Contribution ID: **395**

Type: **Contributed talk**

XPCS in Bunch Mode: XPCS-echo and Wide Timescale Measurements

Friday 30 August 2024 15:45 (15 minutes)

With the emergence of 4th generation synchrotrons, X-ray Photon Correlation Spectroscopy (XPCS) has improved both in terms of the available coherent photon flux and speckle contrast [Chevremont2024]. Together with fast photon counting pixel array detectors, this technique has become more attractive for the investigation of a broad range of systems [Narayanan2023]. However, one of the main limitations of XPCS measurements is the sample degradation by the X-ray beam and resulting beam-induced dynamics [Chushkin2022]. Yet another bottleneck when performing XPCS at a high frame rate for a long time is the time and memory needed to process the data, which scale quadratically with the number of frames.

To address these issues, a novel acquisition scheme has been developed at the TRUSAXS
Instrument (beamline ID02), ESRF. This new scheme has been termed as "time resolved"or "bunch mode" XPCS. It involves acquiring frames at the highest frame rate according to the lowest lag time to be measured only when needed and thus exposure of the sample to the beam is minimized. Bunches of frames are acquired, spaced by variable dead time where the fast beam shutter remains closed and the sample unexposed to X-ray beam. The autocorrelation functions are still calculated by performing the correlation between all the frames, and reconstructing the two-time correlation function (TTCF) before averaging.

In this work, the application of the bunch mode XPCS is demonstrated on samples (colloidal gels formed by short-range attraction between particles) whose correlation functions span over several orders of magnitude in lag time. Another interesting application is for XPCS-echo, where the acquisition is synchronized with an oscillatory motion of the sample imposed by a rheometer [Pham2004]. In this experiment, the detector frames are acquired on each oscillation period and echoes in the autocorrelation function [g2(q,t)] appear each time the sample returns to the initial position. The envelope of echoes measured corresponds to the decay of the autocorrelation function due to the intrinsic dynamics in the sample. For fully reversible motion, the envelope strictly corresponds to the autocorrelation function of the sample at rest. On the other hand, an acceleration of the decorrelation occurs when the sample yields with increasing amplitude of deformation. The XPCS-echo then provides an elegant way to measure the intrinsic dynamics within the sample, discriminating the Doppler shifts caused by the shear.

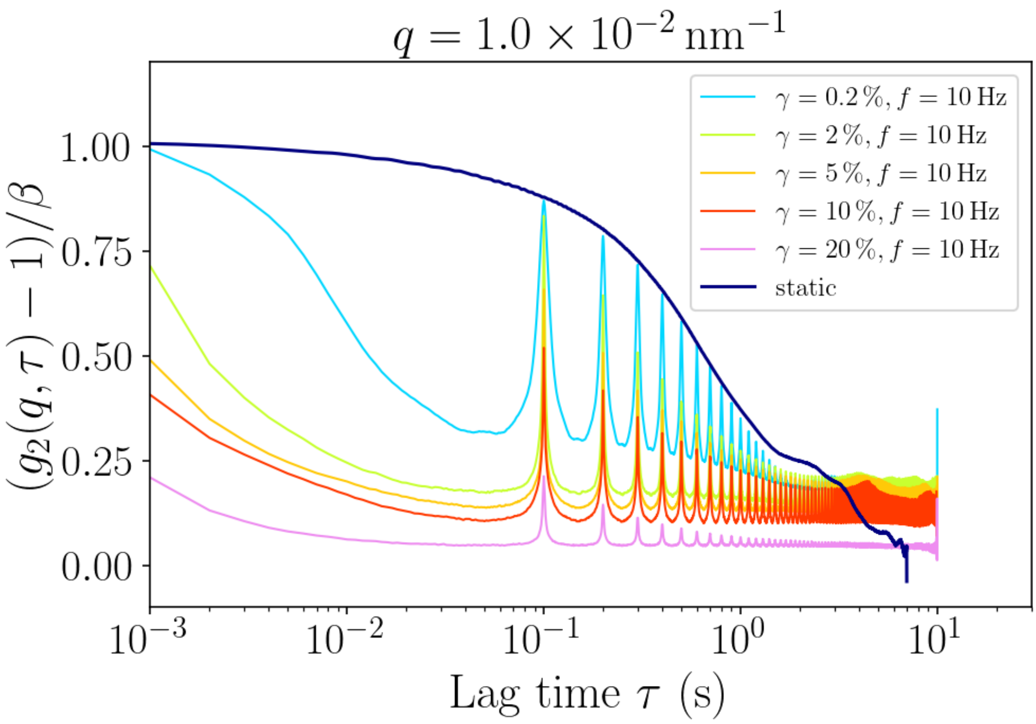

Figure 1: Figure: Measurements of XPCS-echo and normal autocorrelation functions of a dense colloidal suspension of PMMA particles (size ~ 800 nm) in cis-decalin subjected to oscillatory shear of varying amplitudes at a frequency of 10 Hz.

Figure: Measurements of XPCS-echo and normal autocorrelation functions of a dense colloidal suspension of PMMA particles (size ~ 800 nm) in cis-decalin subjected to oscillatory shear of varying amplitudes at a frequency of 10 Hz.

W. Chevremont, T. Zinn & T. Narayanan, J. Synchrotron Rad., 31 (2024) 65.
T. Narayanan, W. Chevremont & T. Zinn, J. Appl. Cryst., 56 (2023) 939.
Y. Chushkin, A. Gulotta, F. Roosen-Runge, A. Pal, A. Stradner & P. Schurtenberger, Phys. Rev. Lett., 129 (2022) 238001.
K. N. Pham, S. U. Egelhaaf, A. Moussaı¨d, & P. N. Pusey, Rev. Sci. Instrum., 75 (2004) 2419.

I plan to submit also conference proceedings

No

Primary author: CHÈVREMONT, William (ESRF)

Co-author: Dr NARAYANAN, Theyencheri (ESRF)

Presenter: CHÈVREMONT, William (ESRF)

Session Classification: Mikrosymposium 12/3: Time Resolved Techniques

Track Classification: 12. Time resolved techniques