

Seminar

Solid-state quantum devices for long-distance quantum networks

Sourabh Kumar

IQST, University of Calgary, Canada

We envision a future in which a global network of quantum nodes connected via quantum channels forms the quantum internet, providing unprecedented security and computational capabilities. Such quantum nodes require reliable quantum processors for quantum information processing and long-lived quantum memories for quantum state storage and synchronisation. Superconducting qubits (SQs) are among the leading candidates for quantum computation. However, their coherence times are too short to serve as long-lived quantum memories, and their operation in the microwave domain makes them unsuitable for long-distance quantum communication at room temperature.

In this talk, I will present our approach to addressing these challenges. I will describe the design, development, and operation of hybrid solid-state quantum devices based on rare-earth-ion-doped (REID) materials that can integrate with superconducting circuits. With their exceptionally long coherence times at cryogenic temperatures, REID materials are well-suited for quantum memories, and we implement a novel protocol enabling multimode storage with on-demand retrieval. Beyond storage, we demonstrate memory-assisted transduction in these systems, which can enable quantum information encoded in microwave-frequency superconducting circuits to be coherently converted into optical photons suitable for long-distance transmission.

Our research provides scalable building blocks for quantum networks and demonstrates how matter–photon interfaces at the quantum level can bridge microwave and optical quantum technologies, with implications for secure communication, distributed sensing, and large-scale quantum computing.

Tuesday, Sep 22nd 2026

11:30 Hrs (Tea / Coffee 11:15 Hrs)

Auditorium, TIFRH