Time-Resolved Photoelectron Circular Dichroism of Fenchone at FERMI

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Chirality plays a fundamental role in nature. A chiral molecule is defined as one whose configuration is not superimposable on its mirror image. Two mirror images of the same chiral compound are called enantiomers, or optical isomers since they can be distinguished by making them interacting with circularly polarized light sources. Chirality has been a subject of deep investigation in biology, chemistry, and pharmaceutics. However, the ultrafast dynamics of chiral compounds is mostly unexplored. One of the more promising investigation techniques for studying the time-dependent dynamics of a chiral compound is time-resolved photo-electron circular dichroism (TR-PECD). In conventional PECD, a circularly polarized pulse ionizes a randomly oriented optical isomer. The dichroism of the sample emerges from a strong forward-backward asymmetry of the angle-resolved photoemission along the propagation direction of the ionizing pulse. Recently, the relaxation dynamics of a photoexcited chiral sample have been tracked with PECD from the electronically excited states of molecules, providing the first demonstration of the sensitivity of TR-PECD to ultrafast chiral dynamics [1,2].

We extended this approach by performing PECD on photoexcited fenchone at the carbon K-edge: we demonstrated that femtosecond chiral dynamics in fenchone can be probed using core level spectroscopy with circularly polarized XUV light provided by the free-electron laser FERMI. This approach has the advantage of merging the chemical sensitivity of core excitation with the chiral sensitivity of circularly polarized light. To this end, the FERMI light source offers unique properties, being the only free-electron laser (FEL) providing both circularly polarized XUV pulses up to the Carbon K-edge and a jitter-free external laser for time-resolved pump-probe experiments.

[1] A. Comby et al., "Relaxation Dynamics in Photoexcited Chiral Molecules Studied by Time-Resolved Photoelectron Circular Dichroism:
Toward Chiral Femtochemistry", J. Phys. Chem. Lett. 7, 4514 (2016)
[2] S. Beaulieu et al., "Probing ultrafast dynamics of chiral molecules using time-resolved photoelectron circular dichroism", Faraday
Discussion 194, 325 (2016)