Statistical mechanics attempts to explain the behaviour of macroscopic physical systems in terms of the mechanical properties of their constituents. Although it is one of the fundamental theories of physics, it has received little attention from philosophers of science. Nevertheless, it raises philosophical questions of fundamental importance on the nature of time, chance and reduction. Most philosophical issues in this domain relate to the question of the reduction of thermodynamics to statistical mechanics.

This book addresses issues inherent in this reduction: the time-asymmetry of thermodynamics and its absence in statistical mechanics; the role and essential nature of chance and probability in this reduction when thermodynamics is non-probabilistic; and how, if at all, the reduction is possible. Containing contributions on current research by experts in the field, this is an invaluable survey of the philosophy of statistical mechanics for academic researchers and graduate students interested in the foundations of physics.

Gerhard Ernst is a Professor of History of Philosophy and Moral Philosophy at Universität Stuttgart. His main research interests are in moral philosophy, epistemology and philosophy of science.

Andreas Hüttemann is a Professor of Philosophy at Westfälische Wilhelms-Universität Münster. His research interests include philosophy of science and early modern philosophy.
TIME, CHANCE AND REDUCTION

Philosophical Aspects of Statistical Mechanics

Edited by

GERHARD ERNST
Universität Stuttgart

ANDREAS HÜTTEMANN
Westfälische Wilhelms-Universität Münster
Contents

List of contributors

1 Introduction

Gerhard Ernst and Andreas Hüttemann

Part I: The arrows of time

2 Does a low-entropy constraint prevent us from influencing the past?
Mathias Frisch

3 The past hypothesis meets gravity
Craig Callender

4 Quantum gravity and the arrow of time
Claus Kiefer

Part II: Probability and chance

5 The natural-range conception of probability
Jacob Rosenthal

6 Probability in Boltzmannian statistical mechanics
Roman Frigg

7 Humean metaphysics versus a metaphysics of powers
Michael Esfeld

Part III: Reduction

8 The crystallization of Clausius’s phenomenological thermodynamics
C. Ulises Moulines

9 Reduction and renormalization
Robert W. Batterman

10 Irreversibility in stochastic dynamics
Jos Uffink

Index

v
Contributors

ROBERT W. BATTERMAN Department of Philosophy, Talbot College, University of Western Ontario, London ON, N6A 3K7, Canada

CRAIG CALLENDER Philosophy Department, University of California San Diego, 9500 Gilman Drive, La Jolla CA 92093–0119, USA

GERHARD ERNST Institut für Philosophie, Universität Stuttgart, Seidenstraße 36, D-70174 Stuttgart, Germany

MICHAEL ESFELD Université de Lausanne, Section de Philosophie, CH-1015 Lausanne, Switzerland

ROMAN FRIGG Department of Philosophy, Logic and Scientific Method, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK

MATHIAS FRISCH Skinner Building, University of Maryland, College Park MD 20742, USA

ANDREAS HÜTTEMANN Philosophisches Seminar, Westfälische Wilhems-Universität Münster, Domplatz 23, D-48143 Münster, Germany

CLAUS KIEFER Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Germany

C. ULISES MOULINES Seminar für Philosophie, Logik und Wissenschaftstheorie, Ludwig-Maximilians-Universität München, Ludwigstraße 31, D-80539 München, Germany

JACOB ROSENTHAL Institut für Philosophie der Universität Bonn, Am Hof 1, D-53113 Bonn, Germany

JOS UFFINK Institute for History and Foundations of Science, Utrecht University, P.O. Box 80.000, NL-3508 TA, Utrecht, The Netherlands