Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A new correlation for predicting transition Reynolds number of varying turbulence intensity with pressure gradient.[1] WEI-TAO BI, MENG-JUAN XIAO, FAN TANG, ZHEN-SU SHE, Peking Univ. — We report a new finding on the correlation predicting the laminar-turbulent transition of a boundary layer for varying incoming turbulence intensity and pressure gradient. The new correlation displays a simple scaling of the transition Reynolds number on the incoming turbulence intensity, much simpler than previously proposed empirical ones, owing to an introduction of a transition central location parameter by our newly proposed symmetry-based description of the laminar-turbulent transition. Excellent agreement between the theory and the measurement/simulation data is found for the skin friction and wall heat flux distributions throughout the transition, as accurately validated by the T3-series flat-plate transition experiment and computation data. Owing to its simplicity, the transition model using the current correlation may have significant engineering interest. Furthermore, the results demonstrate that one may uncover simple similarity law governing the transition onset for both natural and bypass transitions, once relevant (statistical) multilayer structure of TBL is represented. The discovery of such similarity law does not require detailed analysis of complex instability mechanisms of the transition. Future work would be to quantify more transition effects, e.g. those in hypersonic engineering flows, which has been extremely difficult via the traditional approach.

[1]NSFC Grants 11372008, 11452002

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Date submitted: 31 Jul 2019 Electronic form version 1.4