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SIMULATION OF PARTICLE SUSPENSION IN SIMPLE AND COMPLEX FLUID MEDIA USING SMOOTHED PARTICLE HYDRODYNAMICS

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In this talk I will present a particle approach based on smoothed particle hydrodynamics (SPH) and smoothed dissipative particle dynamics (SDPD) to model suspension of colloidal and non-colloidal particles [1]. SDPD is a thermodynamically consistent version of smoothed particle hydrodynamics (SPH) and can be interpreted as a multi-scale particle framework linking the macroscopic SPH to the mesoscopic dissipative particle dynamics method (DPD) [2]. Rigid structures of arbitrary shape embedded in the fluid are modeled by using frozen boundary particles on which artificial velocities are assigned in order to satisfy exactly the no-slip boundary condition on the solid-liquid interface. The correct scaling of the SDPD thermal fluctuations with the fluid-particle size [3] allows us to describe the behavior of the particle suspension on a wide range of spatial scales, ranging continuously from the diffusion-dominated regime typical of sub-micron-sized colloidal objects towards the Brownian-less regime characterizing non-colloidal suspensions.
When modeling a very concentrated particle suspension new technical problems arise. In particular, the simulation of nearly contacting solid particles is a highly challenging task due to the diverging short-range behavior of lubrication forces which pose a serious time-step limitation for explicit integration schemes. In the second part of this talk I will present a semi-implicit splitting scheme which enables effective direct simulations of concentrated multi-particles systems [4].
As a final application, results on the microrheology of rigid colloidal particles suspended in a complex viscoelastic medium described by the Oldroyd-B model will be presented. The method proposed in [5, 6] allows the use of continuum models of complex fluids equipped

with proper thermal fluctuations for the hydrodynamic and microstructural variables introduced according to the Fluctuation-Dissipation Theorem.

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