Eric R. Hudson – Colloquium Seminar – February 20, 2025
UCLA

Laser spectroscopy of a nucleus

In 1976 Kroger and Reich established the existence of a low-lying nuclear excited state in ^{229}Th through the spectroscopy of γ rays emitted following the α decay of ^{233}U. The prospects of a laser-accessible nuclear transition touched off a flurry of proposals to utilize this apparently unique nuclear transition as a sensitive probe of both nuclear structure and chemical environment, to constrain physics beyond the Standard Model, and to construct a clock with unprecedented performance. Unfortunately, Kroger and Reich could only tell us that the transition energy was less than about 100 eV and therefore scientists have spent the intervening 48 years searching for the thorium nuclear transition.

I'll describe our efforts over the last 16 years to construct the first thorium-doped crystals and their use to perform nuclear laser spectroscopy, resulting in a measurement of the nuclear transition energy as $8.355733(2)_{stat}(10)_{sys}$ eV in ^{229}Th:$LiSrAlF_6$. I will also discuss recent work observing the nuclear transition in thin films of $^{229}ThF_4$; ongoing work to understand and harness the effect of the crystalline host on the isomeric transition; and the next steps for using this transition to probe new physics and build better clocks. This work was funded by the NSF and ARO.