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Sympathetic Cooling of Na+ Ions by Ultracold Na Atoms in a Hybrid Trap[1] WINTHROP SMITH, ILAMARAN SIVARAJAH, DOUGLAS GOODMAN, JAMES WELLS, Physics Dept., University of Connecticut, Storrs, CT 06269-3046, FRANK NARDUCCI, Naval Air Systems Command, EO Sensors Division, Bldg 2187, Suits 3190, Patuxent River, Maryland — Laser cooling atoms to ultracold temperatures has opened a fruitful new regime for atomic physics. Closed-shell atomic ions, such as Na+, and nearly all molecular ions lack the optical transitions from the ground state that are required for laser cooling, restricting their use in a variety of experiments: near zero-K reaction studies, cold ion spectroscopy and quantum gates. We have created a hybrid atom-ion trap system to study cooling and reactions of atomic and molecular ions which cannot be laser cooled. It consists of a magneto-optical trap (MOT) for Na, concentric with a linear Paul r.f. ion trap. Recent simulations we have carried out using SIMION 7 [PRA 86, 033408 (2012)] show that cold MOT atoms may be used to sympathetically cool hot atomic or molecular_ions to sub-Kelvin temperatures. We found experimental evidence of this: trapped Na+ ions exposed to equal mass Na MOT atoms have extended lifetimes when MOT-refrigerated in the Paul trap. Unwanted ions (e.g. Na_2^+ from the MOT) may be quenched with minimal disturbance of the trapped Na^+ ions.

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