Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Sensing weak forces and electric fields with trapped ion crystals[1] MATTHEW AFFOLTER, KEVIN GILMORE, ELENA JORDAN, JOHN BOLLINGER, NIST, Boulder — When cooled to near the Doppler limit, ion plasmas confined in a Penning trap form two and three-dimensional crystals, which provide a useful platform for quantum simulation and sensing experiments. This talk will focus on recent experiments to measure small displacements, and hence weak forces and electric fields, using single-plane crystals consisting of several hundred Be^+ ions. By coupling the spin and motional degrees of freedom of the ions through the application of a spin-dependent optical dipole force, displacements of 50 pm (40× smaller than the ground-state wavefunction) are measured with a single measurement signal-to-noise ratio of 1. This displacement sensitivity is calibrated by driving the axial motion of the crystal far from the center-of-mass mode frequency, and implies $12\,\mathrm{yN}/\sqrt{\mathrm{Hz}}$ and $77\,(\mathrm{uV/m})/\sqrt{\mathrm{Hz}}$ sensitivities to forces and electric fields, respectively. When driving on-resonance with the center-of-mass mode, the sensitivity to weak forces and electric fields is greatly improved, but new limitations arise from frequency fluctuations of this mode.

[1]K.G. support from DOE HEP QuantISED; E.J. support from Leopoldina.

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Date submitted: 29 Jun 2020 Electronic form version 1.4