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High precision tests of Proton-Antiproton symmetry: Towards a 100 p.p.t. antiproton g-factor measurement

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Throughout its existence, the Standard Model has proven very successful in describing fundamental interactions of elementary particles. However, one observation, which has yet to be understood, is the asymmetry between the abundance of matter and antimatter in the universe. The BASE experiment, located at CERN's Antiproton Decelerator (AD) facility, measures the fundamental properties of protons and antiprotons in order to test CPT symmetry with high precision. In the recent years, BASE has compared the charge-to-mass ratio of protons and antiprotons at a fractional precision of 69 parts-per-trillion (p.p.t.) [1]. Additionally, the first ever non-destructive observation of spin flips with a single trapped antiproton was demonstrated [2], allowing the measurement of the antiproton's magnetic moment to a fractional precision of 1.5 parts-per-billion (p.p.b.) [3], which improved results by other groups by about a factor of 3000 [4].
In my talk, I will give an overview of the BASE experiment and review the two particle/three trap magnetic moment measurement scheme. I will discuss limitations of the 1.5 p.p.b. measurement of the antiproton's magnetic moment and present a new technique for the detection of a single trapped antiproton's spinstate, which will allow for measurements at increased sampling rate and cyclotron-temperature acceptance. The application of this scheme and the introduction of additional experiment upgrades will enable an antiproton g-factor measurement with a fractional uncertainty of 100 p.p.t. on the short term.

[1] Ulmer, S. et al., Nature 524, 196 (2015)
[2] Smorra, C. et al., Phys. Lett. B 769, 1 (2017)
[3] Smorra, C. et al., Nature 550, 371 (2017)
[4] DiSciacca, J. et al., Phys. Rev. Lett. 110, 130801 (2013)

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