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Self-similar invariant solution in the near-wall region of a turbulent boundary layer at very high Reynolds numbers[1] TOBIAS M. SCHNEIDER, SAJJAD AZIMI, EPFL - Swiss Federal Institute of Technology Lausanne — At sufficiently high Reynolds numbers, shear-flow turbulence close to a wall acquires universal properties. When length and velocity are rescaled by appropriate characteristic scales of the turbulent flow and thereby measured in inner units, the statistical properties of the flow become independent of the Reynolds number. We demonstrate the existence of a wall-attached exact invariant solution of the fully nonlinear 3D Navier-Stokes equations for a parallel boundary layer that captures the characteristic self-similar scaling of near-wall turbulent structures. The solution branch can be followed up to Re=500,000 corresponding to a friction Reynolds number in the millions. Combined theoretical and numerical evidence suggests that the solution is asymptotically self-similar and exactly scales in inner units for Reynolds numbers tending to infinity. Demonstrating the existence of invariant solutions that captures the self-similar scaling properties of turbulence in the near-wall region is a step towards extending the dynamical systems approach to turbulence from the transitional regime to fully developed boundary layers.

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