Contribution ID: **91** Type: **Poster**

Searching for Physics beyond the Standard Model using Antiprotons at BASE

Monday 3 July 2023 21:00 (2 hours)

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] at a relative uncertainty at the 10-parts-per-trillion and parts-per-billion level respectively. Such experiments provide stringent tests of Lorentz and CPT invariance 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 for clocks [1]. Moreover, a CPT-violating interaction of antimatter with ultralight scalar dark matter would induce oscillations of the measured antiproton mass. In this contribution, I will present the results of our search for new physics using the time-based re-analysis of our latest antiproton-to-proton charge-to-mass ratio campaign.

[1] M. J. Borchert et al., Nature 601, 53 (2022).
[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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Session Classification: Poster Session 1