Toward a practical nuclear pendulum

January 27 2017

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Researchers from Ludwig-Maximilians-Universitaet (LMU) Munich have, for the first time, measured the lifetime of an excited state in the nucleus of an unstable element. This is a major step toward a nuclear clock that could keep even better time than today's best atomic timekeepers.

Atomic clocks are the most precise chronometers we now have. These timekeepers are based on precise knowledge of the frequency of specific transitions between defined energy levels in the electron shells of certain atoms. Theoretical studies suggest that nuclear clocks that make use of analogous changes in the energy states of atomic nuclei could provide even more accurate frequency standards for timekeeping purposes. Research teams around the world are now exploring ways of turning this theoretical possibility into a practical reality.

Early last summer, physicists Dr. Peter Thirolf, Lars von der Wense and Benedict Seiferle at LMU's Chair of Medical Physics, in collaboration with colleagues in Mainz and Darmstadt, achieved a notable breakthrough in the quest to develop a functioning nuclear clock. In a paper published in the journal *Nature*, they reported the first experimental detection of a specific energy transition in the nucleus of a particular isotope of the element thorium (Th) that had been predicted decades ago. The nucleus of this unstable isotope, which has an atomic weight of 229, is the only nucleus known to have the properties required for the development of a practical nuclear clock.

With financial support from the EU-funded project nuClock, Thirolf, von der Wense and Seiferle have continued to characterize the energy transition in the 229Th nucleus, and have now succeeded in measuring the lifetime of the excited nuclear state. Their findings appear in the journal *Physical Review Letters*.

"This represents the direct experimentally determined value for the half-life of the excited state of the isotope ^{229}Th," says Benedict Seiferle. The LMU team now plans to measure the energy of the transition itself. With these data in hand, it should be possible in the future to optically induce the transition in a controlled fashion with the help of an appropriately designed laser.

More information: *Physical Review Letters*, doi.org/10.1103/PhysRevLett.118.042501

Provided by Ludwig Maximilian University of Munich