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Modeling the amplification of disturbances using the Spatial Perturbation Equations[1] SHAUN R. HARRIS, Stanford University, M. J. PHILIPP HACK, PARVIZ MOIN, Center for Turbulence Research, Stanford University — We introduce a computational framework for capturing the evolution of nonlinear disturbances in spatially developing viscous shear flows. The Spatial Perturbation Equations (SPE) describe a well-posed streamwise marching formulation that identifies downstream traveling solutions based on their group speed and projects the perturbation state vector onto them. The scheme avoids the inconsistencies of the Parabolized Stability Equations which require ad-hoc remedies such as minimum step sizes or physically unmotivated modifications of the governing equations to stabilize the inherently ill-posed marching procedure. Our novel framework does not rely on spanwise modal wave behavior and enables the use of an explicit advancement scheme. Additionally, it incorporates a robust treatment of nonlinear interactions of harmonics which allows the accurate capturing of high-amplitude perturbations. Comparisons of the evolution of nonlinear disturbances in a boundary-layer flow show excellent agreement with direct numerical simulations.

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