Abstract
Accurate numerical prediction of rarefied flow regime is important both for aerospace systems that operate in this regime, and for the development of new generation of gas-driven nano-and micro-scale devices, for which the gas mean free path is comparable with the reference flow scale and rarefaction effects are essential. Direct simulations Monte Carlo (DSMC) method is the main tool used in the analysis. In this talk we will discuss the effect of rarefaction in nozzle plume flows, radiometric forces and optical lattices.

Understanding the influence of the surface roughness on nozzle plume flow and plume impingement for different flow regimes is critical to the development of microthrusters. Surface roughness effects in rocket nozzles are found to be significant only in very rarefied flows where Reynolds number is about unity.

Rarefaction has also been shown to be an important factor affecting the radiometric forces. The maximum radiometric forces for all gases under consideration are observed at a Knudsen number of about 0.1. For a radiometer vane placed in a finite size chamber, the maximum force is found to be roughly proportional to the surface area of the vane. This is an indication that the collisionless area force, and not thermal transpiration edge force, dominates the radiometric phenomena in that regime. The role of molecular diameter, viscosity and chamber size on radiometric forces have been found to be significant.

In laser based optical lattices-gas interactions, it has been shown that in a weekly collisional regime, optical lattices can trap and accelerate neutral molecules from room temperature level to tens of kilometers over a single laser pulse. In the collisional regime, the optical lattice-gas interaction was found to result in strong energy and momentum deposition to the gas. This knowledge has led to the development of two types of optical lattice-based micropropulsion devices for low and high density regimes. For the high density microthruster, an optical lattice is used to deposit energy and momentum to the region near the nozzle throat with subsequent increase in propulsion efficiency. In the low density microthruster, a multiple orifice flow is considered, and thrust is produced by molecules accelerated to high velocities by a chirped lattice potential.
BRIEF BIO

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Education
PhD. Astronautical Engineering, University of Southern California, May 2007
M.S. Aerospace Engineering-Astronautics, University of Southern California, July 2004;
Diploma, Mechanical Engineering, the Polytechnic, University of Malawi, 1994;

Research Interests
Space instrument design, fluid dynamics, Computational Fluid Dynamics (CFD), propulsion, combustion, spacecraft design, space environment and spacecraft interaction, Direct Simulation Monte Carlo (DSMC), MEMS, rarefied gas dynamics

Other Interests
Working on alternative energy sources:
- Developed a generator that runs on sugar and yeast
- Working on design of energy harvesting devices