Preface

The idea for this book grew out of a series of workshops on the Maximum Entropy Production (MaxEP) principle, held annually from 2003 to 2011.[1] These workshops brought together scientists and students interested in the theory and application of MaxEP to non-equilibrium systems across a wide range of disciplines in physics, chemistry and biology.

A first 'state of the art' account of MaxEP research up to 2004 was presented in a previous book[2] within the same Springer series *Understanding Complex Systems*. The present volume provides a timely update on the significant progress, both theoretical and applied, that has been made in this exciting field over the last 9 years. More than that, however, we saw the opportunity to broaden the horizons of MaxEP research—to make connections between MaxEP and other areas of non-equilibrium science, such as the Fluctuation Theorem and the Maximum Entropy (MaxEnt) principle. These areas have largely been developed in isolation from each other, and yet the concepts of entropy and entropy production play a central role in all of them.

History in general, and the history of science in particular, has demonstrated that there is much to be gained when folks with different viewpoints get together and talk to each other. Therefore, a particular aim of the MaxEP 2011 workshop—held at the Australian National University, Canberra and co-organised by the four Editors—was to bring together scientists from traditionally isolated sectors of non-equilibrium science in order to present their work and ideas on entropy and entropy production, with a view to exploring potential connections between them.

This also became the key aim of the present volume. This book contains contributions from participants of MaxEP 2011 as well as others around the globe who are actively engaged in non-equilibrium science—all of them internationally-recognised experts in their respective fields. It is organised into three parts. Part I provides an overview of the landscape of existing non-equilibrium principles beyond the restrictive scope of the second law of thermodynamics; it also offers a

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[1] National Institute for Agronomy Research, Bordeaux, France (2003–2005), University of Split, Croatia (2006), Max-Planck Institute for Biogeochemistry, Jena (2007–2010), The Australian National University, Canberra, Australia (2011).

[2] Kleidon and Lorenz [1].

tentative road map of potential connections and future research directions within that landscape, based on the material presented in Parts II and III which deal, respectively, with theoretical perspectives on entropy production and applications.

Topics covered include the theoretical basis of MaxEP, non-equilibrium principles associated with Ziegler and Prigogine, the Fluctuation Theorem and related theorems, and MaxEnt, as well as the many applications of these principles to such diverse fields as biogeochemistry, cosmology, crystal growth morphology, Earth system science, evolution of enzyme kinetics, fluid mechanics, land–atmosphere interactions, landscape topography, macroscale technology, planetary climatology, plasma physics and radiative transfer. This volume also brings together a wide variety of analytical and experimental techniques: stability analysis, climate models of varying complexity, fluid mechanics experiments, microbial growth experiments, molecular dynamics and lattice gas simulations, and variational approaches.

Running through it all is the recurring *leitmotiv* of entropy production. We hope that this book will provide readers with an understanding of entropy production as a key unifying concept in non-equilibrium science—one that provides a link between different theoretical approaches as well as between theory and applications.

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Finally, we thank the many participants and support staff of the MaxEP workshops (2003–2011) for their contributions over the years. Their enthusiasm, encouragement and camaraderie have sustained and enriched our own scientific journeys beyond the Second Law.

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Reference

1. Kleidon, A., Lorenz, R. (eds.) Non-equilibrium Thermodynamics and Entropy Production: Life, Earth and Beyond. Springer, Heidelberg (2005)

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