Low Energy Antiproton Experiments – A Review

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Low energy antiprotons offer excellent opportunities to study properties of fundamental forces and symmetries in nature. They can contribute substantially to deepen our fundamental knowledge in atomic, nuclear and particle physics. Searches for new interactions can be carried out by studying discrete symmetries. Known interactions can be tested precisely and fundamental constants can be extracted from accurate measurements.

Among the pioneering experiments have been the trapping of single antiprotons in a Penning trap, the formation and precise studies of antiprotonic helium atomcules and recently the production of antihydrogen. These experiments have led to precise values for antiproton parameters, accurate tests of bound three-body QED, tests of the CPT theorem and better understanding of atom formation. Future experiments promise more precise tests of the standard theory and have a robust potential to discover new physics.

Precsision experiments with low energy antiprotons share the need for intense particle sources and the need for time to develop novel instrumentation with all other experiments, which aim for high precision in exotic fundamental systems. The experimental programs – carried out mostly at the former LEAR facility and at present at the AD facility at CERN – would benefit from intense future sources of low energy antiprotons.

Examples of key antiproton experiments will be given and compared with other experiments in the field. Among the central issues will be their potential to obtain important information on basic symmetries such as CPT and to gain insights into antiparticle gravitation as well as the possibilities to learn about nuclear neutron densities.