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

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The Standard Model of particle physics –the theory that best describes particles and their fundamental interactions –is known to be incomplete, inspiring various searches for “new physics”that goes beyond the model. These include tests that compare the basic characteristics of matter particles with those of their antimatter counterparts. While matter and antimatter particles can differ, for example, in the way they decay (a difference often referred to as violation of CP symmetry), other fundamental properties, such as the absolute value of their electric charges and masses, are predicted to be exactly equal. Any difference –however small – between the properties of protons and antiprotons would break a fundamental law known as CPT symmetry. This symmetry reflects well-established properties of space and time and of quantum mechanics, so such a difference would constitute a dramatic challenge not only to the Standard Model, but also to the basic theoretical framework of particle physics.

The goal of the BASE collaboration is to perform such tests comparing the fundamental properties of protons and antiprotons at lowest energies and with greatest precision, by using single particles in Penning traps. By applying such techniques, we recently performed a high-precision comparison of the antiproton-to-proton charge-to-mass ratio with a fractional precision of 69 parts in a trillion. The measurement was inspired by methods developed by the TRAP collaboration, which compared cyclotron frequencies of antiprotons and negatively charged hydrogen ions.

Another goal of the BASE collaboration is the high-precision comparison of the magnetic moments of the proton and the antiproton. In this context we applied the double Penning trap technique to the proton and performed the to-date most precise and first direct high precision measurement of the particles magnetic moment. In a next step this method will be applied to the antiproton.

In the talk I will give a summary on recent BASE results and give an outlook towards the future goals of BASE.

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