PROGRESS IN THE ZURICH EXPERIMENT ON PARITY VIOLATION IN CHIRAL MOLECULES

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Because of the space inversion symmetry of the electromagnetic force, the ground state energies of the enantiomers of chiral molecules would be identical by symmetry in conventional quantum chemical theory. Including also the parity violating weak nuclear force, they are, however, predicted to be different by a very small parity violating energy difference $\Delta_{\mathrm{pv}}E$ in the sub-feV and low feV range. This small effect has so far never been measured and such experiments constitute a major challenge of physical-chemical stereochemistry with possible importance both for the fundamental physics in the standard model of elementary particles (SMPP) and for the evolution of biomolecular homochirality in the origin of life as reviewed in [1, 2]. An important step in our approach following [3] has been the proof of concept testing the experimental stability of parity states with the achiral molecule $\mathrm{NH_3}$ [4] demonstrating the possibility of detecting values of $\Delta_{\mathrm{pv}}E$ as small as $100\,\mathrm{aeV}$ (or larger). An important next step is to find a parity state in a chiral molecule by measuring and analyzing mid-IR vibration-rotation-tunneling spectra (around $3000\,\mathrm{cm}^{-1}$) of one of our mid-sized chiral candidate molecules with low vapor pressure (listed e.g. in Tab. 2 of Ref. [2]). Here, we report improved cw-laser cavity ring-down spectroscopy [5, 6, 7] referenced to a frequency comb combined with a slit jet expansion and partial pressures below $1\,\mathrm{mbar}$. We report the spectrum of benzene spanning ranges of more than $10\,\mathrm{GHz}$ and other molecules when available at the time of this conference in the mid-IR with complexity similar to the spectroscopy of our chiral candidate molecule, 1,2-dithiine $\mathrm{C_4H_4S_2}$ [8, 9], see also the work on 1,3-difluoroallene CHFCCHF [10, 11] and ClSSCl [12].

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