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Precision Experiments with Trapped Antihydrogen at ALPHA

Hydrogen is the best studied physical system, both theoretically and experimentally, therefore antihydrogen, the
antimatter equivalent of hydrogen, offers a unique way to test matter-antimatter symmetry. In particular, the CPT
invariance theorem implies that hydrogen and antihydrogen have the same spectrum. The ALPHA experiment at
CERN can synthesize and confine a large number of antihydrogen atoms for extended periods of time. This enabled
successful experimental campaigns to measure the frequency of the 1S-2S transition [1, 2] and the hyperfine splitting
of the ground state [3], owing to improved antihydrogen production techniques [4, 5]. An important aspect of the
ALPHA experimental methodology is the identification of the antihydrogen annihilations by means of the silicon
vertex detector. The combination of the above techniques allowed ALPHA to probe the CPT symmetry to an absolute energy sensitivity of 2
$rimes 10^{-20}$ GeV.
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[1] Ahmadi, M. et al. , Nature 548, 506 (2017)\\
[2] Ahmadi, M. et al. , Nature 557, (2018)\\
[3] Ahmadi, M. et al., Nature 541, 66 (2017)\\
[4] Ahmadi, M. et al. , Nature Comm. 8, 681 (2017)\\
[5] Ahmadi, M. et al., Phys. Rev. Lett. 120 , 025001 (2018)

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