Contribution ID: **53** Type: **Oral**

Microwave Spectroscopy of Antihydrogen in the ALPHA Experiment

Sunday, 28 September 2025 10:00 (15 minutes)

Antihydrogen, the bound state of an antiproton and a positron, o ers a unique platform for testing fundamental symmetries in physics [1]. Measurements of the antihydrogen atomic spectrum can allow for stringent testing of CPT symmetry as the transition frequencies are predicted to be identical to hydrogen. Among the most sensitive tests is the measurement of ground-state hyperfine splitting, a transition well-characterized in hydrogen and now accessible in antihydrogen through precision microwave spectroscopy. The Antihydrogen Laser PHysics Apparatus (ALPHA) has produced, trapped, and studied antihydrogen through spectroscopic and gravitational measurements [2,3]. Through microwave spectroscopy, the hyperfine structure of the ground state of antihydrogen has been investigated [4]. Recent advances in antihydrogen production and magnetic field control have enabled a new protocol for such a microwave experiment. In this talk, I will discuss the latest hyperfine measurements in ALPHA and prospects for improved measurements.

[1] M. Charlton, S. Eriksson, and G. M. Shore. "Antihydrogen and Fundamental Physics"(Springer Cham, 2020).
[2] ALPHA Collaboration. Precision spectroscopy of the hyperfine components of the 1S–2S transition in antihydrogen. Nature Physics 21, 201 (2025).
[3] ALPHA Collaboration. Observation of the e ect of gravity on the motion of antimatter. Nature 621, 48 (2023).
[4] ALPHA Collaboration. Observation of the hyperfine spectrum of antihydrogen. Nature 548, 66–69 (2017). https://doi.org/10.1038/nature23446

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Session Classification: Scientific Program