HIGH RESOLUTION SPECTROSCOPY AND PARITY VIOLATION IN CHIRAL MOLECULES

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Parity conservation would result in an exact equivalence of the spectra of the "mirror image" enantiomers of chiral molecules. However, electroweak theory in the framework of the "Standard Model" of modern high energy physics includes parity violation as an essential ingredient and predicts that the ground state energies of enantiomers of chiral molecules differ by a small "parity violating energy difference" $\Delta_{pv}E$. A striking recent development was the discovery that improved theory predicts this energy difference to be one to two orders of magnitude larger than anticipated on the basis of older theories (for reviews with extensive references see[a]). For instance, for CHFClBr it is now calculated to be about 10^{-11} J mol^{-1} (10^{-12} cm^{-1}). Such small energy differences can be measured following a spectroscopic scheme proposed by us in 1980/86. However, most of the spectroscopic ground work to even attempt such experiments was missing at that time. The Zurich group has since then undertaken efforts towards high resolution spectroscopy of chiral molecules with the goal of measuring $\Delta_{pv}E$, but also to understand tunneling stereomutation in axially chiral molecules, new electroweak isotope effects, and femtosecond intramolecular vibrational redistribution as derived from high resolution spectroscopy of chiral molecules. In the lecture we will summarize the current status of these efforts and discuss also briefly the relation to alternative approaches towards the molecular spectroscopy of parity violation through the measurement of frequency shifts in microwave and infrared spectra. If time permits, we shall address also possible tests of CPT violation using chiral molecules.

[a] M. Quack, Angew. Chem. Int. Ed. **114**, 4618-4630 (2002); M. Quack, in *Modelling Molecular Structure and Reactivity in Biological Systems*, Proc. 7th WATOC Congress, Cape Town January 2005, edited by K. J. Naidoo, J. Brady, M. J. Field, J. Gao, and M. Hann (Royal Society of Chemistry, Cambridge, 2006), pp. 3 - 38; M. Quack and J. Stohner, Chimia **59** (7-8), 530-538 (2005)