Lecture Series

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Solidification: perspectives from experiments with colloidal suspensions of particles with hard sphere-like interactions

Tuesday, June 7, 2011 at 14:30-16:15
Thursday, June 9, 2011 at 14:30-16:15
im HS Makromolekulare Chemie, Stefan-Meier-Str.31

Abstract: Almost a century ago Jean Perrin used colloidal suspensions to establish, directly and conclusively, the existence of atoms. He showed that colloidal particles behave like very large atoms; they obey equi-partition of energy and their motions, as predicted by Einstein, are just large-scale manifestations of the thermal motions of atoms. Over about the last twenty years there has been renewed interest in exploiting this analogy between colloids and atoms. However, where Perrin used dilute suspensions, an analogue of the ideal gas, recent work uses concentrated suspensions and, to a striking degree, these mimic the classical behaviour of condensed matter, specifically crystallisation and vitrification.

The properties which make colloidal systems attractive for studies of these processes are the mechanical fragility of colloidal crystals, the long lifetimes of metastable colloidal fluids and the adjustability of the inter-particle potentials. While molecular crystals typically take nanoseconds to nucleate and grow, colloidal crystals take macroscopic times, from minutes to days, to form.

The experiments, analogous to neutron and X-ray scattering conventionally used in condensed matter, are based on laser light spectroscopy and fall into two classes: One measures the formation of crystals in the under-cooled colloidal “melt” by following the growth of a Bragg reflection. The second measures structural relaxation in terms of the statistics of either the particle concentration fluctuations or the particle displacements. Recent experiments challenge the assumptions that underpin both classical theory of freezing and the prevailing views of the glass transition.

The results of experiments and related background will be presented in following lectures;

Introduction (the atom-colloid analogy)
Nucleation (Equilibrium phase behaviour of a suspension of particles with hard-sphere interaction. Nucleation and growth of colloidal crystals.)
Dynamic light scattering (Brownian motion, mean-squared displacement, stretching and related properties to identify many-body dynamics.)
Solidification dynamics (Survey of recent dynamic light scattering studies of the colloidal and molecular dynamics studies of the ballistic hard-sphere fluids.)