

***Prof. Hans Jakob WÖRNER***

***Laboratorium für Physikalische Chemie  
ETH ZÜRICH (Switzerland)***

**IMCN SEMINAR**

***Attosecond soft-X-ray spectroscopy  
in the gas and liquid phase***

**Friday 3 April 2020 – 11:00 am  
Auditoire J.-B. Carnoy (B059)  
Croix du Sud, 4-5, 1348 Louvain-La-Neuve**

More information : Sophie HERMANS ([sophie.hermans@uclouvain.be](mailto:sophie.hermans@uclouvain.be))

## **Prof. Hans Jakob WÖRNER**

**Laboratorium für Physikalische Chemie - ETH ZÜRICH (Switzerland)**

### **ABSTRACT**

Attosecond time-resolved spectroscopy has the potential to address fundamental open questions in chemical sciences. Although the first two decades of research have led to very important advances towards this goal, the techniques of attosecond spectroscopy still need to overcome two gaps. The first gap is the complexity gap, i.e. the challenge of applying attosecond spectroscopy to complex molecules. A promising approach to overcome the complexity gap consists in exploiting the element-, site- and spin-sensitivity of X-ray spectroscopy. We have recently demonstrated the potential of table-top X-ray absorption spectroscopy with a water-window high-harmonic source, observing the temporal evolution of unoccupied molecular orbitals, as well as molecular shape resonances during chemical reactions [1]. Compressing the mid-infrared driving pulses to less than two optical cycles, we have demonstrated the extension of this table-top source to fully cover the oxygen K-edge with fluxes sufficient for time-resolved measurements [2]. Using the same technique, we have also demonstrated the generation of isolated attosecond pulses, which have established a new record of the shortest light pulses ever measured (43 attoseconds) [3]. In our most recent work, we have applied attosecond soft-X-ray spectroscopy to observe electronic dynamics in several molecules. The second gap is the extension from the gas to the liquid phase, which is the relevant phase for the vast majority of chemical and biophysical processes. I will discuss the first realization of femtosecond time-resolved soft-X-ray absorption spectroscopy of liquids with a high-harmonic source [4]. In our most recent collaborative work, we have extended these measurements to study ionization-induced dynamics in several molecular liquids. These combined developments set the stage for attosecond time-resolved studies of molecular systems of chemical complexity.

- [1] Y. Pertot, C. Schmidt, M. Matthews, A. Chauvet, M. Huppert, V. Svoboda, A. von Conta, A. Tehlar, D. Baykusheva, J.-P. Wolf, H. J. Wörner, *Science* **355**, 264 (2017)
- [2] C. Schmidt, Y. Pertot, T. Balciunas, K. Zinchenko, M. Matthews, H. J. Wörner, J.-P. Wolf, *Opt. Exp.* **26**, 11834 (2018)
- [3] T. Gaumnitz, A. Jain, Y. Pertot, M. Huppert, I. Jordan, F. Ardana-Lamas, H. J. Wörner, *Opt. Exp.* **25**, 27506 (2017)
- [4] A. D. Smith, T. Balciunas, Y.-P. Chang, C. Schmidt, K. Zinchenko, F. B. Nunes, E. Rossi, V. Svoboda, Z. Yin, J.P. Wolf, H. J. Wörner, *J. Phys. Chem. Lett.* **11**, 1981 (2020)

### **BIOGRAPHY**

Hans Jakob Woerner's main research focus is the ultra-fast spectroscopy of molecules with an attosecond time resolution ( $1\text{as} = 10^{-18}\text{ s}$ ) and the development of new experimental methods to characterize the structure and dynamics of the valence shell of molecules.

Hans Jakob Woerner has been an Assistant Professor at the Laboratory of Physical Chemistry in the Department of Chemistry and Applied Biosciences since 2010.

He was born in Freiburg, Germany, in 1981.

Hans Jakob Woerner studied chemistry at ETH Zurich, graduating in 2003 and obtaining a doctorate in physical chemistry in 2007. From 2007, he worked as a postdoc at the Laboratoire Aimé Cotton of the CNRS (Centre national de la recherche scientifique) in Orsay, France, and the National Research Council in Ottawa, Canada.

