Contribution ID: **69** Type: **not specified**

Tests of QED by precision spectroscopy of highly-charged ions and exotic atoms

Wednesday, 21 June 2023 09:30 (40 minutes)

Quantum electrodynamics (QED) is the best understood quantum field theory. High-precision tests are being performed using free particles (e.g., the electron anomalous magnetic moment [1]). Many bound electron systems are being studied and compared to the most advanced calculations. One can cite hydrogen, positronium, muonium, highly charged, few electron ions[2] and exotic atoms (atoms in which the electron is replaced by a heavier particle like a muon, a pion or an antiproton).
In this talk I will present a few cases of highly charged ions high-precision results (few ppm accuracy) obtained with our Double Crystal Spectrometer in Paris[3-5] for medium-Z elements, and preliminary results obtained at GSI/FAIR on few-electron uranium. I will then present new ideas [6] and first demonstration results on QED tests using muonic atoms and transition-edge sensor micro-calorimeter at JPARC [7, 8], and their extension to antiprotonic atoms at ELENA in the future. Detailed comparison with QED and relativistic many-body calculations when relevant will be made. I will also describe the new project QUARTET intended to use micro-calorimeters for precision spectroscopy in light (Li to B) muonic atoms to measure the nuclear radii more accurately.

[1] Measurement of the Electron Magnetic Moment, X. Fan, T.G. Myers, B.A.D. Sukra et al. Phys. Rev. Lett. 130, 071801 (2023).
[2] Topical Review: QED tests with highly-charged ions, P. Indelicato. J. Phys. B 52, 232001 (2019).
[3] High-precision measurements of n=2->n=1 transition energies and level widths in He- and Be-like Argon Ions, J. Machado, C.I. Szabo, J.P. Santos et al. Phys. Rev. A 97, 032517 (2018).
[4] Reference-free measurements of the 1s 2s 2p 2P1/2,3/2 ⟶ 1s2 2s 2S1/2 and 1s 2s 2p 4P5/2 ⟶ 1s2 2s 2S1/2 transition energies and widths in lithiumlike sulfur and argon ions, J. Machado, G. Bian, N. Paul et al. Phys. Rev. A 101, 062505 (2020).
[5] Absolute measurement of the relativistic magnetic dipole transition in He-like sulfur, J. Machado, N. Paul, G. Soum-Sidikov et al. Phys. Rev. A 107, 032821 (2023).
[6] Testing Quantum Electrodynamics with Exotic Atoms, N. Paul, G. Bian, T. Azuma et al. Phys. Rev. Lett. 126, 173001 (2021).
[7] Deexcitation Dynamics of Muonic Atoms Revealed by High-Precision Spectroscopy of Electronic K X Rays, T. Okumura, T. Azuma, D.A. Bennett et al. Phys. Rev. Lett. 127, 053001 (2021).
[8] Proof-of-Principle Experiment for Testing Strong-Field Quantum Electrodynamics with Exotic Atoms: High Precision X-ray Spectroscopy of Muonic Neon, T. Okumura, T. Azuma, D.A. Bennett et al. Phys. Rev. Lett. 130, 173001 (2023).

Summary

Primary author: INDELICATO, Paul (Laboratoire Kastler Brossel (CNRS))

Presenter: INDELICATO, Paul (Laboratoire Kastler Brossel (CNRS))

Session Classification: X-rays in nuclear physics