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24th RQC Colloquium

Quantum Science and Technology with Superconducting Circuits

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June 3, 2024(Mon) 16:00–17:00(JST)

This colloquium will be held in **HYBRID** format.

On-site Venue: Wako C00 HQ 2F Large Meeting Room

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

Superconducting electronic circuits are ideally suited not only for studying the foundations of quantum physics but also for exploring applications in quantum information science. Since complex circuits containing hundreds or thousands of elements can be designed, fabricated, and operated with relative ease, superconducting circuits are one of the prime contenders for realizing quantum computers, a goal vigorously pursued by both academic and industrial labs. In this presentation, I will briefly introduce the basic concepts enabling the exploration of quantum physics with superconducting circuits [1] and comment on the state of the art of the field. After that, I will present two examples of recent research results from our lab at ETH Zurich, touching on both fundamental and applied aspects of quantum science with superconducting circuits. Using two superconducting qubits entangled over a distance of 30 meters we have recently succeeded in performing a loophole-free Bell test [2], a fundamental experiment performed for the first time with a macroscopic quantum system. Using a set of 17 superconducting qubits integrated on a single millimeter-scale device, we have recently realized repeated quantum error correction in the surface code [3]. This demonstrates an essential advance in the realization of fault-tolerant quantum computation, which requires the correction of errors occurring due to unavoidable decoherence and limited control accuracy. This and similar demonstrations of repeated, fast, and high-performance quantum error correction support our understanding that fault-tolerant quantum computation will be practically realizable.

[1] A. Blais, A. L. Grimsmo, S. M. Girvin, and A. Wallraff, Rev. Mod. Phys. **93**, 025005 (2021).

[2] S. Storz *et al.*, Nature **617**, 265– 270(2023).

[3] S. Krinner *et al.*, Nature **605**, 669–674 (2022).