Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally Mandal, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Two- and multi-qubit quantum gates in neutral atom and ion-atom hybrid architectures

Bimalendu Deb

IACS, Kolkata

After giving a basic introduction to quantum computing with a particular emphasis on two-qubit gates, we will present a perspective overview on leading quantum computing architectures including ion traps, superconducting circuit QED and neutral atoms in optical tweezers. We will then discuss our recent proposal for quantum computing in an ion-atom hybrid architecture. It is to be noted that an ion-atom hybrid architecture for quantum information processing is yet to be realized experimentally. We demonstrate the universal two-qubit CNOT gate with 89.9% fidelity between an ionic and an atomic qubit relying on Rydberg excitation of the atom and the resulting phonon blockade in the motional states of the ion. We further demonstrate a universal two-qubit gate operation with 97% fidelity between two neutral atom qubits based on ion-mediated interactions. These demonstrations suggest that an ion-atom hybrid system can serve as a module of a quantum network for distributed quantum computing leveraging the best features of charged as well as neutral atom qubits. Finally, we will briefly discuss our recent works on neutral atom multi-qubit gates based on dark state resonances.

Thursday, Jul 2nd 2026

16:00 Hrs (Tea / Coffee 15:45 Hrs)

Auditorium, TIFRH