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湍流与复杂系统国家重点实验室

Mean Flow Scaling for Boundary Layers with Arbitrary Pressure Gradients

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主持人：史一蓬 教授

地　点：工学院 1 号楼 210 会议室

报告内容摘要：

Fluid dynamics research often grapples with the complexities introduced by pressure gradients within boundary layers. The canonical law of the wall (LoW) is insufficient for accurately describing flow behavior under these conditions due to the spatiotemporal effects of pressure gradients. This talk discusses some of our recent efforts in addressing this challenge. We will delve deep into the development of a universal mean flow scaling for boundary layers affected by pressure gradients. By deriving a velocity transformation from the Navier-Stokes equations that accounts for historical effects, we demonstrate that transformed velocity profiles align closely with the LoW, even in strong gradient conditions. The universality of the proposed scaling is tested against a range of flow configurations, including channels subjected to sudden pressure changes and Couette-Poiseuille flows. Subsequently, we use the velocity transformation for near-wall turbulence modeling. Our treatment includes an additional transport equation that tracks the Lagrangian integration of the total shear stress. The resulting model shows a marked improvement over conventional models in the presence of strong pressure gradients.

报告人简介:

Dr. Xiang Yang is an Assistant Professor in the Department of Mechanical Engineering at Pennsylvania State University. He earned his Ph.D. in Mechanical Engineering from Johns Hopkins University in 2016. Subsequently, Yang joined the Center for Turbulence Research in 2016 as a Postdoctoral Research Fellow before becoming a member of the Mechanical Engineering Department at Penn State in 2018, where he has remained since. Yang was honored with the American Physical Society Division of Fluid Dynamics Best Thesis Award in 2017. He was one of the recipients of the Air Force Office of Scientific Research Young Investigator Award in 2022. Dr. Yang's research is centered around high-fidelity numerical simulations of turbulent flows, turbulence modeling based on physics and data, and the exploration of turbulence theories. With a prolific academic record, he has authored over 90 journal articles.

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