PHYSICS COLLOQUIA 2024

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 and manipulation techniques of atomic physics
to an antimatter atom makes antihydrogen a very compelling testbed for fundamental symmetries
such as CPT and the Weak Equivalence Principle. I will discuss the latest development in antihydrogen physics:
the first gravitational studies[1] with the brand-new ALPHA-g experiment. ALPHA-g is designed
to measure the direction and magnitude of the gravitational acceleration of antimatter in the field of the Earth.
I will also review the state-of-the-art of spectroscopic measurements on anti-atoms,
including characterisation of the first laser-driven transition (1S-2S),
observation of the antihydrogen hyperfine structure, observation of the Lyman-alpha transition, and laser cooling of trapped antihydrogen.
To study antihydrogen, it must first be produced, trapped, and then held for long enough to make a measurement - using very few anti-atoms.
I will illustrate the techniques necessary to achieve these many milestones and finally consider the future of antihydrogen studies.

1. Observation of the effect of gravity on the motion of antimatter Anderson, E., et al., (ALPHA Collaboration) Nature 621.716–722 (2023).

Jeff Hangst | Aarhus University (DEN)

GRAVITATIONAL AND SPECTROSCOPIC STUDIES OF ANTIMATTER: THE ALPHA ANTIHYDROGEN EXPERIMENT AT CERN

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UNIVERSITÀ DEGLI STUDI DI MILANO
DOTTORATO DI RICERCA IN FISICA
ASTROFISICA E FISICA APPLICATA

DIPARTIMENTO DI FISICA
via Celoria 16 | 20133 MILANO
Tel. +39 02 50317740
http://phd.fisica.unimi.it | phd@fisica.unimi.it