Demonstration of the Experimental Scheme to Measure the Parity Violating Energy Difference $\Delta_{PV}E$ in Chiral Molecules

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Theoretical calculations of the parity violating energy difference $\Delta_{PV}E$ between the enantiomers of chiral molecules are now well established, resulting in a reaction enthalpy $\Delta_{PV}H_0^{\ominus} = N_A\Delta_{PV}E$ of about 10^{-11} $Jmol^{-1}$ (100 aeV) for stereomutation reactions [1-7]. But the experimental determination of $\Delta_{PV}E$ is still missing and is one of the great challenges in physics and chemistry.

We have set up an experiment which can be considered as a first step towards the measurement of $\Delta_{PV}E$ by a time resolved method proposed 25 years ago [1]. For the experiment a superposition state with initially defined parity has to be prepared with high efficiency in a two photon absorption/stimulated emission step and the time evolution of this superposition state has to be followed with high accuracy for an evolution time of 1 – 10 ms. For the preparation of this experiment we have locked two cw infrared OPOs to a frequency comb with a frequency stability of better than 1 kHz. For the achiral molecule NH_3 we have obtained a nearly complete population transfer to an initially unpopulated higher rotational level in a two photon process using two frequency chirped infrared laser beams. The population transfer is probed by REMPI detection in a time of flight mass spectrometer coupled to a molecular beam set up. A frequency resolution of 300 kHz was demonstrated in the molecular beam measuring the hyperfine structure of the symmetric NH-stretching vibration in NH_3 arising from the nuclear spin of the nitrogen atom.

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