Contribution ID: **80** Type: **not specified**

The g-factor of highly-charged ions – stress test for the Standard Model and access to the atomic mass of the electron

Thursday, 25 September 2014 11:00 (45 minutes)

The ultra-precise measurement of the g-factor of highly-charged ions provides a unique possibility to probe the validity of the Standard Model under extreme conditions. The bound electron is exposed to electric fields of up to 10^16 V/m, yielding a high sensitivity for higher-order contributions and hypothetical physics beyond the Standard Model.

We have determined the g-factor of hydrogen- and lithiumlike silicon by measuring the Larmor- and cyclotron frequencies of single ions in a Penning trap with previously unprecedented precision. The comparison of these values with the prediction of theory yields the most stringent test of quantum electrodynamics and relativistic inter-electron interaction in strong fields.

Furthermore, the developed techniques open an access to fundamental constants. Recently, we have determined the atomic mass of the electron with a relative uncertainty of 30 ppt, more than an order of magnitude better than the current CODATA literature value. This result enables future ultra-high precision tests of the Standard Model, e.g. the determination of the fine-structure constant and bound-state QED tests.

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Session Classification: Talks