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Imaging dynamics in complex molecules with ultrafast electron diffraction

MARTIN CENTURION, University of Nebraska - Lincoln

The conversion of light into chemical and mechanical energy is the driving mechanism in many processes in nature, such as photosynthesis, vision, DNA photodamage and solar energy harvesting and storage. This energy conversion takes place when, after absorbing a photon, the molecule undergoes a rearrangement of the atomic positions and bonds. Observing these dynamics requires simultaneously reaching atomic (sub-Angstrom) spatial resolution and temporal resolution on the order of 100 fs. Recent advances in ultrafast electron diffraction (UED), in particular the implementation of relativistic electron sources for UED experiments with gas phase samples, now allow us to observe structural dynamics in isolated molecules. UED experiments have succeeded in progressing from first demonstrations in diatomic molecules to systems of increasing complexity. We will discuss a few exemplary reactions were we have imaged bond breaking, the motion of nuclear wavepackets and coherent vibrations that persist after the molecule returns to the electronic ground state.