Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Effect of porous surface on pre-transitional supersonic boundary-layer disturbances generated by free-stream vortices PIERRE RICCO, The University of Sheffield — A supersonic laminar flat-plate boundary layer at Mach number M=6 flowing over a porous surface is studied numerically and by asymptotic methods. The flow is perturbed by small-amplitude free-stream vortical disturbances of the convective gust type. These external agents generate streamwise-elongated low-frequency disturbances of the kinematic kind, i.e. compressible streaky Klebanoff modes, and of the thermal kind, i.e. thermal streaks, which grow algebraically downstream. For boundary layer fluctuations with a spanwise wavelength comparable with the boundary layer thickness, the porous surface has a negligible effect on the growth and evolution of the streaks. When the spanwise wavelength is instead larger than the boundary layer thickness, the disturbances are effectively attenuated by the porous surface. For a specified set of frequency and wavelengths, the streaky structures evolve into oblique Tollmien-Schlichting waves through a leading-edge-adjustment receptivity mechanism. The growth rate of these waves increases slightly over the porous set, thus confirming previous results obtained through stability analysis. Our receptivity analysis allows us to calculate the wave amplitude, which is attenuated by the porous surface. Further asymptotic analysis based on triple-deck theory confirms the numerical results.

Pierre Ricco
The University of Sheffield

Date submitted: 24 Jul 2013 Electronic form version 1.4