Contribution ID: **42** Type: **Poster**

Work, heat and entropy in isolated quantum systems

Wednesday 4 September 2024 17:00 (2 hours)

Work, heat and entropy are three of the most fundamental concepts in thermodynamics. Over the past 30 years, the discovery of fluctuation theorems in both classical and quantum systems have extended these concepts from equilibrium (slow) to non-equilibrium (fast) processes. To date, almost all this exploration has defined thermal equilibrium in terms of the canonical thermal distribution. Coincident with this progress, our understanding of thermal states at the microscopic level has evolved substantially, with profoundly new insights provided by the Eigenstate Thermalization Hypothesis. This new theory describes how a pure quantum state may look thermal, despite the absence of chaos-inducing non-linear dynamics. Aside from a few isolated studies, there is a notable absence of research into fluctuation theorems and notions of heat and work from the perspective of the Eigenstate Thermalization Hypothesis.

Here we explore the concepts of heat, work and entropy in a quantum spin-chain undergoing unitary evolution starting from a pure state. This system can conveniently be tuned from integrable to non-integrable by changing the combination of external fields incident on the system. We define notions of heat, work and entropy in this system and explore their dependence on the rate of work extraction and the integrability of the system. Our results provide new connections between the Eigenstate Thermalization Hypothesis and thermodynamic fluctuation theorems, with broad relevance for finite temperature quantum systems.

References

Short bio (50 words) or link to website

From 2020-present I have done research in quantum thermodynamics as a Postdoctoral Research Fellow at the University of Queensland. Prior to this I did my PhD at the University of Otago researching spinor Bose-Einstein condensates and then worked as a Research Associate at Lancaster University researching strongly-correlated light-matter systems.

Relevant publications (optional)

Career stage

Postdoc

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Session Classification: Posters II

Track Classification: FINESS