



## Physics Colloquium

# High Harmonic Generation in Gases and Liquids using intense mid-infrared sources



**November 20, 2024 (Wednesday)**



**5:00 p.m.**



**MWT4, 1/F, Meng Wah Complex,  
Main Campus, HKU**



**Prof. Jiro ITATANI**

*Institute for Solid State Physics, The University of Tokyo*

### Abstract:

In high harmonic generation (HHG), the field-driven sub-cycle electron dynamics plays the fundamental role. In the case of gas HHG, the three-step model leads to the cutoff energy scaling of  $3.17U_p + I_p$  where  $U_p$  is the ponderomotive energy and  $I_p$  is the ionization potential [1]. This simple relationship has motivated the development of optical parametric amplifiers that can produce phase-stable and ultrashort intense pulses in the infrared. We have developed a BiB<sub>3</sub>O<sub>6</sub>-based optical parametric amplifier (OPA) system for the generation of intense SWIR pulses ( $\lambda \sim 1.6 \mu\text{m}$ ) and extended the spectral range of isolated attosecond pulses to the water window [2]. The hierarchical dynamics of electrons, molecular vibration, and molecular rotation in NO and N<sub>2</sub>O gases are clearly observed by the transient soft x-ray absorption spectroscopy at the nitrogen K edge ( $\sim 400 \text{ eV}$ ) [3].

Further extension of the spectral range of intense OPAs into the medium wavelength infrared (MWIR) region allows the generation of high harmonics in solids and liquids [4], because the associated low photon energy prevents multiphoton excitation followed by destructive avalanche ionization. In the case of liquids, thin flat water jet systems are developed, which allow to study destructive laser-matter interaction at higher intensity than with the solid targets with a high repetition rate (1 kHz) light source. We have observed non-trivial nonlinear optical responses and high harmonic generation in H<sub>2</sub>O with 3- $\mu\text{m}$  excitation, where strong absorption by OH vibrations co-exist with field-driven electron dynamics.

### Biography:

Jiro Itatani is a professor at the Institute for Solid State Physics (ISSP), University of Tokyo, Japan. He received his Ph. D. in 1998 from the University of Tokyo. During his Ph.D. work, he stayed at the Center for Ultrafast Optical Science at the University of Michigan in USA. After graduation he was a postdoctoral fellow at RIKEN, Japan, in 1998-2000, and then at the National Research Council Canada in 2000-2003. In 2003-2008, he participated in a project of Japan Science and Technology Agency and stayed at Lawrence Berkeley National Laboratory, USA as a visiting scholar. Since 2008, he is at the Institute for Solid State Physics, University of Tokyo. His research interests include intense ultrafast laser sources, attosecond and strong-field physics, and ultrafast soft x-ray spectroscopy.