The Quantum Dynamics of Chiral Molecules Including Electroweak Parity Violation: Tunneling, Tunneling Switching and Fundamental Asymmetries

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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]. 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 tunneling and tunneling switching phenomena as well as a 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 molecules in relation to theory as available at the time of the meeting. For background reading and some recent results see [1-10].

[1] M. Quack, J. Hacker (Eds.), *Symmetrie und Asymmetrie in Wissenschaft und Kunst, Nova Acta Leopoldina NF Band 127, Nr. 412*, Wissenschaftliche Verlagsgesellschaft, Stuttgart, **2016** (book, 275 pages with contributions in German and English)

[2] M. Quack, *Adv. Chem. Phys.* **2015**, *157*, 249-290.

[3] M. Quack, *Fundamental Symmetries and Symmetry Violations from High Resolution Spectroscopy*, in *Handbook of High Resolution Spectroscopy, Vol. 1*, Chap. 18. (Eds.: M. Quack, F. Merkt), Wiley, Chichester, New York, **2011**, pp. 659-722.

[4] P. Dietiker, E. Miloglyadov, M. Quack, A. Schneider, G. Seyfang, *J. Chem. Phys.* **2015**, *143*, 244305.

[5] R. Prentner, M. Quack, J. Stohner, M. Willeke, *J. Phys. Chem. A* **2015**, *119*, 12805–12822.

[6] C. Fábri, Ľ. Horný, M. Quack, *ChemPhysChem* **2015**, *16*, 3584–3589.

[7] S. Albert, I. Bolotova, Z. Chen, C. Fabri, M. Quack, G. Seyfang, D. Zindel, *Phys. Chem. Chem. Phys.* **2017**, *19*, 11738-11743.

[8] S. Albert, I. Bolotova, Z. Chen, C. Fábri, L. Horný, M. Quack, G. Seyfang, D. Zindel, *Phys. Chem. Chem. Phys.* **2016**, *18*, 21976-21993.

[9] S. Albert, F. Arn, I. Bolotova, Z. Chen, C. Fábri, G. Grassi, P. Lerch, M. Quack, G. Seyfang, A. Wokaun, D. Zindel, *J. Phys. Chem. Lett.* **2016**, *7*, 3847-3853.

[10] S. Albert, Z. Chen, C. Fábri, P. Lerch, R. Prentner and M. Quack, *Mol.Phys.* **2016**, *114*, 2751-2768; SASP Proceedings , Innsbruck University press , 2018