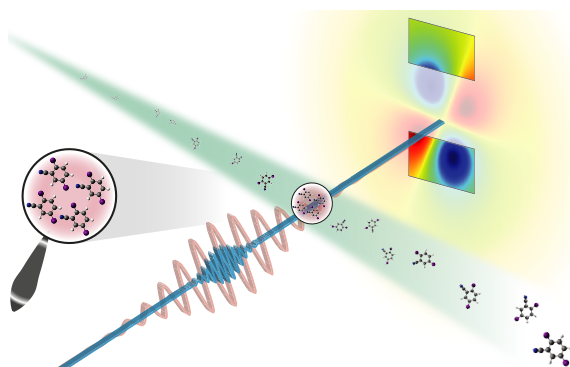
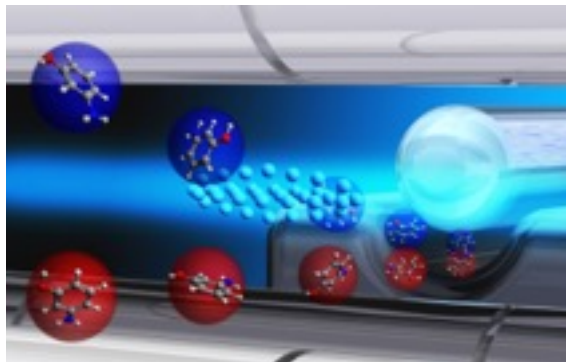


Cold and controlled molecules for FEL experiments

Jochen Küpper

*Center for Free-Electron Laser Science, DESY, Notkestrasse 85, 22607 Hamburg, Germany
Department of Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany
The Hamburg Center for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany*

The structure function relationship is still a largely open area of molecular sciences. On the one hand there is vast evidence for structural influence in chemistry and biology, with highly successful abstractions even at the text-book level. On the other hand, there is very little direct experimental evidence for the details of this structure-function relationship. We have demonstrated a new approach toward the investigation of the influence of conformational details in the molecular structure on the reactivity of gas-phase reactions. The next challenge is the disentangling of the chemical dynamics of individual molecular species with temporal and spatial atomic resolution. The recording of these so-called “molecular movies” is within reach. Corresponding modern experiments in the molecular sciences range from the investigation of ultrafast electron dynamics in small molecules to the coherent diffractive imaging of nanocrystals or viruses of biological samples. The successful filming will often rely on strongly controlled molecular samples. This includes the separation of individual structural isomers or even single quantum states of complex molecules, the ability to strongly fix molecules in space, and to



deliver them to the interaction point of the probe experiment such as, for instance, a free-electron

laser end-station.

In this presentation I briefly review our endeavors to get complex molecules under control, including the spatial separation of different species and the one- and three-dimensional alignment and orientation. Moreover, the controlled samples of such many-body quantum systems have been successfully employed in various benchmark experiments toward the recording of molecular movies and I will discuss the current status and future possibilities.

Overview

Y.-P. Chang, D. Horke, S. Trippel, and J. Küpper, “Spatially-controlled complex molecules and their applications”, *Int. Rev. Phys. Chem.* **34**, 557 (2015); DOI: [10.1080/0144235X.2015.1077838](https://doi.org/10.1080/0144235X.2015.1077838), arXiv:1505.05632 [physics]