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Recent highlights and projects at the Antiproton Decelerator

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Experiments at the Antiproton Decelerator of CERN compare properties of matter and antimatter at low energies for precision tests of fundamental symmetries and interactions.
Using either atoms made of antiprotons (antihydrogen or antiprotonic-helium) or singly trapped antiproton, AD experiments address a broad range of physics questions via a spectrum of different experimental techniques.
The conservation of the combined charge-parity-time symmetry (CPT), a fundamental symmetry in quantum field theory, implies that properties of antimatter particles/atoms (electrical charge, mass, magnetic moment, atomic spectrum etc) should be equal or exactly opposite to that of matter. This symmetry was recently subject to high scrutinity at the AD through the first precision measurements of atomic transitions in trapped antihydrogen. Also, comparison of the charge to mass ratio of a single antiproton to that of an H- ion in a Penning trap provided the most stringent test of CPT invariance with baryons. The magnetic moment of the antiproton could be measured at the ppb level, even surpassing for a few weeks the knowledge on the proton magnetic moment.
Using exotic antiprotonic atoms, two-photon spectroscopy measurements determined the electron-to-antiproton mass ratio with better than ppm precision.
In addition to testing CPT invariance, experimental efforts are oriented towards the study of the interaction of antihydrogen atoms with the earth gravitational field.
Einstein's weak equivalence principle, central to the theory of relativity, has been tested with matter to a high degree of precision, but has never so far been experimentally verified to apply to antimatter.
Three experiments, all using different experimental approaches, are now set up to measure $\bar{g}$ with a first precision goal between 30% and 1%.
Additionaly a new proposal to connect low energy antiprotons for radio-nuclei studies will be setting grounds at the AD and aim to bring the first antiprotons accross the road to ISOLDE.
The upcoming long shutdown 2 will be the opportunity for new developments. In particular, all experiments are now preparing for their connections to the newly commissioned ELENA ring which will provide lower-energy antiproton beams at an improved emittance, which will boost the experimental potentials.
The talk will summarize the recent highlights of the AD and give an outlook on the bright upcoming future of low energy antiproton research with ELENA.

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