Preface to the Second Edition

The publication of this Second Edition of The Dynamics of Heat has given me the opportunity to make some major and, I hope, useful changes to the book. The character of the conceptualization of thermal processes—the direct approach to entropy as what in lay terms would be called “heat” and temperature as the corresponding potential—has been retained and much has been taken directly from the First Edition, but I have completely changed the structure of this text and I have added new material on thermal processes, chemical dynamics, and explicit dynamical modeling. The original goals of a unification of foundations and applications in general, and of thermodynamics and heat transfer in particular, have been the guiding principles for this revision. As such, The Dynamics of Heat continues to be a text that can help students of the applied sciences, engineering, and medicine to take the steps from the simplest beginnings in thermal and chemical physics all the way to more demanding and formal treatments of modern continuum thermodynamics. Students of physics can find an introduction to the foundations of a dynamical theory of macroscopic thermal phenomena that will complement modern treatments of statistical physics.

The book is now divided into four parts. Part I, Processes, Energy, and Dynamical Models, is an extensive revision of the Introduction of the First Edition. I have simplified the original brief description of the material and I have added explicit system dynamics modeling of laboratory experiments. Part II, Thermal and Chemical Processes, takes the introductory elements of the four main chapters of the previous edition and transforms them into an introduction to the dynamics of heat and substances suitable to a first college course on the subject. It builds upon the description of fluid, electrical, and mechanical phenomena introduced in Part I and essentially provides a uniform dynamical systems approach to models of thermal and chemical processes. Part IV, Special Processes and Systems, is the least changed from the previous text and contains the more advanced applications of the four large chapters of the First Edition. The Epilogue of the First Edition has been converted into Part III, A Dynamical Theory of Heat, which now offers a formal conclusion to Part II and an introduction to continuum thermodynamics and radiative transfer useful for the applications in Part IV. The Interlude of the First Edition which had the character of a historical and formal introduction to the thermodynamics of spatially uniform systems, has been omitted. For a direct approach to the dynamics of heat I now prefer the formalism of uniform processes developed in Part III over the classical treatment of cycles. Parts III and IV can be the foundation of an advanced course. Last but not least, the new Introduction is a brief outline of cognitive and historical aspects of human conceptualizations of nature in general and of thermal phenomena in particular.

A number of aspects of the text have been changed and some elements have been added. Here is a list of the most important of these changes and additions:

- There are descriptions including actual laboratory data for thermal and chemical phenomena in some key chapters. Many of the phenomena have subsequently been modeled with the help of simple system dynamics tools, providing explicit and detailed dynamical models. Additional experiments and models can be found on a Website for inquiry based learning (see below).
• Time dependent thermal and, especially, chemical phenomena have been given more space than in the previous edition. They can be found in Part II.

• A discussion of thermoelectricity has been added both in the introduction to thermal processes (Chapter 4) and in a more in-depth study of conductive processes (Chapter 13). This is another demonstration of the ease with which some subjects can be treated that are usually considered advanced material in standard texts.

• To strengthen the didactic approach to introductory continuum physics, I have added a brief development of equations of balance and constitutive relations for the life and migration of locust in a single spatial dimension in Chapter 11.

• Short conceptual and review questions have been added to most of the chapters of the book. They should require no more than a pencil and a piece of paper, and maybe not even that. Answers to these questions are provided in the Appendix.

• There are short answers to many of the end-of-chapter problems in the Appendix. A solutions manual will accompany the book.

• I have changed the sign convention for fluxes. Previously, I had chosen to go with the tradition of electromagnetic field theory where an outward flux is given a positive sign. Now, I prefer to count a flow into a system as a positive quantity. This leads to two changes: (1) in the laws of balance, the rate of change of a fluidlike quantity equals the sum of the currents (rather than the negative sum); (2) a flux as the surface integral of a current density obtains a minus sign. The convention adopted here should be more convenient for engineering students.

Many of the new aspects and elements have been inspired by a didactics of inquiry based learning which I have been privileged to build up with Georges Ecoffey of the University of Applied Sciences of Western Switzerland and Edy Schütz (Bildungszentrum Uster),1 partially under a grant made available by the Eduard Job Foundation for Thermal and Chemical Dynamics in Hamburg, Germany.2 My school and colleagues at the Center of Applied Mathematics and Physics have been supportive in the construction of a studio for introductory physics courses where I have been able to apply new learning materials and tools for the last few years. In particular, I would like to thank Jürg Krieg who has made sure that funds were available, and Arthur Baumann who has been doing much of the actual setting up of the studio. I would like to express my gratitude to Paolo Lubini for editing Chapter 6, Jürg Hosang for end of chapter problems for that same chapter, Georges Ecoffey for editing the entire book, and David Packer and the staff at Springer who have been patient and always very supportive of this project.

Again, my special gratitude goes to my wife Robin who did the language editing of the entire text.

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2. See the Website at http://www.job-stiftung.de.
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