Relativistic shifts of bound negative muon *g*-factors: finite nuclear size effects

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Negative muons deeply bound in a strong Coulomb potential experience a relativistic shift of their magnetogyric ratio. Breit [1] first calculated the shift in 1928 assuming pointlike nuclei, for which the shift is quadratic in Z. However, for $Z \sim 20$ or greater, the μ^- spends a significant fraction of its time *inside* the nucleus, where it "sees" only a fraction of the nuclear charge, reducing its mean velocity and thus the relativistic shift of g. For the heaviest nuclei this *finite nuclear size* effect is dramatic, as first observed by Yamazaki *et al.* [2] in 1974.

An experiment by Mamedov *et al.* [3] in 2003 yielded a value for the relativistic shift in Cdμ^- atoms that disagreed with Yamazaki's experimental result. Subsequent measurements at TRIUMF [4] were in agreement with Yamazaki's original results. A second measurement by Mamedov *et al.* [5] in 2007 again disagreed with Yamazaki's results for both Cdμ^- and Pbμ^-.

We then decided to perform yet another measurement at the highest magnetic field yet (2.4 T) and with such high statistics that there could be no doubt of the results. Without giving away too much and spoiling the tension, we can say that the new, much more precise result for Cdμ^- agrees perfectly with our previous result; the new, more precise result for Pbμ^- shows a slightly (1.5 standard deviation) *larger* shift than we previously measured; and the first measurement ever on muonic tungsten is identical (within a small uncertainty) with that in lead, suggesting that the relativistic shift is nearly independent of Z in the heaviest elements.

It is conceivable that high precision measurements like these might yield unique information on nuclear charge distributions.

[1] G. Breit, Nature **122**, 649 (1928).
[2] T. Yamazaki *et al.*, Phys. Lett. B **53**, 117 (1974).
[3] T.N. Mamedov *et al.*, Physica B **326**, 15 (2003).
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[5] T.N. Mamedov *et al.*, Phys. Rev. A **75**, 054501 (2007).