

Abstract Submitted
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The emergence of logarithmic mean velocity with self-similar spectral energy balance¹ YONGYUN HWANG, Imperial College London, MYOUNGKYU LEE, Sandia National Laboratories — The attached eddy hypothesis of Townsend (The structure of turbulent shear flow, 1956, CUP) states that the logarithmic mean velocity would admit self-similar energy-containing eddies which scale with the distance from the wall. Over the past decade, there has been a growing body of evidence supporting the hypothesis, placing it to be the central platform for the general organisation of coherent structures in wall-bounded turbulent shear flows. Despite this progress, the most fundamental question, namely why this hypothesis is true, remains unanswered over many decades. In this study, we analytically demonstrate that the mean velocity is a logarithmic function of the distance from the wall if and only if the energy balance at integral length scale is self-similar with the distance from the wall. This provides a direct theoretical ground for the attached eddy hypothesis. The analysis is verified with the DNS data of incompressible channel flow at the friction Reynolds number $Re_T = 5200$ (Lee Moser, 2015, J. Fluid Mech., 774:395-415).

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