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Optimal Free-Stream Vortical Disturbances M.J. PHILIPP HACK, Center for Turbulence Research, Stanford University — In boundary layers exposed to moderate levels of free-stream disturbances, natural transition via the exponential amplification of Tollmien-Schlichting waves is *bypassed* by a more rapid breakdown process. The external disturbances interact with the mean shear and induce the growth of highly energetic streaks, which cause transition to turbulence by virtue of the growth of inviscid secondary instabilities. The relationship between external vortices and boundary-layer perturbations is, however, not entirely understood. The present study provides a rigorous link between the dynamics in the free-stream and inside the boundary layer by computing the optimal free-stream vortical disturbances, i.e. the external disturbances which maximize the energy content of the resulting boundary-layer perturbations. The mathematical framework is based on a semi-norm formulation of the adjoint linearized compressible Navier-Stokes equations in curvilinear coordinates and enables the global analysis of disturbance sensitivity as well as the computation of optimal disturbances in flows with variable density and miscellaneous geometries.

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