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The Lamb shift in muonic hydrogen and the proton radius from effective field theories

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Summary

With the combined use of the effective field theories HBET, NRQED and pNRQED, we obtain a model independent expression for the Lamb shift in muonic hydrogen. This expression includes the leading logarithmic $calO(m_\mu$

$al^6)$ terms, as well as the leading $calO\left(m_\mu al^5 \frac{m_\mu^2}{m_\rho^2}\right)$ hadronic effects. The latter are controlled by the chiral theory, which allows for their model independent determination. Out of this analysis and the experimental measurement of the muonic hydrogen Lamb shift we determine the electromagnetic proton radius: $r_p = 0.8413(15)$ fm. This number is at 6.8 variance with respect to the CODATA value. The accuracy of our result is limited by uncomputed terms of $calO(m_\mu$

$al^5 \frac{m_\mu^3}{m_\rho^3}, m_\mu$

$al^6)$. This parametric control of the uncertainties allows us to obtain a model independent estimate of the error, which is dominated by hadronic effects.

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