universität innsbruck

FWF Der Wissenschaftsfonds

Innsbruck Physics Colloquium

Spectroscopic and Gravitational studies of antimatter: the ALPHA antihydrogen experiment at CERN

Jeffrey Hangst

Department of Physics and Astronomy, Aarhus University

Spokesperson, the ALPHA Collaboration at CERN

At CERN, we have rather recently become able to study atoms of antihydrogen - the antimatter equivalent of hydrogen. The question to be addressed is fundamental and profound: “Do matter and antimatter obey the same laws of physics?” For example, the Standard Model requires that hydrogen and antihydrogen have the same spectrum. The possibility of applying the *precision* measurement techniques of atomic physics to an antimatter atom makes antihydrogen a very compelling testbed for fundamental symmetries such as CPT. I will discuss the latest developments in antihydrogen physics: observation of the first laser-driven transition (1S-2S)[1,2] observation of the antihydrogen hyperfine structure[3], observation of the Lyman-alpha transition[4], and laser cooling of trapped antihydrogen[5]. To study antihydrogen, it must first be produced, trapped[6], and then held for long enough[7] to observe a transition - using very few anti-atoms. I will illustrate the techniques necessary to achieve the latest milestones, and then consider the future of optical spectroscopy. I will also discuss the beginning of gravitational studies[8] with the brand-new ALPHA-g experiment, which is designed to measure the direction and magnitude of the gravitational acceleration of antimatter in the field of the Earth.

DK-ALM Pre-Talk: Siegfried Kollotzek

How to dope multiply charged superfluid helium nanodroplets

Time & Location: Tuesday, 18.04.2023, 16:30 h, HS C

Snacks will be provided in between the pre-talk and the colloquium.

1. *Observation of the 1s-2s Transition in Trapped Antihydrogen,* M Ahmadi *et al.,* (ALPHA Collaboration) *Nature* **541**, 506–510 (2017); 2 *Characterization of the 1S-2S transition in antihydrogen,* M Ahmadi *et al.,* (ALPHA Collaboration), *Nature* ***557****, 71–75 (2018);* 3, *Observation of the hyperfine spectrum of antihydrogen,* M Ahmadi *et al.,* (ALPHA Collaboration) *Nature* **548**, 66–69 (2017); 4. *Observation of the 1S–2P Lyman-α transition in antihydrogen,* M Ahmadi *et al.,* (ALPHA Collaboration), *Nature* **561**, 211–215 (2018); 5. *Laser cooling of antihydrogen atoms,* (ALPHA Collaboration), *Nature* **592**, 35–42 (2021); 6. Andresen, G.B. *et al.*, Trapped Antihydrogen, *Nature*, **468**, 673 (2010); 7. Andresen, G. B. *et al*. Confinement of antihydrogen for 1,000 seconds. *Nature Physics* **7**, 558 (2011); 8. 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).

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Innsbruck Physics Colloquium, Organisation: K. Erath-Dulitz, H.-C. Nägerl, T. Schrabback