CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of
MICROTECHNOLOGY
AND NANOSCIENCE

Master Project:

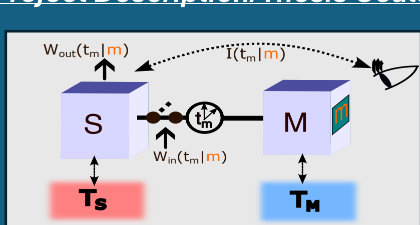
Quantum Information Engine: Converting Information to Useful Work

Assessing Measurement Time, Efficiency and Power

Background:

*Traditional heat engines operate between a cold (T_C) and a hot (T_H) heat reservoir, converting heat into useful work. The efficiency of these engines is limited by the Carnot limit, $n=1-T_C/T_H$. In the realm of **Information Engines**, there is a possibility to surpass this limit with the help of an external agent known as the **Maxwell demon**, providing **information** about the working substance's state. However, it is crucial to consider that achieving higher efficiency may require energy expenditure in erasing the Demon's memory, as indicated by Landauer's erasure work. Many ongoing discussions on information gain in applications overlook the **time** and actual **energy cost** involved in **obtaining information**, assuming that the Maxwell Demon can acquire information instantaneously at no additional energy cost apart from memory erasure to a heat bath.*

Project Description/Thesis Goals:



*This Master project aims to address these critical issues by **theoretically examining** a **quantum heat engine cycle** operating between two heat reservoirs T_S and T_M. The analysis will focus on the following aspects:*

*(i) The evolution of a quantum engine (S) entangled with a quantum meter (M). This will involve the **duration t_m** of the process, the **information gained (I),** and the **fundamental energetic cost (W_{in})** for coupling and decoupling the quantum engine and meter.*

*(ii) Investigating and analyzing significant **thermodynamic performance quantifiers** for **quantum engines**. We will calculate and optimize the ratio between the **work extracted (W_{out})** from the engine using **information (I) obtained** from measurement and the **energy invested** in acquiring **I**.*

What You Will Learn:

*(i) Insights into the currently topical field of **quantum and information thermodynamics**.*

*(ii) Theoretically analyzing **equations of motion for coupled quantum systems** and dealing with essential **thermodynamic observables** such as heat, energy, and entropy in **quantum systems**.*

Useful Skills (not strictly required): *Basic knowledge of Statistical Mechanics and Thermodynamics, basic coding skills (Python, MATLAB).*

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