Trapped antihydrogen: the ALPHA experiment at CERN

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It has been just over 100 years since Niels Bohr proposed his famous model for the hydrogen atom. It is thus very exciting that we are now on the brink of being able to experimentally study antihydrogen - the antimatter equivalent of hydrogen. The Standard Model of fundamental particles and interactions requires that hydrogen and antihydrogen have the same spectrum. At CERN in Geneva, the ALPHA collaboration is working to test this requirement by performing direct spectroscopic measurements on trapped atoms of antihydrogen. I will discuss the newest development along the road to antihydrogen spectroscopy: magnetically trapped antihydrogen. In November of 2010 we reported[1] the first trapping of antihydrogen atoms in a magnetic multipole trap. The atoms must be produced with an energy - in temperature units - of less than 0.5 K in order to be trapped. Subsequently, we have shown that trapped antihydrogen can be stored[2] for up to 1000 s, and we have performed the first resonant quantum interaction experiments with anti-atoms[3]. We have also recently demonstrated a new technique[5] to study the gravitational behaviour of antihydrogen atoms in free-fall, and put the first limit on the electrical neutrality of antihydrogen[5]. I will discuss the many developments necessary to realise trapped antihydrogen, and I will discuss the future of this rapidly emerging field of study.

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2. Andresen, G. B. *et al*. Confinement of antihydrogen for 1,000 seconds. *Nature Physics* **7**, 558 (2011).
3. Amole, C. *et al.,* Resonant quantum transitions in trapped antihydrogen atoms, *Nature* **483**, 439 (2012).
4. Amole, C. *et al.*, Description and first application of a new technique to measure the gravitational mass of antihydrogen, *Nature Communications* DOI: 10.1038/ncomms2787 (2013).
5. Amole, C. *et al.*, An experimental limit on the charge of antihydrogen, Nature Communications 5, 3955 (2014).