# Direct detection of nuclear transition in thorium-229 hints at possibility of nuclear based clock

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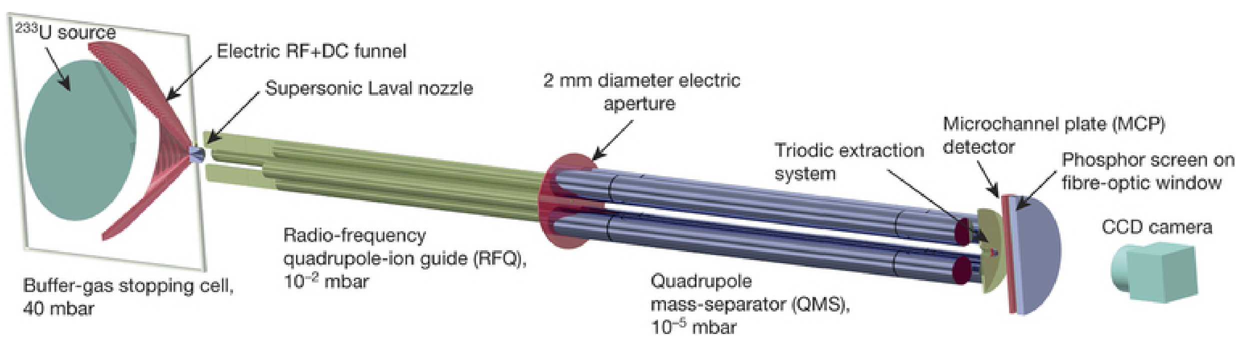


Schematic of the experimental setup. Credit: (c) *Nature* (2016). DOI: 10.1038/nature17669

(Phys.org)—A group of researchers affiliated with several institutions in Germany has developed a means for the direct detection of the nuclear transition in thorium-229 which opens the door to the development of a clock even more accurate than an atomic clock—a nuclear based clock. In a paper published in the journal *Nature*, the researchers outline how they came up with their technique and the testing they carried out to ensure that the results they were getting were accurate. In a related News & Views piece in the same journal edition, Marianna Safronova, with the University of Delaware discuses the work done by the team, the likelihood that their work will lead to a nuclear based clock and the possible uses for such a clock if one could be developed.

As Safronova notes, humans have always looked for new and better ways to keep track of time, which has led us from using the transition between night and day to the electronic transition in caesium atoms that today form the basis of atomic clocks which are capable of keeping time so precisely that they lose or gain a second only every 15 billion years. But still, scientists are not satisfied, many have suggested that creating clocks based on a nuclear transition from an excited state to a ground state, would be an order of magnitude more precise.

The problem has been in figuring out how to measure such a transition—the only means possible today is to use a laser, but today's laser are only capable of measuring the very slowest of transitions, which occurs with thorium-229—but even that has proven problematic, until now. In this new effort, the researchers report using a low-energy microchannel plate detection technique that ultimately led to electrons colliding with a phosphor screen, resulting in the generation of visible light which was captured by a camera. After extensive testing to ensure that the signals came from the decay of the thorium-229 instead of some other source, they team was ready to announce that they had found a way to detect a nuclear transition that could conceivably be used as a means for the basis of a nuclear based clock which could be as much as ten times more accurate than current atomic clocks.

Such a clock Safronova, notes, could be used to test fundamental physics constants and even perhaps even dark matter, or as 3D gravity sensors or perhaps as part of an earthquake detection system.

**More information:** Lars von der Wense et al. Direct detection of the 229Th nuclear clock transition, *Nature* (2016). DOI: 10.1038/nature17669

**Abstract**
Today's most precise time and frequency measurements are performed with optical atomic clocks. However, it has been proposed that they could potentially be outperformed by a nuclear clock, which employs a nuclear transition instead of an atomic shell transition. There is only one known nuclear state that could serve as a nuclear clock using currently available technology, namely, the isomeric first excited state of 229Th (denoted 229mTh). Here we report the direct detection of this nuclear state, which is further confirmation of the existence of the isomer and lays the foundation for precise studies of its decay parameters. On the basis of this direct detection, the isomeric energy is constrained to between 6.3 and 18.3 electronvolts, and the half-life is found to be longer than 60 seconds for 229mTh2+. More precise determinations appear to be within reach, and would pave the way to the development of a nuclear frequency standard.

[Press release](#)