Fundamental and approximate symmetries, parity violation and tunnelling in chiral and achiral molecules

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Symmetry and asymmetry are concepts, which are used in a wide range of contexts, from the fundamental sciences, mathematics, physics, chemistry and biology to the arts, music and architecture [1]. If asymmetries are small , one may still introduce the concept of approximate symmetries . Symmetries can be associated with constants of the motion. Particularly interesting approximate molecular symmetries are nuclear spin symmetry and parity, resulting in approximate constants of the motion. We shall start with an introductory outline of how symmetries can be applied to the understanding of the time scales in fundamental kinetic primary processes. We then briefly discuss our approach to derive molecular quantum dynamics from high resolution spectroscopy with some selected examples from our recent research including results on molecular tunnelling and tunnelling switching phenomena in free molecules and including excitation with coherent time dependent fields. Of particular interest is the control of symmetry by external fields. These lead to interesting nonclassical states recently introduced for molecular quantum switches in our work .We shall also report on current progress towards the observation of the theoretically predicted, new process of parity change with time in isolated chiral molecules, which connects the principles of high energy physics with molecular chemical kinetics and potentially the evolution of biomolecular homochirality. We shall present our most recent analyses of high resolution infrared, THz and GHz spectra of relevant chiral and achiral molecules as available at the time of the meeting and relevant in this context. For background reading and some recent results see [1-12], and www.ir.ETHz.CH (lecture Tromsoe July 2019)

References

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