The Hyperfine Structure of Antiprotonic Helium and the Antiproton Magnetic Moment

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The ASACUSA collaboration is performing laser and microwave spectroscopy of antiprotonic helium atomcules, a metastable three-body system consisting of a helium nucleus, an antiproton and an electron, at the Antiproton Decelerator (AD) of CERN. The atomcule exhibits a hyperfine splitting (HFS) which is unique due to the large angular momentum of the metastable states ($L \sim 35$): the HFS consists of a dominant splitting caused by the interaction of the antiproton orbital angular momentum with the electron spin, and a smaller splitting due to the interaction of the antiproton spin magnetic moment with the other moments.

The hyperfine splitting has been measured for the first time in 2001 with a precision of $\sim$30 ppm [1]. The two observed transitions are in agreement with three-body QED calculations at a level of 60 ppm, which corresponds to the level of the theoretical accuracy. The agreement gives a limit on the antiproton orbital g-factor of the same magnitude. The difference of the two transition frequencies is directly related to the value of the antiproton spin magnetic moment, which so far is known to only 0.3%. As shown recently in [2], this value can be improved by up to one order of magnitude by measuring the HFS of selected levels of antiprotonic helium. ASACUSA has started a new series of measurements with the goal of increasing the experimental precision by an order of magnitude.

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[1] E. Widmann *et al.*, Phys. Rev. Lett. **89**, 243402 (2002).
[2] D. Bakalov and E. Widmann, arXiv:physics/0612021.