Dynamics of concentrated core-shell nanoparticle suspensions from confocal differential dynamic microscopy

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Recently, there has been a surge of interest in understanding the dynamical and structural properties of core-shell nanoparticle (CSNp) suspensions due to their importance in a number of applications, including emulsion stabilization, delivery and sensing. In contrast to their counterpart – hard-sphere suspensions – CSNp suspensions have been shown to exhibit fundamentally different hydrodynamic interactions, due both to solvent permeability into the shell and the fuzzy structure of the particle itself [1, 2]. Most of the experimental work on the equilibrium dynamic properties of CSNp suspensions has so far been on particles with a soft core and a soft shell (microgels) [1]. Here, we investigate the dynamics of CSNps dispersed in water with a hard silica core surrounded by a soft shell composed of poly(N-isopropylacrylamide) (PNiPAM) [3]. Their dynamics is probed by confocal differential dynamic microscopy (ConDDM), a technique that has been recently shown to yield information similar to that of dynamic light scattering, but applicable to dense and opaque colloidal suspensions [4]. We found that the behaviour of the intermediate scattering function (ISF) obtained from DDM analysis of concentrated core-shell nanoparticle suspensions is of the form: $F(q,t) = A(q)[1 - \exp\left(-\left(\frac{t}{\tau(q)}\right)^{\beta(q)}\right)] + B(q)$. For the case of a dilute suspension, the stretching exponent β is found to have a constant value close to 1, as expected for simple Brownian diffusion [5]. Conversely, for higher volume fraction (ϕ) suspensions, we found that $\beta < 1$ and is not independent of q. The characteristic relaxation time $\tau(q)$ at large ϕ deviates from the dilute $1/Dq^2$ behaviour, indicating structural effects that couple to particle dynamics.

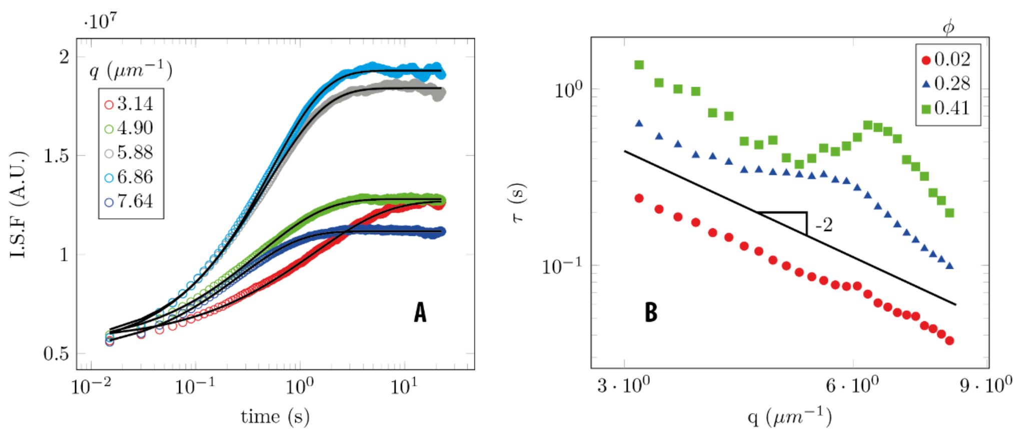

Figure 1: **A)** ISF vs time for $\phi = 0.41$ CSNp suspension at different wave vector q. **B)** Relaxation time τ vs q behavior for different volume fractions ϕ.

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