Stress correlations in complex fluids

M. Bischopinck[1], N. Grimm[2], J. Geiger[1], M. Fuchs[2], A. Zumbusch[1]

[1] *Department of Chemistry, University of Konstanz, 78464 Konstanz*
[2] *Department of Physics, University of Konstanz, 78464 Konstanz*

We present experiments and simulations of colloidal glass-forming dispersions. Investigated particle geometries are ellipsoidal and spherical, where the spheres are designed to allow for rotation measurements by confocal fluorescence microscopy. Experimental results are compared to simulations with convincing agreement thus enabling quantitative comparisons. First results on the stress auto-correlations in a liquid are presented as well.

For the experiments, spherical tracer particles are used to capture rotational dynamics whereas translation is followed for all particles. The binary mixture of spherical colloidal particles is modeled by an event driven simulation of hard spheres. Despite neglecting hydrodynamic interactions in the simulation, capturing rotation-translation coupling via binary scattering processes reproduces experimental results well. This suggests that in dense liquids excluded volume effects play a dominant role. The experimental finding of only minor changes in rotational diffusion close to the glass transition is reproduced by simulations.

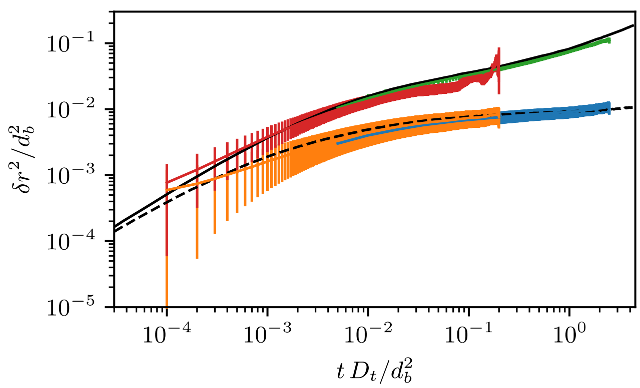

Fig. 1: *Mean squared displacement in experiment (colors) and simulation (black) of a binary hard sphere mixture. Upper line corresponds to small particles, lower line to big ones.*

From a theoretical perspective rotation translation coupling can also lead to activity [1] or BKT critical phenomena in 2D [2]. The close to 90 year old predictions by Perrin on the rotational and translational diffusion of ellipsoidal colloids as function of aspect ratio are verified for the first time. To this end, free diffusion of oblate and prolate colloidal particles is followed with confocal fluorescence microscopy. Simulations confirm that the experiments considered the dilute limit and find a strong density dependence of the translation diffusion coefficient for elongated colloids.

References:

[1] N. Grimm, A. Zippelius, M. Fuchs, *Phys. Rev. E* **106**, 034604 (2022).
[2] T. Bissinger, M. Fuchs, *J. Chem. Phys.* (in press) (2023).