Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Effect of wall cooling or heating on streaks and streamwise vortices developing in compressible boundary layers ADRIAN SESCU, OMAR ES-SAHLI, Mississippi State Univ, MOHAMMED AFSAR, University of Strathclyde, YUJI HATTORI, MAKOTO HIROTA, Tohoku University — Streamwise oriented vortices and streaks develop in boundary layers over flat or concave surfaces as a result of various freestream disturbances or small nonuniformities at the wall. Following the transient growth phase, these streamwise vortices become susceptible to inviscid secondary instabilities, which can lead to early transition to turbulence via bursting processes. We look at the effect of cooling and heating on streamwise vortices and streaks developing in high-speed boundary layers, using the compressible nonlinear boundary region equations. This set of equations represents the high Reynolds number asymptotic form of the Navier-Stokes equations, under the assumption that the streamwise wavenumber of the disturbances is much smaller than the wavenumbers associated with the crossflow directions. The parabolic character of these equations allows a robust and less expensive approach to study boundary layer streaks, by finding the numerical solution via marching in the streamwise direction. With different level of cooling and heating being imposed at the wall, we show that in some conditions it is possible to reduce the skin friction, which can contribute to an overall reduction of the frictional drag.

Adrian Sescu
Mississippi State Univ

Date submitted: 12 Aug 2020 Electronic form version 1.4