

Inconsistent thermostatistics and negative absolute temperatures

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Abstract:

Over the past 60 years, a considerable body of experimental and theoretical work has claimed the existence of negative absolute temperature in spin systems and ultra-cold quantum gases, leading to speculation that the latter may be Dark Energy analogs. Here, we argue that such negative temperatures arise from the use of a popular yet inconsistent entropy definition that violates fundamental thermodynamic relations and fails to produce sensible results for analytically tractable classical and quantum systems. Within a mathematically consistent thermodynamic formalism, based on a microcanonical entropy concept originally derived by Gibbs, absolute temperature remains positive even for systems with bounded spectrum. We address spurious arguments against the Gibbs entropy and comment briefly on heat engines with efficiencies greater than one.