Docket #: S23-088

Baseband Quantum Networks for Superconducting Circuits

Stanford researchers have developed an approach to enable larger superconducting quantum systems that can likely span several refrigerators, necessitating connecting qubits across refrigerators efficiently. Current connectors are limited in its scalability.

Superconducting coaxial cables have not been seriously considered for connecting qubits in neighboring dilution refrigerators because they lose quantum information too quickly at typical superconducting qubit frequencies (approximately 2-8 GHz). However, it is known that such cables are extremely low loss at low frequencies when the wavelength of light is comparable to the fridge-to-fridge separation. This invention enables qubits to be strongly coupled to the low-frequency modes of superconducting coaxial cables using a circuit that transduces quantum information from typical qubit frequencies down to a lower frequency, the so-called baseband, where the tradeoff between frequency-dependent loss and thermal fluctuations is optimized.

Stage of Development

- Proof of concept
- Calculations demonstrated that this invention is significantly better than the current state-of-the-art as measured by two important figures of merit known as single-photon fidelity and quantum channel capacity

Applications

- **Quantum computing data centers,** where computational tasks can be distributed over superconducting quantum processors in different dilution refrigerators

- **End user will be researchers and industry** seeking to run larger quantum simulations or solve larger optimization problems not currently possible with current computation capabilities

Advantages

- **Scalable**
- **Improves the accuracy and capacity of the quantum channel,** especially using frequencies around 200 MHz instead of 8 GHz
- **Enables many hundreds of times increase in transmission rates,** especially in contrast to other approaches, i.e. using optical photons, or microwave photons through waveguides

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