High-Precision Investigation of the Fundamental Properties of the Antiproton and the Proton

S. Ulmer[1], K. Blaum[2], M. Borchert[3], T. Higuchi[1,4], A. Mooser[1], H. Nagahama[1,4], G. Schneider[1,5], S. Sellner[1], C. Smorra[1,6], Y. Matsuda[4], C. Ospelkaus[3], W. Quint[7], T. Tanaka[1,4], J. Walz[5,8], Y. Yamazaki[8]

[1] RIKEN, Ulmer Initiative Research Unit, Saitama, Japan; [2] Max-Planck-Institut für Kernphysik, Heidelberg, Germany; [3]Leibnitz University, Hannover, Germany; [4] The University of Tokyo, Tokyo, Japan; [5] Johannes Gutenberg-Universität, Mainz, Germany; [6]CERN, Geneva, Switzerland; [7] GSI - Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany; [8] Helmholtz-Institut Mainz, Mainz, Germany; [9]RIKEN, Atomic Physics Laboratory, Saitama, Japan

E-mail: stefan.ulmer@cern.ch

The Standard Model (SM) is the theory that describes Nature's particles and fundamental interactions, although without gravitation. However, this model is known to be incomplete which inspires various searches for physics beyond the SM. Among them are tests of charge, parity, time (CPT) invariance that compare the fundamental properties of matter-to-antimatter conjugates at lowest energy and with greatest precision.

In this context, the BASE collaboration [1] at the antiproton decelerator of CERN targets high-precision comparisons of the fundamental properties of antiprotons and protons, namely, charge-to-mass ratios and magnetic moments. To perform these tests we developed a double Penning trap quantum jump spectrometer which enabled us to carry-out the most precise measurement of the proton magnetic moment with a fractional precision of 3.3 parts in a billion [2]. Application of the technique to the antiproton, using the newly developed BASE Penning trap apparatus at the antiproton decelerator of CERN, will provide a thousand-fold improved comparison of proton/antiproton g-factors, work towards this goal is in progress. In addition we performed in BASE the most precise comparison of the proton-to-antiproton charge-to-mass ratio, with a fractional precision of 69 parts in a trillion [3]. To date, our measurement constitutes to most precise test of CPT invariance with baryons. Recent improvements in the stability of the apparatus demonstrate the feasibility to improve this test by another factor of 10. In the talk I will summarize our most recent results and the future perspectives of the BASE experiment program.

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