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Role of Spatio-Temporal Wave-front in causing Flow Transition
SWAGATA BHAUMIK, The Ohio State University, TAPAN SENGUPTA, I. I. T. Kanpur, India — Theoretically, boundary layer transition has been identified to occur via K- and H- or N-type routes (Y. S. Kachanov, Ann. Rev. Fluid Mech., 26, 1994) depending upon the arrangement of Λ-vortices in the transitional zone. While the aligned pattern of these vortices are identified with the first type, a staggered arrangement is attributed to the latter. Subsequently, the H-type breakdown is explained due to triad resonant interaction between a monochromatic spatial 2D TS wave and its two oblique 3D sub-harmonic counterparts. We show via high accuracy DNS of receptivity of the zero-pressure gradient boundary layer that both K- and H-types of transition can be noted for monochromatic deterministic wall-excitation due to growth of spatio-temporal wave-front, which in Bhaumik & Sengupta (Phys. Rev. E, 89, 043018, 2014) has been established as the precursor of flow transition. In addition to the high accuracy dispersion-relation preserving numerical schemes, computations are also carried out over a significantly longer computational domain. The H-type transition is noted for lower frequency of excitation cases, while K-type is seen to occur for higher frequency cases which is in contrast to current theoretical view-point, particularly for H-type transition.

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