Physicists propose a way to make atomic clocks more accurate

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(Phys.org)—Physicists Andrei Derevianko of the University of Nevada and Victor Flambaum and Vladimir Dzuba of the University of New South Wales have proposed in a paper published in *Physical Review Letters* a way to improve on the accuracy of atomic clocks. They suggest stripping away electrons from ions to reduce the negative effects of stray fields that reduce the performance of current atomic clocks.

Researchers continue to look for ways to increase the accuracy of atomic clocks because higher accuracy would allow for finer measurements of very small changes in the values of the physical constants that underlie some of the most basic principles of physics. One example is the fine structure constant – a more accurate measurement of its changes might lead the way to the development of a unified theory.

Recent research has focused on switching to a nuclear clock as theories have indicated they might be more accurate than atomic clocks. Practical limitations, such as the high degree of difficulty in calculating frequency transitions and the danger of working with radioactive materials have prevented the development of such clocks however, which is what led this new effort to see if the model for an atomic clock could be improved.

Atomic clocks are based on using atomic transitions as a means of defining a time standard and are accurate to one part in 10^{17}. The goal is to improve that to 10^{19}. To achieve such accuracy, the researchers propose stripping away some of the electrons of a particular ion to cause

the remaining electrons to bind tighter to the nucleus. Doing so, they reason would reduce the stray fields that can creep into the electromagnetic trap used to measure the electronic transition, which skew the results. Based on that assumption, they've calculated that the observation of the electron transmission of a bismuth-209 ion would produce the desired accuracy.

The researchers acknowledge that building such a clock would be difficult, but suggest it should be possible and argue that it would be much more practical than trying to build and work with a nuclear clock. They conclude by suggesting that the time has come to put more effort into improving the atomic clock and less into nuclear clock research.

More information: Highly Charged Ions as a Basis of Optical Atomic Clockwork of Exceptional Accuracy, *Phys. Rev. Lett.* 109, 180801 (2012) DOI: 10.1103/PhysRevLett.109.180801

Abstract
We propose a novel class of atomic clocks based on highly charged ions. We consider highly forbidden laser-accessible transitions within the 4f12 ground-state configurations of highly charged ions. Our evaluation of systematic effects demonstrates that these transitions may be used for building exceptionally accurate atomic clocks which may compete in accuracy with recently proposed nuclear clocks.

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