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Photodissociation of the prototypical chiral molecule iodomethylbutane: Wavelength-dependent effects

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Photodissociation, which occurs on femtosecond timescales, is crucial for understanding various biological, chemical, and physical processes. Investigating photodissociation at atomic scales offers insights into the dynamics and pathways of molecular fragmentation, which can only be directly studied using pulsed light sources with durations comparable to or shorter than the timescales of the phenomena. Free-electron lasers (FELs) are particularly advantageous in this context, as they produce ultrashort, ultrabright pulses in the XUV and X-ray regimes. Their short wavelengths enable site- and element-selective inner-shell photoionization, allowing experiments to be conducted with high temporal and spatial resolution. This capability is significant because core-hole states can provide a distinct perspective on the evolving system. Consequently, optical laser (OL)-pump and FEL-probe techniques are commonly employed.

In such experiments, the OL initiates specific dissociation pathways, which are then investigated using time-delayed FEL pulses. By varying the time delay between the pump and probe pulses, time-resolved studies can be performed.

In this study, highly intense XUV pulses from the Free-Electron-Laser in Hamburg (FLASH) were used to probe the OL-induced fragmentation of the prototypical chiral molecule iodomethylbutane (C□H□□I) using 267 nm and 800 nm pulses from a Ti

laser. Ion velocity-map images and time-of-flight spectra were collected with a double-sided Velocity-Map-Imaging spectrometer. To explore different fragmentation channels at the iodine 4d edge, two photon energies were used: 63 eV (neutral iodine) and 75 eV (singly charged iodine). The OL-pump XUV-probe scans demonstrated that the molecule dissociates significantly more slowly with an 800 nm pump compared to a 267 nm pump. These results reveal substantial wavelength and intensity dependence in the OL-induced dissociation dynamics, providing a foundation for future time-resolved studies.

Biography

Valerija Music is a Ph.D. student in AMO physics at the University of Kassel in Germany. She conducts her research at FEL facilities and is therefore permanently located in Hamburg at DESY and European XFEL. The main scope of her work is the investigation of ultrafast dynamics in chiral systems via photoelectron circular dichroism9,10,11,12,13 as a tool for chiral recognition. She has expertise in building and running VMI spectrometers for performing experiments at XUV and soft X-ray beamlines of large-scale facilities such as FELs and synchrotrons. She is part of several international research collaborations and experimental FEL campaigns.