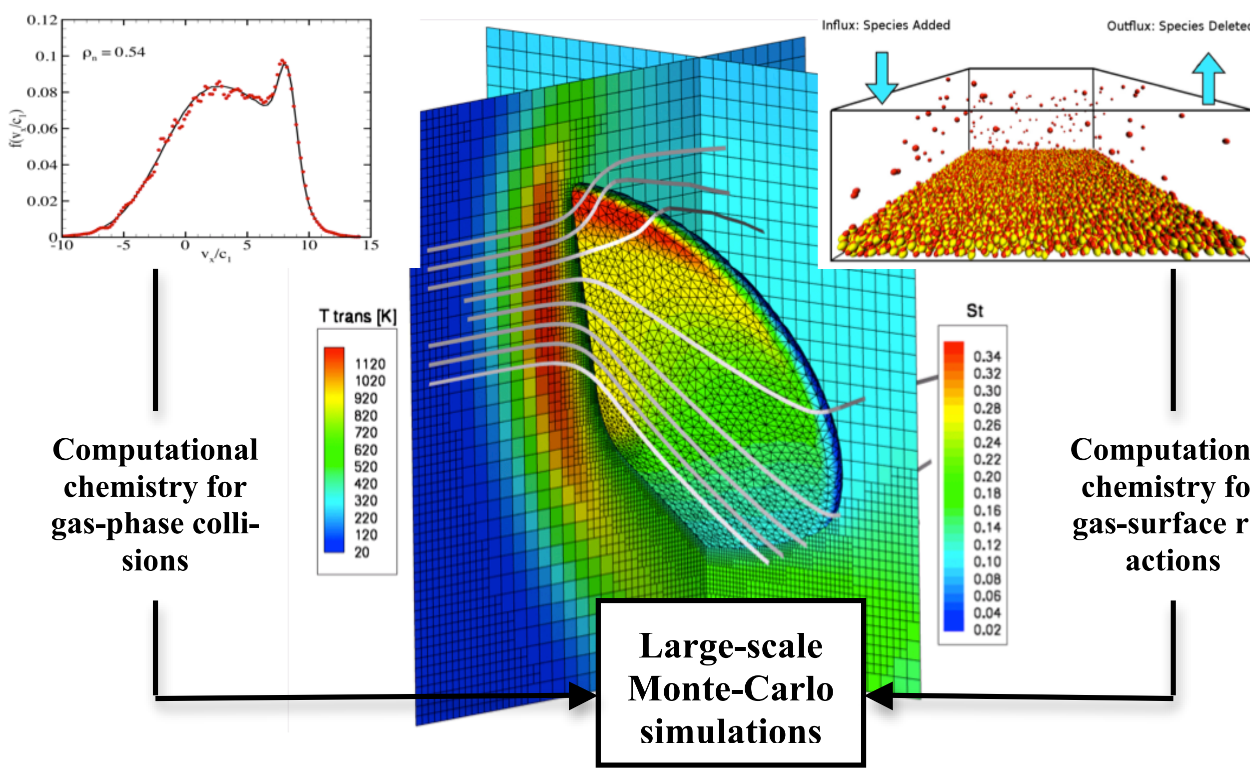
Particle Simulation of Highly Nonequilibrium Gas Flows

T. E. Schwartzentruber

Assistant Professor, Department of Aerospace Engineering and Mechanics; University of Minnesota

The gas flowing over a spacecraft at very high altitudes or flowing over a microscale object at sea-level can be in a state of nonequilibrium. The degree of nonequilibrium is typically characterized by the Knudsen number, defined as the ratio of the mean-free-path of gas molecules to the characteristic length scale of interest. A gas may be in chemical nonequilibrium and thermal nonequilibrium, but may also be in a state of *collisional*-nonequilibrium where gas molecules do not have equilibrium (Maxwell-Boltzmann) velocity and internal energy distributions. For such flows the transport closure models employed in the Navier-Stokes equations become invalid.

An accurate approach for modeling these flows is the direct simulation Monte Carlo (DSMC) particle method. The method and its relation to continuum CFD techniques will be outlined. Example results for both hypersonic flows and microscale flows will be highlighted. Furthermore, fundamental studies employing the Molecular Dynamics (MD) method will be presented with the purpose of developing new collision models for DSMC.



Bio Tom (Prof. Schwartzentruber) received his Bachelor's degree in Engineering Science and his Master's degree in Aerospace Engineering from the University of Toronto in the area of CFD. He then received his PhD degree in Aerospace Engineering from the University of Michigan in the area of DSMC (particle) simulation. For his PhD work, he received the AIAA "Orville and Wilbur Wright" graduate award. He joined the faculty in the Aerospace Engineering and Mechanics department at the University of Minnesota as an assistant professor in January 2008 and has recently received a Young Investigator Program award from the AFOSR.