Long-lived Positronium for pulsed antihydrogen production

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The foreseen production of cold antihydrogen atoms at CERN's Antiproton Decelerator (AD) opened up the possibility to perform direct measurements of Earth's gravitational acceleration on antimatter bodies [1]. This is the primary goal of the AEgIS collaboration: measure the value of g using a moiré deflectometer/Talbot-Lau interferometer with a pulsed source of cold, neutral atomic antimatter [2].

This talk is focused on the milestones achieved by AEgIS along the first development of a pulsed source of cold antihydrogen using charge-exchange between trapped antiprotons and cold Rydberg positronium [3]. Cold antiproton plasmas were first prepared with well-established techniques in a custom Malmberg-Penning trap with partially open electrodes to allow Rydberg Ps atoms to enter the trap [4] [5]. Ps was subsequently formed and detected in the cryogenic, high magnetic field environment of the experiment using Single-Shot Positron Annihilation Lifetime Spectroscopy (SSPALS) [6]. The crucial ability to manipulate it optically via pulsed laser beams was achieved thanks to a newly developed detection method based on a cryogenic Micro-Channel Plate (MCP), able to spatially image photo-positrons from Ps photo-dissociation events with a resolution of ~100 um [7]. Thanks to this high-resolution imaging detector, the accurate measurement of the Ps atoms' velocity distribution emitted from the cryogenic target and the optimization of the charge-exchange cross-section with antiprotons were possible. Furthermore, this detector provided shot-by-shot diagnostics of Ps Rydberg excitation and alignment towards the antiprotons in the trap for the first experimental trials of pulsed antihydrogen production.

References

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