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Guest Editors: Dr. Florent Duchaine and Dr. Daniel Mira

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Section Information:

This section focuses on original reasoning and new research results in fundamentals and applications in thermodynamics. Original manuscripts in different areas of thermodynamics, including critical up-to-date reviews are solicited. We welcome submissions addressing novel issues, as well as those on more specific topics. It is hoped that the thermodynamics section will inspire and motivate scientists and practitioners to revisit important and critical issues related to the Laws of Thermodynamics as the most fundamental laws of nature.

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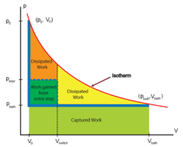
Featured Papers

DOI:10.3390/e25030539

More Stages Decrease Dissipation in Irreversible Step Processes

Authors: Peter Salamon, Bjarne Andresen, James Nulton, Ty N. F. Roach and Forest Rohwer

Abstract: The dissipation in an irreversible step process is reduced when the number of steps is increased in any refinement of the steps in the process. This is a consequence of the ladder theorem, which states that, for any irreversible process proceeding by a sequence of relaxations, dividing any relaxation step into two will result in a new sequence that is more efficient than the original one. This results in a more-steps-the-better rule, even when the new sequence of steps is not reoptimized. This superiority of many steps is well established empirically in, e.g., insulation and separation applications. In particular, the fact that the division of any step into two steps improves the overall efficiency has interesting implications for biological evolution and emphasizes thermodynamic length as a central measure for dissipation.



DOI:10.3390/e25030504

Stochastic Thermodynamics of a Finite Quantum System Coupled to Two Heat Baths

Authors: Heinz-Jürgen Schmidt and Jochen Gemmer

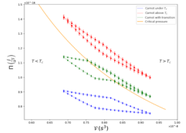
Abstract: We consider a situation where an N-level system (NLS) is coupled successively to two heat baths with different temperatures without being necessarily thermalized and approaches a steady state. For this situation we apply a general Jarzynski-type equation and conclude that heat and entropy is flowing from the hot bath to the cold one. The Clausius relation between increase of entropy and transfer of heat divided by a suitable temperature assumes the form of two inequalities. Our approach is illustrated by an analytical example. For the linear regime, i.e., for small temperature differences between the two heat baths, we derive an expression for the heat conduction coefficient.

DOI:10.3390/e25020311

Carnot Cycles in a Harmonically Confined Ultracold Gas across Bose–Einstein Condensation

Authors: Ignacio Reyes-Ayala, Marcos Miotti, Michal Hemmerling, Romain Dubessy, Hélène Perrin, Victor Romero-Rochin, Vanderlei Salvador Bagnato

Abstract: Carnot cycles of samples of harmonically confined ultracold ^{87}Rb fluids, near and across Bose–Einstein condensation (BEC), are analyzed. This is achieved through the experimental determination of the corresponding equation of state in terms of the appropriate global thermodynamics for non-uniform confined fluids. We focus our attention on the efficiency of the Carnot engine when the cycle occurs for temperatures either above or below the critical temperature and when BEC is crossed during the cycle. The measurement of the cycle efficiency reveals a perfect agreement with the theoretical prediction ($1-T_L/T_H$), with T_H and T_L serving as the temperatures of the hot and cold heat exchange reservoirs. Other cycles are also considered for comparison.



DOI:10.3390/e25040577

Geometric Modeling for Control of Thermodynamic Systems

Authors: Arjan van der Schaft

Abstract: This paper discusses the way that energy and entropy can be regarded as storage functions with respect to supply rates corresponding to the power and thermal ports of the thermodynamic system. Then, this research demonstrates how the factorization of the irreversible entropy production leads to quasi-Hamiltonian formulations, and how this can be used for stability analysis. The Liouville geometry approach to contact geometry is summarized, and how this leads to the definition of port-thermodynamic systems is discussed. This notion is utilized for control by interconnection of thermodynamic systems.