Influence of unsteady perturbations on a wall-normal vortex[1]

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— We numerically examine the influence of unsteady perturbations on a wall-normal vortex. The present study considers a model vortex similar to a Burgers vortex with no-slip boundary condition prescribed along its symmetry plane. The boundary layer generated along the symmetry plane of the model vortex gives rise to a significant difference from the Burgers vortex, which has dynamical implications in examining vortical flows near wall boundaries. We utilize three-dimensional direct numerical simulations (DNS) to examine the input-output response of the vortex with respect to various perturbations introduced near its vortex core. The perturbed flow exhibits the emergence of instabilities and changes to the behavior of vortex breakdown. The influence of various perturbation parameters is considered in order to characterize the features of dynamical response, including changes to the azimuthal velocity and pressure profiles. Moreover, vortical structures obtained from DNS and companion water tunnel experiments are examined in detail with proper orthogonal decomposition (POD) to highlight key energetic features.

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