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# Book Review: *Entropy*

**Entropy.** A. Greven, G. Keller, and G. Warnecke (eds.), Princeton University Press, Princeton, 2003.

When I first received this book, I was afraid that I had made a mistake in agreeing to review it. This trepidation was based on a number of impressions including the facts that: the first equation in the book defining entropy is incorrect; the combined references do not include the names of a number of investigators I would have expected to see there; and the contributors come from a wide variety of fields, whose practitioners have potentially very different views of entropy. Fortunately, most of my trepidations were laid to rest by the high quality of most of the contributions.

The contents were based on papers that were presented at a symposium on entropy that took place at the Max Planck Institute for the Physics of Complex Systems in Dresden during June 2000. The book consists of four parts: Part 1 deals with fundamental concepts; Part 2 with Entropy in Thermodynamics; Part 3 with Entropy in Stochastic Processes; and Part 4 with Entropy and Information. The assignment of articles to these parts is more or less arbitrary since all the articles, with the exception of two on information theory, involve thermodynamics and statistical mechanics of equilibrium and nonequilibrium systems. It is impossible for me to make cogent remarks on all sixteen articles so I will choose a small set to comment on.

The two chapters by Muller and Georgii in Part 1 are fairly elementary discussions of entropy in thermodynamics and its probabilistic, aspects.

In Part 2, the first chapter by Hutter and Wang emphasizes the rational thermodynamics of Truesdell and his followers. The next chapter by Muller discusses entropy in nonequilibrium systems and attempts to justify the use of extended thermodynamics in systems far from equilibrium but does not present a general rationale for its validity. Chapter Six by Dafermos describes the utility of the concept of entropy for hyperbolic systems. Chapter Seven by Uffink entitled Irreversibility and the Second



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law of Thermodynamics is a useful presentation of the history of the second law and the concepts of reversible, irreversible, irrecoverable, and quasistatic *processes*. In thermodynamics, an irreversible process between states A and B is succinctly defined as one in which the system and its surrounding cannot be simultaneously returned from their final to their initial states. The last chapter in this part by Lieb and Yngvason is by far the most interesting and presents a beautiful and logical description of the existence and uniqueness of entropy based on the adiabatic accessibility of equilibrium thermodynamic states.

Part 3 contains articles by Varadhan on Large Deviations and Entropy, by den Hollander on Relative Entropy for Random Motion in a Random Medium, by Olivieri on Metastability and Entropy and by Maes on Entropy Production in (Driven Spatially Extended Systems). It would have been useful to discuss how entropy should be defined in nonequilibrium systems using either thermodynamics or statistical mechanics. This part concludes with an amusing article by Lebowitz and Maes entitled Entropy: A Dialogue. The dialogue is between a scientist and an angel and includes deep insights into the relationship between the entropy and the measurement process. There is a hint here on how to discuss the Kauzman Paradox.

In Part 4, there are articles by Benatti on Classical and Quantum Entropies: Dynamics and Information; by Rissanen on Complexity and Information in Data; by Young on Entropy in Dynamical Systems; and by Keane on Entropy in Ergodic Theory. Benatti gives a useful discussion of Shannon and von Neumann Entropies and the Kolmogorov–Sinai Entropy. Unfortunately, again there is no prescription on how to define entropy in dynamical systems.

It would have been useful somewhere to have a precise definition of equilibrium states. This definition includes time independence, absence of fluxes, and the ability to approach the state from a variety of directions.

On the whole, this is a useful and informative volume and could well be on the bookshelves of physical chemists and specialists in statistical mechanics.

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