

Abstract Submitted
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Progress Towards AlH+ Photon Recoil Spectroscopy with Improved Motional State Readout of Barium Ion¹ QIMING WU, JAMES DRAGAN, 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,^{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 π pulse between the two Zeeman sublevels of the $S_{1/2}$ in Ba+. This is followed by a carrier π 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%.

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²Lien, et al., **Nat. Commun.** 5:4783 (2014)

³Seck, et al., **Phys. Rev. A** 93, 053415 (2016)

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