Abstract Submitted
for the DAMOP14 Meeting of
The American Physical Society

Optical cooling of AlH^+ to the rotational ground state CHIEN-YU LIEN, CHRISTOPHER SECK, BRIAN ODOM, Department of Physics and Astronomy, Northwestern University — We demonstrate cooling of the rotational degree of freedom of trapped diatomic molecular ions to the rotational ground state. The molecule of interested, AlH^+, is co-trapped and sympathetically cooled with Ba^+ to milliKelvin temperatures in its translational degree of freedom. The nearly diagonal Franck-Condon-Factors between the electronic X and A states of AlH^+ create semi-closed cycling transitions between the vibrational ground states of X and A states. A spectrally filtered femtosecond laser is used to optically pump the population to the two lowest rotational levels, with opposite parities, in as fast as 100 μs via driving the A-X transition. In addition, a cooling scheme relying on vibrational relaxation brings the population to the $N = 0$ positive-parity level in as fast as 100 ms. The population distribution among the rotational levels is detected by resonance-enhanced multiphoton dissociation (REMPD) and time-of-flight mass-spectrometry (TOFMS). Although the current two-photon state readout scheme is destructive, a scheme of single-molecule fluorescence detection is also considered.

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Date submitted: 29 Jan 2014 Electronic form version 1.4