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Maxwell demons in phase space

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Although there is not a complete “proof” of the second law of thermodynamics based on microscopic dynamics, two properties of Hamiltonian systems have been used to prove the impossibility of work extraction from a single thermal reservoir: Liouville’s theorem and the adiabatic invariance of the volume enclosed by an energy shell (Helmholtz’s theorem). In this talk, I will review these two properties and analyze the dynamics of isothermal and microcanonical Szilard engines in the phase space. In particular, we will see that ergodicity breaking plays a crucial role in all these variants of the Maxwell demon because the enclosed volume is no longer an adiabatic invariant in non-ergodic systems.

Summary

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