Fundamental tests with antihydrogen atoms based on advances in non-neutral plasma physics

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Abstract: Antihydrogen can be synthesized and trapped by mixing positron and antiproton plasmas confined in superimposed Penning-Malmberg and minimum-B trap fields. Superb control of these two plasmas is necessary to trap antihydrogen. Recent advances in plasma physics have allowed CERN's ALPHA collaboration to increase our trapping rate by a factor of twenty, and have allowed us to trap as many as 1000 antihydrogen atoms simultaneously.

The work on antihydrogen is motivated by the baryogenesis problem (the scarcity of antimatter in the University). We have measured the spin flip frequency of these antiatoms to 0.1%, and the charge of the antiatoms to 0.7ppb; both of these studies search for CPT violations. Recently, we were able to determine the 1s-2s transition energy by illuminating antiatoms held within a 243nm laser cavity. At an accuracy of 200ppt, this is, by some measures, approaching the most precise CPT tests, and tighter limits are expected shortly. We have also set crude bounds on the gravitational properties of these antiatoms (antimatter g limited by +/-100g), and are constructing a new apparatus designed to measure the antimatter g to 1%; this is a test of the weak equivalence principle.

In this talk I will discuss some of the recent advances in plasma physics, as well as some of the results of our CPT and weak equivalence tests.