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BASE –towards a 10-fold improved measurement of the antiproton magnetic moment

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BASE is a collaboration whose main experiment is located at CERN, with the goal of contributing to resolving the puzzle of the striking matter-antimatter imbalance and the mystery of the origin of dark matter. The related experiments are conducted by performing ultra-precise comparisons of the fundamental properties of single antiprotons and protons trapped in a sophisticated four Penning-trap system.

The flagship experiments uniquely conducted by the BASE collaboration are the magnetic moment measurements of single protons and antiprotons. Our last measurements, the most precise determinations of these constants to date, are at the 300 p.p.t. level for protons (G. Schneider, A. Mooser, S. Ulmer, et al. Science 358, 1081 (2017)) and at 1.5 p.p.b. for antiprotons (C. Smorra, S. Ulmer, et al. Nature 550, pages 371–374 (2017)). To improve these limits, we have developed many new technological innovations and experimental methods, including fast sub-thermal cooling, a superconducting magnetic field compensation system, a new antiproton catching system for the ELENA era, and an ultra-stable quantum spin-state detection system. Putting all these experimental developments together, we are currently conducting a new proton/antiproton magnetic moment measurement campaign, with the goal to improve the precision in the determination of the antiproton magnetic moment by a factor of 5 to 10.

In this talk, I will report on the status of the BASE experiment, focusing on the progress made towards more precise proton and antiproton magnetic moment measurements. I will discuss the current experimental limitations and plans for future improvements, that will be based on the first coherent single-particle nuclear spin-quantum-spectroscopy.

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