Three-photon Excitation of the 8.4-eV Nuclear Isomer in $^{229}Th^{3+}$ Atoms

F F Karpeshin[1]

[1] *Mendeleyev Institute for Metrology, Moskovsky pr., 19, 190005, St.-Petersburg, Russia.*
Contact Phone: +79811660745
Contact Email: fkarpeshin@gmail.com

Much attention in current scientific research is paid to the problem of creation of the nuclear clocks and, accordingly, the next-generation frequency standard. The number one candidate for creating a nuclear clock is the unique nuclide ^{229}Th, whose excited state $3/2^+[631]$ lies only 8.355740(3) eV above the ground state $5/2^+[633]$. And the year of 2024 will go down in the history of physics and metrology as the year of nuclear clocks. It was marked by a fountain of publications on the successful excitation of the ^{229}Th nucleus by a laser through the joint efforts of physicists from LMU Munich, PTB, JILA, UCLA, and others. Record-breaking samples of atomic clocks demonstrate a relative error within several units of 10^{-18}, while to solve complex fundamental and applied problems, an additional reduction in errors by another order of magnitude is necessary. A further reduction in error would resolve the long-standing issue of the possible drift of fundamental constants. The most pressing problem of modern physics is the search for dark matter and energy.

At the same time, the technologies used have extremely low resource efficiency. Thus, in the method of frequency comb, only $1/10^{13}$ of the consumed power is used for its intended purpose of isomer excitation. The rest is lost in the resonator, amplifiers, non-resonance modes of the frequency comb, *etc.* Contrary, I propose a scheme which is two orders of magnitude more efficient than direct pumping of the isomer. The method is applicable to both ionized and neutral thorium atoms. Implementation of the method involves excitation of both the nucleus and the final-state electron shell with a single laser photon. Application of the method to three-photon pumping of the isomer in $^{229}Th^{3+}$ is discussed.