ESRF	**Experiment title:** Ultraslow dynamics in charge stabilized colloidal systems	**Experiment number**: SC-1979
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Report:

We investigated the hydrodynamic behavior of series of charge stabilized colloidal suspensions in terms of tuning their interaction potential. More precisely, we varied the strength of the direct interactions of the particles in the suspension to study the correlation between those direct interactions and the indirect hydrodynamic interactions. The direct interaction pair potential V(r) between two charge-stabilized colloidal particles is described by a screened Coulomb ("Yukawa") potential $V(r)=e^2z^2/4\pi\varepsilon_0\varepsilon_r r \exp(\kappa r)$, where z is the effective number of charges per macroion, ε_0 is the vacuum dielectric constant and ε_r the relative dielectric permittivity of the solvent. r is the interparticle distance and κ is the inverse Debye screening length which is related to the total amount of charges that are present in the solution: $\kappa=e^2(k_BT\varepsilon_0\varepsilon_r)^{-1}(nz+2c_s)$, where c_s is the amount of added electrolyte and n is the number density of the macroions. In order to change the direct interaction strength we either varied the electrolyte concentration to change the inverse screening length κ at a given volume fraction ϕ, or we changed the interparticle distance r by varying the volume fraction at a fixed electrolyte concentration c_s.

From a master suspension consisting of silica particles suspended in water, we prepared series of different volume fractions and different electrolyte concentrations. The particle size R=400Å is evaluated from the analysis of the SAXS scattering intensity profile on a dilute screened sample. The result is in good accordance to the hydrodynamic Radius R_H=480Å obtained by a dynamic light scattering experiment on a dilute suspension.

The investigated volume fractions ranged between 0.02 and 0.2 and the added electrolyte concentrations between 100 and 1000µmol/l potassium chloride. For each sample the static structure factor S(q) is extracted from the SAXS experiment and fitted within the RMSA (rescaled mean spherical approximation) to characterize the direct interactions. Then, we used XPCS to probe the effective diffusion coefficient D(q) on wavevectors covering the S(q) maximum. The combination of SAXS and XPCS experiments allowed us to extract the corresponding hydrodynamic function H(q) of each prepared sample: $H(q)=D(q)*S(q)/D_0$, where

$D_0=k_BT/(6\pi\eta R)$ is the Stokes-Einstein diffusion coefficient or free diffusion coefficient which is obtained by measuring the diffusion of a diluted, non-interacting particle suspension.

Figures 1-3 display the static structure factor S(q), the inverse effective diffusion coefficient $D_0/D(q)$ and the extracted hydrodynamic function H(q) of suspensions with different volume fractions and added electrolyte, respectively.

Figure 1 shows the results of a suspension with low volume fraction ($\phi/2\sim0.025$). The finding of $H(q_{max})>1$ implies a faster dynamics on lengthscales corresponding to the mean interparticle distances. In contrast, for a suspension with a higher volume fraction (fig. 2 with $2\phi\sim0.1$) the finding of $H(q_{max})<1$ indicates a slowing down of the dynamics. By adding electrolyte to this suspension this slowing down effect is even stronger. For example, the hydrodynamic function H(q) of a suspension with volume fraction 2ϕ decreases from $H(q_{max})=0.8$ to $H(q_{max})=0.6$ by changing the electrolyte concentration from no salt to 100µmol/l added salt (fig.3).

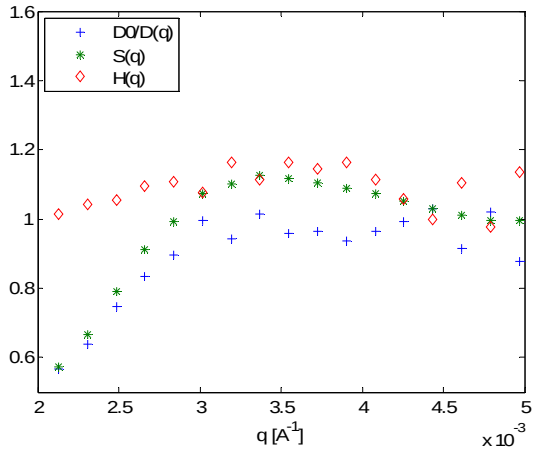

Fig.1: Hydrodynamic function H(q), static structure factor S(q)and the inverse diffusion coefficient $D_0/D(q)$ for a colloidal suspension of volume fraction $\phi/2$ and no electrolyte added. .

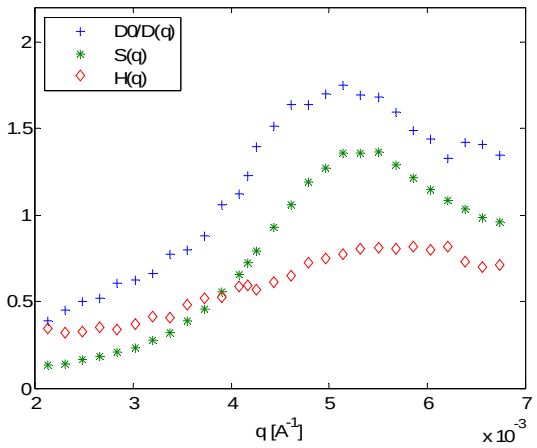

Fig.2: H(q), S(q) and the inverse diffusion coefficient $D_0/D(q)$ for a colloidal suspension with volume fraction 2ϕ and no electrolyte added.

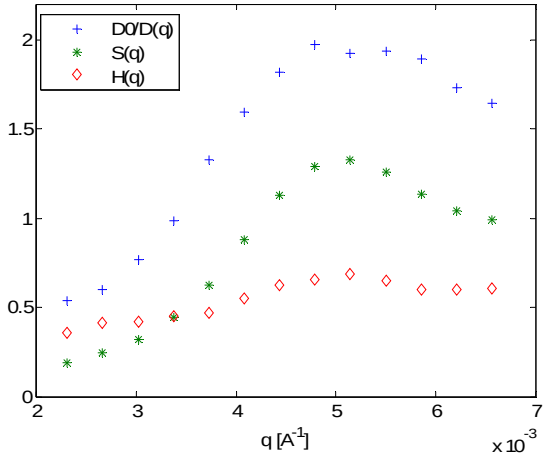

Fig.3: H(q), S(q) and the inverse diffusion coefficient $D_0/D(q)$ for a colloidal suspension of volume fraction 2ϕ and100 µmol/l electrolyte added.