ESRF	**Experiment title:** Slow Dynamics in glassy Ferrofluids : towards anisotropic aging ?	**Experiment number**: SC-1866
Beamline: ID10C	**Date of experiment**: from: 22/02/2006 to: 28/02/2006	**Date of report**: 28/02/2006
Shifts: 18	**Local contact(s)**: Dr. Aymeric ROBERT	*Received at ESRF:*

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Report :

The aim of the proposal was to investigate the slow dynamics of glassy magnetic colloidal dispersions in zero field and under an applied magnetic field,which introduces an interaction potential anisotropy in the system. The system consists of charge-stabilized spherical magnetic colloidal nanoparticles (γ-Fe_2O_3) dispersed in water at elevated concentration (volume fraction $\Phi \approx 30$vol%), thus locating the samples as repulsive glass forming.

Therefore we used the 2D-X-ray Photon Correlation Spectroscopy (2D-XPCS) capabilities of the ID10C Troïka beamline. We used 7.06keV x-rays (i.e below the Fe-absorption K-edge at 7.112keV). A 40*40μm^2 pair of slits was used in order to define a partially coherent X-ray beam. The sample was placed in a specific sample environment (borrowed from ID02) allowing to apply a permanent homogeneous magnetic field perpendicular to the X-ray beam. In the present case we worked with a 0.4 T magnetic field.

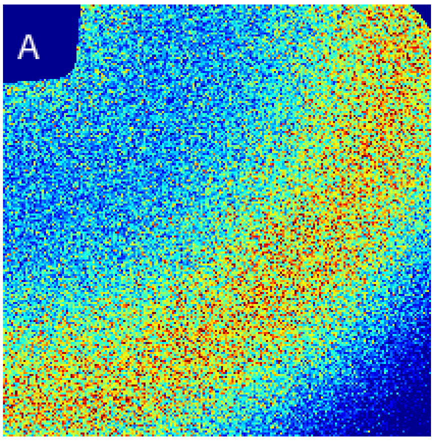
A direct illumination deep depleted CCD, performing in single-photon-counting mode with pixels size of 20*20 μm^2) is placed 1.8 meters from the sample and records the time-resolved speckle patterns scattered by the coherently illuminated sample. The intensity autocorrelation function are then computed out of the series of frames with a specific 2D-XPCS multi-τ, multi-Q correlator software accessible at the beamline. Three different samples (with various particle sizes, resulting in various magnetic interaction contribution to the interaction potential in addition to electrostatic repulsion originating from the charge-stabilization) were investigated with and without magnetic field successively, taking care of recording the exact time of each operation operated on the sample in order to clearly map out the history of the sample. For each configuration, time-resolved speckle patterns were recorded over 11 hours (we were limited to 12h because of the refill of the machine and needed almost 1h to properly

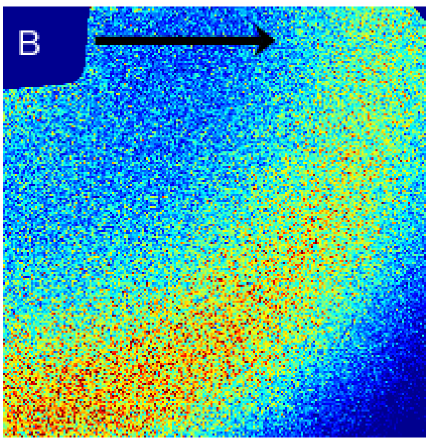
align the sample and record dark files for correct background substraction of the CCD frames). Each frame was taken over an acquisition time of typically 10s, to which 2.5s needs to be added for readout. The choice of the exposure time was dictated to the time required to get sufficient statistics on each CCD frame to performe 2D-XPCS calculation afterwards. This could be reduced largerly by increasing the incident flux of the experimental setup, in getting the third undulator tuned at our working energy. We specifically resquested this option in a continuation-proposal in order to access to faster timescales.

Conventional (i.e non-coherent) SAXS measurements were first performed on each of the three samples in order to get a form-factor. On one specific sample, a 2D-XPCS rough evaluation of the data clearly indicates that the dynamics is successfully probed. *Without the presence of the magnetic field*, the speckle patterns are isotropic (cf. Fig.1.A) and present a correlation peak related to the static structure peak of this glassy system, located at Q=0.045 $Å^{-1}$. Dynamics is observed and indication of aging are obvious from the preliminary analysis of the data. *When applying a magnetic field*, the scatterring pattern is anisotropic, as presented in Fig.1.B. It presents a symmetry along the field direction (indicated by the arrow).

We were able for the first time, out of the same speckle patterns, to observe anisotropic dynamics regarding to the field direction, as well as anisotropic aging phenomena. Correlation functions are presented in Fig.1.C at Q=0.045 $Å^{-1}$ and at the same age for H=0 and H = 4 kOe. Out of this preliminary analysis we can already say that the dynamics is faster under field for comparable ages of the sample. In addition the dynamics is observed to be slower in the direction perpendicular to the field as compared to the direction of the field.

A complete Q and age dependence of the field/nofield configurations are currently being analyzed on the whole set of data. A continuation proposal for the study of the magnetic field strength dependence is being submitted.





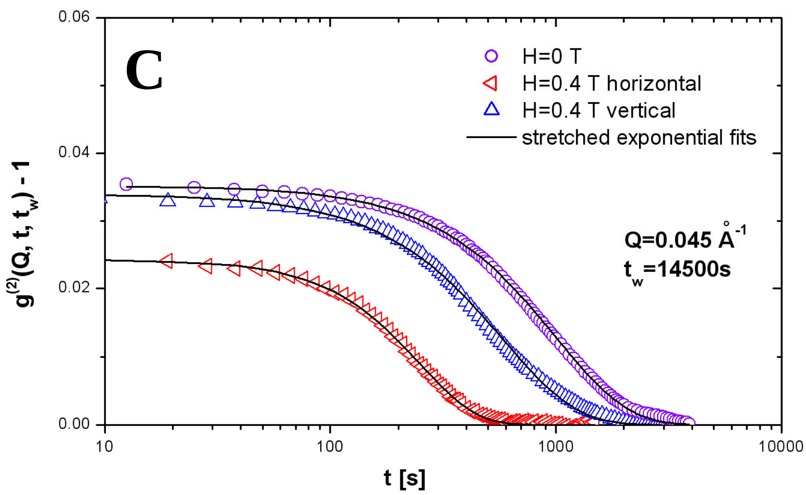


Figure 1.A : Isotropic speckle pattern measured without magnetic field. The ring corresponds to the peak of I(Q), located at Q=0.045$Å^{-1}$.

Figure1.B : Anisotropic speckle pattern measured with a magnetic field of 4 kOe (i.e. direction of the arrow) on the same sample

Figure 1.C : Intensity autocorrelation functions measured at Q=0.045$Å^{-1}$ at the same age (t_w=14500s) and on the same sample without field (H=0 Oe) and with field (H=4 kOe) along the field direction (horizontal) and perpendicular to the magnetic field (vertical)