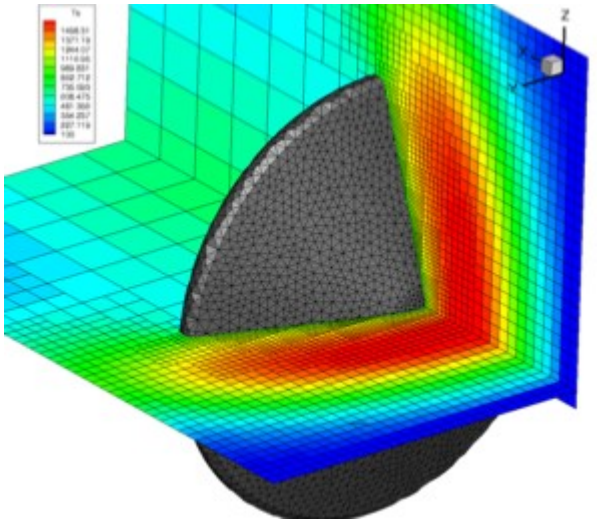
DSMC
Direct Simulation Monte-Carlo method



Orion reentry simulation (Norman, P., Valentini, P., and Schwartzentruber, T.E.,) u. Minnesota

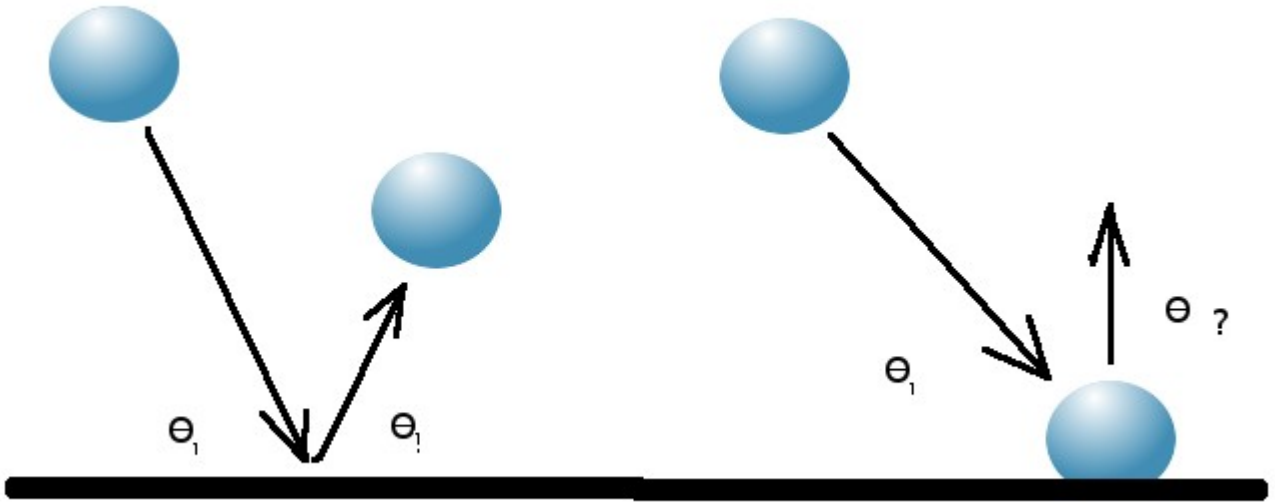
- Gas molecules have large mean free path in comparison to size.
- Small <10-6 sec time stepping simulation.
- Simulation can divide transport phase and energy redistribution phases into two independent components.
- Transport phase → move molecules, interact with surfaces
- Energy Phase → collide nearest neighbours
- Too many real molecules to simulate in a computer : use a statistical approach.

- Transport .

  Move molecules ds = V.dt

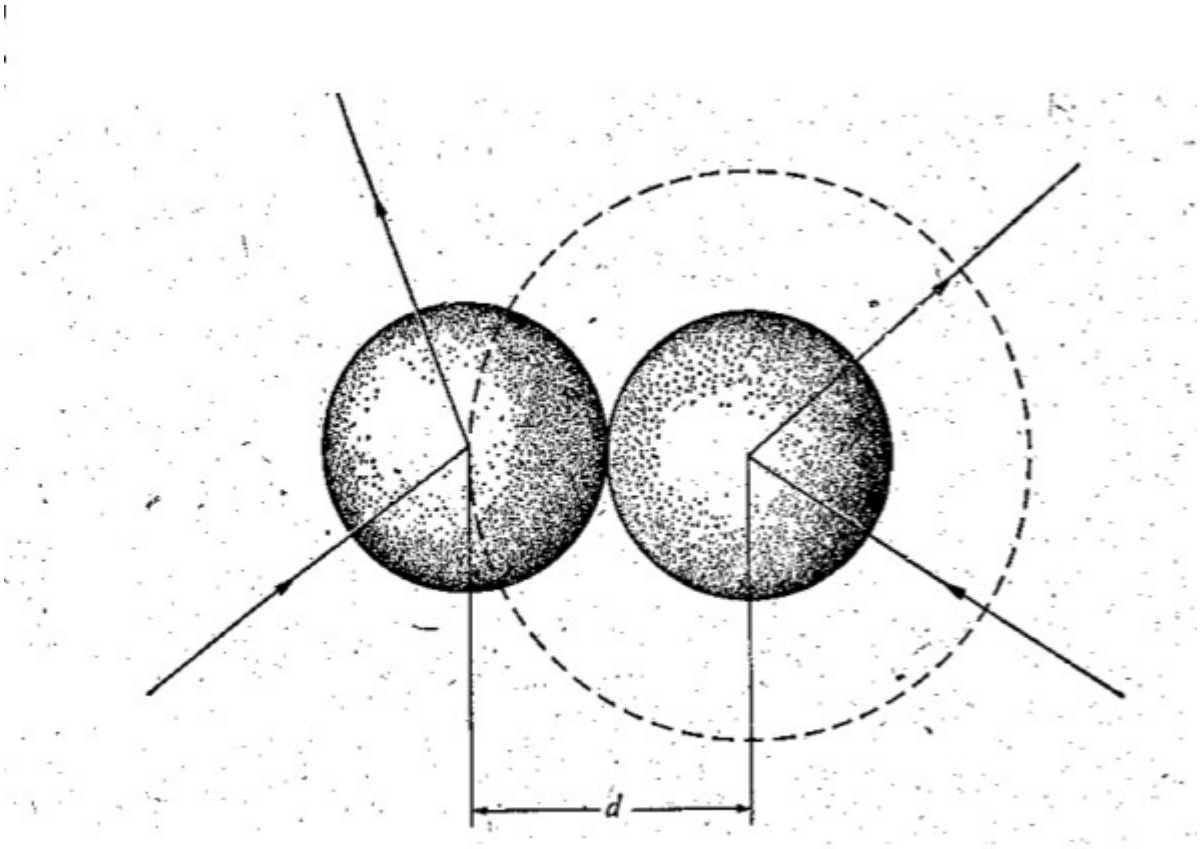
  Hit surface ?

  - a) reflect. Conservation of momentum.
  - b) absorbed-reinjected. Conservation of energy.

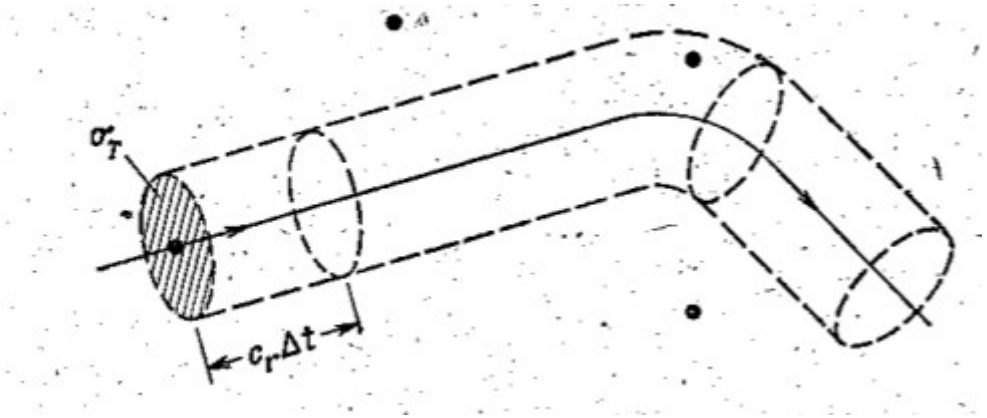


- Collisions.
  - Hard Sphere
  - Variable Hard Sphere
  - Variable Soft Sphere

$$d = \left(\frac{15\left(mkT/\pi\right)^{1/2}}{2\left(5-2\,\omega\right)\left(7-2\,\omega\right)\mu} \right)^{1/2}$$



- Only simulate representative molecules.
  - 1 in 10^{12} for near continuum flow
- Find probability of collisions for dt for molecules in a small region.
- Select pairs for collision based on probability
  - (acceptance-rejection technique)
- Post collision velocities based on conservaion of energy/momentum.



- Flow macroscopic properties based on statistical sampling of simulated molecules over time.

---> density (molecules per unit volume)

------> Velocity (average speed of molecules)

---> Temperature...translational,rotational, vibrational

(energy of random motion, spin and internal molecule state)

-----> Pressure ??? (only at surfaces)

Www.aeromech.usyd.edu.au/dsmc

THE UNIVERSITY OF SYDNEY

AEROSPACE, MECHANICAL AND MECHATRONIC ENGINEERING

DSMC

Direct Simulation Monte-Carlo

The DSMC (Direct Molecular Simulation - Monte Carlo Method) gas flow simulation technique was pioneered by Emeritus Professor Graeme Bird at the Department of Aeronautical Engineering, University of Sydney. The method was originally used for simulation of rarefied gas flow around rentry vehicles, but has now progressed to the stage of being a useful tool for solving a large range of aerodynamic and aerospace problems.

How does the method work?
Where can you get the software?
View a demo of the method.
View some sample solutions.

SAMPLE RESEARCH SOLUTIONS

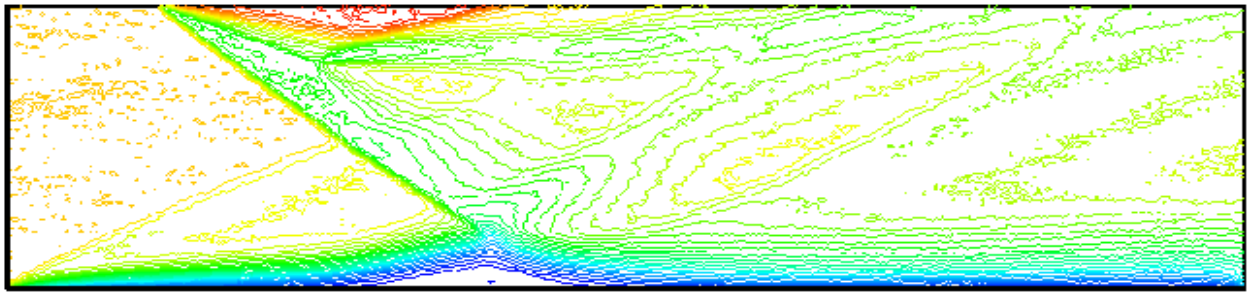
Some of the projects now being undertaken in the school using this method are

- Simulation of flow separation in near continuum region.
- Rankine-Heugonot weak/strong shock reflection solutions.
- Nano-Fluid Simulations.
- Investigation of stability of low Reynold's number flows.

Here are some flow pictures of our recent projects.

Interaction of Shock and Boundary Layer Flow

Mach No. Contours



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