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Asymptotic Structure of Turbulent Boundary Layers: Multi-Valued Solutions and Boundary Layer Separation BERNHARD SCHEICHL, ALFRED KLUWICK, Institute of Fluid Mechanics and Heat Transfer, Vienna University of Technology, Vienna, Austria — A comprehensive theory of incompressible turbulent boundary layers (TBL) is established by adopting a minimum of assumptions regarding the flow physics and properly investigating the equations of motion in the high- Reynolds-number limit. The logarithmic law of the wall is revealed and shown to be associated with an asymptotically small rotational streamwise velocity defect on top of the viscous wall layer. Consequently, the classical scaling of two-tiered TBL provides the simplest feasible flow structure. It is, however, possible to extend this concept and to formulate a three-tiered TBL having a slightly larger, i.e. a 'moderately' large, velocity defect. This allows for, amongst others, the prediction of the in the past intensely debated phenomenon of non-unique equilibrium flows for a given pressure gradient. Most important, the observation that all commonly employed closures contain small numbers which may serve to measure the slenderness of the shear layer finally leads to a fully self-consistent asymptotic description of TBL which exhibit a velocity defect of $O(1)$ and, in turn, can even undergo marginal separation.

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