

Dissertation press release**22.10.2020**

What is the role of quantum effects in miniature heat engines and refrigerators?

Title of the dissertation Coherent Thermal Machines: Fluctuations and Performance

Contents of the dissertation The ongoing development of quantum technologies has already had an enormous impact on almost every aspect of modern life. The next step of this development will be the creation of quantum information technology such as quantum computers and quantum cryptographic tools. Building such devices is a very difficult task in practice. It requires precise control over the constituent quantum systems, which are only a few atoms in size and must be kept at temperatures close to absolute zero.

The subjects of study of this dissertation are coherent thermal machines, miniaturized versions of well-known thermal machines like heat engines, heat pumps or refrigerators. Their working substance might consist of as little as a single atom and is therefore sensitive to quantum effects. We investigate these machines for the following reasons. First, to increase the performance of small-scale thermal machines and thus develop better thermal management solutions for quantum circuits, improving our control of quantum devices such as quantum computers. Second, to investigate whether quantum effects can be harnessed to create devices that operate more efficiently than what is possible without these quantum effects. And finally, to improve our fundamental understanding of the laws of thermodynamics on the smallest scales.

As the result of this theoretical study, we present practical instructions on how to optimally build and operate coherent thermal machines. Furthermore, we establish that, in the so-called adiabatic weak-coupling regime, quantum effects generally have a detrimental influence on the performance of such machines. We thus show that future research should focus on setups featuring strong coupling or fast driving in order to achieve quantum supremacy in the field of thermal machines.

Field of the dissertation Quantum Thermodynamics

Doctoral candidate Paul Menczel, M.Sc.

Time of the defence 11.11.2020 at 13:00

Place of the defence Aalto University School of Science, via remote technology.
Remote connection link: <https://aalto.zoom.us/j/68824530640>

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