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Memory behaviors of entropy production rates in heat conduction

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Abstract

Based on the relaxation time approximation and first-order expansion, memory behaviors in heat conduction are found between the macroscopic and Boltzmann-Gibbs-Shannon (BGS) entropy production rates with exponentially decaying memory kernels. In the frameworks of classical irreversible thermodynamics (CIT) and BGS statistical mechanics, the memory dependency on the integrated history is unidirectional, while for the extended irreversible thermodynamics (EIT) and BGS entropy production rates, the memory dependences are bidirectional and coexist with the linear terms. When macroscopic and microscopic relaxation times satisfy a specific relationship, the entropic memory dependences will be eliminated. There also exist initial effects in entropic memory behaviors, which decay exponentially. The second-order term are also discussed, which can be understood as the global non-equilibrium degree. The effects of the second-order term are consisted of three parts: memory dependency, initial value and linear term. The corresponding memory kernels are still exponential and the initial effects of the global non-equilibrium degree also decay exponentially.

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