A NEW EXPERIMENT TO TEST PARITY SYMMETRY IN COLD CHIRAL MOLECULES


Parity violation (PV) has never been observed in molecules. Caused by the weak nuclear force, PV should lead to a tiny energy difference between the enantiomers of a chiral molecule, and in turn to frequency differences in the rovibrational spectra of the two enantiomers. A PV measurement constitutes a test of the standard model and a probe of physics beyond it. It could also shed some light on the origins of biomolecular homochirality.

PV frequency shifts are however predicted to be extremely small, in the millihertz to hertz range for vibrational transitions at 30 THz\(^1\). We present our on-going work towards developing the technologies needed for this precision spectroscopic measurement. This includes developing frequency stabilised quantum cascade lasers (QCLs) calibrated against primary standards\(^2\). We also present our latest efforts to develop buffer-gas-beams of organo-metallic species of interest for a PV measurement\(^3\). Buffer-gas beams formed using laser ablation of solid-state molecules in a cryogenic cell containing gaseous helium at 4 K exhibit both low velocity and some of the highest beam fluxes to date. We also present the results of preliminary spectroscopic investigations conducted on methyltrioxorhenium (MTO)\(^4\), an achiral test molecule from which promising chiral derivatives have recently been synthesized\(^5\). We are currently investigating new methods combining mid-infrared and microwave fields to enhance detection sensitivity compared to conventional direct mid-infrared absorption schemes and to enable enantiomer-specific measurements\(^6\).

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\(^1\)A. Cournol et al, Quantum Electron. 49, 288 (2019).