Thermodynamic Resources in Continuous-Variable Quantum Systems

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Thermodynamic resources, beyond their well-known usefulness in work extraction and other thermodynamic tasks, are often important also in tasks that are not evidently thermodynamic. Here we develop a framework for identifying such resources in diverse applications of bosonic continuous-variable systems. Introducing the class of bosonic linear thermal operations to model operationally feasible processes, we apply this model to identify uniquely quantum properties of bosonic states that refine classical notions of thermodynamic resourcefulness. Among these are (1) a suite of temperature-like quantities generalizing the equilibrium temperature to quantum, non-equilibrium scenarios; (2) signal-to-noise ratios quantifying a system's capacity to carry information in phase-space displacement; and (3) well-established non-classicality measures quantifying the resolution in sensing and parameter estimation tasks.