Computational research on diffraction imaging using attosecond sources

Giang Tran [1,2], Katsumi Midorikawa [2], Eiji J. Takahashi[1,3]

[1]Ultrafast Coherent Soft X-ray Photonics Research Team, RIKEN Center for Advanced Photonics, RIKEN, [2]Attosecond Science Research Team, RIKEN Center for Advanced Photonics, RIKEN, [3]Extreme Laser Science Laboratory, RIKEN Cluster for Pioneering Research, RIKEN

E-mail: giang.tran@riken.jp

The development of attosecond sources [1-4] based on high harmonic generation (HHG) opens the opportunities to capture the ultrafast phenomena in matter. In addition, the table-top scale of attosecond sources allows to perform the experiments such as coherent diffraction imaging (CDI) [5], which are only undertaken at large scale facilities. However, the low power and broad continuum spectrum attosecond sources prevent the applicability of CDI technique in the laboratory scale.

In this work, we show the possibility of obtaining high resolution images using the combination of CDI and attosecond sources. Making use of the high power attosecond sources [2-3] generated from high intensity synthesized laser and new developed algorithms, we demonstrate the potential to overcome the limitation of broad bandwidth to obtain high resolution images. In addition, the complex information of sample recovered from the broadband diffraction intensity demonstrates the potential to apply the attosecond sources for exploring the inner structure of samples.

[1] Eiji J. Takahashi et al. Attosecond nonlinear optics using gigawatt scale isolated attosecond pulses. Nature Communications 4, 2691, 2013.

[2] B. Xue et al. Fully stabilized multi-TW optical waveform synthesizer: Toward gigawatt isolated attosecond pulses. Sci. Adv. 6, eaay2802, 2020.

[3] Bing Xue et al. Gigawatt-class, tabletop, isolated attosecond pulse light source. Optica 9, 360-363, 2022.

[4] Katsumi Midorikawa. Progress on tabletop isolated attosecond light sources. Nature Photonics 16 2022.

[5] J. Miao et al. Beyond crystallography: Diffractive imaging using coherent x-ray light sources. Science 348 (2015).