Non-equilibrium phase transitions

One of the paradigms for non-equilibrium statistical physics consists in the study of noisy dynamics [1, 2], where non-equilibrium phase transitions are non-analytic points of non-equilibrium steady states or of the time-evolution. Non-equilibrium phase transitions has a much richer phenomenology than equilibrium phase transitions, because states lack a universal description in terms of thermodynamic potentials. From a methodological point of view, this situation results in a large variety of universality classes without general tools for their characterisation [3].

Many equilibrium phase transitions are detected by superextensivity of the Bures metric, also known as fidelity susceptibility [4] and proportional to the Fisher information [5, 6]. The rationale relies upon the geometric interpretation of the Fisher information as the distance between two infinitesimally close states with respect to a varying control parameter. Indeed, superextensive metric implies instability with respect to small changes, e.g. due to critical points separating different phases. While the Fisher information reduces to standard susceptibilities for thermal phase transitions [7], it represents a more sophisticated tool for quantum phase transitions, and for non-equilibrium phase transitions. The latter case is in the very early stage [8, 9].

Aim of the project is to systematically extend the aforementioned characterisation to (classical and especially quantum) non-equilibrium phase transitions. The Fisher information is also a figure of merit of metrology, being the inverse of the smallest variance in the estimation of the state parameters [5]. Therefore, the above phase transitions will also apply to precision metrology of the phase transition control parameters. Moreover, the project has applications in (again, classical and especially quantum) non-equilibrium thermodynamics, since the entropy production and the extractable work can be bounded by the Fisher information.

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