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Studies of Exotic Physics with Antiprotons and Protons

Tuesday, 6 July 2021 12:00 (30 minutes)

The Standard Model of particle physics is both incredibly successful and glaringly incomplete. Among the questions left open is the striking imbalance of matter and antimatter in our universe, which inspires experiments to compare the fundamental properties of matter/antimatter conjugates with high precision. The BASE collaboration at the antiproton decelerator of CERN is performing such high-precision comparisons with protons and antiprotons. Using advanced cryogenic particle traps, we have performed the most precise measurement of the proton-to-antiproton charge-to-mass ratio with a fractional uncertainty of 69 parts per trillion [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 (ALPs) [5], and most recently, we have used our ultra-sensitive single particle detection systems to derive narrow-band constraints on the conversion of ALPs into photons [6]. 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, and the development of the transportable antiproton trap BASE-STEP.

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Session Classification: Variation of the Fundamental Constants, Tests of the Fundamental Symmetries and Probes of the Dark Sector

Track Classification: Precision Tests: Variation of the fundamental constants, tests of the fundamental symmetries and probes of the dark sector