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Evolution of solenoidal and dilatational perturbations in transitional supersonic and hypersonic boundary layers. OMAR KAMAL, JEAN-PIERRE HICKEY, University of Waterloo, CARLO SCALO, Purdue University, FAZLE HUSSAIN, Texas tech University — We have investigated the interaction between the dilatational and solenoidal components of instability waves relying on DNS simulations of temporally-evolving compressible boundary layers ranging from Mach numbers of 2.0 to 10.0. For idealized flow conditions at subsonic-to-moderate supersonic speeds, transition to turbulence occurs due to amplification of Tollmien-Schlichting (T-S) waves (first Mack mode) exponentially amplified until nonlinear breakdown and transition to turbulence occurs. Under the same conditions, at hypersonic speeds, transition is governed by acoustically resonating trapped waves (second Mack mode). While the former are expected to be solenoidal in nature and the latter predominantly dilatational, we demonstrate that, in general, they always coexist and that, even at Mach=10 there is an appreciable energy transfer from the dilatational to the solenoidal at limit-cycle amplitude conditions in 2D simulations. In three-dimensional simulations very rapid breakdown is observed. Mechanisms of energy exchange between the dilatational and solenoidal components during the transition will be discussed.

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