universität innsbruck

Department of Theoretical Physics

Theory Colloquium

Özgür E. Müstecaplıoğlu, Department of Physics, Koç University, İstanbul, Turkey

"Fundamentals and Applications of Quantum Thermodynamics"

Abstract

Understanding the quantum nature of the atomic structure, particularly the discrete character of electronic energy states in solids, led to the invention of revolutionary devices such as transistors. Nowadays, researchers explore if exploiting more profound quantum effects, especially quantum superposition (coherence), can yield similar game-changing progress. Promising significant improvement of classical communication and computation systems using refined forms of quantum coherence, called quantum entanglement, has already been demonstrated. The critical question is to determine the bounds of the superiority of quantum devices based upon quantum coherence. Thermodynamics is the natural theory that one may expect to answer that question, considering the close relationship between information and energy. In addition, the impact of the second quantum revolution on thermal machines could have appealing improvements on their efficiency, too. On the other hand, the extension of the classical thermodynamical laws to the quantum realm turns out to be a challenging endeavor. The efforts produce the rapidly emerging field of quantum thermodynamics. This talk will present a short and simple introduction to the fundamentals of quantum thermodynamics and discuss its application to quantum heat engines, refrigerators, thermal diodes, and transistors. An overview of the effect of the finite size of quantum systems, which is especially crucial for topological quantum matter, and on the role of quantum coherence and entanglement in non-thermal quantum baths on the quantum heat engine operations will be included.

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