UCLA

AMO Physics Seminar

Friday, April 2, 2021 @ 2:00 PM
Zoom link in email

Quantum logic and precision measurements with atomic and molecular ions

David Leibrandt

NIST & University of Colorado, Boulder

The tools of trapped-ion quantum logic can be used to enable and enhance precision measurements, with applications in time and frequency metrology and the search for physics beyond the standard model. In this talk, I will cover three experiments at this fertile intersection of fields. I will begin with a description of optical atomic clocks based on Al+, which use quantum gates with a co-trapped second ion species for preparation and readout of the Al+ state, and offer the tantalizing prospect of Heisenberg-limited measurements with entangled ions. Recent progress includes fractional systematic uncertainty below 10-18, optical coherence times up to 8 s, frequency ratio measurements between Al+, Sr, and Yb clocks with total uncertainty below 10-17, and improved constraints on models of ultralight dark matter. Next, I will discuss an experiment in which quantum-logic readout is used to prepare pure rotational and hyperfine states of a single CaH+ ion, and the frequencies of THz rotational transitions are measured with sub-100-Hz resolution. Our methods can be extended to study rotational and vibrational transitions of a large class of diatomic and polyatomic molecular ions that are useful in the search for new physics. Finally, I will conclude with a brief preview of a new experimental effort aimed at laser excitation of the 229Th3+ nuclear isomer transition, which has orders of magnitude enhanced sensitivity to physics beyond the standard model in the QED and QCD sectors.