Abstract Submitted
for the DPP11 Meeting of
The American Physical Society

Identification and Manipulations of Impurity Ions in Magnesium Ion Plasma[1] F. ANDEREGG, M. AFFOLTER, C.F. DRISCOLL, D.H.E. DUBIN, UCSD — A nominally "pure" $Mg24^+$ ion plasma accumulates impurity ions over periods of hours to days by charge exchange with residual background gas ($P \sim 10^{-10}$ Torr) in a Penning-Malmberg trap. We use thermal cyclotron spectroscopy (TCS) to identify ion impurities, and observe spatial separation at low temperatures. TCS consists of applying rf bursts at the impurity cyclotron frequencies, with LIF measurement of the majority species heating due to collisions with the heated impurites. We find that for short bursts the heating is proportional to the burst amplitude squared, and to the square of the burst duration, as predicted by a simple single particle model. We spatially separate the impurities from the Magnesium ions by two different techniques: a) With laser cooling to $T < 10^{-3}$ eV, the $E \times B$ rotation causes centrifugal separation, with heavier ions at larger radii. We typically observe a 5–20% "hole" in the center of the Mg plasma where the "dark" lower-mass impurities reside; and we directly observe the Mg25 and Mg26 at the outer edge of the Mg24 column. b) Resonant laser pressure in the z-direction pushes on the Mg24, and the species separates longitudinally when this laser force is greater than the mass-dependent centrifugal force.

[1]Supported by NSF PHY-0903877 and DOE DE-SC0002451.

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Date submitted: 19 Jul 2011 Electronic form version 1.4