Toward direct VUV frequency comb spectroscopy of the ^{229m}Th nuclear state

Chuankun Zhang[1], Lars von der Wense[1], Jun Ye[1]

1. JILA, National Institute of Standards and Technology and University of Colorado, Boulder, CO, USA

Recent breakthroughs in the search for the low-energy ^{229m}Th isomeric state have constrained its energy range to 8.12 ± 0.11 eV above the ground state, within the reach of state-of-the-art VUV frequency combs. This opens the possibility for direct laser excitation of the nuclear transition instead of relying on the excited state decay. Direct VUV frequency comb spectroscopy of the ^{229m}Th isomeric state in the ongoing experiment at JILA promises a further reduction of its energy uncertainty by 6 orders of magnitude, making it possible to develop a nuclear-based optical clock. In neutral atoms, the ^{229m}Th state decays dominantly via the internal-conversion channel with a lifetime of about 10 us. Using this decay channel, we designed our experiment for optical excitation of the isomeric state on a thin (10 nm) ^{229}Th layer deposited on a metallic substrate irradiated by the JILA VUV frequency comb. We will present our progress in this experimental effort.

This work is supported by AFOSR Grant No. FA9550-19-1-0148, ARO Grant No. W911NF2010182, NSF Grant No. PHY-1734006 and the National Institute of Standards and Technology. Lars v.d.Wense acknowledges support from the Alexander von Humboldt Foundation.