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Searching for Physics beyond the Standard Model using Antiprotons at BASE

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The Baryon Antibaryon Symmetry Experiment (BASE) at the antiproton decelerator of CERN is dedicated to high-precision measurements of the fundamental properties of the proton and the antiproton. Using single-particle multi-Penning-trap techniques, we compare the proton/antiproton charge-to-mass ratios [1] and magnetic moments [2,3] with ultra-high precision. Such experiments provide stringent tests of CPT invariance and direct tests of matter/antimatter symmetry in the baryon sector.

Our measurement campaigns typically span several months up to more than one year. Besides comparing static fundamental properties, we can apply time-based analysis methods to our data and gain sensitivity to additional effects beyond the Standard Model.
Signatures of different types of Lorentz violation (with and without CPT violation) appear as signals at harmonics of the sidereal frequency [4]. A difference in gravitational coupling to protons and antiprotons would induce an annual variation of their charge-to-mass ratios, providing a test of the weak equivalence principle. Moreover, a time-based analysis of the antiproton magnetic moment constitutes the first direct search for axion-like dark matter using antimatter, and allows to derive first limits on previously unconstrained coefficients of the Standard Model Extension [4].

In this contribution, I will discuss the latest technical improvements, including a newly invented superconducting multi-layer magnetic shielding system that made, compared to [1], a considerably improved charge-to-mass ratio measurement campaign possible. In addition, I will present the results of the time-based analysis of the most recent BASE measurements.

[1] S. Ulmer et al., Nature 524, 196 (2015).
[2] C. Smorra et al., Nature 550, 371 (2017).
[3] G. Schneider et al., Science 358, 1081 (2017).
[4] Y. Ding and V. A. Kostelecký, Phys. Rev. D 94, 056008 (2016).

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