Quantum Material Research by Resonant Inelastic Soft X-ray Scattering Facility at NanoTerasu

J. Miyawaki

Institute for Advanced Synchrotron Light Source,
National Institutes for Quantum Science and Technology (QST), Sendai, Japan

*E-mail: miyawaki.jun@qst.go.jp

Resonant inelastic X-ray scattering (RIXS) is an advanced spectroscopic technique based on the photon-in/photon-out principle, enabling the exploration of the energy-momentum dispersion in elementary excitations and ordered states such as plasmons, orbitons, magnons, phonons, and charge-density waves. In the past two decades, there has been a remarkable improvement in the energy resolution of soft X-ray RIXS, facilitating detailed investigations into spin and charge excitations. As a complementary technique to inelastic neutron scattering, soft X-ray RIXS has become an essential method for studying these excitations. RIXS has a significantly large scattering cross-section by using the resonance effect and can utilize highly focused X-rays, allowing measurements not only on bulk samples but also on very small samples in the micrometer range or ultrathin films in the nanometer thickness range. Furthermore, as an X-ray spectroscopic technique, RIXS offers relatively high degrees of measurement flexibility, making it suitable for operando measurements and various other applications.

In Japan, the construction of NanoTerasu, a 3 GeV-class synchrotron radiation facility, is currently underway in the Tohoku region. At NanoTerasu, an ultrahigh-resolution RIXS facility is being developed. This state-of-the-art RIXS facility is designed to achieve an exceptional energy resolution of 10 meV in the soft X-ray region, specifically targeting the Fe *L*-edge. Extensive efforts are being made to complete the construction by the beginning of 2025 with the first aim of acquiring RIXS spectra. Once this facility is operational, it is expected to greatly contribute to the study of garnets, as it will enable RIXS measurement at Fe *L*-edge as well as at *M*-edge of rare earth elements.

In the presentation, I would like to provide an overview of the ongoing development of the ultrahigh-resolution RIXS facility at NanoTerasu and discuss recent research utilizing soft X-ray RIXS. Additionally, I will touch upon research prospects of spin excitations explored by ultrahigh resolution soft X-ray RIXS.

[1] J. Miyawaki *et al.*, "Design of Ultrahigh Energy Resolution RIXS Beamline at NanoTerasu", J. Phys. Conf. Ser. 2380, 012030 (2022).