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Laser spectroscopic determination of the ^{6}He nuclear charge radius[1]

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The weakly bound ^{6}He nucleus is an excellent testing ground for few-body nuclear calculations and is of great interest since its halo structure was suggested in the 80s. In this thesis work, we performed precision laser spectroscopy on individual metastable ^{6}He atoms confined and cooled in a magneto-optical trap (MOT). This technique enabled us to accurately measure the isotope shift between ^{6}He and ^{4}He to be 43194.772(56) MHz in the 2^3S_1–3^3P_2 transition at 389 nm. Based on this measurement and the atomic theory calculation, the root-mean-square charge radius of ^{6}He was determined to be 2.054(14) fm [1]. This result confirmed the neutron-halo structure of the ^{6}He nucleus model-independently for the first time and helps reveal the structure of the loosely bound system. This experiment also demonstrates a new technique for precision laser spectroscopy of short-lived radioactive atoms, and provides a unique atomic method for nuclear physics studies. [1] L.-B. Wang *et al.*, Phys. Rev. Lett. **93**, 142501 (2004)

[1]Work performed at Argonne National Laboratory in collaboration with K. Bailey, G.W.F. Drake, J.P. Greene, D. Henderson, R.J. Holt, R.V.F. Janssens, C.L. Jiang, Z.-T. Lu, P. Mueller, T.P. OConnor, R.C. Pardo, K.E. Rehm, J.P. Schiffer, and X.D. Tang.