Stuttgarter Physikalisches Kolloquium

Max-Planck-Institut für Intelligente Systeme
Max-Planck-Institut für Festkörperforschung
Fachbereich Physik, Universität Stuttgart

Ansprechpartner: Dr. Michael Hirscher
E-Mail: hirscher@mf.mpg.de
Telefon: 0711 - 689-1808

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Stuttgarter Max-Planck-Institute, Heisenbergstraße 1, 70569 Stuttgart-Büsnau

Gastgeber: Prof. Siegfried Dietrich, Max-Planck-Institut für Intelligente Systeme, Telefon: 0711 - 689-1920

Colloidal dispersions in external fields: A topic for Statistical Mechanics?

Prof. Matthias Fuchs
Universität Konstanz

Abstract

Colloidal dispersions show a broad variety of rheological phenomena. Einstein calculated that the viscosity of dilute solutions increases linearly with the volume fraction of the solute. Concentrated systems, like clay, can form soft solids which deform elastically under small applied stresses. In order to fluidize them, a yield stress has to be overcome. For all concentrations, shear thinning sets in as soon as the enforced flow rate becomes faster than intrinsic relaxation times; the viscosity of dense solutions decreases by orders in magnitude. Shear thickening can be observed in everyday solutions like cornstarch in water, when the viscosity jumps increasing the flow rate only slightly. The response to applied forces and stresses also is highly nonlinear in general. Besides elastic and fluid response, creep can be observed in colloidal solids for intermediate stresses. The velocity-force relations of individual probe particles in colloidal glass show a de-localization transition at a finite force threshold.

Fundamental understanding of these phenomena requires to describe classical many body systems far from thermal equilibrium. Stationary states in even simple situations like constant shear flow do not possess a Boltzmann-Gibbs distribution function as shear breaks detailed balance. I will review recent advances in our understanding of these non-equilibrium phenomena arising from the combination of microscopic theory, computer simulations and experiments on colloidal model systems. A many-particle Fokker-Planck equation for interacting Brownian particles will be the basis that will be analyzed using inter alia mode coupling theory.