Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Direct numerical simulation of Doppler laser cooling of ultra-cold ion plasmas in a Penning trap with a rotating wall CHEN TANG, DOMINIC MEISER, University of Colorado, Boulder, JOHN BOLLINGER, National Institute of Standards and Technology, SCOTT PARKER, University of Colorado, Boulder —
Ultra-cold ion crystals in Penning traps enable interesting research at the forefront of different areas of physics. Doppler laser cooling ions to a fraction of millikelvin allows the formation of a two-dimensional hexagonal structure. There are two major differences of Doppler cooling in a Penning trap when compared to neutral atom traps. The motion of ions is subject to the external trap electric and magnetic fields, as well as the Coulomb interactions between ions. We observe both exact crystal and non-equilibrium states can exist at extremely low temperature. The ion planar modes are separated into two branches, the higher frequency cyclotron and the lower frequency magnetron branch. The potential energy in the magnetron branch can be relatively large for non-equilibrium states even when the thermal kinetic energy is very low. A direct numerical simulation of many interacting ions in a Penning trap with a rotating wall is implemented to classically model the ions dynamics. Both axial and planar Doppler cooling are modelled using stochastic momentum impulses based on two-level atomic scattering rates. The numerical simulations help us characterize the ultra-cold ion crystal by observing the power spectrum density, mean square displacement and other detailed diagnostics.

Chen Tang
University of Colorado, Boulder

Date submitted: 17 Aug 2020 Electronic form version 1.4