Abstract Submitted
for the DAMOP16 Meeting of
The American Physical Society

Simulations Of Laser Cooling In An Ultracold Neutral Plasma[1]

THOMAS LANGIN, TREVOR STRICKLER, Rice University, THOMAS POHL, Max Planck Institute for Complex Systems, DANIEL VRINCEANU, Texas Southern University, THOMAS KILLIAN, Rice University — Ultracold neutral plasmas (UNPs) generated by photoionization of laser-cooled, magneto-optically trapped neutral gases, are useful systems for studying strongly coupled plasmas. Coupling is parameterized by Γ_i, the ratio of the average nearest neighbor Coulomb interaction energy to the ion kinetic energy. For typical UNPs, Γ_i is currently limited to ~ 3. For alkaline earth ions, higher Γ_i can be achieved by laser-cooling. Using Molecular Dynamics and a quantum trajectories approach, we have simulated laser-cooling of Sr^+ ions interacting through a Yukawa potential. The simulations include re-pumping from two long-lived D-states, and are conducted at experimentally achievable parameters (density $n = 2\,\mathrm{e}{+}14\,\mathrm{m}^{-3}$, size $\sigma_0 = 4\,\mathrm{mm}$, T_e=19 K). Laser-cooling is shown to both reduce the temperature by a factor of 2 over relevant timescales (tens of μs) and slow the electron thermal-pressure driven radial expansion of the UNP. We also discuss the unique aspects of laser-cooling in a highly collisional system; in particular, the effect of collisions on dark state formation due to the coupling of the $P_{3/2}$ state to both the $S_{1/2}$ (via the cooling transition) and the $D_{5/2}$ (via a re-pump transition) states.

[1]Supported by NSF and DoE, the Air Force Office of Scientific Research, the NDSEG Program, and NIH NCRR S10RR02950, an IBM SUR Award in partnership with CISCO, Qlogic and Adaptive Computing

Thomas Langin
Rice University

Date submitted: 29 Jan 2016 Electronic form version 1.4