

Title

XPCS: X-ray Photon Correlation Spectroscopy

Short title

XPCS

People

Federico Zontone, Maciej Jankowski, Yuriy Chushkin

Scope

Disordered matter represents a category of systems where spatial and temporal fluctuations dictate their spatial and temporal structural properties. While disorder has a mild influence on the (average) structure, e.g. via density, the dynamical properties can dramatically change by orders of magnitude upon a limited variation of thermodynamic parameters like temperature and pressure.

Density fluctuations can be measured by coherent light in a scattering experiment where the speckle pattern becomes resolved in the detector. Speckles are ensembles of fine interferences encoding the exact instantaneous structural arrangement of the specimen. They are modulated in space by the size of the coherent probe and in time by the dynamics of the sample fluctuations.

X-ray Photon Correlation Spectroscopy (XPCS), the X-ray analogue of Dynamic Light Scattering (DLS), is a unique tool able to quantify temporal (electron) density fluctuations providing the intermediate scattering function $f(Q,t)$ at the scattering vector Q , the physical quantity describing the relaxation behaviour of the system in the Fourier space.

Thanks to the high brilliance of the 4th generation synchrotron sources like the Extremely Brilliant Source (EBS) at the ESRF, XPCS can probe the temporal domain down to tens of nano-sec from the meso-scale at small Q to the atomic scale at large Q , covering a large variety of soft and hard condensed matter systems not accessible by DLS, e.g. opaque colloids, gels and phase-ordering alloys at the meso-scale, deeply super-cooled melts and structural glasses at the atomic scale.

The tutorial covers the fundamental principles of XPCS based on coherent X-ray scattering and details of the data collection. We introduce the status of data handling and analysis showing how the physics of the dynamics can be extracted. Finally, we highlight the large impact of EBS on XPCS, allowing the extension towards very fast (10 ns) time scales thanks to new detection schemes and towards high energies (> 20 keV) allowing high-pressure studies of structural glasses in diamond anvil cells.

Maximum participants

25

Program

Three lectures: 50 min (FZ) + 50 min (YC) + 30 min (MC)

- “Coherent X-ray beams and X-ray Photon Correlation Spectroscopy”, Federico Zontone

- “Modern data handling and analysis demo”, Maciej Jankowski, Yuriy Chushkin
- “XPCS at EBS”, Yuriy Chushkin and Federico Zontone

Start/finish

Spanned time: 14h00 – 16h30

14h00 - 14h50 – Tutorial intro and 1st lecture (FZ)

14h50 - 15h00 - Break

15h00 - 15h50 - 2nd lecture (MJ, YC)

15h50 - 16h00 - Break

16h00 - 16h30 – 3rd lecture (YC, FZ)

Meeting room/equipment

Yes/Video projector

Organisation

On site