

Arthur S. Iberall Distinguished Lecture

December 3, 2010 ☼ University of Connecticut ☼ 4:00 p.m.
Lieberman Conference Room, Bousfield Psychology Building

Thermodynamics in the 21st Century (Implications for Physical Intelligence)

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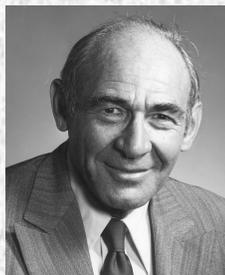
Abstract

In the 19th century, the insights of Carnot in explaining the fundamental processes that converted heat to mechanical work eventually led to the formulation of the concept of entropy by Clausius. During the same time period, studies on the inter-conversion of energy by Joule, Helmholtz, Mayer and others led to the formulation of the law of conservation of energy. The first and the second laws of thermodynamics gave rise to a rich theory with innumerable practical applications. This 19th century formulation, however, was a *theory of states* based on the idealized concept of reversible processes. Entropy was not directly related to irreversible processes that generated it and the theory did not have a way of computing the rate of entropy production.

In the 20th century, the study of irreversible process led to Onsager's work on reciprocal relations. Later, Prigogine introduced a general formulation of thermodynamics as a *theory of irreversible processes*. Prigogine and his group realized that irreversible processes are the architects of structure and self-organization in non-equilibrium systems. These non-equilibrium structures, called dissipative structures, are maintained through the constant production of entropy. They have been extensively studied in the later half of 20th century. These advances in thermodynamics related irreversible processes to self-organization but they did not reveal how function, semantics and higher levels of organization we see in ecological and other systems arise from irreversible processes. Understanding the role of thermodynamics and irreversible process in these systems is the task of the 21st century thermodynamics.

We may expect 21st century thermodynamics to shed light on epistemic systems that have structure (syntax) and function (semantics), which are basic to what one might term as "physical intelligence". Also of interest is thermodynamics of sustainable systems, which will require an understanding of the thermodynamic aspects of economic systems. The lecture will explore possible approaches to these challenging tasks.

ARTHUR S. IBERALL DISTINGUISHED LECTURE SERIES



Dedicated to the exploration of connections between physical processes and their manifestations in nature, life, humankind, mind, and society. The series honors the physicist, Arthur S. Iberall (1918-2002), whose intellectual legacy includes homeokinetics, a method of applying the laws of thermodynamics to all self-organizing systems. His applied research contributed significantly to the development of the first space suit, the high-speed dental drill, stove surface burners, the fancy-stitch sewing machine, and the electric knife.

Dilip K. Kondepudi is Thurman D. Kitchin Professor of Chemistry at Wake Forest University. A Fellow of the American Association for the Advancement of Science, he has been a visiting professor at the Solvay Institute, Belgium, at Keio University, Japan, and at Laboratoire Interdisciplinaire Carnot de Bourgogne, Univ. of Burgundy, France. With his mentor, Ilya Prigogine, he co-authored *Modern Thermodynamics* which has been published in six languages and used as a text in over twenty-five countries. His research in non-equilibrium thermodynamic systems has focused on the origin of chiral asymmetry that is ubiquitous in nature, from elementary articles to morphology of mammals. More recently, he has turned his attention to broader and nontraditional applications of thermodynamics: semantic, ecological and economic systems.

