RIKEN QUANTUM COMPUTING

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38th RQC Colloquium

Quantum algorithmic primitive for quantum machine learning

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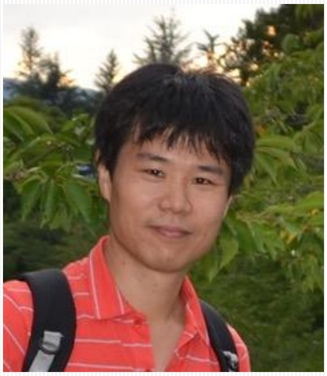

Oct 21, 2025(Tue) **16:00 – 17:00**(JST)

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

In this talk, I will begin with the topic of a quantum machine learning problem where we are interested in classifying the label of an unknown "quantum data" (specifically, the phase of a quantum ground state). The optimal measurement strategy for this problem needs full knowledge on the target state; hence I will show a circumventing method based on partial state tomography [1]. Yet we may have a route of coherently using the data to devise the optimal measurement. The promising method is the Density matrix exponentiation (DME), which is a general procedure that converts an unknown quantum state into the Hamiltonian evolution. The issue of DME is that it is proven to require O(1/epsilon) state copies in error epsilon. I'll show a method [2] that goes beyond this lower bound and achieves O(log(1/epsilon)) or O(1) state copies, by using non-physical processes. This can realize a general-purpose quantum algorithm for property estimation, that achieves exponential circuit-depth reductions over existing protocols across various tasks; I will present quantum principal component analysis, quantum emulator, and entropy calculation, as examples.

References:

[1] Tanji, Yano, Yamamoto, Quantum phase classification via quantum hypothesis testing, arXiv:2504.04101, 2025

[2] Wada, Kato, Harada, Yamamoto, State-to-Hamiltonian conversion with a few copies, arXiv:2509.14791, 2025