The Road to Maxwell’s Demon
Conceptual Foundations of Statistical Mechanics

Time asymmetric phenomena are successfully predicted by statistical mechanics. Yet the foundations of this theory are surprisingly shaky. Its explanation for the ease of mixing milk with coffee is incomplete, and even implies that un-mixing them should be just as easy. In this book the authors develop a new conceptual foundation for statistical mechanics that addresses this difficulty. Explaining the notions of macrostates, probability, measurement, memory, and the arrow of time in statistical mechanics, they reach the startling conclusion that Maxwell’s Demon, the famous perpetuum mobile, is consistent with the fundamental physical laws.

Mathematical treatments are avoided where possible, and instead the authors use novel diagrams to illustrate the text. This is a fascinating book for graduate students and researchers interested in the foundations and philosophy of physics.

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Conceptual Foundations of Statistical Mechanics

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To my wife Tami, and to my children Alma, Avigail, and Shaul – M. H.
For my daughter Marie – may your trajectory, like that of Maxwell’s Demon, evolve through growing potentialities and increasingly meaningful experiences – O. S.
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This book is a product of more than a decade of joint work during which we have greatly benefited from discussions with many people.

First and foremost, the approach we put forward here has been greatly influenced by David Albert’s groundbreaking book from 2000 *Time and Chance*. Albert’s way of thinking about Maxwell’s Demon has made us realize that the foundations of statistical mechanics are in need of clarification, refinement and sometimes even revision, and this realization has led us to develop many of our ideas that come up in this book. Although we agree with Albert on some important matters – such as the radical idea that Maxwell’s Demon is consistent with statistical mechanics – our approach substantially differs from his on a number of issues. However, the need to explain our differing opinions has greatly helped us sharpen our thoughts on the topics we address in this book.

Many conversations with the late Itamar Pitowsky over more than two decades have been extremely valuable to us. Itamar’s open mind to new ideas and his constant encouragement throughout our research kept us on the right track.

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