Contribution ID: **25** Type: **not specified**

Enhancing the Dynamic Range of Quantum Sensing via Quantum Circuit Learning

Wednesday, 10 December 2025 16:00 (30 minutes)

Quantum metrology is a promising application of quantum technologies, enabling the precise measurement of weak external fields at a local scale. In typical quantum sensing protocols, a qubit interacts with an external field, and the amplitude of the field is estimated by analyzing the expectation value of a measured observable. Sensitivity can, in principle, be enhanced by increasing the number of qubits within a fixed volume, thereby maintaining spatial resolution. However, at high qubit densities, inter-qubit interactions induce complex many-body dynamics, resulting in multiple oscillations in the expectation value of the observable even for small field amplitudes. This ambiguity reduces the dynamic range of the sensing protocol. We propose a method to overcome the limitation in quantum metrology by adopting a quantum circuit learning framework using a parameterized quantum circuit to approximate a target function by optimizing the circuit parameters. In our method, after the qubits interact with the external field, we apply a sequence of parameterized quantum gates and measure a suitable observable. By optimizing the gate parameters, the expectation value is trained to exhibit a monotonic response within a target range of field amplitudes, thereby eliminating multiple oscillations and enhancing the dynamic range. This method offers a strategy for improving quantum sensing performance in dense qubit systems.
reference: arXiv:2505.04958 (2025)

Presenter: MATSUZAKI, Yuichiro (Chuo U.)

Session Classification: Plenary Session