

Molecular dynamics probed via strong-field ionization of state- and isomer-selected molecules *fixed in space*

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State-selected aligned and oriented molecular ensembles serve as ideal samples to study ultrafast molecular dynamics in the molecular frame [1,3]. Possible probing mechanisms are the investigation of molecular-frame photoelectron angular distributions [2] or the detection of structural changes via X-ray and electron diffraction [3,3a].

We have developed techniques to manipulate the motion of molecules in cold supersonic beams using strong inhomogeneous electric and laser fields at 1 kHz repetition rate [4]. State-, conformer-, and size-selection is achieved by electric deflectors, the analogue of the Stern-Gerlach deflector and the electrostatic bender for charged particles. The state-selected molecules are aligned by strong laser fields or oriented in combination of laser fields and static electric fields. The laser pulses for alignment and orientation are provided by a kHz “femtosecond” Ti:Sapphire laser system. The laser pulse length can be varied continuously between 50 fs and 500 ps. This allows for the manipulation of the rotational degrees of freedom of the molecules non-adiabatically (impulsively) as well as adiabatically, and the study of the intermediate regime.

Here, we will present our work on the alignment and orientation of iodobenzene and carbonyl sulphide (OCS). We will discuss the (non) adiabaticity of the alignment and orientation of OCS. Photoelectron angular distributions of OCS will be presented. In addition we will discuss our results on the separation of molecular conformers [5] and state- and size-selected clusters [6].

Molecular-frame photoelectron angular distributions (MFPADs) allow to image the electronic structure. In pump-probe type experiments one can thus follow the dynamics of these controlled systems. Future studies will include investigations on rearrangement processes of the internal structure of larger molecules. Internal energy conversion in molecules as well as ultrafast dissociation processes of water clusters will be studied in addition.

References:

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