

Oettinger, Hans Christian: *“Preservation of thermodynamic structure in model reduction and coarse graining”*

It is the task of nonequilibrium thermodynamics to develop the mathematical structure of evolution equations that guarantees physical and mathematical soundness. I present a promising candidate for such a structure, known as GENERIC (general equation for the nonequilibrium reversible-irreversible coupling) or metriplectic structure. Once we have identified the proper thermodynamic structure of sound evolution equations, the preservation of this structure under many-to-one transformations is an interesting topic, which may be called nonequilibrium statistical mechanics. One can distinguish between two fundamentally different types of such structure-preserving many-to-one transformations depending on whether or not (additional) irreversibility emerges:

(i) In coarse graining, fast degrees of freedom are eliminated by considering them as fluctuations, which are naturally accompanied by emerging dissipation. Among the systematic structure-preserving coarse graining rules, Green-Kubo relations play a key role. I would like to offer some (thought-)provoking comments on the relationship between coarse graining and mathematics.

(ii) Model reduction can be regarded as a solution procedure. Invariant manifolds and the implementation of constraints are key issues. The general ideas of structure-preserving model reduction are illustrated for the Kramers problem, that is, the description of transitions between two potential wells separated by a high barrier.