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Precision comparison of the g-factor of the proton and anti-proton

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We report the first measurement of the antiproton magnetic moment using a single antiproton. The magnetic moment in nuclear magnetons is $\mu_{\bar{p}}/\mu_N = -2.792845 \pm 0.000012$, a 4.4 parts per million (ppm) measurement. This represents a factor of 680 improvement in precision over previous work using exotic atom spectroscopy, which has achieved a 3000 ppm precision and remained essentially unchanged in the past 20 years.[1,2] Our measurement allows for an improved comparison of the proton and antiproton magnetic moments, yielding a result consistent with the prediction of charge, parity and time reversal symmetry. Following a proof of principle, 2.5 ppm measurement of the proton magnetic moment,[3] the experiment was moved to CERN for the antiproton experiment. Initial work focused on catching, cooling and trapping a single antiproton from the 5 MeV beam at CERN's Antiproton Decelerator. Following this work, we undertook a magnetic moment measurement. The spin and cyclotron frequency are measured to determine the g-factor, $g/2 = f_s/f_c$. Prospects for further improvement should be possible with single spin flip detection, similar to what was used to measure the electron magnetic moment - currently the most precisely measured property of a fundamental particle.[4] The new antiproton magnetic moment measurement is likely a first step towards improved precision by an additional factor of 10^3 or 10^4 improvement, with a precision at the part per billion level.[5,6,7]

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