Measuring the Ground State Hyperfine Splitting of Antihydrogen

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CPT Invariance of the Standard Model dictates that the fundamental properties of particles and their anti-particles are equal. Antihydrogen is the simplest stable atom composed solely of antimatter and its corresponding matter partner hydrogen is one of the most precisely studied atomic systems. Consequently, a comparison of the spectra of hydrogen and antihydrogen issues one of the most stringent tests of CPT symmetry.

The ASACUSA (Atomic Spectroscopy And Collisions Using Slow Antiprotons) collaboration based at the Antiproton Decelerator at CERN aims to measure the ground state hyperfine splitting of antihydrogen in a Rabi-like experiment [1]. Antiprotons are accumulated in the MUSASHI trap [2] and then transported to the so-called double CUSP trap. In this mixing trap consisting of multi-ring electrodes and two pairs of anti Helmholtz coils, antihydrogen is produced by mixing antiprotons with positrons [3, 4]. The anti-atoms escape the trap as a polarised beam and enter the spectroscopy apparatus which comprises of a microwave cavity for inducing hyperfine transitions, a state-analysing sextupole magnet and an antihydrogen detector [5, 6] for monitoring the count rate of the arriving anti-atoms.

Spectroscopy and the goal to reach a relative precision at the ppm level is not yet feasible due to the low number of antihydrogen atoms produced in the ground state. Therefore, the present main focus lies on increasing the production rate and measuring properties of the anti-atoms created. In this talk the setup of the ASACUSA-CUSP experiment will be presented as well as its challenges and recent developments, including the first measurement of the quantum state distribution of antihydrogen atoms in a beam [7].

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[1] http://cern.ch/asacusa