15：00-, Fri 26th-January-2024
KPSI, Kyoto, JAPAN
The 104th KPSI Seminar, QST

Ultrafast Spectroscopy with Modern Light Sources

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Abstract

The rapid development and ongoing improvements in modern light sources have led to significant advancements in the brilliance, coherence, and short pulse duration of the radiation they provide. This radiation can be utilized to study the electronic properties of chemical systems, which govern chemical bonding characteristics. Soft X-ray spectroscopy has evolved as a powerful tool for investigating the electronic structure of matter with element-, site-, and orbital specificity. However, the majority of relevant chemical and all biochemical processes occur in the liquid phase, posing an experimental challenge. Therefore, sophisticated experimental end-stations and sample delivery systems are necessary to probe molecular systems in their natural environment: the liquid phase.

In this presentation, I will explore the advancements in high harmonic spectroscopy for probing the intrinsic characteristics of bulk liquids [1,2]. I will explain how its underlying principles have been harnessed to transform it into a spectroscopic tool for the investigation of fundamental properties of liquids. Additionally, I will discuss the development of 'water window' table-top photon sources. These innovative sources have facilitated the inaugural time-resolved measurements of multi-photon-induced dynamics within liquid alcohols and biomolecules in solution, employing an HHG-based setup [3,4]. Table-top soft X-ray (SXR) sources, powered by intense femtosecond lasers, have enabled the execution of time-resolved X-ray absorption spectroscopy (TrXAS), allowing us to examine structural and electronic dynamics as they unfold [5-9]. The 'water window' spectral domain, stretching from the carbon to oxygen K absorption edges (284 to 538 eV), has broadened the scope for performing TrXAS on liquid samples and solutions, encompassing the absorption edges of elements critical to biology, including carbon, nitrogen, and oxygen.

Furthermore, I will discuss activities at free-electron laser facilities and the instrumentation that has been designed for liquid phase soft X-ray spectroscopy, enabling the investigation of the electronic structure of biochemical systems in the liquid phase.

References
[1] T. Luu et al. Nat. Comm. 9, 3732 (2018) [2] A. Mondal et al. Nat. Phys. 19, 1813 (2023) [3] A. D. Smith, et al. J. Phys. Chem. Lett. 11, 1981 (2020) [4] Z. Yin et al Nature, 619, 749 (2023) [5] S. Teichmann, et al, Nat. Commun. 7, 11493 (2016) [6] A.S. Johnson et al. Science Advances 4 eaar3761 (2018) [7] X. Fu et al, Communication Physics 3, 92 (2020) [8] A. Attar et al. Science 356, 54 (2017) [9] N. Ishii et al Nat. Comm. 5, 3331 (2014)