Laser spectroscopy of cooled antiprotonic helium atoms

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The Atomic Spectroscopy and Collisions Using Slow Antiprotons (ASACUSA) collaboration at the Antiproton Decelerator facility of CERN is carrying out precise laser spectroscopy experiments on antiprotonic helium (\(\bar{p}\text{He}^+ \equiv \bar{p} + \text{He}^{2+} + e^-\)) atoms [1, 2, 3]. Employing buffer-gas cooling techniques in a cryogenic gas target, samples of atoms were cooled to temperature \(T = 1.5\text{–}1.7\) K, thereby reducing the Doppler width in the single-photon resonance lines [3]. By comparing the results with three-body quantum electrodynamics calculations, the antiproton-to-electron mass ratio was determined as \(M_p/m_e = 1836.1526734(15)\). Besides providing a consistency test of CPT symmetry, the results have recently been used to set constraints on any exotic fifth force that may exist at the \(\sim 1\) Å length scale [4, 5, 6, 7]. Further improvements in the experimental precision are currently being attempted.