Fall 2024 Physics Colloquium

Friday, October 25, 2024

3:00 PM

PAS 201 or Zoom

(**https://arizona.zoom.us/j/81283840289**)

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Work Sum Rule for Open Quantum Systems

Abstract: If you hit a quantum system, like a molecule, in one place the effect can be felt immediately far away, an effect we term "quantum work-at-a-distance." This is yet another example of a salient feature of quantum mechanics that always disturbed Albert Einstein, the non-local character of quantum states. Rapid advances in quantum control are making it possible to realize the promise of quantum advantage (due to the quantum superposition principle and entanglement) in quantum machines, but real quantum systems are invariably subject to environmental noise leading to decoherence, a key limiting factor. The assessment of claims of such quantum advantage being achieved in real-world applications requires a rigorous thermodynamic analysis of quantum machines strongly coupled to their environment. Prior attempts to formulate the Laws of Thermodynamics for a small region within a larger quantum system have led to inconsistencies and unexplained infinities. This has led some researchers to claim that it might not even be possible to thermodynamically characterize the performance of quantum machines. This long-standing controversy has finally been resolved by taking into account quantum work-at-a-distance. Our central result is a Sum Rule for quantum work—analogous to the Friedel sum rule describing charge distributions in quantum impurity problems—which describes how work is partitioned over regions where external forces are acting as well as distant force-free regions.

Parth Kumar, Caleb M. Webb, and Charles A. Stafford, Work Sum Rule for Open Quantum Systems, Physical Review Letters **133**, 070404 (2024).

Caleb M. Webb and Charles A. Stafford, How to Partition a Quantum Observable, Entropy **26**(7), 611 (2024).

**** Refreshments served in PAS 218 at 2:30 PM – 3:00 PM ****

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