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Measuring single molecular ion spectra by Coulomb crystal heating

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Quantum information processing with ions uses the normal modes of motion of a Coulomb crystal to perform gates by transferring information between ions. The information transfer can also be used to perform spectroscopy. The experiment uses two ions: a control ion for laser cooling and readout and a target ion for spectroscopy. The interaction of light with the target ion excites the motion of the two ion Coulomb crystal. This motion can then be observed by a change in control ion fluorescence. For atomic ions various methods of excitation and readout have been demonstrated ranging from quantum logic spectroscopy to sympathetic heating spectroscopy. In this talk, I will present our progress towards using a molecular ion as the target ion. Specifically, I will discuss our experiments looking at vibrational overtones in CaH^+ and rovibronic transitions in BH^+. The vibrational transitions of metal hydrides are candidates for observing temporal changes in the ratio of the proton mass to the electron mass and BH^+ is a candidate for direct laser cooling of molecular ions.