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Log law via first principles[1] JOE KLEWICKI, University of New Hampshire, PAUL FIFE, University of Utah, TIE WEI, LANL — The first-principles based theory of Fife et al. 2005 *J. Fluid Mech.* **532**, Fife et al. 2009 *J. Discrete & Cont. Dyn. Sys.* **24** is tested relative to the properties of the logarithmic mean velocity profile. The theory demonstrates that the mean momentum balance (MMB) formally admits a hierarchy of scaling layers, with an associated length scale distribution that asymptotically scales with distance from the wall. DNS data are shown to support these and other analytical findings. The mean velocity profile exhibits logarithmic dependence (exact or approximate) when the solution to the MMB exhibits (exact or approximate) self-similarity on the hierarchy. Exact self-similarity corresponds to a constant leading coefficient in the logarithmic mean velocity equation. An independent equation for this coefficient (von Kármán coefficient, κ), and its various equivalent forms are shown support by DNS data. Physically, κ exists owing to approximately scale invariant dynamics over an internal layer hierarchy. The theory clarifies how and why logarithmic dependence occurs and that logarithmic dependence is inherently approximate.

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