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Stochastic model of turbulent mixing by the Rayleigh-Taylor and Richtmyer-Meshkov instabilities

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The turbulent mixing produced by the Rayleigh-Taylor and Richtmyer-Meshkov instabilities is of extreme importance in inertial confinement fusion, astrophysics, and many other applications. We suggest a new stochastic model to describe the mixing process. The system of governing equations consists of the equation of motion, which balances inertial, buoyant, and random dissipative forces in the flow, the Kolmogorov condition for the mean value of the dissipation energy, and a stochastic differential equation for fluctuations of the dissipation energy with a log-normal distribution. The free parameter of the model is adjusted to fit the observations. The probability density function for the position, velocity and the dissipation energy is a solution of the Fokker-Planck equation. We have shown that the growth-rate of the mixing zone is very sensitive to the stochastic effects. Several scenarios are analyzed to describe the generation of inertial scales in the flow in the cases of Rayleigh-Taylor and Richtmyer-Meshkov instabilities. For an ensemble of bubbles and spikes, the partition function of the bubble/spike position is obtained for various density ratios and the acceleration history. Our results agree with existing data and suggest new diagnostic parameters for observations.