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Precision measurement of the hyperfine splitting of positronium

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Positronium (Ps) is an ideal system for precision test of bound-state Quantum Electrodynamics (QED). The hyperfine splitting (HFS) of the ground-state Ps has a discrepancy of 16 ppm (4.5σ) between the averaged previous experimental value and the theoretical calculation with $O(\alpha^3)$ corrections. A new experiment which reduced possible systematic uncertainties, which are Ps thermalization effect and non-uniformity of magnetic field, was performed to check the discrepancy. It revealed that the Ps thermalization effect was as large as 10 ± 2 ppm, which could have been underestimated as a systematic uncertainty in the previous experiments. Treating this effect correctly, a new independent experimental result of 203.3942 ± 0.0016 (stat., 8.0 ppm) \pm 0.0013 (syst., 6.4 ppm) GHz was obtained. This result is consistent with the QED prediction within 1.1σ , whereas it disfavours the previous experimental average by 2.6σ . It shows that the Ps thermalization effect is crucial for precision measurement of HFS. In this presentation, I will explain the details of the new experiment. Future prospects for improved precision will be also briefly discussed.

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