Manipulating the Motion of Large Molecules: Translation, Rotation, and Conformer Selection

Jochen Küpper

Fritz-Haber-Institut der MPG, Berlin, Germany

Large molecules have complex potential-energy surfaces with many local minima. They exhibit multiple stereo-isomers, even at the very low temperatures of ~1 K in a molecular beam. We have developed methods to manipulate the motion of large, complex molecules and to select their quantum states.[1] We have exploited this state-selectivity to spatially separate individual conformers (structural isomers) of complex molecules[2] and to demonstrate unprecedented degrees of laser alignment and mixed-field orientation of these molecules.[3]

Such clean, well-defined samples would strongly benefit or simply allow novel experiments with complex molecules, for instance, femto-second pump-probe measurements, X-ray or electron diffraction in the gas-phase, high-harmonic generation, or tomographic reconstructions of molecular orbitals. These samples would also be very advantageous for metrology applications, such as, for example, matter-wave interferometry or the search for electroweak interactions in chiral molecules. Moreover, these samples provide an extreme level of control for stereo-dynamically controlled reaction dynamics of complex molecules.
In this presentation, I will describe and compare the manipulation methods employed and our respective results. In addition, I will discuss the prospects of imaging experiments using the upcoming X-ray free-electron lasers.

[1] Wohlfart et al. *Phys. Rev.* A **77**, 031404(R) (2008)
[2] Filsinger et al. *Phys. Rev. Lett.* **100**, 133003 (2008)
[3] Holmegaard et al. *Phys. Rev. Lett.* **102**, 023001 (2009);
Filsinger et al. arXiv:*physics* 0903.5413