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Inconsistencies in steady state thermodynamics[1] RONALD DICKMAN, RICARDO MOTAI, Universidade Federal de Minas Gerais — We address the issue of extending thermodynamics to nonequilibrium steady states. Using driven stochastic lattice gases, we ask whether consistent definitions of an effective chemical potential μ, and an effective temperature T_e, are possible. These quantities are determined via zero-flux conditions of particles and energy between the driven system and a reservoir. For the models considered here, the fluxes are given in terms of certain stationary average densities, eliminating the need to perturb the system by actually exchanging particles; μ and T_e are thereby obtained via open-circuit measurements, using a virtual reservoir. In the lattice gas with nearest-neighbor exclusion, temperature is not relevant, and we find that the effective chemical potential, a function of density and drive strength, satisfies the zeroth law, and correctly predicts the densities of coexisting systems. In the Katz-Lebowitz-Spohn driven lattice gas, both μ and T_e need to be defined. We show analytically that the zeroth law is violated, and determine the size of the violations numerically. Our results highlight a fundamental inconsistency in the extension of thermodynamics to nonequilibrium steady states.

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