Exploring contact between out of equilibrium systems in steady states - The question of non-equilibrium Intensive Thermodynamic Parameters

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Abstract

Although equilibrium thermodynamics is well established and universal, an equivalent theoretical framework remains to be built for non-equilibrium systems, at least for simple ones which are in a steady state. Oono & Paniconi (1998) and some years after, Sasa and Tasaki (2006) have developed a "Steady State Thermodynamics" (SST) which is exploring the general thermodynamic structure that steady state systems should obey. On the other hand, an analytic approach based on simple statistical systems has led to the definition of Intensive Thermodynamic Parameters (ITP) with respect to conserved quantities (Bertin, Martens, Dauchot and Droz (2007)). They play an analogous role as temperature or chemical potential at equilibrium. More recently, Pradhan, Seifert et.al. (2011) and Dickman et.al. (2014, 2015) have revived these studies with numerical simulations of driven lattice gas models. They have tested in particular the consistency of Sasa and Tasaki's SST by exploring the zeroth law that must be satisfied by intensive parameters. They have found that a thermodynamic structure is at best approximately verified.

This work aims to pursue in more details the investigation of the contact between steady state systems and to make the link between statistical approaches on one side, and Sasa and Tasaki's thermodynamical approach on the other side. In this poster, we will present theoretical results based on exact calculations on mass transport models, emphasizing the important role of contact dynamics in determining the steady state reached by two systems in contact. Different possible definitions of the chemical potentials will be discussed, together with their consistency. These results also have important implications for the validity of the Sasa-Tasaki formalism.

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