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Multi-layer prediction of mean velocity profiles in turbulent boundary layers XI CHEN, College of Engineering, Peking University, FAZLE HUSSAIN, Department of Mechanical Engineering, University of Houston, ZHENSU SHE, College of Engineering, Peking University — A multi-layer prediction of the mean velocity profile (MVP) is developed for the zero pressure gradient (ZPG) turbulent boundary layer (TBL), in good agreement with empirical data over a wide range of the Reynolds number (Re). The theory builds on our model of the mixing length for channel and pipe flows, in which all of the physical parameters characterizing the viscous sublayer, buffer layer and bulk layer are held universal, as well as the Karman constant 0.45. The theory predicts a logarithmic law constant B of 6.5. The identified differences between the channel/pipe and TBL are the absence of a wall-confined central core layer and a fractional scaling of the total stress for the latter. Then, the theory yields an analytic expression for the wake function and friction coefficient in excellent agreement with measurements. In conclusion, a unified theory is presented for the MVPs of all canonical wall-bounded turbulent flows.

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