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The Base Experiment

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Throughout its existence, the Standard Model has proven very successful in describing fundamental interactions of elementary particles. However, the asymmetry between the abundance of matter and antimatter in the universe has yet to be understood.
The BASE experiment, located at CERN's Antiproton Decelerator (AD) facility, measures the fundamental properties of protons and antiprotons to test CPT symmetry with high precision. In the past, the BASE collaboration has compared the charge-to-mass ratio of protons and antiprotons at a fractional precision of 16 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].
Within this contribution I will present an overview over the BASE experiment and review the two-particle triple-trap measuring scheme that was used to measure the antiproton's magnetic moment with a fractional precision of 1.5 p.p.b. I will review the main systematic limitations of this previous antiproton g-factor measurement, and present recently implemented experiment upgrades. These contain a dedicated cooling trap for ultra-fast sub thermal cooling cycles of the cyclotron modes, and the implementation of a magnetic shimming and shielding system for stabilization and homogenization of the magnetic field of the measurement trap. Together with the implementation of phase sensitive detection methods, these improvements will enable an antiproton g-factor measurement with a fractional uncertainty of 100 p.p.t.
[1] Ulmer, S. et al., Nature 601, 53-57 (2022)
[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)

Scientific topic

Symmetries

Author: ERLEWEIN, Stefan (Max Planck Society (DE))

Presenter: ERLEWEIN, Stefan (Max Planck Society (DE))

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