Contribution ID: **138** Type: **Invited Oral**

Quantum state control and precision spectroscopy of single molecular ions

Monday 16 October 2023 16:30 (30 minutes)

Over the past decades, atoms are trapped and laser cooled to near zero temperature, minimizing the motional effects in spectroscopy. Internal states of atoms can be coherently manipulated and pre-pared in pure quantum states, including entangled states that are impactful in quantum information processing, sensing, and metrology. This talk will describe the effort of the Ion Storage group at NIST in bringing molecular ions to equal footings with atoms in terms of state control and spectro-scopic precision. The project builds on laser cooling and trapping techniques, frequency comb tech-nology, and quantum-logic spectroscopy protocols nowadays routinely employed in cold-atom re-search and trapped ion optical clocks. That enables demonstrations, on single molecular ions, of co-herent quantum state manipulation [1], nondestructive state detection [1-3], rotational [4, 5] and vibrational [6] spectroscopy with better than part-per-trillion resolution, and quantum entanglement [7]. The group is exploring new opportunities in physics and chemistry offered by the richer struc-ture and broader species selections in molecules.
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Session Classification: Optical Ion Clocks II

Track Classification: Molecular, Atomic, Ion and Nuclear Clocks