MS 2: Precision Mass Spectrometry and Fundamental Applications II

Time: Monday 14:30–15:15 Location: f128

Invited Talk MS 2.1 Mon 14:30 f128

High Precision Comparison of the Antiproton-to-Proton Charge-to-Mass Ratio — •Stefan Ulmer — RIKEN, Wako, Saitama 351-0198, Japan — on behalf of the BASE collaboration

Invariance under the charge, parity, time-reversal (CPT) transformation is one of the fundamental symmetries of the standard model of particle physics. This CPT invariance implies that the fundamental properties of antiparticles and their matter-conjugates are identical, apart from signs. There is a deep link between CPT invariance and Lorentz symmetry, although model dependent. A number of high-precision CPT and Lorentz invariance tests have been performed, but only a few direct high-precision tests that compare the fundamental properties of matter and antimatter are available. The BASE collaboration at the antiproton decelerator of CERN aims at such tests by comparing the fundamental properties of protons and antiprotons with ultra-high precision. Very recently we measured the proton-to-antiproton charge-to-mass ratio with a fractional precision of 69 parts in a trillion. The measurement relies on fast comparisons of the cyclotron-frequencies of a single antiproton and a negatively charged hydrogen ion using an advanced Penning trap system. With an upgraded apparatus we demonstrated the feasibility to overcome our 69 ppt result by another factor of 10. In the talk I will summarize the results described above.

MS 2.2 Mon 15:00 f128

A high-precision experiment for the determination of the proton mass — •Fabian Heisse[1,2], Jiamin Hou[1], Florian Köhler-Langes[1], Andreas Mooser[3], Wolfgang Quint[2], Günter Werth[4], Klaus Blaum[1], Stefan Ulmer[3], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]RIKEN Ulmer Initiative Research Unit, Hirosawa, Wako, Saitama 351-0198, Japan — [4]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

The proton, together with the electron and the neutron, form the central building blocks of the visible universe. The precise knowledge of its properties, among others its atomic mass, is of great interest for high-precision tests as well as for metrology.

Therefore, a new experiment consisting of a cryogenic fivefold Penning-trap setup is built up in our group for the determination of the proton mass with improved accuracy. The measurement principle is based on a simultaneous phase-sensitive comparison of the proton's cyclotron frequency to that of a bare carbon ($^{12}C^{6+}$) nucleus. With this new setup it is planned to pin down the atomic mass of the proton with a relative uncertainty as low as 10^{-11} or better. The status of the experiment and the experimental setup will be presented.