Contribution ID: **10** Type: **5 min talk**

Search for dark photon dark matter using large-scale superconducting quantum computers as detectors

Tuesday, 17 September 2024 17:20 (5 minutes)

Superconducting quantum computers can be ideal detectors for dark photon dark matters in many aspects such as (1) the macroscopically large coupling to photons of superconducting qubits; (2) large detection capacity from the platform that can host O(1000) such bits now and >O(10^6) bits in the near future [1]; (3) the optimal control and readout system minimizing the errors and noises; (4) frequency tunability allowing a wide-band search ability, and so on. In our recent work, we illustrated that a dark photon dark matter resonant to a qubit frequency can excite the qubit [2]. While the single qubit excitation probability can be as high as 10% after ~100us for \epsilon~10^-11, the dark count can be effectively suppressed below 1%. The signal rate can be further enhanced by entangling the qubits through the gate operations [3]. In this presentation, I will provide the overview of the search, discuss the experimental feasibility using the current NISQ machine as well as the prospect using the future FTQC machines, and present some preliminary search results using the IBM-Q.

[1] IBM-Q roadmap, https://newsroom.ibm.com/2023-12-04-IBM-Debuts-Next-Generation-Quantum-Processor-IBM-Quantum-System-Two,-Extends-Roadmap-to-Advance-Era-of-Quantum-Utility
[2] T. Moroi et al. Phys. Rev. Lett. 131, 211001 (2023)
[3] T. Sichanugrist et al. arXiv: 2311.10413

Note to organizers: Given the relevance and complementarity, it would be highly appreciated if this can be a joint talk with Karin Watanabe's contribution in case both are accepted (both are the works done within the same collaboration). Although these two abstracts share the same root idea, they pursue distinctively different approaches; one utilizes an existing fancy but sub-optimal device targeting quick results; the other involves a hardware development for the dedicated setup targeting rather longer term however can reach the ultimate sensitivity. We very much hope our works can deserve a joint talk however if one has to choose one of them, please consider to prioritize Karin Watanabe's contribution in the light of encouraging early career researchers.

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