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Quantum Spontaneous Stochasticity THEODORE DRIVAS, GREGORY EYINK, The Johns Hopkins University — Classical Newtonian dynamics is expected to be deterministic, but recent fluid turbulence theory predicts that a particle advected at high Reynolds-numbers by "nearly rough" flows moves nondeterministically. Small stochastic perturbations to the flow velocity or to the initial data lead to persistent randomness, even in the limit where the perturbations vanish! Such "spontaneous stochasticity has profound consequences for astrophysics, geophysics, and our daily lives. We show that a similar effect occurs with a quantum particle in a "nearly rough" force, for the semi-classical (large-mass) limit, where spreading of the wave-packet is usually expected to be negligible and dynamics to be deterministic Newtonian. Instead, there are non-zero probabilities to observe multiple, non-unique solutions of the classical equations. Although the quantum wavefunction remains split, rapid phase oscillations prevent any coherent superposition of the branches. Classical spontaneous stochasticity has not yet been seen in controlled laboratory experiments of fluid turbulence, but the corresponding quantum effects may be observable by current techniques. We suggest possible experiments with neutral atomic-molecular systems in repulsive electric dipole potentials.

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