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Adiabatic Expansion Cooling of Antihydrogen Atoms[1] DANIELLE HODGKINSON, WILLIAM BERTSCHE, University of Manchester, JOEL FAJANS, University of California, Berkeley, ALPHA COLLABORATION — We present a technique to adiabatically cool antihydrogen by trapping in a small magnetic well and subsequently expanding the trapping volume. Lowering antihydrogen kinetic energy is expected to benefit antihydrogen spectroscopy and gravity experiments. For spectroscopic measurements, kinetic-energy reduction can decrease doppler effects and increase laser interaction-time, thus narrowing spectral linewidth. For gravity experiments, reducing antihydrogen kinetic energy makes it possible to confine in a reduced-strength magnetic field and minimizes effects from field errors. Simulations of the experimental procedure are presented, showing that an ensemble of antihydrogen atoms held in a static well undergo no significant changes in mean total energy, whereas adiabatically cooled populations have mean total energy reduced by about 37%. Simulating gradual removal of the magnetic trap confirms the expectation that adiabatically cooled ensembles tend to annihilate at later times. Simulated annihilation-time distributions are found to resemble experimental data. The presented technique predominantly reduces axial kinetic energy but orbit-mixing between axial and transverse dimensions leads to transverse kinetic-energy reduction.

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