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Physics with Trapped Antihydrogen

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For more than a decade antihydrogen atoms have been formed by mixing antiprotons and positrons held in arrangements of charged particle (Penning) traps [1,2]. More recently, magnetic minimum neutral atom traps have been superimposed upon the anti-atom production region, promoting the trapping of a small quantity of the antihydrogen yield [3-5]. We will review these advances, and describe some of the first physics experiments performed on antihydrogen including the observation of the two-photon 1S-2S transition [6], investigation of the charge neutrality of the anti-atom [7,8] and studies of the ground state hyperfine splitting [9]. We will discuss the physics motivations for undertaking these experiments and describe some near-future initiatives. 1. M. Amoretti *et al.* (ATHENA Collaboration), *Nature* **419** (2002) 456 2. G. Gabrielse *et al.* (ATRAP Collaboration), *Phys. Rev. Lett.* **89** (2002) 213401 3. G.B. Andresen *et al.* (ALPHA Collaboration), *Nature* **468** (2010) 673 4. G.B. Andresen *et al.* (ALPHA Collaboration), *Nature Phys.* **7** (2011) 558 5. G. Gabrielse *et al.* (ATRAP Collaboration), *Phys. Rev. Lett.* **108** (2012) 113002 6. M. Ahmadi *et al.* (ALPHA Collaboration), *Nature* **541** (2017) 506 7. C. Amole *et al.* (ALPHA Collaboration), *Nature Commun.* **5** (2014) 3955 8. M. Ahmadi *et al.* (ALPHA Collaboration), *Nature* **529** (2016) 373 9. C. Amole *et al.* (ALPHA Collaboration) *Nature* **483** (2012) 439