Direct numerical simulation of particulate flows: investigating finite-size effects

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Although fluid-particle systems are technologically relevant in many contexts, our understanding of their dynamics is still incomplete. Phenomena such as particle clustering are therefore still difficult to predict with the aid of engineering-type approaches. The situation is even more intricate when the particles are not small compared to the smallest flow scales, and/or the Reynolds number on the particle scale is not negligibly small. In this situation it becomes necessary to resolve the flow around the individual particles up to a precision which yields the correct hydrodynamic forces. This fully-resolved approach, although computationally demanding, is becoming increasingly feasible for investigating said dynamics in idealized configurations.
Here I will report on numerical studies on dilute suspensions of particles in homogeneous flows, with and without gravity. In the former case particles are on average settling through the fluid, which leads to the formation of wakes. The specific wake structure in turn induces various regimes of particle motion which are further modified by collective (multi-particle) effects. In the latter case we are interested in the interaction between a turbulent background flow and the suspended particles, investigating such questions as: where are particles preferentially located with respect to turbulent flow structures?

In 1997 Markus Uhlmann received a PhD from Ecole Centrale de Lyon (France) in the field of compressible turbulence modeling. As a PostDoc he worked on control of wall-bounded turbulent flows at Universidad Politecnica de Madrid (Spain), and on the turbulent energy cascade at the Potsdam Institute for Climate Impact Research (Germany), before joining CIEMAT (in Madrid) as a researcher in 2002. From then, his main focus has been on multi-phase (particulate) flow. In 2008 Markus Uhlmann was appointed Professor of Numerical Fluid Mechanics at University of Karlsruhe (now Karlsruhe Institute of Technology), where he is currently joint head of the Institute for Hydromechanics. He serves as associate editor for the International Journal of Multiphase Flow and is a member of the steering committee of HLRS, which currently hosts Germany's fastest supercomputer.

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