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Towards parity violation and tunneling in chiral molecules: An experiment in the mid-infrared range using a pulsed slit jet expansion.

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Our scheme aims to measure the parity violating energy difference between the enantiomers of chiral molecules which has been predicted to be very small, e.g. about 100 aeV for CHFClBr [2] and 1 feV for 1,2 Dithiine [3], but so far has never been measured. The effect might be important for the origin of biomolecular homochirality and for precision tests of the standard model of particle physics at low energy [4]. The scheme starts with the preparation of a pure parity state of the molecule in a two photon process by exciting to a rovibrational state with an excitation energy close to or above the barrier for the interconversion of the two enantiomers [5]. Essential for the preparation step is a complete understanding of the IR-spectrum in this energy region where tunneling splittings are large. To measure such infrared spectra with high accuracy a new setup has been built to investigate polyatomic molecules of moderate size in the required spectral range from 2800 to 3500 cm^{-1} (3.6 µm to 2.9 µm) using an OPO referenced to a frequency comb reaching an accuracy better than 1 kHz for the mid-IR laser frequency. The spectra are measured in a slit jet molecular beam expansion using cavity ring-down spectroscopy [6, 7]. Due to the Doppler shift the effective frequency uncertainty is about 1 MHz. We will present test results for ammonia (NH3), which is also of general interest as prototype tunneling molecule [8] as well as for nuclear spin symmetry (see [9, 10] and Refs. cited). The results of the experiments are consistent with nuclear spin symmetry conservation in seeded supersonic jet expansions providing cooling to temperatures below 7 K. In the achiral molecule NH3 one has also effective intramolecular parity conservation [5]. Results on potential chiral candidates for measuring parity violation will be presented as available at the time of the meeting.

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Author: Dr WICHMANN, Gunther (ETH Zürich)

Co-authors: Dr MILOGLYADOV, Eduard (ETH Zürich); Dr SEYFANG, Georg (ETH Zürich); Prof. QUACK, Martin (ETH Zürich)

Presenter: Dr WICHMANN, Gunther (ETH Zürich)

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