DAMOP08-2008-020098

Abstract for an Invited Paper
for the DAMOP08 Meeting of
the American Physical Society

Antihydrogen Production within a Penning-Ioffe Trap (ATRAP)

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Slow antihydrogen atoms are produced in a Penning trap that is located within a quadrupole Ioffe trap. 5-MeV antiprotons provided by the CERN Antiproton Decelerator are slowed in a Be degrader and captured in the Penning trap where they are further cooled by collisions with cold trapped photoelectrons produced using a 20-mJ excimer laser pulse. Positrons from a Na-22 source are cooled with gas molecules and are trapped in a separate Penning trap and then transferred through a small aperture into the 1-T field of the main Penning trap where they are also cooled by electrons. Typically, 60 million positrons and 0.5 million antiprotons are collected within 15 minutes. Antihydrogen is formed as the positrons and antiprotons are mixed in a slowly-ramped nested well, and is detected by Stark-field ionization. The Ioffe trap, intended to ultimately confine extremely cold, ground-state H atoms, results in divergent magnetic fields, and we demonstrate that antihydrogen can be formed by combining its constituents in these fields. In fact, the number of detected antihydrogen atoms increases when the 400-mK Ioffe trap is turned on. This work is done by the ATRAP collaboration: G. Gabrielse (spokesperson), P. Larochelle, D. Le Sage, B. Levitt, W.S. Kolthammer, R. McConnell, P. Richerme, J. Wrubel, A. Speck, M.C. George, D. Grzonka, W. Oelert, T. Sefzick, Z. Zhang, A. Carew, D. Comeau, E.A. Hessels, C.H. Storry, M. Weel and J. Walz.