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Stochastic Model of the Conditional Lagrangian Acceleration of a Fluid Particle in Developed Turbulence

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Various types of models have been recently suggested to fit the Lagrangian high-Re turbulence data by the groups at Cornell and ENS-Lyon, and DNS by Mordant et al., Yeung, and Gotoh and Fukayama. The random intensity of noise approach to the 1D Laval-Dubrulle-Nazarenko model, based on the Navier–Stokes equation, is used to describe Lagrangian acceleration of a fluid particle in developed turbulence. This leads to consideration of a nonlinear Langevin equation for the acceleration a with coupled additive and multiplicative noises. The stationary PDF associated to this equation is calculated exactly for model white-in-time Gaussian noises. The additive noise intensity and the cross correlation are assumed to depend on velocity fluctuations u in an exponential way. The resulting conditional acceleration PDF $P(a|u)$, variance, and mean are found to be in a good agreement with the recent high-precision Lagrangian data by Mordant, Crawford, and Bodenschatz (2003).

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