Contribution ID: **2** Type: **Talk**

Terahertz-induced ultrafast symmetry control in condensed matter: Water and Silicon

Thursday 15 February 2018 10:20 (20 minutes)

The combination of strong terahertz (THz) with tailored optical fields for spectroscopy of solids lies at the heart of SOLSTICE. New research avenues emerge for THz-induced symmetry control in condensed matter, as illustrated for liquid water and silicon in this talk.

Water dynamics in the THz region is dominated by the intermolecular forces of the hydrogen-bond network, which is held responsible for many of water's anomalous properties. While there is recent consensus that these dynamics consist of several relaxation mechanisms, their microscopic origin is still debated. Most commonly, they are associated with the rotation and/or libration of water molecules. Within a larger collaboration, we studied the molecular polarizability anisotropy of liquid water revealed by THz-induced transient orientation, that breaks the susceptibility's isotropy [1]. The observed ultrafast orientation of water permits deeper insights into the transient structure of water.

In silicon, we explore new opportunities of THz-dressing-based symmetry control manifesting in high-order harmonic generation from crystals [2]. Terahertz-dressing of crystals extends the toolbox for ultrafast information manipulation for petahertz electronics and, more generally, for controlling nonperturbative light-matter interactions.

[1] P. Zalden, L. Song, X. Wu, H. Huang, F. Ahr, O. D. Mücke, J. Reichert, M. Thorwart, P. K. Mishra, R. Welsch, R. Santra, F. X. Kärtner, and C. Bressler, "Molecular polarizability anisotropy of liquid water revealed by terahertz-induced transient orientation,"submitted (2017).
[2] H. Huang, L. Song, N. Tancogne-Dejean, N. Klemke, A. Rubio, F. X. Kärtner, and O. D. Mücke, "High-Order Harmonic Generation from Solids Dressed by an Intense Terahertz Field,"submitted to CLEO 2018.

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Session Classification: Attosecond 2

Track Classification: Contributed talk