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Confinement of antihydrogen for 1000 seconds (ALPHA Experiment)

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Atoms made of a particle and an antiparticle are unstable, usually surviving less than a microsecond. Antihydrogen, made entirely of antiparticles, is believed to be stable, and it is this longevity that holds the promise of precision studies of matter-antimatter symmetry. We have recently demonstrated trapping of antihydrogen atoms by releasing them after a confinement time of 172 ms [1]. A critical question for future studies is: how long can anti-atoms be trapped? Here we report the observation of anti-atom confinement for 1000 s, extending our earlier results by nearly four orders of magnitude [2]. Our calculations indicate that most of the trapped anti-atoms reach the ground state. Further, we report the first measurement of the energy distribution of trapped antihydrogen which, coupled with detailed comparisons with simulations, provides a key tool for the systematic investigation of trapping dynamics. These advances open up a range of experimental possibilities, including precision studies of CPT symmetry and cooling to temperatures where gravitational effects could become apparent.

[1] G. Andresen et al. (ALPHA Collaboration), Nature (London) 468, 673 (2010).

[2] G. Andresen et al. (ALPHA Collaboration), Nature Physics (London) 7, 558 (2011) [arXiv:1104.4982].

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