The ^{3}He charge radius and the ^{3}He-^{4}He isotope shift from laser spectroscopy of muonic He ions

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Hydrogen-like light muonic ions, in which one negative muon replaces all the electrons, are extremely sensitive probes of nuclear structure, because the large muon mass increases tremendously the wave function overlap with the nucleus. Using pulsed laser spectroscopy we have measured three 2S-2P transitions in the muonic helium-3 ion (μ^3He$^+$), an ion formed by a negative muon and bare helium-3 nucleus. This allowed us to extract the Lamb shift, the 2P fine structure splitting, and the 2S-hyperfine splitting in μ^3He$^+$ [1] Comparing these measurements to theory we determine the rms charge radius of the helion (^{3}He nucleus) to be r_h = 1.97007(94) fm, in good agreement with the value from elastic electron scattering, but a factor 15 more accurate. We determine the ^{3}He-^{4}He (squared) charge radius difference of $\delta r^2 = 1.0636(6)_\mathrm{exp}(30)_\mathrm{theo}\mathrm{fm}^2$, in excellent agreement with recent measurements in ordinary helium atoms [2, 3]. Our results represent benchmarks for few-nucleon theories and open the way for precision QED tests in He atoms and ions.

References

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