



Innsbruck Physics Colloquium

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

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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 structure³, observation of the Lyman-alpha transition⁴, and laser cooling of trapped antihydrogen⁵. To study antihydrogen, it must first be produced, trapped⁶, and then held for long enough⁷ 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 studies⁸ 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-alpha 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).