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47 - A Slow Optical Centrifuge

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An optical centrifuge is a tool for controlling coherent molecular rotation with an intense laser field. It is a linearly polarized pulse which starts by rotating slowly and accelerates up to ∼10 THz over ∼100 ps. Whether a molecule will follow it is determined by comparing the molecule's moment of inertia to the anisotropic polarizability of the molecule. Several light diatomic and triatomic molecules have been spun (O_2, N_2, CS_2, OCS, CO, CO_2) and more recently the larger chiral molecule propylene oxide (CH_3CHCH_2O) has been shown to orient when spun with the centrifuge. These larger and more complex molecules respond to the twisting polarization vector more slowly so require either a slower acceleration or a stronger field. The latter is limited by multi-photon ionization, so simply amplifying the centrifuge pulse is not an option. By increasing the duration of the centrifuge while reducing the maximum rotational frequency, the adiabatic trapping probability is improved. This allows a high degree of rotational excitation in circumstances which were previously unattainable such as for heavier more complex molecules or those with a lower anisotropic polarizability. This will be applied to the study of laser-induced chiral molecule orientation, and molecular superrotors in superfluid helium nanodroplets. We present characterization methods for this "slow"optical centrifuge which take advantage of the uniquely shaped pulses.

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