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Quantum state selection of polar molecules: Alignment, orientation and conformational control

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Building on ideas that go back to Stern in the 1920s we use an inhomogeneous static electric field to deflect a cold beam of polar molecules. The deflection spatially disperses the rotational quantum states of the molecules. We show that the molecules residing in the lowest-lying rotational states can be selected and used as targets for further experiments. In particular, the quantum-state-selected molecules enable unprecedented strong alignment, induced by a moderately intense laser pulse, as well as strong orientation induced by a mixed laser and static electric field. Here, alignment refers to confinement of one or more molecule-fixed axes along laboratory-fixed axes, and orientation refers to the molecular dipole moments pointing in a specific direction. Also, it is shown that the deflection enables separation of the different conformers of a single molecule. We discuss new opportunities offered by the enhanced degree of orientational control, made possibly by quantum state selection, including time resolved studies of torsion, and eventually enantiomeric conversion, of axially chiral molecules. Collaborators: J. Küpper, G. Meijer, L. B. Madsen.

[1] *Laser-Induced Alignment and Orientation of Quantum-State-Selected Large Molecules*, L. Holmegaard, J. H. Nielsen, I. Nevo, H. Stapelfeldt, F. Filsinger, J. Küpper, and G. Meijer, Phys. Rev. Lett. **102**. 023001 (2009).