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Variation approach to describe bulk flow of wall turbulence XI CHEN, Peking University, FAZLE HUSSAIN, Texas Tech University, ZHEN-SU SHE, Peking University — A mean field theory for the mean velocity profile in the bulk of canonical wall bounded turbulence (channel, pipe and turbulent boundary layer) is developed, in good agreement with empirical data over a wide range of the Reynolds number (Re). In analogy to the Landau's mean field theory (1937) using order parameter to explain phase transition in critical phenomena, the current theory builds a variational description for a characteristic length scale, which minimizes the effective free energy for turbulent momentum flux. It leads to a defect power law for the characteristic length scale, not only offering a novel derivation for the logarithmic mean velocity profile, but also quantifying the geometry effect in turbulent channel and pipe flows. Finally, the Karman constant is proved to be a universal constant under such the variational description, and its physical interpretation is also presented.

Fazle Hussain
Texas Tech University

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