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Precise nuclear charge radii via bound electron g factor measurements

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The gyromagnetic g-factor of bound electrons in highly charged ions is ideal for testing quantum electrodynamics (QED) in the strongest electric fields. In heavy highly charged ions (HCI) the innermost electrons experiences electric fields exceeding 10^{15} V/cm that are otherwise unreachable in laboratories, but in a system still simple enough to enable high-precision theory calculations.
Additionally, the bound electron g factor is significantly influenced by the nuclear properties due to the close vicinity of the electrons to the nucleus. This makes it possible to extract nuclear charge radii with similar or higher precision compared to muonic-atom spectroscopy.

The ALPHATRAP experiment is a dedicated cryogenic Penning-trap setup to measure these bound electron g-factor of single HCIs. By co-trapping two hydrogenlike neon ions ($^{20}Ne^{9+}$ and $^{22}Ne^{9+}$) we have determined their isotope g-factor shift with 13 digits precision in respect of g. This allows to test the QED recoil contribution to highest precision and to improve the mean square nuclear charge radius difference by an order of magnitude compared to the literature value. Furthermore, we set limits on hypothetical new physics beyond the standard model. Recently we measured the g factor of hydrogenlike tin ($^{118}Sn^{49+}$). Given agreement with theory calculation this allows the extraction of the tin nuclear charge radius with a precision, which is only a factor of four less precise compared to the current literature value. Finally, I will give an outlook on upcoming studies and prospects.

Primary author: HEISSE, Fabian (Max Planck Institut für Kernphysik)

Presenter: HEISSE, Fabian (Max Planck Institut für Kernphysik)

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