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21st RQC Colloquium

Quantum Simulations of Problems in Statistical Physics

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Feb. 14, 2024(Wed) **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 overview some of the recent developments in quantum simulations of phase transitions in classical and quantum spin systems. First, the Kibble-Zurek mechanism for phase transitions in the transverse-field Ising model will be examined. I present experimental results collected from D-Wave quantum annealers [1]-[3] and show that ultra-short-time measurements lead to precise agreement of theory and experiment for the 1D chain as well as for the difficult case of the 3D spin glass. The second part concerns the theory of the so-called Nishimori line in the spin glass problem, which has been shown to be verifiable by state preparation and weak measurements [4, 5]. The theory implies that an extensive GHZ-like state can be prepared by a circuit of finite depth. It has been tested experimentally on the IBM Eagle r3 processor, and the result is in satisfactory agreement with the theory if noise effects are properly taken into account [6]. These developments indicate that quantum devices have matured to the point where simulations of statistical physics problems can be performed at realistic scales if we choose proper problems.

[1] Y. Bando et al, Phys. Rev. Res. 2, 033369 (2020).
[2] A. D. King et al, Nature Physics, 18, 1324 (2022).
[3] A. D. King et al, Nature, 617, 61 (2023).
[4] G.-y. Zhu et al, Phys. Rev. Lett. 131, 200201 (2023).
[5] G.-y. Zhu et al, (in preparation)
[6] E. Chen et al, arXiv: 2309.02863.