Nuclear spin selective control of molecular motion

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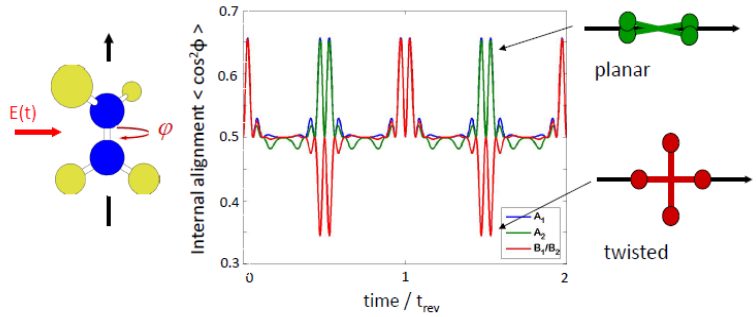
Control over the rotational dynamics of molecules, in particular molecular alignment, has many applications ranging from chemical reaction dynamics to the control of high harmonic generation. Moderately intense, non-resonant laser pulses provide an efficient means to steer rotational dynamics. An intriguing aspect of laser induced molecular rotation is its sensitivity to the symmetry of rotational states and consequently to the nuclear spin state of the molecule. Here, we discuss various aspects and applications of nuclear spin selective rotation. First, We demonstrate that transient molecular alignment of symmetric molecules depends on their nuclear spin [1]. The ability to control rotational wavepackets of different nuclear spin isomers also opens new routes for selective reactive scattering as we show by calculating differential cross sections for atom – diatomic scattering.



Nuclear spin selective torsion: After interaction with a short non-resonant laser pulse, different nuclear spin isomers (red, green and blue curves) have different transient geometries. These differences can be exploited to excite either uni-directional torsion or rotation with additional laser pulses.

Sequences of moderately intense, non-resonant laser pulses also allow the control of intramolecular torsion in non-rigid molecules. Since torsional motion depends on the nuclear spin state of the molecule, different nuclear spin isomers can be manipulated selectively by a sequence of time-delayed laser pulses. We show that pulses with different polarization directions can induce either overall rotation or internal torsion, depending on the nuclear spin [2]. Nuclear spin selective control of the angular momentum distribution may lead to new ways to *separate and explore nuclear spin isomers of polyatomic molecules.*

References:

[1] T. Grohmann, M. Leibscher, J. Chem. Phys. **134**, 204316 (2011).

[2] J. Floß, T. Grohmann, M. Leibscher, T. Seideman, J. Chem. Phys. **136**, 084309 (2012).