MODERN NON-EQUILIBRIUM STATISTICAL MECHANICS

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March 19, 2025

This 12 hours course is devoted to modern developments in non-equilibrium statistical mechanics in dynamical system setting. Both classical and quantum case will be considered (roughly six hours each). The format of the course is four lectures of 3 hours each. The web page for the course is in preparation.

Lecture 1. Classical dynamical systems. Entropy cocycle, entropy production observable, and entropy balance equation. Transient fluctuation relation. Control parameters and fluxes. Generalized finite time transient fluctuation relation. Finite time linear response theory. Large time limit and entropy production. Green-Kubo formula and Onsager reciprocity relations. Fluctuation Theorem and relations with respect to the initial (reference) state. Hypothesis testing of the arrow of time. L^p-Liouvilleans.

Lecture 2. Non-equilibrium steady states. Gallavotti-Cohen Fluctuation Theorem. Principle of regular entropic fluctuations (PREF). Examples: toy models, differentiable transformations, Anosov diffeomorphisms, open Hamiltonian systems. Introduction to quantum dynamical system with review of modular theory.

Lecture 3. Quantum Entropy cocycle, entropy production observable, and entropy balance equation. Quantum transient fluctuation relations. Interpolating entropic functionals /α-z Renyi relative entropies. Generalized transient fluctuation relation and finite time linear response theory. Example: confined open quantum systems. Quantum L^p-Liouvilleans, Large time limit and entropy production. Green-Kubo formula and Onsager reciprocity relations. Fluctuation Theorem and relations (with respect to initial reference state). Non-equilibrium steady states.

Lecture 4. Two-times quantum measurement entropy production. Bruneau-Panati formula. Stability. Ancila state tomography. Quantum principle of regular entropic fluctuations. Examples: Toy models, XY quantum spin chain, Heisenberg spin chain, Electronic black box model, Pauli-Fierz systems.