Progress in Algebraic Reynolds Stress Model development for compressible flows
CARLOS GOMEZ, SHARATH GIRIMAJI, Texas A&M University — The standard algebraic Reynolds stress modeling (ARSM) approach is used to develop closures for compressible turbulence. A new rapid-pressure strain correlation model that is sensitive to gradient ($Ma_g$) and turbulent ($Ma_t$) Mach numbers is employed in the closure development. At low $Ma_g$, the pressure-strain correlation model assumes its standard incompressible form and the ARSM of Girimaji (1996) is recovered. Based on the analysis of the Navier-Stokes equation in the rapid distortion limit, it is suggested that at intermediate $Ma_g$ the effects of pressure, on an average, is to counter that of inertia. This leads to a balance between production and pressure-strain correlation leading to no temporal change in Reynolds stresses in this regime. In the high $Ma_g$ regime, the effect of pressure is negligible compared to inertia thus yielding a fully explicit algebraic Reynolds stress model. The complete proposed model is tested in a 2D supersonic mixing layer. Similarity profiles of mean streamwise velocity and turbulence quantities are compared with the experimental data of Goebel and Dutton (1991). Numerical mixing layer spreading rates are found to be in relatively good agreement with experimental data.