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Antihydrogen

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Do matter and antimatter obey the same fundamental laws, as we currently understand them? To what extent are particles and antiparticles precise analogues of one another? These are the central questions motivating the study of antihydrogen, the antimatter counterpart of the hydrogen atom.

We have developed tools that enable us to synthesize and trap antihydrogen atoms in magnetic potential wells [1], and to hold them for long periods of time [2]. And, we have conducted prototypical experiments with antihydrogen that probe microwave [3] and optical transitions [4], charge neutrality [5], and gravitational interactions [6]. Looking forward, we and others hope to advance the state-of-the-art in precision characterisation of the antihydrogen atom to the greatest extent possible.

I will introduce and motivate the study of antihydrogen, summarize a few recent experimental highlights, and comment on near term opportunities, prospects, and challenges for the field.

[1] Andresen *et al.* (ALPHA Collaboration), Trapped Antihydrogen, *Nature*, **468**, 673 (2010).
[2] Andresen *et al.* (ALPHA Collaboration), Confinement of antihydrogen for 1,000 seconds. *Nature Physics* **7**, 558 (2011).
[3] Amole *et al.* (ALPHA Collaboration), Resonant quantum transitions in trapped antihydrogen atoms, *Nature* **483**, 439 (2012).
[4] Ahmadi *et al.* (ALPHA Collaboration), Observation of the 1s-2s transition in trapped antihydrogen, *Nature* **541**, 506 (2017).
[5] Amole *et al.* (ALPHA Collaboration), An improved limit on the charge of antihydrogen from stochastic acceleration, *Nature* **529**, 373 (2016); Amole *et al.* (ALPHA Collaboration), An experimental limit on the charge of antihydrogen, *Nature Communications* **5**, 3955 (2014).
[6] Amole *et al.* (ALPHA Collaboration), Description and first application of a new technique to measure the gravitational mass of antihydrogen, *Nature Communications* **4**, 1785 (2013).