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Toward realization of quantum error correction and fault-tolerant quantum computing

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Abstract

Now that 50-100 qubit scale quantum computers have been realized, then an experimental demonstration of quantum error correction is becoming a reality. In this talk, I will present a result of simulation of quantum error correction on the scale of 50 qubits under a realistic noise model. Specifically, we will discuss what physical conditions are required to extend the lifetime of logical qubits against the coherence time of physical qubits. In the post-NISQ era, it is required to evaluate the performance of quantum error correction on the scale of 1000 qubits. For such a situation, we will show that it is possible to simulate quantum error correction over 1000 qubits by using a quasi-probability method, taking advantage of the fact that most of the quantum circuits employed in quantum error correction are Clifford. Furthermore, by applying quantum error mitigation, which was developed as a method to overcome the noise problem in NISQ devices, to quantum error correction, the number of required physical qubits can be greatly. We expect that these researches will make an important contribution to the evolution from the NISQ era to the FTQC era closing their gap.