Nuclear charge radius of helium-8

Helium-8 (^{8}He) is the most neutron-rich matter that can be synthesized on earth: it consists of two protons and six neutrons, and remains stable for an average of 0.2 seconds. Unlike the regular helium-4 (^{4}He), which usually has the two neutrons packed closely with two protons, the additional neutrons in ^{8}He form a halo around a compact, ^{4}He-like core. Because of its intriguing properties, ^{8}He has the potential to reveal new aspects of the fundamental forces among the constituent nucleons. Physicists have recently succeeded in laser trapping and cooling this exotic helium isotope, and have performed precision laser spectroscopy on individual trapped atoms. Based on atomic frequency differences measured along the isotope chain ^{4}He – ^{6}He – ^{8}He, the nuclear charge radius of ^{8}He has been determined for the first time to be 1.9 fermi (one fermi equals to one millionth of a nanometer). The result shows that the charge radius of ^{8}He is smaller than that of ^{6}He as illustrated in the figure to the right. This may be understood by noting that the four extra neutrons are more evenly distributed around the ^{4}He core than the neutron pair in ^{6}He as shown in the figure below. The result is in good agreement with recent predictions of the state-of-the-art nuclear structure theories, and it provides a critical test of the present understanding of these loosely-bound halo nuclei. The ^{6}He measurement was first performed at the ATLAS accelerator facility of Argonne, and the ^{8}He measurement at GANIL, France. This work was supported by the U.S. Department of Energy, Office of Nuclear Physics.

- *Laser Spectroscopic Determination of the ^{6}He Nuclear Charge Radius*
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- *Nuclear Charge Radius of ^{8}He*
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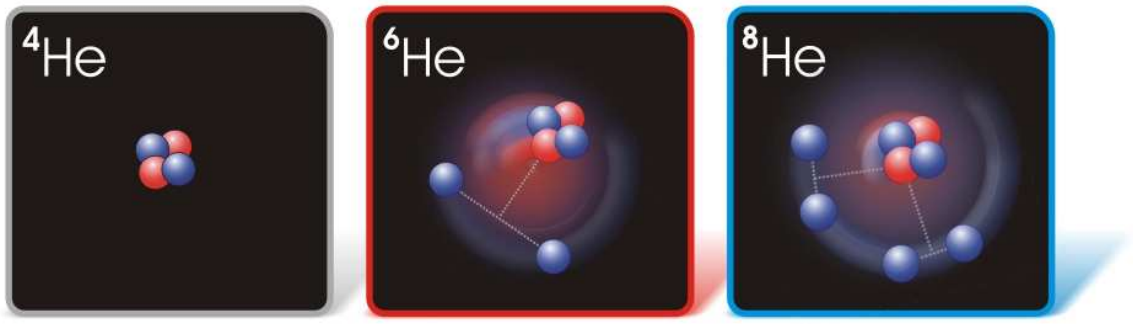

Figure: Illustration of the nuclear structure of the neutron halo isotopes ^{6}He and ^{8}He as compared to the stable and tightly bound ^{4}He. Being dragged by the halo neutrons, the ^{4}He-like core moves around the center of mass inside ^{6}He or ^{8}He, resulting in a larger charge radius.

More information can be found at http://www.phy.anl.gov/mep/atta/