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Driven motion of colloids in active microrheology

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In active microrheology, a strong external force is applied to a colloidal probe immersed in a complex fluid, so that among other quantities the nonlinear force-velocity relation can be measured. It provides information on the local viscoelastic properties of the complex fluid or soft solid. Generally, in dense fluids, the probe's friction coefficient decreases strongly with increasing force [1]. If the probe is pinned in a glass, the probe remains localized by the nearest-neighbor cages for small enough forces. Then the stationary probe density distribution (see Fig. 1) displays the local cage and its plastic deformation [2]. Close to the depinning threshold of a probe in glass, intermittent dynamics sets in where the probe particle undergoes a combination of highly localized motion and rare, increasingly long-ranged excursions, leading to anomalous force-induced diffusion behavior [3]. The long-time diffusion coefficients become anisotropic and strongly force dependent.

I discuss computer simulations and recent theoretical results based on the mode-coupling theory of the glass transition [1–4].

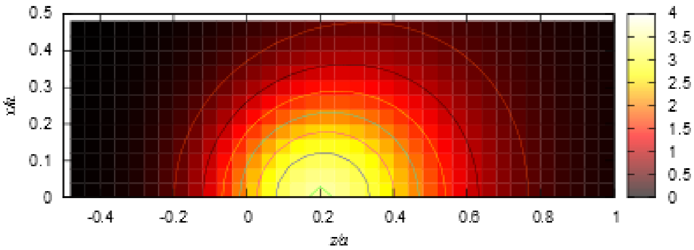

Figure 1: Probability density of a forced Brownian probe particle (radius a) pinned in a metastable amorphous solid made of equal-sized hard spheres (at packing fraction 0.52). The probe experiences a force of 10 $k_B T/a$ to the right; mode coupling theory calculation from [2]

References

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