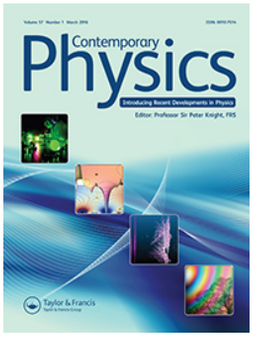

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Entropy demystified: the second law reduced to plain common sense, 2nd edition, by Arieh Ben-Naim

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BOOK REVIEW

Entropy demystified: the second law reduced to plain common sense, 2nd edition, by Arieh Ben-Naim, Singapore, World Scientific, 2016, 276 pp., £24 (paperback), ISBN 978-981-3100-12-1. Scope: general interest, reference. Level: general readership, undergraduate, advanced undergraduate, postgraduate, teacher.

Entropy is often presented as an intriguing and mysterious concept in Physics. Furthermore, its importance is considerable due to its connection to one important law of Physics: the second law of thermodynamics. The very title of this book, which in principle is intended for a public interested in science, implies that the concept itself has been somehow mystified along the years. There might be different reasons for this, as is also discussed in the text. But I have to say that this book represents an excellent tool for clarifying this important concept by clearly exposing most of the ideas we know about the very meaning of entropy.

The author explains with enough clarity using historical arguments going from the early definition of Entropy by Rudolf Clausius (1822–1888) in the context of the thermodynamic cycle of Sadi Carnot (1796–1832). Later, Ludwig Boltzmann (1844–1906) developed a statistical definition by taking into account the microscopic components of a physical system. In the twentieth century, John von Neumann (1903–1957) developed the concept of entropy in the new quantum statistical mechanics, which is commonly known in the context of quantum information as *von Neumann entropy*. Subsequently, Claude Shannon (1916–2001) used the concept of entropy in information theory as the measure of the lost information in a transmitted message, which is usually referred to as *Shannon entropy*. Finally, Jacob Bekenstein (1947–2015) has been one of the main contributors to the foundation of black hole thermodynamics and the connection between information and gravitation, raising a renewed interest in the physics community.

As the author claims from the very beginning of the book, 'Entropy is a Shannon measure of information'. Moreover, the author also insists, and I agree, that the book is not a book to learn thermodynamics or even to learn the applications of the concept of entropy, both objectives very noble that might be learned from many other excellent books in the literature. Thus, according to the author, the main objective of the book is an attempt to explain what entropy is and as a consequence serve as an aid towards a better understanding of the concept.

By the very nature of the book, which is not a textbook, the author not only explains the physical concepts, using mathematical reasoning only when strictly necessary, but also expresses some personal and interesting reflections on the matter at the end.

The book starts with a very accurate short history of the second law of thermodynamics, by paying much attention in the non-atomistic and atomistic formulation. Then, it follows a brief introduction to probability theory providing the fundamental ideas towards an understanding of the statistical viewpoint of the entropy. As is commonly done when teaching entropy from a probabilistic point of view, the author also describes experiments with dice to finally connect them with real-world experiments. The present second edition includes a new section in one of the last chapters, where the author attempts to briefly explain the relationship between entropy and the Shannon measure of information.

The book ends with a final chapter including some personal reflections on the second law of thermodynamics and the concept of entropy. He analyses the sources of the mystery around the concept of entropy and provides a critical view of some of the misunderstandings and misinterpretations of the concept commonly used in teaching thermodynamics. This final chapter is in my opinion one of the best, since here the author dares to provide a synthesis of what has been previously said before and furthermore discusses his personal viewpoint that the second law of thermodynamics is nothing else than a statement of common sense.

Furthermore, the book includes some programmes for simulating some of the games explained in the book, that can be found at the web page http://www.ariehbennaim.com/

The author explicitly declares that the book has been written bearing in mind a reader who in principle knows nothing of science and mathematics, and assuming as the only prerequisite plain common sense. Well, perhaps this has been his intention in writing the book, and certainly the book can be read by a general audience, though with a keen interest in science and certain knowledge of mathematics. Needless to say, it can be used as a supplementary material for teaching thermodynamics and statistical physics at an undergraduate or postgraduate level, and can be a great read for undergraduate and postgraduate students of Sciences and Engineering.

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