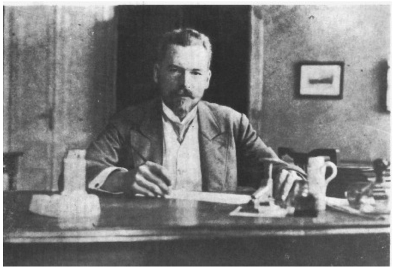

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Quantum and classical contributions to entropy production in fermionic and bosonic systems

Sunday, September 18, 2022 4:20 PM (25 minutes)

As previously demonstrated, the entropy production – a standard measure of irreversibility of thermodynamic processes – is related to generation of correlations between degrees of freedom of the system and its environment [1]. A natural question appears whether such correlations are classical or quantum. This work deals with this problem by investigating noninteracting fermionic and bosonic systems. It is shown that for both classes of systems the entropy production is mostly related to the generation of quantum coherence in the eigenstate basis of the environment, namely, the Fock basis. This might suggest that the entropy production is mainly of a quantum origin. However, a more refined insight is provided by defining the classical correlations as a maximum amount of information accessible through measurements [2]. In fermionic systems measurements can be performed only in the Fock basis due to parity superselection rule forbidding the quantum superpositions of states with different particle parity [3]; therefore correlations are mostly quantum. For bosonic systems, however, a higher amount of information is provided by Gaussian measurements in the position-momentum phase space. While the position-momentum correlations are mostly quantum for low temperatures, they become purely classical in the high-temperature limit. This demonstrates a qualitative difference between fermionic and bosonic systems regarding the existence of a quantum-to-classical transition in microscopic description of the entropy production.

[1] New J. Phys. 12, 013013 (2010); Phys. Rev. Lett. 123, 200603 (2019)
[2] Phys. Rev. A 84, 042109 (2011)
[3] Phys. Rev. A 103, 032426 (2021)

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