BASE: High-Precision Comparisons of the Fundamental Properties of Antiprotons and Protons

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The striking imbalance of matter and antimatter in our universe has yet to be understood, which inspires experiments to compare the fundamental properties of matter-antimatter conjugates at lowest energy and with great precision. The BASE collaboration at the antiproton decelerator of CERN is performing such high-precision comparisons with protons and antiprotons. Using advanced, ultra-stable, cryogenic particle traps and superconducting detectors with single particle sensitivity, we have performed the most precise measurement of the proton-to-antiproton charge-to-mass ratio with a fractional precision of 11 significant digits [1]. In another measurement, we have invented a novel spectroscopy method, which allowed for the first ultra-high precision measurement of the antiproton magnetic moment with a fractional precision of 1.5 parts in a billion [2]. Together with our recent measurement of the proton magnetic moment [3] this improves the precision of previous experiments [4] by more than a factor of 3000. A time series analysis of this recent magnetic moment measurement furthermore enabled us to set first direct constraints on the interaction of antiprotons with axion like particles [5].

In my talk I will review the recent achievements of BASE and will outline strategies to further improve our high-precision studies of matter-antimatter symmetry. This outlook will involve the implementation of sympathetic cooling of antiprotons using quantum logic methods, as well as a motivation and first design studies for transportable antiproton traps for precision measurements.

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