Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A new scenario of the optimal route from free-stream perturbations to bypass transition in a boundary layer. XUERUI MAO, University of Nottingham, FAZLE HUSSAIN, texas tech university — The optimal route from free-stream perturbations to bypass transition in a flat plate boundary layer is found by computing of the nonlinear optimal inflow perturbation evolution. This study fills the gap between secondary instability of velocity streaks and transition, and reveals that the transition is not the consequence of the saturation of the most unstable secondary instability as widely supposed, but of the interaction of multiple secondary modes, whose phase mismatch induces strong shears leading to a tertiary instability. The optimal route illustrates that free-stream perturbation components gradually enter the boundary layer and contribute to transition successively: the steady (and low-frequency) inflow perturbations induce near-wall velocity streaks; the sinusoidal meandering motion of streaks triggered by high-frequency perturbations generates helical vortex filaments; the filaments then undergo tertiary instability associated with higher-frequency perturbations, leading to an avalanche of breakdown into a tangle of numerous finer-scale vortices and thence to turbulence.

Xuerui Mao
Univ of Nottingham

Date submitted: 03 Aug 2020 Electronic form version 1.4