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Linear and nonlinear dynamics of second-mode instability in hypersonic boundary layers (HBL)[1] UNNIKRISHNAN SASIDHARAN NAIR, DATTA GAITONDE, The Ohio State University — Hypersonic transition is often dominated by the second-mode instability. We perform a direct numerical simulation (DNS) informed by linear stability theory, to understand the eventual three-dimensional breakdown of this instability. Linear amplification and nonlinear saturation of this two-dimensional wave eventually culminate in the appearance of oblique waves, which break down the HBL into a turbulent state. A modal analysis of the transitional region identifies lambda-shaped vortices belonging to both fundamental and subharmonic categories. While the former appears relatively downstream, the subharmonic waves are observed immediately following nonlinear saturation. This nonlinear stage of transition is further analyzed through a novel unsteady flow perturbation (UFP) technique. UFP essentially tracks the linear evolution of perturbations on a nonlinearly saturated background flow, using body force constraints, thus approximating a Floquet analysis for general configurations. UFP is shown to identify the most receptive superharmonic/subharmonic components in the periodically distorted flow. In addition to providing insights into the dynamics, relative to DNS, it provides an accurate low cost approximation of the breakdown spectrum in the early transitional stages.

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