STEEPEST-ENTROPY-ASCENT DYNAMICAL MODELS
OF IRREVERSIBLE RELAXATION FROM NON-EQUILIBRIUM TO STABLE EQUILIBRIUM.
UNIFIED TREATMENT FOR SIX NON-EQUILIBRIUM FRAMEWORKS

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EXTENDED ABSTRACT

By suitable reformulations, we review the mathematical frameworks of six different approaches to the description of non-equilibrium dynamics in a way that allows us to set up a unified formulation of the Maximum Entropy Production Principle (MEPP) valid in all these contexts. This way, we readily extend to these other frameworks the concept of Steepest Entropy Ascent dynamics introduced by the present author in previous work on quantum thermodynamics [1-13]. Actually, the present formulation constitutes a generalization even in the quantum thermodynamics framework. The analysis emphasizes that in the SEA implementation of the MEPP, a key role is played by the geometrical metric with respect to which to measure the length of a trajectory in state space and the norm of the dynamical generator. The metric tensor turns out to be directly related to the inverse of the Onsager’s generalized conductivity tensor. We conclude that in most of the existing theories of non-equilibrium the time evolution of the state representative can be seen to actually follow in state space the path of SEA with respect to a suitable metric connected with the generalized conductivities. The resulting unified family of SAE dynamical models are all intrinsically consistent with the second law of thermodynamics. The H theorem (non-negativity of the local entropy production density) is a general and readily proved feature of SEA dynamics. In each of the several different approaches to non-equilibrium that are unified by the SEA concept, the present unifying approach may prove useful in providing new basis for effective numerical treatment of irreversible, conservative relaxation towards equilibrium from far non-equilibrium states. The six frameworks are: A) Classical Statistical Mechanics; B) Small-Scale and Rarefied Gases Dynamics (i.e., kinetic models for the Boltzmann equation); C) Statistical or Information Theoretic Models of Relaxation to Equilibrium; D) Rational Extended Thermodynamics and Macroscopic Non-Equilibrium Thermodynamics; E) Mesoscopic Irreversible Thermodynamics; F) Quantum Statistical Mechanics, Quantum Thermodynamics, and Intrinsic Quantum Thermodynamics.

REFERENCES