# DY 53: Focus: Disordered Systems/Glasses under Shear (joint session CPP/ DY)

Time: Thursday 15:30–17:00 Location: C 243

**Invited Talk** DY 53.1 Thu 15:30 C 243

**Microscopic flows of complex suspensions** — •Anke Lindner — PMMH-ESPCI, Paris

The flow of complex suspensions is ubiquitous in nature and industrial applications. Their non-Newtonian character is due to flow-induced orientation, rearrangement, or deformation of microscopic objects suspended in simple fluids. These objects can be isotropic or anisotropic, rigid or deformable, active or passive. Linking the microstructure on the particle level to the macroscopic response under flow is one of the fundamental scientific challenges of soft matter physics. Recent microfabrication techniques lead to a precise control of even complex particle properties and new microfluidic rheometers show high resolution. Using these new approaches, we present two examples of flows of complex suspensions in chosen microfluidic geometries which allow this link to be established. First, we use a solution of flexible polymers, where normal stresses are known to arise when the polymers are stretched under flow and characterize the onset of elastic flow instability in a serpentine channel as a function of its curvature. The calibrated serpentine channel can then be used as a sensitive rheometer to detect even small normal stresses in unknown suspensions. Second, we employ a Y-channel, a powerful rheometer for measuring shear viscosities, to study the viscosity of active suspensions of e-coli bacteria. In this way we link the activity of the bacteria to the measured non-Newtonian effective viscosity.

DY 53.2 Thu 16:00 C 243

**Thinning and Thickening in Active Microrheology** — •Ting Wang and Matthias Sperl — Institut für Materialphysik im Weltraum, DLR, Köln, Germany

When pulling a probe particle in a driven granular system with constant velocity, one can characterize the probe by a velocity-dependent friction coefficient. With increasing control velocity, the friction of the probe keeps constant in the small-velocity regime (linear response), decreases in the moderate-velocity regime (thinning), and then increases in the large-velocity regime (thickening).

There are three distinct processes behind those phenomena: diffusion, damping and direct collision; the magnitude of the pulling velocity determines which process dominates, resulting in thinning or thickening behavior. We confirm this physics picture by stochastic simulation.

DY 53.3 Thu 16:15 C 243

**Transition to flow of binary glasses under applied stress or strain rate** — •Marco Laurati[1], Tatjana Sentjabrskaja[1], Jan Hendricks[1], Alan R Jacobs[2], George Petekidis[2], and Stefan U Egelhaaf[1] — [1]Condensed Matter Physics Laboratory, Heinrich-Heine University Düsseldorf — [2]IESL-FORTH, University of Crete

We investigate and compare the transition to flow of glasses composed by two species of colloidal hard spheres presenting large size asymmetry, upon application of a constant stress or constant shear rate. The transition to flow of the binary glasses is affected by the composition of the mixture, and reflects changes in the prevailing caging mechanism, i.e. transitions between different glass states [1]. Furthermore, the timescales characterising the onset of flow significantly differ depending on the nature of the applied field, i.e. stress or strain. The relaxation of the accumulated stress after removal of the applied field demonstrates the presence of residual stresses that can be tuned through the mixture's composition. The recovery of strain after creep reveals a non monotonic dependence of the recovery time as a function of the previously applied stress, with a maximum recovery time observed in correspondence to the yield stress of the glass. [1] T. Sentjabrskaja et al. (2014), Soft Matter, 10, 6546-6555.

DY 53.4 Thu 16:30 C 243

**Yielding in concentrated colloidal dispersions: relation between stress overshoot and microscopic structure and dynamics** — Marco Laurati, Kevin Mutch, and •Stefan Egelhaaf — Condensed Matter Physics Laboratory, Heinrich Heine University, 40225 Düsseldorf, Germany

The microscopic structure and dynamics of concentrated colloidal dispersions at different times after application of shear is determined using confocal microscopy. When the stress overshoot occurs in the rheological response, we observe super-diffusion and a maximally deformed cage, i.e. maximum structural anisotropy [1,2]. The anisotropy is not only characterized by a quadrupolar (angular momentum $l = 2$) distortion expected by continuum elasticity theory, but also a higher order hexadecupolar ($l = 4$) mode which marks the transition form reversible elastic to irreversible plastic deformation [3]. This mode suggests that yielding of local cages proceeds through the rearrangement of particles in the first neighbour shells, which switch from the compressional to the extensional axis. Also in the steady-state of shear, cage-breaking events are found to persist. In addition to the anisotropic cage deformation, yielding is also accompanied by a strong rise in the isotropic ($l = 0$) distortion, which corresponds to a pressure increase.

[1] N. Koumakis et al. (2012) Phys. Rev. Lett. 108, 098303. [2] K.J. Mutch et al. (2013) Eur. Phys. J. - Special Topics 222, 2803. [3] C.P. Amann et al. (2013) arxiv:1302.2030.

DY 53.5 Thu 16:45 C 243

**Continuum Mechanics Simulations in Glass Forming Liquids** — •Heliana Cardenas and Thomas Voigtmann — Deutsches Zentrum für Luft- und Raumfahrt, Köln, Germany

Amorphous glassy materials show complex flow features when they are formed by solidification of dense liquids. An important feature of such systems is the non-linear nature of the flow rule relating stresses and strains when they are perturbed by external forces. The transition itself is characterized by slow dynamics where the intrinsic relaxation time plays a determining role on describing this behavior.

Schematically, the interaction of non-linear rheology and slow relaxation can be captured by so-called "fluidity" models, where the (spatially local) structural relaxation rate is a function of flow rate. The spatial dynamics of fluidity is controlled by a diffusion coefficient related to a cooperativity length scale.

We use finite volume method (FVM) to combine the resulting constitutive equation with the Navier-Stokes equations to effectively describe the flow behavior of glass-forming systems in various geometries and for different time-dependent protocols.