

Mathematical Aspects in Non-Equilibrium Thermodynamics

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Introduction

Prof. Csaba Asszonyi, D.Sc. (1941–2022): The present Special Issue is dedicated to the memory of our beloved, respected friend, colleague and teacher, the late Professor Csaba Asszonyi.

The research field of professor Asszonyi was continuum mechanics and irreversible thermodynamics. He played a pioneering role in establishing the thermodynamical background of rock rheology and engineering rock mechanics. He was educated as a mechanical engineer, started his career as research engineer, and then performed coordinated mining research in Hungary. Later on, he went into the industry and became a company group leader. Seventeen years ago, he established the Montavid Thermodynamic Research Group.

His thinking focused on thermodynamic concepts, connecting an application-oriented, engineering attitude with deep theoretical ideas. He developed several industrial applications of thermodynamic rheology. His contributions included the extension of linear viscoelasticity with internal variables and the unification of classical rheological bodies in a thermodynamic framework. He was the author of more than two hundred articles, dozens of patents, and ten books. He refused honours and distinctions, and only at the end of his life became the honorary president of the Society for the Unity of Science and Technology.

The Special Issue “Mathematical Aspects in Non-equilibrium Thermodynamics” consists of five original research papers. Although the current topic has a long history, there are still numerous open questions regarding the structure of evolution equations, the corresponding thermodynamically compatible initial and boundary conditions, and also their relation to experimental and practical aspects. These five papers actually cover various recent and relevant topics such as optimization, finite time thermodynamics, the role of the second law in continuum physics, multi-component mixtures, and boundary conditions. We hope that this Special Issue will be able to play a role in further progress to come in the future.

In the paper “The Role of the Second Law of Thermodynamics in Continuum Physics: A Muschik and Ehrentraut Theorem Revisited” by V. A. Cimmelli and P. Rogolino [1], the authors revisited the second law of thermodynamics and how the entropy inequality plays a crucial role in the derivation of evolution equations, also providing local and global formulations of the second law. The classical results of Muschik and Ehrentraut are reformulated in the present modern mathematical context of second law, thus highlighting a few geometric aspects as an outcome. They also emphasized that the non-equilibrium concept of temperature and entropy far from equilibrium is not necessarily identical to the one close to equilibrium, and how these notions need further investigation.

The paper “Integrability of the Multi-Species TASEP with Species-Dependent Rates”, written by Eunghyun Lee [2], is related to totally asymmetrical simple exclusion processes; it



Citation: Kovács, R.; Rogolino, P.; Oliveri, F. Mathematical Aspects in Non-Equilibrium Thermodynamics. *Symmetry* **2023**, *15*, 929. <https://doi.org/10.3390/sym15040929>

Received: 2 March 2023
Accepted: 10 April 2023
Published: 17 April 2023



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Some Aspects Of Non Equilibrium Thermody

Byung Chan Eu, Mazen Al-ghoul



Some Aspects Of Non Equilibrium Thermody:

Non-equilibrium Thermodynamics of Superfluid Helium and Quantum Turbulence Maria Stella Mongiovi, David Jou, Michele Sciacca, 2025-07-23 This book puts together non equilibrium thermodynamics heat transport properties of superfluid He II and thermodynamic and dynamic aspects of quantum turbulence A one fluid extended model of superfluid helium with heat flux as an additional independent variable is presented and compared with the two fluid model to explore how both models complement each other Important features arise in rotating situations and in superfluid turbulence characterized by quantized vortices leading to strong nonlinearities between heat flux and temperature gradient The dynamics of vortex lines and their interaction with heat dynamics a central topic in superfluid turbulence is dealt with by introducing the vortex line density as an independent variable and writing its dynamical equations considering the transitions from laminar to turbulent flows and from diffusive to ballistic regimes Classical and quantum turbulence are compared from a mesoscopic view and from their energy spectra The work also explores some parallelisms of quantum vortex thermodynamics with cosmic string thermodynamics and black hole thermodynamics exhibiting duality connections amongst them It emphasizes didactical views over specialistic details and may be used as an introduction to nonequilibrium thermodynamics of superfluid helium and its heat transport properties second sound nonlocal transport nonlinear connections with quantum turbulence The book is useful to researchers in superfluid helium in heat transport and in thermodynamics of cosmic strings and black holes The diversity and complexity of its several physical equations will be inspiring for researchers in mathematical physics

Non-Equilibrium Thermodynamics with Application to Solids W. Muschik, 2014-05-04 This book puts emphasis on developing the basic ideas behind the different approaches to non equilibrium thermodynamics and on applying them to solids After a survey about different approaches an introduction to their common fundamentals is given in the first part In the second part the mechanical behavior of special materials such as viscoelasticity viscoplasticity viscoelastoplasticity and thermoplasticity are discussed The third part is devoted to extended thermodynamics The basic ideas phenomenological as well as microscopical are reviewed and applied to thermo and viscoelastic materials Electromagnetic solids showing dielectric relaxation such as ceramics showing electromagneto mechanical hysteresis and superconductivity are treated in the fourth part In the last part stability with regard to constitutive equations is investigated Especially stability of quasi static processes and of elastic plastic systems are discussed

Nonequilibrium Thermodynamics Yasar Demirel, 2013-12-16 Natural phenomena consist of simultaneously occurring transport processes and chemical reactions These processes may interact with each other and may lead to self organized structures fluctuations instabilities and evolutionary systems Nonequilibrium Thermodynamics Third Edition emphasizes the unifying role of thermodynamics in analyzing the natural phenomena This third edition updates and expands on the first and second editions by focusing on the general balance equations for coupled processes of physical chemical and biological

systems The new edition contains a new chapter on stochastic approaches to include the statistical thermodynamics mesoscopic nonequilibrium thermodynamics fluctuation theory information theory and modeling the coupled biochemical systems in thermodynamic analysis This new addition also comes with more examples and practice problems Informs and updates on all the latest developments in the field Contributions from leading authorities and industry experts A useful text for seniors and graduate students from diverse engineering and science programs to analyze some nonequilibrium coupled evolutionary stochastic and dissipative processes Highlights fundamentals of equilibrium thermodynamics transport processes and chemical reactions Expands the theory of nonequilibrium thermodynamics and its use in coupled transport processes and chemical reactions in physical chemical and biological systems Presents a unified analysis for transport and rate processes in various time and space scales Discusses stochastic approaches in thermodynamic analysis including fluctuation and information theories Has 198 fully solved examples and 287 practice problems An Instructor Resource containing the Solution Manual can be obtained from the author ydemirel2@unl.edu

Chemical Thermodynamics: With Examples For Nonequilibrium Processes Byung Chan Eu, Mazen Al-ghoul, 2010-08-06 Thermodynamics is an ever evolving subject This book aims to introduce to advanced undergraduate students and graduate students the fundamental ideas and notions of the first and second laws of thermodynamics in a manner unavailable in the usual textbooks on the subject of thermodynamics For example it treats the notions of unavailable work compensated and uncompensated heats and dissipation which make it possible to formulate the thermodynamic laws in more broadened forms than those in the conventional treatment of equilibrium thermodynamics It thus strives to prepare students for more advanced subjects of irreversible processes which are encountered in our everyday scientific activities In addition it also aims to provide them with functional and practical knowledge of equilibrium chemical thermodynamics of reversible processes in real fluids It discusses temperature work and heat thermodynamic laws equilibrium conditions and thermodynamic stability thermodynamics of reversible processes in gases and liquids in surfaces chemical equilibria reversible processes in electrolyte solutions and dielectrics in static electric and magnetic fields A couple of examples for irreversible processes associated with fluid flows and chemical pattern formation and wave propagations are discussed as examples for applications of broader treatments of the thermodynamic laws in the realm of irreversible phenomena

Understanding Non-equilibrium Thermodynamics Georgy Lebon, David Jou, 2008-01-12 Our time is characterized by an explosion of information and by an acceleration of knowledge A book cannot compete with the huge amount of data available on the Web However to assimilate all this information it is necessary to structure our knowledge in a useful conceptual framework The purpose of the present work is to provide such a structure for students and researchers interested by the current state of the art of non equilibrium thermodynamics The main features of the book are a concise and critical presentation of the basic ideas illustrated by a series of examples selected not only for their pedagogical value but also for the perspectives offered by recent technological advances

This book is aimed at students and researchers in physics chemistry engineering material sciences and biology We have been guided by two apparently antagonistic objectives gener ity and simplicity To make the book accessible to a large audience of n specialists we have decided about a simpli ed but rigorous presentation Emphasis is put on the underlying physical background without sacri cing mathematical rigour the several formalisms being illustrated by a list of amplexandproblems Alloverthiswork wehavebeenguidedbytheformula Getthemorefromtheless withthepurposetomakeamaximumofpeople aware of a maximum of knowledge from a minimum of basic tools Besidesbeinganintroductorytext ourobjectiveistopresentanoverview as general as possible of the more recent developments in non equilibrium thermodynamics especially beyond the local equilibrium description

Nuclear Science Abstracts ,1966

The High Temperature Aspects of Hypersonic Flow

Wilbur C. Nelson,2014-12-02 The High Temperature Aspects of Hypersonic Flow is a record of the proceedings of the AGARD NATO Specialists Meeting held at the Technical Centre for Experimental Aerodynamics Rhode Saint Genese Belgium in April 1962 The book contains the papers presented during the meeting that tackled a broad range of topics in the aspects of hypersonic flow The subjects covered during the meeting include pressure measurements interference effects the use of wind tunnels in aircraft development testing high temperature gas characteristics boundary layer research stability and control and the use of rocket vehicles in flight research Aerospace engineers and aeronautical engineers will find the book invaluable

Thermodynamics of Non-Equilibrium Processes for Chemists with a Particular Application to Catalysis V.

Parmon,2009-09-26 Thermodynamics of Non Equilibrium Processes for Chemists with a Particular Application to Catalysis consists of materials adapted from lectures on the thermodynamics of nonequilibrium processes that have been taught at the Department of Natural Sciences of Novosibirsk State University since 1995 The thermodynamics of nonequilibrium processes traditionally required students to have a strong background in physics However the materials featured in this volume allow anyone with knowledge in classical thermodynamics of equilibrium processes and traditional chemical kinetics to understand the subject Topics discussed include systems in the thermodynamics of irreversible processes thermodynamics of systems that are close to and far from equilibrium thermodynamics of catalysts the application of nonequilibrium thermodynamics to material science and the relationship between entropy and information This book will be helpful for research into complex chemical transformations particularly catalytic transformations Applies simple approaches of non equilibrium thermodynamics to analyzing properties of chemically reactive systems Covers systems far from equilibrium allowing the consideration of most chemically reactive systems of a chemical or biological nature This approach resolves many complicated problems in the teaching of chemical kinetics

Differential Geometric Foundations of Non-Equilibrium

Thermodynamics Marcus Hildebrandt,2025-02-27 While all field theories are nowadays available in a modern differential geometric coordinate free formulation on manifolds this has been so far only rudimentary accomplished in general non equilibrium thermodynamics In this work it is shown how a fitting geometric structure can be derived for arbitrary compact

discrete Schottky Systems thermodynamic systems such as stars and black holes using only a few thermodynamic principles This leads to deep geometric insights Some central results are the following while in the theory of relativity the energy momentum tensor determines the geometry of the space in non equilibrium thermodynamics the 1 form of the entropy production rate is responsible for the emergence of a well known geometric structure the contact geometry Relaxation processes remain in the fibers in which they start and end on an attractor manifold that can be identified with the classical equilibrium subspace of thermostatics One then proves that outside this attractor manifold there are no reversible process directions As a consequence of this the 2nd Law of thermodynamics lives mainly on the fibers of the state manifold the so called vertical geometric structure while the 1st Law of thermodynamics is formulated on the horizontal components of the state manifold The internal energy provides a physical gauge for each fiber The 1st and 2nd Law of thermodynamics are coupled via the representation of the entropy flux 1 form that can be represented in the dual basis of exchange 1 forms such as the heat 1 form This fact can be used to provide a coordinate free invariant definition of non equilibrium temperature Finally it is shown that probably the most general geometric structure to model non equilibrium thermodynamics of compact discrete Schottky systems is given by a composite fibred cocontact phase manifold that includes time as an explicit dimension

Some aspects of non-equilibrium thermodynamics in the presence of a radiation field. Based on a set of lectures given at the University of Paris, Institut d'Astrophysique. February - March, 1961 Richard N. Thomas, 1965

Thermodynamics Mizutani Tadashi, 2011-01-14 Progress of thermodynamics has been stimulated by the findings of a variety of fields of science and technology The principles of thermodynamics are so general that the application is widespread to such fields as solid state physics chemistry biology astronomical science materials science and chemical engineering The contents of this book should be of help to many scientists and engineers

Bioelectrochemistry IV Bruno Andrea Melandri, Giulio Milazzo, Martin Blank, 2012-12-06 by G MILAZZO and M BLANK This book contains the lectures of the fourth advanced course Bioelectrochemistry W Neroe Muscle Function Bioelectrochemistry Mechanisms Energetics and Contro which took place at the Majorana Center in Erice Italy October 20th to November 1 1991 The scope of the course was international in terms of both sponsorship and participation Sponsors included the Bioelectrochemical Society NATO International Union of Pure and Applied Biophysics IUPAB the World Federation of Scientists and the Italian National Research Council One third of the sixty participants were from Italy but the majority came from eighteen other nations Since the course was part of the International School of Biophysics the biophysical point of view was emphasized in integrating the biology with the electrochemistry Lecturers were asked to use a quantitative approach with accepted standards and proper units since this is absolutely essential for developing an effective common language for communication across disciplines Participants were also urged not to forget that biological systems could also be considered as physical systems Ion channels are proteins and their properties as polyelectrolytes contribute to the specific biological properties The existence of families

of channels with very similar structures but different selectivities suggests that the specificities arise from slight variations of a general basic design These perspectives on nerve muscle function helped to make the school course a unique treatment of the subject

NBS Special Publication ,1973 *On the Non-equilibrium Thermodynamics of Thermal Radiation Fields* Alfonso Rueda,1973 *Chemical Thermodynamics: Reversible And Irreversible Thermodynamics (Second Edition)*. Byung Chan Eu,Mazen Al-ghoul,2018-03-09 This book enables the reader to learn in a single volume equilibrium and nonequilibrium thermodynamics as well as generalized forms of hydrodynamics for linear and nonlinear processes applied to various hydrodynamic flow processes including chemical oscillation phenomena and pattern formations shock wave phenomena sound wave propagations and Liesegang pattern formation amongst others Chemical Thermodynamics introduces advanced undergraduate students and graduate students to the fundamental ideas and notions of the first and second laws of thermodynamics by seamlessly combining equilibrium and nonequilibrium thermodynamics in a unicameral viewpoint based on the first and second law of thermodynamics Part I of the book discusses equilibrium thermodynamics in historical deference covering topics generally dealt with in traditional equilibrium thermodynamics In Part II the concept of entropy for reversible processes is extended and developed for thermodynamics of irreversible processes by using the concept of calortropy heat evolution so that the mathematical theory of macroscopic processes in matter including a generalized form of hydrodynamics is ensured to remain consistent with the thermodynamic laws [Geometric Perturbation Theory in Physics](#) Stephen Malvern Omohundro,1986 This book which focusses on mechanics waves and statistics describes recent developments in the application of differential geometry particularly symplectic geometry to the foundations of broad areas of physics Throughout the book intuitive descriptions and diagrams are used to elucidate the mathematical theory It develops a coordinate free framework for perturbation theory and uses this to show how underlying symplectic structures arise from physical asymptotes It describes a remarkable parity between classical mechanics which arises asymptotically from quantum mechanics and classical thermodynamics which arises asymptotically from statistical mechanics Included here is a section with one hundred unanswered questions for further research

Recent Advances in Mechanics of Non-Newtonian Fluids Wei-Tao Wu,Mehrdad Massoudi,2020-02-21 Non Newtonian non linear fluids are common in nature for example in mud and honey but also in many chemical biological food pharmaceutical and personal care processing industries This Special Issue of Fluids is dedicated to the recent advances in the mathematical and physical modeling of non linear fluids with industrial applications especially those concerned with CFD studies These fluids include traditional non Newtonian fluid models electro or magneto rheological fluids granular materials slurries drilling fluids polymers blood and other biofluids mixtures of fluids and particles etc *Thermodynamics of Fluids Under Flow* D. Jou,J. Casas-Vazquez,M. Criado-Sancho,2013-03-09 The thennodynamics of fluids under shear flow is an active and very challenging topic in modem non equilibrium thennodynamics and statistical mechanics The interest is both theoretical and practical From the theoretical

point of view the influence of the shear effects on the thermodynamic potentials requires the formulation of thermodynamic theories beyond the local equilibrium hypothesis this is a field with many open questions which fosters an active dialogue between macroscopic and microscopic theories the latter based either on the kinetic theory of gases or on computer simulations of gases or liquids Furthermore it also requires an open discussion between thermodynamics and hydrodynamics because some of the phenomena observed may have a purely thermodynamic origin due to the modification of some equations of state or a purely in general there will be an interplay of both thermodynamic hydrodynamic origin but and hydrodynamic effects To clarify the formulation of a non equilibrium thermodynamics beyond the local equilibrium regime and its relationship with microscopic theories and with hydrodynamic theories currently represents an important frontier From the practical point of view many situations of technological interest are present in fluid systems under flow Indeed the modification of the thermodynamic equations of state for the chemical potential imply modifications in the phase diagram of substances in non equilibrium states or on the conditions of chemical equilibrium and stability

Stochastic Approach to Fatigue K. Sobczyk, 2014-05-04 Fatigue of engineering materials is a very complicated process that is difficult to accurately describe and predict It is no doubt nowadays that a fatigue of real materials should be regarded as a random phenomenon and analyzed by use of stochastic theory This volume of the lectures summarises the latest achievements in stochastic modelling and analysis of fatigue The lectures cover the following important aspects of modern analysis of fatigue methodology of stochastic modelling of fatigue tools for characterization of random fatigue loads physical and mechanical aspects of random fatigue basic stochastic models for fatigue and the estimation of fatigue reliability of specific structural systems

Special Publication ,1973

Unveiling the Magic of Words: A Review of "**Some Aspects Of Non Equilibrium Thermody**"

In a world defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is really awe-inspiring. Enter the realm of "**Some Aspects Of Non Equilibrium Thermody**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve to the book is central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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Table of Contents Some Aspects Of Non Equilibrium Thermody

1. Understanding the eBook Some Aspects Of Non Equilibrium Thermody
 - The Rise of Digital Reading Some Aspects Of Non Equilibrium Thermody
 - Advantages of eBooks Over Traditional Books
2. Identifying Some Aspects Of Non Equilibrium Thermody
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Some Aspects Of Non Equilibrium Thermody
 - User-Friendly Interface
4. Exploring eBook Recommendations from Some Aspects Of Non Equilibrium Thermody
 - Personalized Recommendations
 - Some Aspects Of Non Equilibrium Thermody User Reviews and Ratings
 - Some Aspects Of Non Equilibrium Thermody and Bestseller Lists

5. Accessing Some Aspects Of Non Equilibrium Thermody Free and Paid eBooks
 - Some Aspects Of Non Equilibrium Thermody Public Domain eBooks
 - Some Aspects Of Non Equilibrium Thermody eBook Subscription Services
 - Some Aspects Of Non Equilibrium Thermody Budget-Friendly Options
6. Navigating Some Aspects Of Non Equilibrium Thermody eBook Formats
 - ePub, PDF, MOBI, and More
 - Some Aspects Of Non Equilibrium Thermody Compatibility with Devices
 - Some Aspects Of Non Equilibrium Thermody Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Some Aspects Of Non Equilibrium Thermody
 - Highlighting and Note-Taking Some Aspects Of Non Equilibrium Thermody
 - Interactive Elements Some Aspects Of Non Equilibrium Thermody
8. Staying Engaged with Some Aspects Of Non Equilibrium Thermody
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Some Aspects Of Non Equilibrium Thermody
9. Balancing eBooks and Physical Books Some Aspects Of Non Equilibrium Thermody
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Some Aspects Of Non Equilibrium Thermody
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Some Aspects Of Non Equilibrium Thermody
 - Setting Reading Goals Some Aspects Of Non Equilibrium Thermody
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Some Aspects Of Non Equilibrium Thermody
 - Fact-Checking eBook Content of Some Aspects Of Non Equilibrium Thermody
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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