Application of the Immersed Boundary Method to particle-laden and bubbly flows

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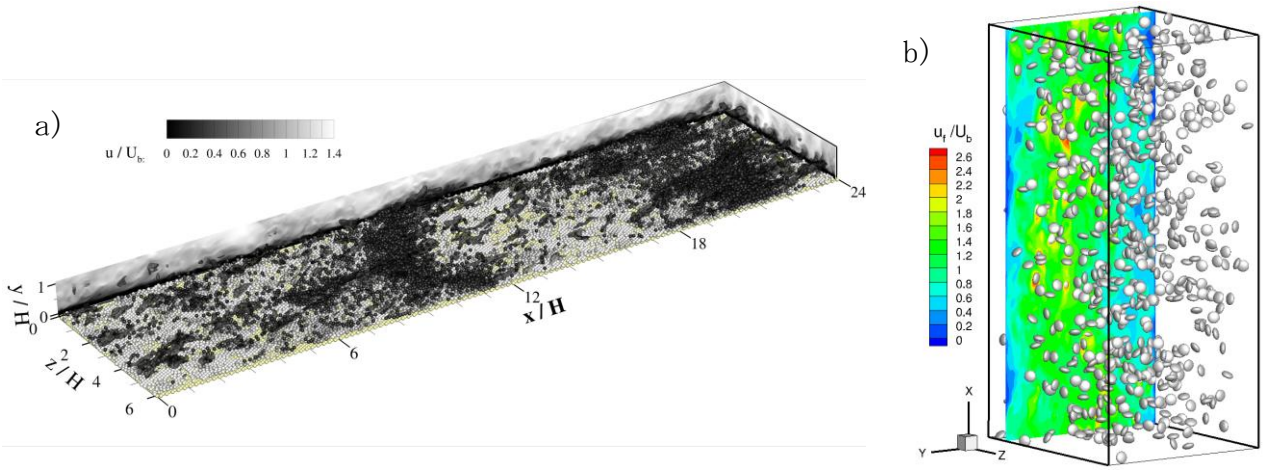
ABSTRACT

The numerical simulation of turbulent flows laden with solid particles is of specific importance for a wide range of situations relevant for engineering as well as fundamental research. If particles are smaller than the smallest scales of turbulence, i.e. the Kolmogorov scales, they are usually modelled as mass points without spatial extension. If, in contrast, the particles are larger than the smallest scales, a spatial resolution of the particle geometry is required. The same applies to non-spherical particles with more complex shapes.



Application of the IBM to different configurations. a) Instantaneous particle distribution in an open channel flow. Contour plot of u / U_b on the sides of the domain, 3d-iso-surfaces of fluid fluctuations with u' / U_b = -0.3 inside the domain. Particle colours: grey = fixed, white = $|u_p| < 1.5\ u_\tau$, black = $|u_p| > 1.5\ u_\tau$. b) Light ellipsoidal particles in a vertical channel flow. Snapshot of particle position and slice of fluid velocity (streamwise component) for an instant in time during the simulation.

In the recent years, the Immersed Boundary Method (IBM) has proven to be an efficient method for the fully coupled, three-dimensional simulation of many mobile particles in viscous flows with interface resolution. The idea of the talk is to give an overview of the recent extensions and improvements of the basic method of Uhlmann [J. Comput. Phys., 2005] and their use for various physical configurations, including the modeling of ellipsoidal particles, deformable bubbles and of particle collisions. Highly-resolved simulations of an open channel flow laden with spherical particles are presented.