Progress Towards AlH+ Photon Recoil Spectroscopy with Improved Motional State Readout of Barium Ion\textsuperscript{1} QIMING WU, JAMES DRA-\textsuperscript{2}GAN, GREGORIO RABELO, BRIAN ODOM, Northwestern University — With rotational-vibrational ground state cooling of aluminium monohydrate (AlH+) and robust control over Ba+ internal and motional degrees of freedom,\textsuperscript{2 3} we can perform Photon Recoil Readout (PRR) of AlH+ en route to precision spectroscopy of single-molecule. Taking advantage of the fast cycling molecular electronic transition, repeated photon recoil events will set the ions in a motion dependent on the spectroscopic transition to a long-lived vibrational excited state. Here we present our progress of sympathetic cooling of a single AlH+ to the ground state of motion with a co-trapped Ba+. In addition, we report our improvements on motional-state detection of Ba+. Coherent manipulation is implemented by a far-off-resonant Raman laser driving a red sideband $\pi$ pulse between the two Zeeman sublevels of the $S_{1/2}$ in Ba+. This is followed by a carrier $\pi$ pulse to selectively shelve one spin state from $S_{1/2}$ to $D_{5/2}$, utilizing a narrow-linewidth 1762 nm laser. This new shelving approach is favourable and will improve our detection efficiency to near 100%.

\textsuperscript{1}Supported by AFOSR

Qiming Wu
Northwestern University

Date submitted: 31 Jan 2019
Electronic form version 1.4