

A Special Case of a Thermodynamically Reversible Szilard Engine

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Abstract

There is a special case in which a Szilard engine can be considered to be thermodynamically reversible if one of the boundary walls of the particle chamber of the Szilard engine is built out of the physicality of the information by which it functions in such a manner as to make the information by which it functions available to both sides of that boundary wall simultaneously. In such a case, no energy needs to be input to erase information that would accumulate inside the engine because that information is already outside the engine, thus making such a Szilard engine thermodynamically reversible.

Keywords: Szilard engine, thermodynamic reversibility, quantum gate

A Szilard engine theoretically functions by using information about a particle's position and motion to determine shutter timing to enable transformation of the momentum of the particle in the engine into useful work. The conventional understanding of the Szilard engine is that it cannot be thermodynamically reversible because with each cycle of the engine, the physicality of the information by which the engine functions would build up inside the engine, and that would eventually lead to malfunction unless that information was somehow erased, and erasure of that information would require an input of energy. [1] The information by which a Szilard engine functions is ultimately the shutter timing, and that shutter timing can be derived from information about the particle's position, speed, and direction, along with the dimensions of the Szilard engine's particle chamber. The conventional understanding that a Szilard engine is not thermodynamically reversible is correct, except for a special case of a Szilard engine in which one of the boundary walls of the particle chamber of the Szilard engine is constructed out of the

physicality of the information by which the engine functions in such a manner as to make that information available to both sides of the boundary wall simultaneously. For instance, if a wall consisted of a single layer of letter-shaped bricks, then the physicality of those bricks and the information of the letters that those bricks represented, would be available to both sides of the wall simultaneously (although that information would be phase-shifted by 180 degrees between the sides of the wall). If such information was thus simultaneously available to both the inside and the outside of the Szilard engine, then the physicality of that information could not accumulate inside the Szilard engine because that information is already outside the engine. Therefore, in the special case of a Szilard engine which has (at least part of) a particle chamber boundary wall that is built out of the physicality of the information by which that Szilard engine functions, that Szilard engine would be thermodynamically reversible.

A quantum gate must be both logically and thermodynamically reversible, and since all Szilard engines are logically reversible, the special case of a thermodynamically reversible Szilard engine can be considered as potential representation of a quantum gate and of the physicality of the information involved. Information-rich physicalities, such as the aperiodic crystal that is the DNA molecule, might be considered as candidate substances for the construction of an information-containing boundary wall in a thermodynamically reversible Szilard engine, and thereby provide new considerations for quantum computing. [2]

References

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