Two-Photon Electron-Nucleus Resonance as a Tool of Producing the ^{229}Th Isomer

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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 $3/2^+$ lies only 8.355740(3) eV above the ground state $5/2^+$. 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 PTB, LMU Munich, 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.

I discuss the possibility of further refinement of the isomer by means of the resonant optical pumping method. The attention is focused on taking into account the resonance width. This either helps to increase the scanning step and, thus, reduce the scanning time, or simply increases the cross section by orders of magnitude. I consider a radical broadening of the isomer line due to mixing with an electronic transition. In the case under consideration, it turns out to be two orders of magnitude more efficient than direct pumping of the nucleus with a laser. This method is applicable to both ionized and neutral thorium atoms. The implementation of the method assumes excitation of both the nucleus and the electron shell in the final state.