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Overlap region in turbulent boundary layer over a rough surface

NOOR AFZAL, Aligarh M. University & ACN College E&M Aligarh, India — The one term non-linear outer layer in George & Castillo (1997, AMR 50, 689), based on their AIP argument, was matched with inner wall layer leading to power law velocity, which denied very existence of traditional log law, while Clauser (1956) patched same outer layer with inner wall log law. Jones, Nickles & Marusic (2008, JFM 616, 195) proposal that free stream velocity (in GC97) and friction velocity (in Coles 1956) are potentially valid scalings according to their theoretical criterion in the outer layer, is misleading, being not correct. Further, in Nishioka (2010, FDR 42, 45502-5) and Prandtl (1935, AT) the additive constant in power law velocity is singular at large Reynolds numbers is also not correct, and this constant is shown to be zero. In the present work, two terms outer layer expansion is considered where leading term scales with free steam velocity and first order with friction velocity. The leading term turns out to be a non-linear wake type equation through application of Izakson-Millikan-Kolmogorov hypothesis. The first order terms lead to alternate functional equations, arising from ratios of two successive derivatives of the functional equations, each of which admits two functional solutions, the power law velocity profile in addition to log law velocity profile. The comparison with extensive data on rough & smooth walls also provide strong support to present work.

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