Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Vortex dynamics in high-speed rarefied cavity flows VISHNU VENUGOPAL, GIRIMAJI SHARATH S, Texas A&M Univ — Space-access vehicles are frequently exposed to high non-equilibrium conditions, particularly during an atmospheric re-entry. Any cavity on the surface of such vehicles including suction chambers and impact damages can drastically alter the aerodynamic behavior around the vehicle. For instance, even if the freestream is rarefied, the flow within the cavity could be close to continuum due to the entrapment and accumulation of many molecules. This can significantly change the dynamics of vortex patterns, that are commonly present in a cavity flow, eventually affecting the surface properties along cavity walls. So, it is important to characterize the vortex dynamics in a cavity flow as a function of the degree of rarefaction (Knudsen number), cavity size and flow speed. Direct numerical simulations are performed for lid driven cavity flows using a Unified Gas Kinetic Scheme. A parametric study is performed to quantify physically possible vortex configurations for a given combination of Knudsen number, cavity aspect ratio and lid velocity. The underlying physical mechanisms involved in the production of different vortex structures are highlighted. Finally, an effort is made to develop a reference diagram that clearly classify the regions of physically possible vortex configurations.

Vishnu Venugopal
Texas A&M Univ

Date submitted: 01 Aug 2015 Electronic form version 1.4