The Hyperfine Stuctrure of Antiprotonic Helium and the Antiproton Magnetic Moment

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The ASACUSA collaboration is performing laser and microwave spectroscopy of antiprotonic helium ($\bar{p}He^+$), a metastable three-body system consisting of a helium nucleus, an antiproton and an electron, at the Antiproton Decelerator (AD) of CERN. $\bar{p}He^+$ exhibits a hyperfine splitting (HFS) which is unique due to the large angular momentum of the metastable states ($L_{\bar{p}} \approx 35$): the HFS consists of a dominant splitting caused by the interaction of $L_{\bar{p}}$ with the electron spin S_e and a smaller splitting due to the interaction of the antiproton magnetic moment $\mu_{\bar{p}}$ with the other moments. The hyperfine splitting has been measured for the first time in 2001 with a precision of 3×10^{-5} [1]. The two observed transitions are in agreement with QED calculations at a level of 6×10^{-5}, which corresponds to the theoretical accuracy. The agreement gives a limit on the antiproton *orbital g*-factor of $\left|g_l^{\bar{p}} - 1\right| < 6\times10^{-5}$ [2]. The difference of the two transition frequencies is directly related to the value of the *spin* magnetic moment $\mu_{\bar{p}}$, which so far is known to only 0.3%. ASACUSA has started a new measurement with the goal of increasing the experimental precision by an order of magnitude, which would lead to a determination of $\mu_{\bar{p}}$ to 0.1%.

References

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