Contribution ID: **106** Type: **Theory**

Spin-State Teleportation at MeV Energies via Entanglement Generation and Manipulation Between Protons

Tuesday 9 December 2025 14:30 (35 minutes)

Quantum teleportation enables the transfer of an unknown quantum state between distant qubits via entanglement. While it has been demonstrated in systems such as photons and superconducting circuits, it remains largely unexplored in nuclear physics at MeV energies. We propose new teleportation protocols based on Bell-state projection and transition operators that are naturally realized in low- and intermediate-energy proton–proton scattering. When two protons are in a spin-singlet state with low or intermediate center-of-mass energy, an appropriately chosen elastic scattering between one of them and a third, state-carrying proton projects their spin state onto a Bell state, thereby achieving spin-state teleportation. Our work establishes a foundation for spin teleportation in nuclear reactions and opens a pathway for quantum information applications in MeV-scale hadronic systems.

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Session Classification: Day 1 - Session 03