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Lévy Dynamics of Stretching in 2-Dimensional Steady Random Flow Fields[1] MARCO DENTZ, IDAEA-CSIC, Barcelona, Spain, TANGUY LE BORGNE, Geosciences Rennes, UMR 6118, Université de Rennes 1, CNRS, Rennes, France, DANIEL LESTER, RMIT University, Melboure, Australia, FELIPE P. J. DE BARROS, University of Southern California, 3620 S. Vermont Avenue, KAP 224B, Los Angeles, — Stretching and compression of material fluid elements is key for the understanding and quantification of the mixing dynamics. For 2-dimensional steady random flows the elongation of a material strip $\rho(t)$ grows algebraically as $\rho(t) \propto t^{\gamma}$. The stretching exponent γ depends on the heterogeneity strength. While the Poincaré-Bendixson theorem explains the absence of exponential stretching in steady $2d$ flows, the mechanisms of the algebraic stretching behavior and its relation to the flow statistics are not known. Here we formulate the deformation of a material fluid element in streamline coordinates, which unravels the dynamics of the stretching provess as a Lévy walk. We provide an explicit relation between the stretching process and the flow heterogeneity and derive the scaling behavior of elongation with time. We find for the stretching exponent γ is bounded between 1/2 and 2, where $\gamma = 1/2$ corresponds to weak heterogeneity and $\gamma = 2$ to strongly heterogeneous flow fields.

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