Development of X-ray speckle visibility spectroscopy for breaking the limit of time resolution in X-ray Photon Correlation Spectroscopy

Ichiro Inoue[1,2], Yuya Shinohara[1,3], Akira Watanabe[1], Yoshiyuki Amemiya[1,3]

[1]Graduate School of Frontier Sciences, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8561, Japan
[2]RIKEN SPring-8 Center, 1-1-1 Kouto, Sayo-cho, Sayo-gun, Hyogo 679-5148, Japan
[3]JST-CREST, 4-1-8 Honcho, Kawaguchi, Saitama 332-0012, Japan

When coherent X-rays impinge upon a disordered system, a grainy scattering pattern called speckle pattern is observed [1]. When the system evolves with time, the corresponding speckle pattern also changes. Temporal changes in the speckle patterns therefore provide information on the system dynamics. This technique, which is called X-ray photon correlation spectroscopy (XPCS) [2], is a rather new technique, but has shown the potential to access dynamic properties of various materials, such as colloidal suspensions, block copolymer, supercooled liquids, alloys, and antiferromagnetic materials.

Although XPCS is a powerful technique for material science as recent studies show, it has a limitation of time resolution: dynamics faster than the frame rate of detector cannot be measured. When a two-dimensional (2D) detector is used in XPCS, the time resolution is limited to the order of milliseconds.

For improving the time resolution of XPCS, we have extended speckle visibility spectroscopy (SVS) in the region of visible light [3] to the region of X-rays (X-ray SVS; XSVS) [4]. Since the minimum exposure time of the scattering patterns determines the time resolutions of XSVS and SVS, micro- or nano- second dynamics can be measured even with a 2D detector. Thus, XSVS has potential to bridge the time gap between XPCS and inelastic neutron/X-ray scattering techniques, and will be one of the promising tools for material science in the next generation synchrotron X-ray facilities, such as diffraction limited storage rings and energy recovery linac X-ray sources.

In this presentation, we will describe the principle of XSVS and show the result of the application of XSVS to Brownian colloidal suspensions.

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