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First principle simulation of ultra-cold ion crystals in a Penning trap with Doppler cooling and a rotating wall potential CHEN TANG, DOMINIC MEISER, University of Colorado, Boulder, JOHN BOLLINGER, National Insisitute of Standards and Technology, SCOTT PARKER, University of Colorado, Boulder — A direct numerical simulation of many interacting ions in a Penning trap with a rotating wall is presented. The ion dynamics is modelled classically. Both axial and planar Doppler laser cooling are modeled using stochastic momentum impulses based on two-level atomic scattering rates. The plasmas being modeled are ultra-cold two-dimensional crystals made up of 100s of ions. We com- pare Doppler cooled results directly to a previous linear eigenmodes analysis. Agreement in both frequency and mode structure are obtained. Additionally, when Doppler laser cooling is applied, the laser cooled steady state plasma axial temperature agrees with the Doppler cooling limit. Nu- merical simulations using the approach described and benchmarked here will provide insights into the dynamics of large trapped-ion crystals, improving their performance as a platform for quantum simulation and sensing.

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