Ultrastrong coupling physics and its implications, latest developments in quantum computing and quantum physics

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Abstract

Superconducting circuits architecture is one of the promising quantum computing platforms to date, due to its good scalability and outstanding controllability. Besides these amazing attributes, the circuit architecture allows us to explore physics beyond the usual quantum optics experiments. In particular, the light-matter coupling strength $g/\omega$ in the superconducting circuit has reached to 1.34, while in standard quantum optics experiment, the coupling strength is of $10^{-6}$. In this so-called ultrastrong coupling (USC) regime, the Jaynes-Cummings model with rotating wave approximation, obtained from the minimal coupling Hamiltonian between a two-level atom and a quantized electromagnetic field, is not valid. More general quantum Rabi model is required, which was proposed by Isidor Rabi 80 years ago. Its recent analytical integrability and experimental realizations in the superconducting circuit, metamaterial THz cavities, carbon nanotube microcavity exciton-polaritons, etc, are timely. In this talk, without assuming any familiarity with the superconducting circuit and the quantum Rabi model, the basics of the two will be discussed in the first part, followed by some quantum computing applications such as quantum memory and quantum error correction, due to its built-in $\mathbb{Z}_2$ parity symmetry. In the second part, the long-lasting controversies arising from gauge ambiguities in the quantum Rabi model will then be discussed.

Short Biography

Thi Ha Kyaw is a theoretical physics researcher at Centre for Quantum Technologies, National University of Singapore and an ICTP TRIL fellow concurrently. He is interested in ultrastrong light-matter interaction, shortcut to adiabaticity, superconducting circuits architecture and open quantum systems.