Positron Quantum Cyclotron and Antihydrogen

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Current measurements illustrate the usefulness of low energy studies of particle properties and fundamental symmetries. A one electron quantum cyclotron -- a single trapped electron cooled to such a low temperature that the quantum structure of its cyclotron motion is clearly resolved -- is used to make a greatly improved measurement of the electron magnetic moment. This measurement, with QED theory, establishes a much more accurate new value for the fine structure constant -- the fundamental measure of the strength of the electromagnetic interaction. A positron quantum cyclotron will produce the most stringent test of CPT invariance with a lepton system. Precise laser spectroscopy or antihydrogen would greatly improve the accuracy at which CPT can be tested with leptons and baryons. Great progress in measuring the velocity and internal orbit properties of antihydrogen atoms brings closer the goal of comparing antihydrogen and hydrogen atoms, using highly accurate laser spectroscopy to provide what likely will be the most strenuous test of CPT invariance with baryons and leptons. A new, laser-controlled method for producing slow antihydrogen is the second of two methods now available to make slow antithydrogen.