No Double Magic for Calcium-52

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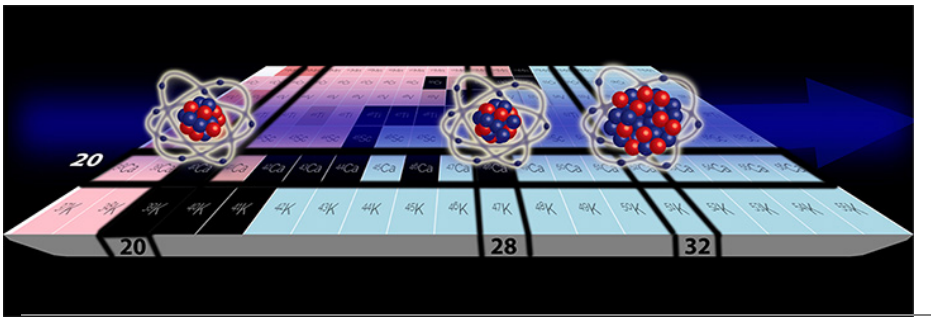
Nuclear theorists from UT and Oak Ridge National Laboratory are among the researchers who have found that Calcium-52 doesn't quite have the magic scientists once thought. The results were published in ***Nature Physics*** **(http://www.nature.com/nphys/journal/vaop/ncurrent/full/nphys3645.html)** February 8.

Calcium, at number 20 on the periodic table, has 20 protons, which places it squarely in the "magic" numbers of nuclear physics. Scientists have found that if an atomic nucleus has either protons or neutrons in certain numbers—2, 8, 20, 28, 50, 82, or 126—they arrange themselves in complete shells and make the nucleus more strongly bound than their neighbors. A doubly-magic nucleus has **both** protons and neutrons in magic numbers.

It had been proposed that the Calcium-52 isotope might be doubly-magic. To test this hypothesis, researchers measured the radius while adding 32 neutrons to the nucleus of a calcium atom. They found that in contrast to nuclei that are indeed doubly-magic, the nucleus kept growing, while its more magical cousins have smaller radii because they are more strongly bound.

> The image below shows the chain of the studied calcium isotopes. The "doubly magic" isotopes with mass numbers 40 (Ca-40) and 48 (Ca-48) exhibit equal charge radii. The first measurement of the charge radius in Ca-52 yielded an unexpectedly large result. Image: COLLAPS Collaboration/Ronald Fernando Garcia Ruiz.



Several nuclear models had already calculated what would happen, but none predicted the radius growing as much as the experiment found. First-principles computations using state-of-the-art nuclear interactions and the supercomputer Titan at Oak Ridge National Laboratory reproduced the similarity of the charge radii for ^{40,48}Ca, and yielded an increase of radii beyond ^{48}Ca. However, to understand the unexpected large difference between the charge radii of ^{52}Ca and ^{48}Ca still poses a theoretical challenge.

The study was done at the ISOLDE Radioactive Ion Beam facility at CERN, with theory support from scientists here in Tennessee, including:

- Andreas Ekström (UT Postdoc)
- Gaute Hagen (ORNL Physics Division Staff & UT Adjunct Faculty)
- Gustav Jansen (UT Postdoc at the time of the study, now ORNL Staff at the Oak Ridge Leadership Computing Facility)

- Thomas Papenbrock (UT Professor of Physics)
- Kyle Wendt (UT Postdoc at the time of the study, now a Postdoc at Darmstadt Technical University)

Please see the write-up from CERN at: **http://home.cern/about/updates/2016/02/has-magic-gone-calcium-52 (http://home.cern/about/updates/2016/02/has-magic-gone-calcium-52)**.