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Seeing excitons in motion

Initiative: Freigeist-Fellowships

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Projekt-Website: https://www1.physik.uni-hamburg.de/en/th1/ag-daria-gorelova.html

Excitons are quasiparticles that describe a special state of electrons in a semiconductor crystal or in a semiconducting molecule. They play the key role for the photovoltaic effect used by solar cells, and the ability to see how excitons are moving will enable the observation and control of mechanisms that govern its efficiency. The goal of this project is to invent methods to follow excitonic motion by means of ultrashort light pulses with sub-femtosecond (shorter than a millionth of a billionth of a second, 10 E-15 sec) temporal and sub-nanometer (shorter than a billionth of a meter, 10 E-9 m) spatial resolution, which is necessary to capture details of this extremely fast motion. The interaction of light pulses and moving electrons at sub-femtosecond time scales gives rise to quantum effects that do not appear at longer times. A rigorous quantummechanical analysis will be employed to describe how photovoltaic materials in the regime of exciton dynamics interact with ultrashort light pulses. This description will provide tools to extract the finest details of exciton dynamics, a very complex type of electron dynamics, from signals obtained by means of ultrashort light pulses. Based on this analysis, the project aims to propose and design novel, cutting-edge experiments that will open up new perspectives for renewable energy research.

Projektbeteiligte

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Open Access-Publikationen

Ultrafast orbital tomography of a pentacene film using time-resolved momentum microscopy at a FEL
Attosecond imaging of photoinduced dynamics in molecules using time-resolved photoelectron momentum microscopy
Theoretical Description of Attosecond X-ray Absorption Spectroscopy of Frenkel Exciton Dynamics
Microscopic nonlinear optical response: Analysis and calculations with the Floquet Bloch formalism