Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Evolution of vortex-surface fields in transitional boundary layers[1]

YUE YANG, YAOMIN ZHAO, SHIYING XIONG, Peking Univ — We apply the vortex-surface field (VSF), a Lagrangian-based structure-identification method, to the DNS database of transitional boundary layers (Sayadi et al., J. Fluid Mech., 724, 2013). The VSFs are constructed from the vorticity fields within a sliding window at different times and locations using a recently developed boundary-constraint method. The isosurfaces of VSF, representing vortex surfaces consisting of vortex lines with different wall distances in the laminar stage, show different evolutionary geometries in transition. We observe that the vortex surfaces with significant deformation evolve from wall-parallel planar sheets through hairpin-like structures and packets into a turbulent spot with regeneration of small-scale hairpins. From quantitative analysis, we show that a small number of representative or influential vortex surfaces can contribute significantly to the increase of the drag coefficient in transition, which implies a reduced-order model based on VSF.

[1]This work has been supported in part by the National Natural Science Foundation of China (Grant Nos. 11472015, 11522215 and 11521091), and the Thousand Young Talents Program of China.

Yue Yang
Peking Univ

Date submitted: 27 Jul 2016 Electronic form version 1.4