Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

**Transition in Hypersonic Boundary Layers: Role of Dilatational Waves** CHUANHONG ZHANG, YIDING ZHU, QING TANG, HUIJING YUAN, JIEZHI WU, SHIYI CHEN, CUNBIAO LEE, State Key Laboratory of Turbulence and Complex Systems, Collaborative Innovation Center of Advanced Aero-Engine, Peking University, MOHAMED GAD-EL-HAK, Department of Mechanical & Nuclear Engineering, Virginia Commonwealth University — Transition and turbulence production in a hypersonic boundary layer is investigated in a Mach 6 quiet wind tunnel using Rayleigh-scattering visualization, fast-response pressure measurements, and particle image velocimetry. A previously undiscovered unusual behavior of the second instability mode is noticed. Very high frequency dilatational waves are observed to grow rapidly followed by very fast annihilation. The second instability mode is a key modulator of the hypersonic laminar-to-turbulence transition, and the bulk viscosity plays an important role in that dynamical process. At its peak, the second mode strongly interacts with the first instability mode to directly promote a rapid growth of the latter and immediate transition to turbulence. This interaction can be explained by a nonlinear coupling of vorticity and dilatation in the interior of the boundary layer, combined with a viscous linear coupling at the wall. Our study of transition in hypersonic flows suggests that more attention should be given to the inviscid dilatational waves and their coupling with transverse vortical structures.

cunbiao lee
State Key Laboratory of Turbulence and Complex Systems,
Collaborative Innovation Center of Advanced Aero-Engine,
Peking University

Date submitted: 15 Jul 2014 Electronic form version 1.4