ICTS Statistical Physics & Condensed Matter Seminar

Title : Can Quantum Statistics Power a Heat Engine?

Speaker : Sourin Das (IISER Kolkata, West Bengal)

Date : Thursday, 25 June 2026

Time : 3:00 PM (IST)

Abstract : Quantum statistics is traditionally viewed as a kinematic property that determines how particles occupy available states. In this talk, I will show that quantum statistics can itself serve as a powerful resource for energy conversion in a transport setting. Focusing on particles obeying Haldane exclusion statistics, we demonstrate that statistical interactions generate an intrinsic breaking of particle-hole symmetry, even in the absence of interactions, band asymmetry, or external symmetry-breaking mechanisms. The consequences for transport are profound. The symmetry breaking produces strong thermoelectric response and large deviations from the Wiedemann-Franz law. In particular, exclusion statistics can substantially enhance the thermoelectric figure of merit, establishing a new route toward efficient energy harvesting driven purely by quantum statistics. Building on this insight, I will show that exclusion statistics can be elevated to the status of a genuine thermodynamic resource. Within a nonlinear Landauer framework, quantum heat engines employing fractional-statistics carriers can surpass performance bounds previously regarded as universal for fermionic systems. Bosonic and fractional-statistics working media exhibit enhanced power output, improved efficiency-power trade-offs, and superior refrigeration capabilities. Finally, I will discuss a realistic realization based on thermally driven magnon transport, where the predicted advantages emerge in an experimentally accessible spin-caloritronic setting. These results suggest a new paradigm for quantum thermodynamics in which statistical correlation and not interactions, topology, or coherence alone become the fundamental resource governing transport, refrigeration, and energy conversion.

Venue : Emmy Noether Seminar Room
Zoom Link: https://icts-res-in.zoom.us/j/99347656757?pwd=jap2H0bd5ELL5ttKI1xajO2F8xt1ww.1
Meeting ID: 993 4765 6757
Passcode: 875867