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Type: **Invited Speaker**

Quantum simulation and sensing experiments with large ion crystals

Monday, 25 September 2023 14:45 (30 minutes)

In this talk, I will present experiments carried out with long ion strings and planar ion crystals with engineered long-range spin-spin interactions. In a first experiment, we variationally prepare low- and high-energy states of a nearest neighbor Heisenberg spin chain. Subsequently, measurements are carried out to learn the entanglement Hamiltonian describing subsystems of the spin chain that show a transition from an area-law to a volume-law of entanglement [1]. In a second experiment, we demonstrate the use of finite-range entangling interactions for creating squeezed states [2]. When going to interaction times where the squeezing parameter fails to detect entanglement, we observe Schrödinger cat-like states. The experiment can be extended to planar ion crystals stored in a monolithic, microfabricated linear ion trap [3]. After preparing the out-of-plane modes of crystals with up to 105 ions close to the ground state by EIT cooling, we induce long-range spin-spin interactions mediated by these modes and observe the build-up of spin-spin correlations and squeezing.

[1] M. K. Joshi, C. Kokail, R. van Bijnen et al, arXiv: 2306.00057

[2] J. Franke et al., arXiv: 2303.10688, to appear in Nature

[3] D. Kiesenhofer, H. Hainzer et al., PRX Quantum 4, 020317 (2023)

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