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Work Relations Connecting Nonequilibrium Steady States Without Detailed Balance YING TANG, RUOSHI YUAN, PING AO, Shanghai Jiao Tong Univ — Bridging equilibrium and nonequilibrium statistical physics attracts sustained interest. Hallmarks of nonequilibrium systems include a breakdown of detailed balance, and an absence of a priori potential function corresponding to the Boltzmann-Gibbs distribution, without which classical equilibrium thermodynamical quantities could not be defined. Here, we construct dynamically the potential function through decomposing the system into a dissipative part and a conservative part. We then develop a nonequilibrium theory by defining thermodynamical quantities based on the potential function. We elucidate this procedure explicitly in a class of time-dependent linear diffusive systems without mathematical ambiguity. We also obtain the exact work distribution, and generalized work relations for the calculation of free energy difference between nonequilibrium steady states. Our results demonstrate that concepts for equilibrium can be naturally extended to nonequilibrium steady state, which provides a platform to study thermodynamics of systems without detailed balance.

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