ASEN 6061
MOLECULAR GAS DYNAMICS and DSMC

Instructor: Professor Brian M. Argrow

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Course website: http://learn.colorado.edu

Applications: High-Knudsen-number modeling and simulation for physics-based, gas-surface interaction; on-orbit satellite drag and trajectory analysis; high-speed atmospheric entry; weakly-ionized and reacting rarefied flows; flow in miniature and MEMS devices...

Learning Goals

- Learn fundamentals of kinetic theory, the basis for the molecular description of a dilute gas.
- Learn the foundations, implementation, and applications of the Direct Simulation Monte Carlo (DSMC) method for modeling rarefied-gas flows

Learning Outcomes

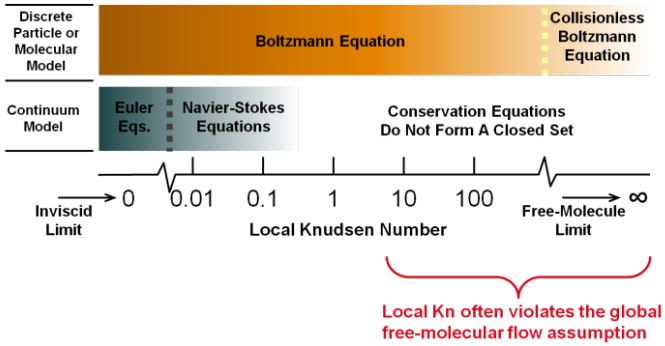
- Understanding of basic kinetic theory and molecular models
- Understanding of the appropriate applications and limitations of kinetic theory and DSMC
- Ability to obtain and verify simple one- and two-dimensional DSMC results

Course Overview: Description of the composition and flow of gases on a microscopic level to examine the behavior of the molecules that make up a macroscopic flow system. Thermodynamic properties, transport phenomena, and the governing Boltzmann Equation are derived from molecular collision dynamics and the kinetic theory. Kinetic theory and DSMC are introduced in project-based assignments and in-class discussion.

Prerequisites: Familiarity with compressible flows and thermodynamics, with some differential equations and tensor notation. Simple programming and numerical methods using a "high level language" such as C++ and/or a computing environment such as MATLAB or Mathematica.

Course Outline:

1. *Kinetic Theory*
2. *Binary Elastic Collisions*
3. *Basic Kinetic Theory*
4. *Equilibrium Gas Properties*
5. *Inelastic Collisions and Surface Interactions*
6. *Collisionless (Free-Molecular) Flow*
7. *Transition Regime Flows*
8. *DSMC Topics*



Text: G. A. Bird, **Molecular Gas Dynamics and the Direct Simulation of Gas Flows**, Oxford, 1998.

Additional References:

Bird, G. A., **The DSMC Method, Version 1.1**, 2013, ISBN 9781492112907 (https://www.createspace.com/3689652).

Vincenti and Kruger, **Introduction to Physical Gas Dynamics**, Wiley, 1965; Krieger, 1986.

Grading:	PROJECTS	50%
	HOMEWORK, UNIT QUIZZES	25%
	EXAMS (2)	25%

Additional Notes:

1. Collaboration is permitted on homework. This means you may discuss the means and methods for solving problems and even compare answers, but you are not free to copy someone's assignment. The work that you turn in must be your own—copying is not allowed for any assignments. **Collaboration on quizzes or exams, using another student's work as your own, or allowing another student to use your work as their own is academic misconduct and is not tolerated.** If you are caught in any of these activities, you will receive a grade of "F" for the course and a report will be made to the Dean's office for further punitive action.

   Read the statement of the University's Student Honor Code at http://www.colorado.edu/academics/honorcode/.

2. You can review the University's policy for religious obligations at http://www.colorado.edu/policies/fac_relig.html

3. Students with disabilities who qualify for academic accommodations must provide a letter from Disability Services (DS) and discuss specific needs with the professor, preferably during the first two weeks of class. DS determines accommodations based on documented disabilities (303-492-8671, Willard 322, www.colorado.edu/sacs/disabilityservices).

4. Students are required to be familiar with the University's policies regarding classroom behavior and associated procedures as described at http://www.colorado.edu/policies/classbehavior.html.

5. Students are required to be familiar with the University's policies regarding Sexual Harassment which applies to all students, staff, and faculty as described in http://www.colorado.edu/sexualharassment. This site is also provides information on campus resources available to assist individuals who believe they have been sexually harassed.