PROPERTIES OF TRAPPED Ca^+ IONS AT SUB-KELVIN TEMPERATURES

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Production and trapping of laser cooled Ca^+ ions is a key step towards studying chemical reactions such as $Ca^+ + CH_3F \rightarrow CaF^+ + CH_3$ at very low temperatures[a]. At sufficiently low temperatures, the trapped ions adopt an ordered structure commonly known as a Coulomb or Wigner crystal. Experimentally, Coulomb crystals can be observed by monitoring the ion fluorescence but key information regarding the crystals, such as ion temperatures, cannot be obtained solely from these images. To resolve this issue, molecular dynamics (MD) simulations are performed on ensembles of Ca^+ ions in a time-dependent potential to accurately determine the thermal properties of the crystals. Results of the simulations are presented, showing the effect of the crystal geometry on the ion temperatures. Methods of selectively controlling kinetic energies of the ions are illustrated in the context of proposed reaction dynamics experiments.

[a] S. Willitsch, M. T. Bell, A. D. Gingell, S. R. Procter and T. P. Softley, *Phys. Rev. Lett.* **100** (2008), 043203