Contribution ID: **115** Type: **Poster**

Adiabatic Rapid Passage of Phonons in Trapped Ion Crystals

Tuesday, 26 September 2023 19:30 (2 hours)

In a recent demonstration of the quantum charge coupled device (QCCD) trapped ion architecture [1], circuit time is dominated by cooling operations. Some motional modes of a multi-ion crystal are cooled inefficiently due to the geometry of the cooling lasers and the coupling of the mode to the sympathetic coolant ion species, requiring as much as 1 ms to cool to the ground state, whereas others can be cooled in just a few us. Previous work has shown that motional quanta can be transferred from mode to mode by modulating electric fields that couple those modes at their difference frequency [2,3]. While useful for transferring population out of hard-to-cool modes, this technique can be hampered by filters meant to suppress high frequency noise on the electrodes that control the trapping potential, and is sensitive to drifts in the mode frequency or drive amplitude. We propose a method that extends this technique by a process analogous to adiabatic rapid passage, where we directly control the trapping potentials to create an avoided crossing that we sweep through to transfer population with quasi static voltages. Using this method, we demonstrate full population transfer out of motional modes with transfer times that are over an order of magnitude smaller than the time it would take to directly cool those modes to the ground state .

[1] Moses, S. A., et al. “A race track trapped-ion quantum processor.” arXiv preprint arXiv:2305.03828 (2023).

[2] Gorman, Dylan J., et al. “Two-mode coupling in a single-ion oscillator via parametric resonance.” Physical Review A 89.6 (2014): 062332.

[3] Hou, Pan-Yu, et al. “Coherently coupled mechanical oscillators in the quantum regime.” arXiv preprint arXiv:2205.14841 (2022)

Primary authors: FABRIKANT, Maya (Quantinuum); Dr SUTHERLAND, Tyler (Quantinuum); Dr BURTON, Cody (Quantinuum); Dr MADJAROV, Ivaylo (Quantinuum); Dr LAURIA, Paul (Quantinuum)

Presenter: FABRIKANT, Maya (Quantinuum)

Session Classification: Tuesday Poster