The Bottleneck Effects and the Kolmogorov Constant in Three-Dimensional Turbulence

D.A. Donzis[1] and K.R. Sreenivasan[2]
[1]Texas A&M Univ., USA; [2]ICTP, Italy

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A large database from direct numerical simulations (DNS) of isotropic turbulence, including recent simulations for box-sizes of up to 4096^3 and Taylor microscale Reynolds numbers of up to about 1000, is used to explore the bottleneck effect in three-dimensional energy spectrum and in second-order structure functions, and to determine the Kolmogorov constant, C_K. The difficulties in estimating C_K at any finite Reynolds number are examined. The data show that the bottleneck effect decreases with the Reynolds number. On this basis, an alternative to the usual procedure for determining C_K is suggested. The proposal does not depend on any particular choice of fitting ranges or power-law behaviors in the inertial range. Within the resolution of the numerical data, C_K thus determined is constant in the Reynolds number. A simple model including non-local transfers is proposed to reproduce the observed scaling. Implications of the findings are discussed.