

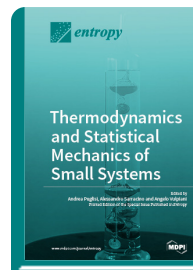
Special Issue Reprint

Thermodynamics and Statistical Mechanics of Small Systems

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A challenging frontier in modern statistical physics concerns systems with a small number of degrees of freedom, far from the thermodynamic limit. Beyond the general interest in the foundation of statistical mechanics, the relevance of this subject is due to the recent increase of resolution in the observation and manipulation of biological and man-made objects at micro- and nano-scales. A peculiar feature of small systems is the role played by fluctuations, which cannot be neglected and are responsible for many non-trivial behaviors. The study of fluctuations of thermodynamic quantities, such as energy or entropy, goes back to Einstein, Onsager, and Kubo; more recently, interest in this matter has grown with the establishment of new fluctuation–dissipation relations, and of so-called stochastic thermodynamics. This turning point has received a strong impulse from the study of systems that are far from the thermodynamic equilibrium, due to very long relaxation times, as in disordered systems, or due to the presence of external forcing and dissipation, as in granular or active matter. Applications of the thermodynamic and statistical mechanics of small systems range from molecular biology to micro-mechanics, including models of nano-transport, Brownian motors, and (living or artificial) self-propelled organisms.

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