Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Formation of roll/streaks structures in boundary layers as an instability of turbulence/mean-flow interaction PETROS IOANNOU, University of Athens — Stochastic Structural Stability Theory (SSST) provides a deterministic nonlinear dynamical system for evolving the statistical mean state of a turbulent system. In this presentation SSST is applied to the problem of understanding the origin of the roll/streak structures that arise from free stream turbulence and are associated with bypass transition in boundary layers. Roll structures in the cross-stream/spanwise plane and associated streamwise streaks are shown to arise as a linear instability of interaction between the free stream turbulence and the mean flow. In this interaction Reynolds stresses arising from free stream turbulence are organized by perturbation streamwise streaks to force perturbation rolls giving rise to an amplification of the streamwise streak that in turn further organize the free stream turbulence to produce through this feedback interaction an instability of the roll/streak/turbulence complex. The dominant turbulent perturbation structures involved in supporting the roll/streak/turbulence complex instability are the non-normal oblique optimal perturbations. The emergence of the roll/streak structure arises at a bifurcation in the parameter of free stream turbulence intensity. The instability eventually equilibrates nonlinearly producing perturbation stable streaks and vortex circulations in agreement with the observed structures in transitional boundary layers.

Petros Ioannou
University of Athens

Date submitted: 06 Aug 2010 Electronic form version 1.4