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Turbulent transport of material particles

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When particles transported in a turbulent flow are neutrally buoyant and small (typically comparable in size with the dissipation scale of the surrounding turbulence) they behave as tracers for fluid particles. However, in many practical situations, the transported particles are heavier and/or larger, and their dynamics, which is then affected by inertial effects, deviates from the fluid particles dynamics.

Here, we report measurements of Lagrangian velocity and acceleration statistics of particles transported in a turbulent flow obtained with an acoustic Doppler velocimetry technique : from the Doppler frequency shift of acoustic waves scattered by particles in a turbulent flow, we measure the velocity of the particles. The particles are tracked over a significant fraction of the integral time of the considered turbulence with a high time resolution. This allows to resolve the dynamics of the particles over a wide range of scales in the inertial range of turbulence, from the injection scale, down to the dissipation scale.

We consider a homogeneous isotropic grid turbulence generated in a wind tunnel with a Reynolds number based on Taylor microscale of $R_\lambda \sim 180$. In a first stage of this program we aim to study isolated particles dynamics with a particular focus on the effects of particles finite size and of the particle to fluid density ratio. As particles we use soap bubbles which we can inflate with light or heavy gases in order to vary their density from neutrally buoyant to much higher than the surrounding fluid. The size of the particles can also be independently adjusted from 2 mm to 6 mm, which corresponds to inertial range scales. The versatility of our setup allows to explore a parameter space over a significant range of particles densities and sizes. We present acceleration and velocity time increments statistics (along particles trajectories) and lagrangian velocity correlations. Intermittent dynamics, with time scale dependent statistics, is observed, although intremittency is lower than previously reported for fluid particles. The characteristic timescales of the particles dynamics (correlation time and small scale cutoff)

present systematic trends with the particles size and density which will be discussed.