Slow relaxation in colloidal mesophases

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Over the last decade, X-ray photon correlation spectroscopy (XPCS) has become feasible owing to the coherent beams produced by third generation synchrotrons. This technique is particularly adapted to the study of slow relaxations, in both crystalline and disordered materials. In contrast with dynamic light scattering, it can be used with opaque samples and can reach much higher scattering vectors. It therefore shows great promise for the study of concentrated colloidal suspensions, where it can probe the dynamics of the system over space scales comparable to the interparticle distance. Previous work has shown that isotropic solutions of spherical particles can be thoroughly characterized using XPCS. In particular, the hydrodynamic interaction between particles has been quantified and shown to be in agreement with theoretical models.

We have recently used XPCS to determine the collective diffusion coefficient of anisotropic particles organized in nematic or smectic mesophases. At long range (below the structure peak), the collective dynamics of the nematic phase (composed of nanorods) experiences strong and scale-dependent slowing down, in contrast with isotropic suspensions of slender rods or of spherical particles. In smectic phases formed of large platelets, the hydrodynamic interaction between the particles sets in gradually with increasing concentration and can be described semi-quantitatively by a highly simplified model.