

Local Quasi-Equilibrium Description of Multi-Scale Systems

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We propose an extension of Onsager's theory, originally formulated to describe non-equilibrium aged systems, in order to analyze the dynamics systems characterized by degrees of freedom that relax in different time scales (aging). Our theory is based on the assumption of local quasi-equilibrium states in phase space having a non-stationary probability density. This assumption entails the existence of a time-dependent temperature of the system $T(t)$ reflecting lack of thermal equilibrium between system and bath, which enables us to formulate a Gibbs equation. The relation between the local quasi-equilibrium and bath temperatures is given in terms of a scale function. We show that the fluctuation-dissipation relation remains valid in terms of the local quasi-equilibrium temperature $T(t)$ of the system whose value depends on the timescale considered. The formalism is applied to systems with a slow relaxation dynamics and to granular systems.