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Theoretical predictions of the structure of heavy muonic atoms and searching for an elephant in the room

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When coming close to an atom, a muon can be captured by the nucleus and form a hydrogen-like muonic ion, which is typically also surrounded by atomic electrons. This atomic system is commonly referred to as a muonic atom. Due to the muon's high mass, it is located much closer to the nucleus; and, especially for heavy nuclei, this results in big nuclear size effects and a strong dependence of the muon bound-state energies on the nuclear charge and current distributions, as well as in large relativistic effects [1, 2]. A combination of the knowledge about the level structure and experiments measuring the transition energies in muonic atoms enabled the determination of nuclear parameters like charge radii, electric quadrupole and magnetic dipole moments [3].
Theoretical predictions of the fine-, hyperfine structure, and dynamical splitting of muonic atoms, based on rigorous QED calculations will be presented. State-of-the-art techniques from both nuclear and atomic physics are brought together in order to perform the most comprehensive to date calculations of the quantum-electrodynamics and nuclear contributions. A long-standing problem of fine-structure anomalies in muonic atoms will be revisited in the light of the last improvements on nuclear-polarization [4] and self-energy calculations [5].
Finally, we will discuss the currently used tabulated values of the rms radii based on their extraction from the muonic spectra and possible further development in this direction.

References

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Primary author: ORESHKINA, Natalia S. (MPIK Heidelberg)

Co-authors: KEITEL, Christoph H. (Max Planck Institute for Nuclear Physics); VALUEV, Igor A. (MPIK Heidelberg)

Presenter: ORESHKINA, Natalia S. (MPIK Heidelberg)

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