Positronium Manipulation for Antihydrogen Production

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The AEgIS collaboration (Antihydrogen Experiment: gravity, Interferometry, Spectroscopy) is aiming at testing the Weak Equivalence Principle (WEP) on neutral antimatter. The WEP states that everything massive falls at the same rate under gravity. A cold beam of pulsed antihydrogen (Hbar) sent through a moiré deflectometer is the scheme considered to measure the free fall of Hbar in the Earth's gravitational field.

In AEgIS, Hbar can be produced in a pulsed way utilizing the charge exchange reaction [1]. The implementation of this scheme involves producing a cloud of positronium atoms (Ps, the bound state of an electron and a positron) by implanting a 20 nanoseconds bunch of positrons into a nanochannel silicon target [2]. The Ps atoms are excited to a Rydberg state (an excited electronic state of high principal quantum number) through a two photon resonant transitions. Two laser pulses are used, one in the UV range to excite Ps atoms from the ground state to n=3 and a second one in the mid infrared to excite the transition between n=3 and the Rydberg state [3-4]. After free flight, the Rydberg Ps atoms reach a plasma of antiprotons kept into a Penning trap made of a 1T magnetic field and circular electrodes. Collisions between Rydberg Ps atoms and antiprotons can lead to the formation of Hbar atoms.

We report on recent progress inside the AEgIS experiment. We will focus on the development of a recent technique for quick diagnostic of Ps excitation and velocimetry using two photon resonant ionization and an MCP for imaging the photopositrons trapped on their cyclotron motion after ionization. This background free technique allows for both spatial and temporal resolution in imaging the Ps cloud properties. This efficient scheme offers the possibility to regularly check the status of Ps production during Hbar production run.

References

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