Inertial particles in turbulence

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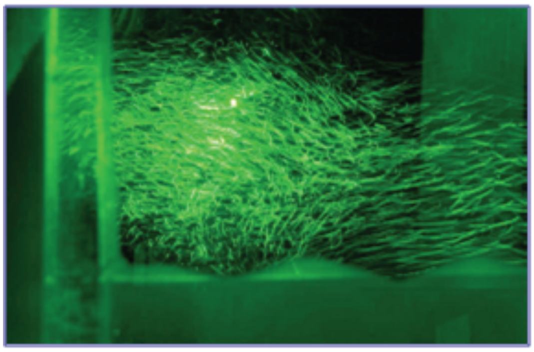
Dispersed two phase flows are relevant to many fields, as they occur in both natural phenomena (rain formation, marine snow) and technological applications (combustion chambers, chemical reactors). Such flows are generally described using the following parameters : the Reynolds number (turbulence intensity), the Stokes number (particle inertia), the Rouse number and the Froude number (effects of gravity). Given the complexity of the equation of a particle moving in a turbulent flow, most models rely on heavy simplifications, which is why further experiments are still needed. Among the reported behaviours of these flows, preferential concentration and settling speed alteration of inertial particles when the carrying phase is in a turbulent state have largely been documented. Moreover, the tendency of the dispersed phase to preferentially accumulate in certain regions of the flow while leaving others completely void seems to be connected to the modification of its settling speed, as observed in the experiments of Aliseda. Aliseda suggested that as the particles coalesce into clusters they would form bigger meta-particles that would be responsible for the alteration of the settling velocity. This claim is supported by recent experiments and numerical works involving a back reaction of the fluid phase on the particles. In these two-way simulations, particles and fluid have been observed to fall together, which is consistent with the meta particles hypothesis. To study these phenomena, we devised an experiment in which heavy solid particles fall in a turbulent flow generated by oscillating grids. The goals of our study are the following (i) to disentangle the effects of the different parameters and (ii) to further probe the relation between local particle/fluid slip velocity and settling speed modification. By tuning our particle populations in both density (using glass, ceramic, steel and tungsten carbide particles giving us the following particle/water density ratios 2.5, 4, 7 and 14) and size (10 to 200 µm refined using a set of sieves) we can map our parameter space to assess the influence of each one relative to the others. Moreover, the use of a double measurement setup with particle image velocimetry (PIV) and particle tracking (PTV) gives us access to both fluid and particle velocities, enabling us to test the meta-particle hypothesis. To complement this experimental study, further two-way numerical simulations are also being conducted.



Romain Monchaux est professeur associé à l'ENSTA-Paris où il mène des recherches en turbulence basées essentiellement sur le montage d'expériences modèles. Ses principales activités concernent la transition à la turbulence dans les écoulements cisaillés et la dynamique de particules inertielles sous écoulement, thème qu'il développe depuis son post-doctorat au LEGI à Grenoble. Auparavant, durant sa thèse au CEA de Saclay, il a travaillé sur l'effet dynamo et proposé une mécanique statistique des écoulements turbulents.