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Accurate determination of Karman constant and mean velocity in high Reynolds number turbulent pipe ZHEN-SU SHE, XI CHEN, YOU WU, Peking University, FAZLE HUSSAIN, University of Houston, SHE TEAM — In 1904, Prandtl1 presented the boundary layer concept, which initiated a century old search for analytic solution of turbulent flow near a wall. Here, we present a theory combining multi-layer perturbation with Lie-group analysis, for a complete determination of the similarity solution in turbulent channel and pipe flows. In particular, we present a procedure enabling close interaction with empirical data, which accomplishes an objective determination of key parameters involved in the solution. A remarkable outcome is all data suggest a universal Karman constant, having the value of 0.45. Based on measured parameter, the predicted MVPs agree with experimental/simulation data within 1% at all points for a wide range of Re covering nearly three decades. Because both multi-layer and Lie-group symmetry are general, this is a promising framework for mean flow solutions of a wide class of turbulent flows, including incompressible, compressible and rough-wall boundary layers, and Rayleigh-Benard convection.

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