RIKEN QUANTUM COMPUTING

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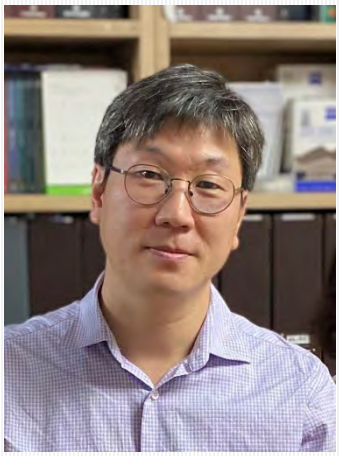
19th RQC Colloquium

Scalable and Programmable Phononic Network Using Vibrational Modes of Trapped Ions



Prof. Kihwan Kim

Tsinghua University

Dec. 27, 2023(Wed) **16:00–17:00**(JST)

This colloquium will be held in HYBRID format.

On-site Venue: Wako C61 Wako Welfare and Conf. 2F Large Meeting Room

Online Venue: Zoom. To receive the link, register in advance at https://krs2.riken.jp/m/rqc_registration_form

Trapped ion system is one of the leading physical platforms to realize a practical quantum computer and quantum simulator. Recently, the vibrational degrees of freedom of trapped ions have been extensively studied and are getting attention as a quantum resource for continuous variables quantum information processing [1]. For example, phonons in multiple vibrational modes can perform boson sampling to reveal quantum advantage. Different from a photonic system, the number states of phonons can be deterministically prepared and detected and the total number is well conserved. However, to our knowledge, there has been no experimental realization of a phononic network with more than two modes. Here we present the phononic network that consists of up to four modes with the capability of programming an arbitrary network with deterministic preparation and detection. In the network, beam-splitting operations between any pairs of modes are implemented through the coupling with ion-qubits [2]. As the benchmark of the performance of the phononic network, we demonstrated the algorithms of tomography for any multi-mode phononic states in a single measurement configuration [3]. Our experiment demonstrates a clear and novel pathway to scale up a phononic network for various quantum information processing beyond the limitations of classical and other quantum systems.

[1] W. Chen, J. Gan, J.-N. Zhang, D. Matuskevich, and K. Kim, Chin. Phys. B 30, 060311 (2021).
[2] W. Chen, et al., Nature Physics 19, 877 (2023).
[3] L. Banchi, W. S. Kolthammer, and M. Kim, Phys. Rev. Lett. 121, 250402 (2018).