Abstract Submitted
for the DPP15 Meeting of
The American Physical Society

Temperature evolution of strongly coupled electron-ion plasmas[1]

SANAT KUMAR TIWARI, NATHANIEL SHAFFER, SCOTT D. BAALRUD, University of Iowa, Iowa city, Iowa — Molecular dynamics simulations of electron-ion plasmas have been carried out, focusing on the classical strongly coupled regime relevant to ultracold neutral plasmas. The interaction of oppositely charged species is modeled using a pseudopotential with a repulsive core at a specified distance ϵ in units of average interparticle spacing. This parameter distinguishes classical from quantum statistical regimes. Simulations are initiated with an equilibration phase in which ions and electrons are held to fixed independent temperatures using a thermostat. Subsequently, the thermostats are removed and the system is allowed to evolve. Two effects are observed: (1) For sufficiently small values of ϵ, the plasma rapidly heats, (2) electrons and ions equilibrate on a longer time scale. The critical ϵ value for the onset of heating and the temperature equilibration rate are compared with existing theory. Excess pressure is calculated in each case based on the equilibrium radial distribution functions obtained during the equilibration phase. The $\Gamma - \epsilon$ phase space is explored, revealing qualitative differences in the temperature evolution due to electron-ion interactions in the classical and quantum regimes.

[1]The authors gratefully acknowledge support from NSF grant PHY-1453736.

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Date submitted: 21 Jul 2015 Electronic form version 1.4