Contribution ID: **51** Type: **Poster**

Ivan Vybornyi, ”Sideband Thermometry on Ion Crystals”, QT4HEP22 poster

Poster title: “Sideband Thermometry on Ion Crystals”

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Short summary of your poster content

Trapped ions present a prospective platform for quantum technology and an excellent framework for research in scope of quantum simulation and searches for new physics. In particular, ground-state-cooled Coulomb crystals consisting of many ions serve a base for trapped-ion quantum computing and optical ion clocks. In any application case, a high level of control over the motional temperature is required (e.g. for better estimating the fidelities of quantum gates or second-order Doppler shift in clocks). While spin-mediated ion cooling techniques are well-established, the problem of accurately quantifying the resulting motional state remains resolved only partly. In particular, as the ground state regime is achieved for larger and larger ion crystals (over a hundred ions in recent experiments), the new thermometry tool is required, since common ion thermometry schemes fail to provide an accurate temperature estimation for an arbitrary motional mode when a large number of ions is involved.

To resolve the bottleneck, we consider the many-body dynamics arising when the motional sideband transitions are driven in a near ground-state regime, a widely used approach in thermometry of single ions. We theoretically investigate the sideband method by analyzing the Fisher Information and reveal some valuable insights. Extending the approach further, we account for entanglement created between the ions in a crystal and propose a novel temperature estimation technique, suitable for an ion crystal of arbitrary size. The new method is then field-tested in experiments with 4-ion (T. Mehlstäubler lab, PTB) and 19-ion (C. Roos lab, University of Innsbruck) crystals, enabling us to prove its reliability.

Poster printing

Yes

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Session Classification: Networking cocktail and Poster Session