Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Loading and loss of ions in the trapping region of a linear Paul trap[1] JAMES WELLS, W.M. Keck Science Department of Claremont McKenna, Pitzer, and Scripps Colleges, REINHOLD BLMEL, Wesleyan University, JONATHAN KWOLEK, University of Connecticut, DOUGLAS GOODMAN, Wentworth Institute of Technology, WINTHROP SMITH, University of Connecticut — The trap depth of a radio-frequency (rf) Paul ion trap is derived using a pseudopotential approximation, which models the time-dependent saddle potential as a time independent potential well. The depth depends on the physical spacing of the trap electrodes, the species trapped, the amplitude and frequency of the applied rf fields, and the furthest extent of the ion's motion before being lost from the trap, $\hat{R}_{\mathrm{cut}}$. Traditionally, $\hat{R}_{\mathrm{cut}}$ is taken to be equal to the shortest distance from the center of the trap to the electrodes, though in a physical trap, $\hat{R}_{\mathrm{cut}}$ occurs at a smaller radius. We show that $\hat{R}_{\mathrm{cut}}$ is a chaos border, which arises due to the quartic admixture in the z potential of the trap. Once an ion moves beyond $\hat{R}_{\mathrm{cut}}$, the regular periodic motion of the ion becomes chaotic and it is no longer trapped. Further, using experiment, simulation, and analytical theory, we show that $\hat{R}_{\mathrm{cut}}$ can be used to predict the saturated ion number in the trap at loading rates achievable in many atom-ion hybrid trap systems, which can be used to measure cold ion-atom collision rates.

[1]W.W.S. would like to acknowledge NSF support (in part) from grant 1307874.

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Date submitted: 03 Feb 2017 Electronic form version 1.4