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Stringent tests of bound-state QED using highly charged ions

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The ultra-precise determination of the *g*-factor of highly charged ions is a unique possibility to test the validity of the Standard Model, particularly Quantum Electrodynamics (QED) in extreme electric fields up to 10¹⁶ V/cm. While the weak-field regime has been exquisitely tested, in the presence of strong fields higher-order contributions beyond the Standard Model might become significant. It is possible to sensitively search for such effects by measuring the Larmor- and cyclotron frequencies of single, highly charged ions in a cryogenic Penning trap with high precision. This way, by measuring the *g*-factor of medium heavy hydrogenlike ions with previously unprecedented precision, we have been able to perform the most stringent test of QED in strong fields. Particularly the effect of the nucleus on the g-factor of the electron is a novel and unique access to nuclear size and structure information.
To push these tests far into the strong-field, heavy ion regime, in the past years we have set up a new setup, ALPHATRAP at the Max-PIanck-Institut für Kernphysik in Heidelberg. ALPHATRAP has been successfully commissioned in the last months and is now setting out to perform measurements of the g-factor of the heaviest elements up, to hydrogenlike ²⁰⁸Pb⁸¹⁺. This will not only enable the most sensitive tests of QED, but also open a unique access to fundamental constants as the atomic mass of the electron and the finestructure constant α.

Primary author: Dr STURM, Sven (Max-Planck Institut für Kernphysik)

Presenter: Dr STURM, Sven (Max-Planck Institut für Kernphysik)

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