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Seminar

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Sala Struttura della Materia (Dipartimento di Fisica)

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"Restructuring of colloidal aggregates in turbulent flows"

Abstract

Particles in the colloidal and micrometer size range have a strong tendency to stick together and form clusters or aggregates that, depending of the type of particles, might undergo further transitions such as coalescence or sintering. Flow in the suspending fluid has a distinct influence on the dynamics of this aggregation process. Not only does the flow enhance the rate of aggregation and thus the growth of aggregates, but also, hydrodynamic stress caused by fluid velocity gradients and fluid-particle velocity differences can lead to restructuring and breakup of aggregates. Understanding of these phenomena is crucial for describing dynamics of aggregating particles in flowing suspensions which is of high relevance for many environmental and industrial applications, such as the processing of colloids in the polymer, food, and pharmaceutical industry, and modeling of suspended solids in coastal waters and estuaries.

In this work, the focus is put on restructuring of aggregates during their growth in a turbulent flow. Typically, small aggregates assume a fractal like structure characterized through a mass fractal dimension. Restructuring is quantitatively described as an evolution of the aggregate fractal dimension, i.e. from a relatively small value at the beginning (indicating open aggregates) to a high value at later times (indicating dense aggregates). A methodology is presented to obtain this evolution from monitoring aggregate growth in an experiment. The methodology is based on a detailed population balance model accounting for aggregation and breakup, and the dependency of these rate processes on the fractal dimension. In agreement with theoretical studies in the literature, results suggest that restructuring sets in when the mean aggregate size is still considerably smaller than the steady state aggregate size where aggregation and breakup balance. The duration of the restructuring process is found to be proportional the viscous time scale of the underlying turbulent flow.

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