CMET Seminar

Dr. Gerhard Nägele

Professor, Theoretical Physics

Heinrich-Heine-University Düsseldorf

Forschungszentrum Jülich

DATE:

March 22, 2016

TIME:

11:00 a.m.

LOCATION:

366 CLB

Dr. Nägele received his Ph.D. in physics, with distinction, from the University of Konstanz in Germany. He is on Scientific Staff at the Institute of Complex Systems, Forschungszentrum Jülich, and Professor of Theoretical Physics at the Heinrich-Heine University in Düsseldorf. His current research activities comprise the many-body theory and computer simulation of the structure, diffusion, rheology, and the equilibrium and non-equilibrium phase behavior of colloidal suspensions in the bulk phase, at two-dimensional interfaces, and in external gravitational and electric fields. His research aims to derive macroscopic transport properties from the knowledge of the microscopic interactions, and explore the application of colloid methods to biological systems and industrially relevant processes such as continuous filtration. He is the author of over 100 publications, has contributed to multiple books, and has presented lectures in several countries.

"Rheology and Diffusion Properties of Concentrated Microgel Suspensions with Application to Filtration"

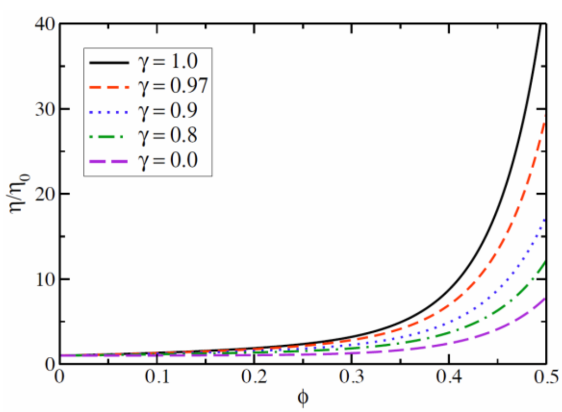

Fig.1 Theoretical results for zero-frequency viscosity of hydrodynamically structured (permeable) particle systems as function of concentration (see [1] for details).

Microgel suspensions exhibit interesting rheological and diffusion properties determined by direct and hydrodynamic interactions. Using an annulus model to account for the solvent permeability of the particles, we calculate the high-frequency suspension viscosity, wave-number dependent diffusion function and short-time self-diffusion coefficient of concentrated non-ionic PNiPAM microgel suspensions, with results in excellent agreement with simulation and experimental data [1,2]. Moreover, an extension of our precise analytic methods to the calculation of long-time properties including the zero-frequency viscosity and long-time self-diffusion coefficient is presented, with the results compared to simulation and experimental data. Our theoretical expressions for these transport properties are used to scrutinize the validity of two generalized Stokes-Einstein relations in which diffusion properties are related to viscosities.

The predicted transport properties are an important ingredient to our realistic modeling of convective-diffusive particle transport in the continuous membrane ultrafiltration process of permeable particles dispersions. The efficiency of the separation process depends on hydrodynamic boundary conditions, membrane properties and particle-membrane interactions. We calculate the inhomogeneous concentration polarization layer of particles formed near the membrane surface, and the trans-membrane permeate flux for various operating conditions. Cross-flow ultrafiltration of both non-ionic [3] and ionic [4] microgel systems is considered. It is shown that microgel permeability, and the concentration-dependent viscosity and gradient diffusion coefficient significantly influence the filtration behavior [3,4].

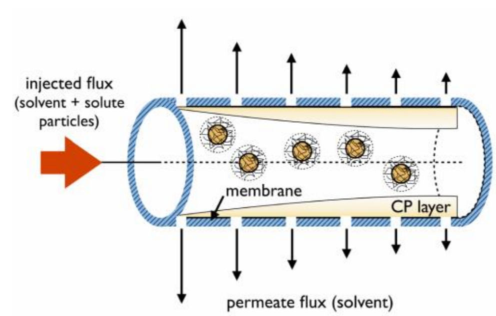

Fig. 2 Hollow-fiber membrane used in the inside-out cross-flow filtration process (see [3] for details).