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Using Spin Dephasing for Mode Thermometry in a 2D Trapped-Ion Crystal[1] BRIAN SAWYER, JOSEPH BRITTON, JUSTIN BOHNET, JOHN BOLLINGER, NIST, Boulder — Crystals of hundreds of ions confined in Penning traps allow for studies of large quantum systems in a two-dimensional geometry. The transverse "drumhead" modes of our 2D crystal along with the valence electron spin of the trapped $^9Be^+$ serve as a resource for generating spin-motion and spin-spin entanglement. Applying a spin-dependent optical dipole force to a macroscopic spin superposition, we determine the absolute temperature of a single drumhead mode by directly measuring spin dephasing induced by thermal fluctuations of the motion. This technique does not rely on resolved-sideband transitions and is applicable over a large range of mode temperatures. Furthermore, by measuring the spin distribution directly, we distinguish between coherent and thermal mode occupation. Trapped ions are extremely sensitive to small external forces ($\sim$1 yN), and we will discuss extensions of this technique for use in spectroscopy and ion trap characterization.

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