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CPT tests with protons and 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 protons and antiprotons. Using single-particle multi-Penning-trap techniques, we measure their charge-to-mass ratios, magnetic moments and lifetimes. Comparing these properties of the antiproton with the proton results in stringent limits on CPT violation in the baryon sector.

Since its approval in 2013, BASE has measured the antiproton-to-proton charge-to-mass ratio with a fractional precision of 69 parts per trillion [1], testing the Standard Model at the atto-electronvolt scale. Moreover, using a newly developed triple-Penning-trap method, we have reached a fractional precision of 1.5 parts per billion for the magnetic moment of the antiproton [2]. Combining this result with the 0.3 parts per billion measurement of the proton's magnetic moment [3], we provide a baryon-magnetic-moment based CPT test at the parts per billion level, improving by a factor of 3000 compared to the previous experiments [4]. Concerning the antiproton's lifetime, the unique implementation of an antiproton reservoir trap has allowed us to set a direct constraint of $\tau = 10.2$ years [5], improving the previous best limit by a factor of 30.

In this talk, I will review the techniques that have made these achievements possible and discuss the resulting tests of CPT invariance.

- [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] J. DiSciaccia et al., Phys. Rev. Lett. 110, 130801 (2013).
- [5] S. Sellner et al., New. J. Phys. 19, 083023 (2017).

Content of the contribution

Experiment

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