Time change and Universality in Turbulence

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Abstract

We discuss a unifying description of the probability densities of turbulent velocity increments for a large number of turbulent data sets that include data from low temperature gaseous helium jet experiments, a wind tunnel experiment, an atmospheric boundary layer experiment and a free air jet experiment. Taylor Reynolds numbers range from $R_\lambda = 80$ for the wind tunnel experiment up to $R_\lambda = 17000$ for the atmospheric boundary layer experiment. Empirical findings strongly support the appropriateness of normal inverse Gaussian distributions for a parsimonious and universal description of the probability densities of turbulent velocity increments. Furthermore, the application of a time change in terms of the scale parameter δ of the normal inverse Gaussian distribution results in a collapse of the densities of velocity increments onto Reynolds number independent distributions. We discuss this kind of universality in terms of a stochastic equivalence class that reformulates and extends the concept of Generalized Extended Self-Similarity.