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Negative probability of random multiplier in turbulence[1] XUAN BAI, WEIDONG SU, State Key Laboratory for Turbulence and Complex Systems, Department of Mechanics and Engineering Science, Peking University, Beijing 100871, China — The random multiplicative process (RMP), which has been proposed for over 50 years, is a convenient phenomenological ansatz of turbulence cascade. In the RMP, the fluctuation in a large scale is statistically mapped to the one in a small scale by the linear action of an independent random multiplier (RM). Simple as it is, the RMP is powerful enough since all of the known scaling laws can be included in this model. So far as we know, however, a direct extraction for the probability density function (PDF) of RM has been absent yet. The reason is the deconvolution during the process is ill-posed. Nevertheless, with the progress in the studies of inverse problems, the situation can be changed. By using some new regularization techniques, for the first time we recover the PDFs of the RMs in some turbulent flows. All the consistent results from various methods point to an amazing observation–the PDFs can attain negative values in some intervals; and this can also be justified by some properties of infinitely divisible distributions. Despite the conceptual unconventionality, the present study illustrates the implications of negative probability in turbulence in several aspects, with emphasis on its role in describing the interaction between fluctuations at different scales.

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