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Making Cold Antihydrogen from Antimatter Plasmas

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The overview, status and recent progress of cold antihydrogen experiments will be presented, with emphasis upon plasma processes and challenges. Both the ATRAP [1,2] and ATHENA [3] have made low energy antihydrogen atoms using antiprotons from CERN's Antiproton Decelerator, and positrons from a radioactive source. The many steps required to trap and form separate non-neutral plasmas of these particles in a Penning-Malmberg trap will be described. Antihydrogen atoms in excited atomic states have been formed by two methods – during positron-cooling of antiprotons in a nested Penning trap [4] and via 3-body recombination with merged antiproton and positron plasmas, and also by resonant charge exchange of antiprotons and Rydberg positronium [5]. The distribution of excited states and antihydrogen velocities comes from electric-field ionization spectroscopy. Progress toward the goal of forming ground state antihydrogen cold enough ($<<1$ K) to be stored in a magnetic trap will be discussed. A comparison of the spectroscopy of cold, trapped antihydrogen with hydrogen would provide the most precise test of CPT invariance with leptons and baryons.

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[3] ATHENA, Nature **419**, 456-459, 2002
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