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Anti-proton and Anti-hydrogen Studies at ATRAP

S. Ettenauer[1], J. DiSciacca[1], M. Marshall,[1] K. Marable,[1] G. Gabrielse[1*], E. Tardiff[1], R. Kalra[2], D.W. Fitzakerley[2], M.C. George[2], E.A. Hessels[2], C.H. Storry[2], M. Weel[2], D. Grzonka[3], W. Oelert,[3,4], T. Sefzick[3], A. Müllers[4†], and J. Walz[4†]
(ATRAP Collaboration)

[1] *Dept. of Physics, Harvard University, Cambridge, MA 02138, U.S.A.*
[2] *York University, Department of Physics and Astronomy, Toronto, Ontario M3J 1P3, Canada*
[3] *IKP, Forschungszentrum Jülich GmbH, 52425 J ülich, Germany*
[4] *Institut für Physik, Johannes Gutenberg Universität Mainz, D-5509, Mainz, Germany*

Contact email: *settenauer@fas.harvard.edu*

Significant experimental efforts continue to be dedicated to basic nucleon properties of the anti-proton such as its charge-to-mass ratio [1], magnetic moment, or -by means of spectroscopy of anti-hydrogen- its charge radius or magnetic form factor. When compared to their matter-counterparts, precision measurements of anti-protons and anti-hydrogen will further provide very stringent tests of CPT (charge conjugation, parity and time reversal) symmetry as fundamental to our formulation of physics in terms of Lorentz invariant, local quantum field theories.

At ATRAP, this type of research is currently pursued along two aspects. The first goal is to perform precise spectroscopy of anti-hydrogen in a magnetic atom trap. Here, a milestone has recently been accomplished by simultaneously trapping 5 anti-hydrogen atoms on average with confinement times of 15 to 1000 s- long enough to ensure that they have reached their ground state [2]. The second goal is to precisely determine the anti-proton's magnetic moment $\mu_{\overline{p}}$. By utilizing one-particle methods in a Penning trap [3,4,5] ATRAP has performed the first direct measurement of $\mu_{\overline{p}}$ with a precision of 4.4 parts per million [6], a 680 fold improvement over the literature value [7]. These techniques can be applied for both, proton and anti-proton, and ultimately promise a gain in experimental precision of $\mu_{\overline{p}}$ by at least a factor of 10^3 in addition to the present measurement.

This talk will present recent progress in ATRAP's anti-hydrogen efforts as well as the first direct measurement of the anti-proton's magnetic moment.

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*collaboration spokesperson
†participating in anti-hydrogen studies only