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Lagrangian measurements of inertial particle accelerations in turbulent flows.[1]

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Fluid turbulence exhibits strong intermittency at the small scales: the probability of high amplitude fluctuations, caused by intense regions of local vorticity is greatly increased from what would be predicted if the fluctuations had a Gaussian distribution. This results in the acceleration probability density function (pdf) of passive fluid particles having highly stretched exponential tails. Particles with density greater than that of the surrounding fluid, i.e., inertial particles, will respond to the flow differently than passive fluid particles. They will be ejected from the intense, intermittent high vorticity regions into regions of high strain, thereby preferentially sampling the flow. This has consequences for raindrop formation in clouds, industrial mixing, dispersion and pollution, and also provides insight into the fluid structure itself. Here we review recent experimental measurements of inertial particles in turbulence. We show that as inertial effects become more pronounced, the tails of the acceleration pdf become less stretched, and that clustering occurs at the small scales. We present measurements of the radial distribution function, a statistical measure of clustering, and relate this to the changes we observe in the acceleration pdf. Results of wind-tunnel experiments are compared with measurements from stirred tanks and "box turbulence" and related to direct numerical simulations and models. Effects of particle size and initial flow conditions will be discussed.

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