Testing the Standard Model with Molecules

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Search for violation of fundamental symmetries provides a unique opportunity for testing the Standard Model. Atomic and molecular experiments offer a low energy and comparatively inexpensive alternative to high energy accelerator research in this field. As the observable effects (such as parity violation, PV) are expected to be very small, highly sensitive systems and extremely precise measurements are required for the success of such experiments. Atomic and molecular theory can provide crucial support for these experiments. An important task of theoretical research is to identify optimal molecular and atomic systems for measurements and to understand the mechanisms behind the enhanced sensitivity, which is strongly dependent on the electronic structure. Thus, accurate computational methods are needed in order to provide reliable predictions rather than estimates, and to obtain the various parameters that are required for the interpretation of the experiments. I will present the results of our recent investigations of molecules in the context of search for parity violating effects. An overview of the theoretical methods will be provided, including the recently developed scheme for assigning error bars on theoretical predictions [1]. Then, I will focus on showcasing the different types of systems (diatomic, triatomic, and chiral molecules) that are promising candidates for experiments that aim to test the Standard Model and perhaps detect new physical phenomena [2, 3, 4].

References

[1] A. A. Kyuberis, L. F. Pasteka, E. Eliav, H. A. Perrett, A. Sunaga, S. M. Udrescu, S. G. Wilkins, R. F. Garcia Ruiz, and A. Borschevsky, *Phys. Rev. A* **109**, 022813 (2024).

[2] Y. Hao, P. Navratil, E. B. Norrgard, M. Ilias, E. Eliav, R.G.E. Timmermans, V. V. Flambaum, and A.Borschevsky, *Phys. Rev. A* **102**, 052828 (2020).

[3] M. R. Fiechter, P. A. B. Haase, N. Saleh, P. Soulard, B. Tremblay, R. W. A. Havenith, R. G. E. Timmermans, P. Schwerdtfeger, J. Crassous, B. Darquié, L. F. Pašteka, and A. Borschevsky, *J. Phys. Chem. Lett.* **13**, 10011 (2022).

[4] Y. Chamorro, V. Flambaum, R. F Garcia Ruiz, A. Borschevsky, L. F Pasteka, *Phys. Rev. A* **110**, 042806 (2024).