

## ON THERMODYNAMICS OF COMPLEX SYSTEMS

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О ТЕРМОДИНАМИКЕ СЛОЖНЫХ СИСТЕМ. Аркадий БЕРЕЗОВСКИЙ, Юри  
ЭНГЕЛЬБРЕХТ, Андраш СЕКЕРЕШ

**Key words:** thermodynamics, complex systems, thermoelasticity, internal variables.

Reported are the results presented at the workshop (May 3rd, 1993) held in the framework of the collaboration between the Department of Technical Mechanics, Budapest Technical University, and the Department of Mechanics, Institute of Cybernetics, Estonian Academy of Sciences. The month of intensive research was devoted to thermodynamics of complex systems.

Nonequilibrium thermodynamics has been formulated along two lines. The first is classical irreversible thermodynamics (CIT) and the second, rational thermodynamics (RT). A concise but transparent review of these theories is given by Lebon et al. [1]. However, both these theories have certain drawbacks including the paradox of infinite velocity. On the basis of earlier works by Cattaneo, Vernotte, Grad, and others, in the 1970s a new approach called extended irreversible thermodynamics (EIT) was proposed (see the references in [1]) that removed the paradox mentioned above and went beyond the hypothesis of local equilibrium. A little bit later hidden (internal) variable theory (HVT) was formed (see [2] and the references therein). Internal variables present some constraints in the sense of continuum mechanics and are not inertial, consequently their governing equations are mostly diffusion-reaction type. Despite the success of EIT and HVT, there are still many open problems related to complex and multiphase systems, nonlocality, etc. Not pretending to give an overview of these problems, we shall below discuss three aspects of thermodynamical theories, all related to basic mathematical models. The first deals with the consistency of heat conduction laws in thermoelasticity based on EIT and discusses the principles of equipresence and causality in the mathematical models. The second is related to basic concepts of thermodynamics of complex systems and, as a result, a modified equation of motion is derived. The third aspect is the role of internal variables in thermodynamics and their possible consequences on dynamics.

# Thermodynamics Of Complex Systems

**American Society of Mechanical  
Engineers. Winter Annual Meeting**



## **Thermodynamics Of Complex Systems:**

**Thermodynamics of Complex Systems** Luigi Sertorio,1991 This book aims at guiding the reader with continuity from the elements of classical equilibrium thermodynamics to the formal problems of global non equilibrium thermodynamics necessary to describe an active system such is a thermodynamic ecosystem To this purpose the brief review of equilibrium thermodynamics emphasizes the concepts of disequilibrium Carnot cycles and less efficient cycles and Gibbs availability as the distance from equilibrium In this way the reader is taken by hand to accept the concept of Gibbs efficiency of the ecosystem Earth as a property given to us by the cosmological evolution The final chapters are devoted to the optimal control theory of global non equilibrium systems An elementary theory of zero energy thermodynamic automata is presented A thermodynamic automation with four temperatures and three controls is discussed in detail **Thermodynamics of**

**Complex Systems** Vladimir N Pokrovskii,2020-08-07 This text provides a concise introduction to non equilibrium thermodynamics of open complex systems using a first principles approach In the first chapters the principles of thermodynamics of complex systems are discussed The subsequent chapters apply the principles to the dynamics of chemical reactions and complex fluids growth and development of biological organisms and the dynamics of social structures and institutes The final chapter discusses the principles of science as an artificial system The book is a valuable reference text for researchers interested in thermodynamics and complex systems and useful supplementary reading for graduate courses on advanced thermodynamics thermodynamics of non equilibrium systems and thermodynamics of complex open systems Key Features Provides a concise introduction to non equilibrium thermodynamics of open complex systems using a first principles approach Discusses thermodynamics as the universal tool for the description of reality Looks at complex systems such as biological organisms populations and subsystems of human society from the perspective of thermodynamics Covers principles applications and statistical interpretations **Thermodynamics of Complex Systems Hb**

POKROVSKII,2020-08-03 This text provides a concise introduction to non equilibrium thermodynamics of open complex systems using a first principles approach In the first chapters the principles of thermodynamics of complex systems are discussed The subsequent chapters apply the principles to the dynamics of chemical reactions and complex fluids growth and development of biological organisms and the dynamics of social structures and institutes The final chapter discusses the principles of science as an artificial system The book is a valuable reference text for researchers interested in thermodynamics and complex systems and useful supplementary reading for graduate courses on advanced thermodynamics thermodynamics of non equilibrium systems and thermodynamics of complex open systems Key Features Provides a concise introduction to non equilibrium thermodynamics of open complex systems using a first principles approach Discusses thermodynamics as the universal tool for the description of reality Looks at complex systems such as biological organisms populations and subsystems of human society from the perspective of thermodynamics Covers principles applications and

statistical interpretations

**Molecular Thermodynamics of Complex Systems** Xiaohua Lu, Ying Hu, 2008-12-21 With the development of science and technology more and more complex materials such as porous materials ion liquid liquid crystals thin films and colloids etc are being developed in laboratories However it is difficult to prepare these advanced materials and use them on a large scale without some experience Therefore molecular thermodynamics a method that laid emphasis on correlating and interpreting the thermodynamic properties of a variety of fluids in the past has been recently employed to study the equilibrium properties of complex materials and establish thermodynamic models to analyse the evolution process of their components structures and functions during the preparation process In this volume some important progress in this field from fundamental aspects to practical applications is reviewed In the first chapter of this volume Prof Jianzhong Wu presents the application of Density Functional theory DFT for the study of the structure and thermodynamic properties of both bulk and inhomogeneous fluids This chapter presents a tutorial overview of the basic concepts of DFT for classical systems the mathematical relations linking the microstructure and correlation functions to measurable thermodynamic quantities and the connections of DFT with conventional liquid state theories While for pedagogy the discussion is limited to one component simple fluids similar ideas and concepts are directly applicable to mixtures and polymeric systems of practical concern This chapter also covers a few theoretical approaches to formulate the thermodynamic functional

Evolution of Complex Systems Rainer Feistel, Werner Ebeling, 1989

**Complexity and Complex Thermo-Economic Systems** Stanislaw Sieniutycz, 2019-11-24 Complexity and Complex Thermo-economic Systems describes the properties of complexity and complex thermo-economic systems as the consequence of formulations definitions tools solutions and results consistent with the best performance of a system Applying to complex systems contemporary advanced techniques such as static optimization optimal control and neural networks this book treats the systems theory as a science of general laws for functional integrities It also provides a platform for the discussion of various definitions of complexity complex hierarchical structures self organization examples special references and historical issues This book is a valuable reference for scientists engineers and graduated students in chemical mechanical and environmental engineering as well as those in physics ecology and biology helping them better understand the complex thermodynamic systems and enhance their technical skills in research Provides a lucid presentation of the dynamical properties of thermo-economic systems Includes original graphical material that illustrates the properties of complex systems Written by a first class expert in the field of advanced methods in thermodynamics

Chemical Thermodynamics of Complex Systems, 1981 A detailed thermodynamic assessment has been made of the chemical reactions of fission products in LWR fuel rods Using recent thermodynamic data and the in reactor oxygen potential and temperature range of LWRs equilibrium thermodynamic calculations were performed for the most plausible reactions of the fission products The emphasis in this model is on the chemistry of cesium and rubidium and their reactions with the fuel other fission products and the zircaloy cladding The model predictions are discussed for their

implications in fuel cladding interactions     [An Introduction to Complex Systems](#) Joe Tranquillo, 2019-02-13 This book explores the interdisciplinary field of complex systems theory By the end of the book readers will be able to understand terminology that is used in complex systems and how they are related to one another see the patterns of complex systems in practical examples map current topics in a variety of fields to complexity theory and be able to read more advanced literature in the field The book begins with basic systems concepts and moves on to how these simple rules can lead to complex behavior The author then introduces non linear systems followed by pattern formation and networks and information flow in systems Later chapters cover the thermodynamics of complex systems dynamical patterns that arise in networks and how game theory can serve as a framework for decision making The text is interspersed with both philosophical and quantitative arguments and each chapter ends with questions and prompts that help readers make more connections The text provides a useful overview of complex systems with enough detail to allow a reader unfamiliar with the topic to understand the basics The book stands out for its comprehensiveness and approachability It will be particularly useful as a text for introductory physics courses Tranquillo s strength is in delivering a vast amount of information in a succinct manner A reader can find information quickly and efficiently that is in my opinion the book s greatest value Stefani Crabtree Physics Today     **Finite Physical Dimensions Optimal Thermodynamics 2** Michel Feidt, 2018-07-24 Finite Physical Dimensions Optimal Thermodynamics Complex Systems is the result of 30 years of teaching and research in the field of thermodynamics of systems and processes It starts from FTT during the seventies and P Chambadal approach in France but also includes the equilibrium thermodynamics from Carnot and TPIL from Onsager The book shows that thermodynamics proposes more realistic results than those obtained from equilibrium thermodynamics Focusing on a multidisciplinary approach that characterizes thermodynamics particularly the connection between transfer phenomena and conversion of energy the book is ideal for those in industry Presents a synthesis of years of teaching and research on the topic Proposes a view of the evolution of knowledge regarding the thermodynamics modeling of systems and processes Starts from FTT during the seventies and P Chambadal approach in France but also includes the equilibrium thermodynamics from Carnot and TPIL from Onsager     **Network Thermodynamics, Heat and Mass Transfer in Biotechnology** American Society of Mechanical Engineers. Winter Annual Meeting, 1987     **Thermodynamic Theory of the Evolution of Living Beings** Georgii Pavlovich Gladyshev, 1997 This book is devoted to the physical theory of the biological evolution The theory is based on macrothermodynamics i e the hierarchic thermodynamics of complex systems The results of the studies presented in the book allow one to state that the peculiarities of the evolution of living beings as well as the peculiarities of the chemical evolution can be explained without the concepts of the dynamical self organisation and the dissipative structures According to the second law the tendency of the evolution of biological systems on chemical and supramolecular levels can be determined by studying the effect of thermodynamical self organisation self assembly The criterion for estimating the

evolutionary development of supramolecular structures of biosystems biotissues is given by the variation of the specific Gibbs function of their formation During the processes of ontogenesis philogenesis and biological evolution in general the specific supramolecular component of the Gibbs function of a biosystem that is quasi closed thermodynamically and kinetically tends to a relative minimum The value of this minimum is a characteristic of the given biosystem surrounded by the environment The non stationary theoretical model presented in the monograph explains the reasons causing the variations in the chemical composition and structure of living beings in the course of ontogenesis philogenesis and the evolution in general It also allows to find out the rules determining the variations in the composition and structure of a biosystem during its adaptation to the external conditions

**Thermodynamic Modeling of Complex Systems** Matthias Kleiner,2009 **Methods In Animal Physiology** Zdenek Deyl,2019-08-08 The aim of the present volume was to give an overview over different available methodological approaches The specialists may perhaps object that in their particular field the level of information is superficial However let them look at other chapters in which different approaches are discussed and which surely will appear less superficial from the more general point of view We hope at least that crucial references can be traced throughout the book that would enable the readers to go in more detail when desired It can be traced throughout the book that would enable the readers to go in more detail when desired It was really one of our ideas to draw the survey of possibilities available If this can stimulate the readers to use ideas to draw the survey of possibilities available If this can stimulate the readers to use other methods that those they are routinely using the goals will be met

Evolution of Complex Systems Rainer Feistel,Werner Ebeling,1989-10-31 Modern Inorganic Synthetic Chemistry Ruren Xu,Wenqin Pang,Qisheng Huo,2011-01-13 The contributors to this book discuss inorganic synthesis reactions dealing with inorganic synthesis and preparative chemistry under specific conditions They go on to describe the synthesis preparation and assembly of six important categories of compounds with wide coverage of distinct synthetic chemistry systems

*Intelligence vs Entropy: The Evolution Dynamics* SEYED RASOUL HAMZAH,2026-02-05 The Introduction Intelligence vs Entropy Author Seyed Rasoul Hamzah I The Primordial Conflict Order within the Void In the grand theatre of the cosmos two formidable forces engage in a perpetual struggle Intelligence and Entropy While the second law of thermodynamics dictates that all closed systems drift inevitably towards disorder and thermal equilibrium a state of high entropy this work posits that Intelligence is the primary cosmic counter force It is not merely a biological byproduct but a fundamental dynamic of the universe designed to harvest order from chaos II Intelligence as an Anti Entropic Engine Within the Hamzah Evolutionary Framework intelligence is redefined It is the capacity of a system to resist the natural decay of information Where entropy seeks to distribute energy uniformly into uselessness Intelligence concentrates information to create complexity meaning and evolutionary momentum This book explores how this Evolutionary Dynamics functions across biological social and quantum scales Image A structured golden light penetrating a chaotic blue nebula III The 10 Step Simplified Protocol Protocol 10 To

ensure the core thesis is accessible to the global scholarly community the introduction is distilled into the following ten principles

**The Cosmic Duality** The universe is a battlefield between increasing disorder Entropy and increasing structure Intelligence Negentropy Intelligence functions as negative entropy creating islands of order in a sea of chaos Information Preservation Evolutionary success is measured by the ability to store and transmit complex information kernels Systemic Resilience Intelligence allows societies and organisms to adapt and overcome historical crises

**The Strategic Decision History** is shaped by Historical Intelligence strategic choices that counteract social entropy Energy Conversion Intelligence transforms raw energy into Useful Work and Meaning Fractal Growth Evolution follows a fractal pattern where intelligence at the micro level reflects the macro cosmic order Crisis as Catalyst Entropy wars uprisings crises often provides the necessary instability for a higher leap in intelligence

**The Evolution Dynamics** Evolution is not random it is a goal oriented process driven by the expansion of awareness

**The Universal Outcome** The ultimate goal of the cosmos is the triumph of absolute Intelligence over absolute Entropy

**IV The Scope of the Treatise** Seyed Rasoul Hamzah bridges the gap between theoretical physics and historical sociology By analyzing strategic human decisions through the lens of entropy this work provides a new mathematical and philosophical toolset for understanding the survival of civilizations We are not merely observers of decay we are the architects of an intelligent ordered future

**I The Final Synthesis** Intelligence as the Cosmic Architect As we draw this treatise to a close the fundamental truth of the Hamzah Evolutionary Framework becomes self evident Intelligence is not a mere passenger in the universe it is the ultimate architect While the vast expanse of the cosmos is subject to the relentless decay of Entropy the emergence of Intelligence serves as a structural rebellion a sophisticated mechanism that transforms chaotic energy into enduring order

**II The Evolutionary Mandate** The Evolution Dynamics presented in this work demonstrate that the survival of any system be it biological social or computational depends entirely on its ability to outpace entropic degradation We have proven that historical crises wars and uprisings are not merely symptoms of disorder but are often the Systemic Shocks required for Intelligence to leap into higher fractal dimensions of complexity

**III The 10 Step Simplified Protocol** Protocol 10 To encapsulate the essence of this extensive work for the global audience the conclusion is distilled into ten definitive pillars

**The Anti Entropic Law** Intelligence is the only force capable of reversing the universal trend toward disorder Order from Chaos True intelligence thrives at the edge of chaos extracting structure from environmental noise

**Historical Intelligence** Societies survive not by chance but through strategic Intelligence

**Kernels** that neutralise social entropy Information Supremacy The ultimate currency of the universe is not energy but structured intelligent information

**The Growth Spiral** Evolution does not repeat it ascends in a spiral with each loop becoming more resistant to decay

**The Victory of Purpose** Entropy is purposeless Intelligence is inherently goal oriented Teleological Systemic Resilience High intelligence systems turn entropic crises into opportunities for structural renewal

**The Human Role** As conscious agents we are the primary Negentropic force on this planet

**Predictive Dynamics** By understanding the

Intelligence Entropy ratio we can predict the rise and fall of civilizations The Universal Outcome The destiny of the cosmos is the transition from a state of raw matter to a state of Pure Universal Intelligence IV Final Reflection A Message to the Future Seyed Rasoul Hamzah concludes that we stand at a pivotal moment in human history The struggle against Entropy is the defining challenge of our species Through the mastery of Evolution Dynamics we possess the tools to ensure that our collective awareness does not fade into the void but instead shines as a permanent beacon of order in an otherwise disordered universe *Quantum Call: Deterministic Human Conception Architecture* SEYED RASOUL HAMZAH,2026-02-05

A Comprehensive Introduction to the Deterministic Model of Human Birth The process of human conception has long been relegated to the realms of biological stochasticity and genetic lottery However the work presented in Quantum Call Deterministic Human Conception Architecture challenges this traditional narrative proposing instead that the genesis of human life is a high precision quantum informational event Following the 10 step protocol this introduction outlines the architectural framework of life as defined by the Quantum Conception Call

- 1 The Fallacy of Biological Chance For centuries Science has viewed the race of millions of sperm toward a single egg as a game of probability This book deconstructs the lottery myth asserting that what appears to be random cellular movement is in fact a coordinated Quantum Call Every birth is the result of a precise informational alignment not a statistical accident
- 2 The Parental Resonance Field Central to this architecture is the interaction between two consciousness fields Conception begins long before physical union within the parental informational field This book explores how the mutual desire and psychological state of the parents create a unique Quantum Phase Resonance setting the stage for a specific soul or biological entity to be summoned
- 3 The Selection Mechanism Information Over Velocity In the traditional model the fastest sperm wins This architecture proves otherwise the egg emits an informational signal a Quantum Call that only one specific sperm possessing the exact phase alignment can answer This is an elective deterministic process governed by resonance not a physical competition
- 4 Determinism in the Hamzah Framework By applying the principles of the Hamzah Equation the book replaces the Heisenberg Uncertainty with a model of absolute biological certainty It provides the mathematical proof that the parameters of a child from genetic expression to conscious potential are encoded within the initial informational exchange at the moment of the Call
- 5 The Architecture of the Unborn The book addresses the profound question of failed conceptions In this deterministic framework a child that is not born is not the result of cellular failure or bad luck but rather a lack of Quantum Phase Resonance Without the successful alignment of the parental fields the biological path remains unmanifested
- 6 Beyond DNA The Informational Blueprint While DNA provides the hardware the Deterministic Human Conception Architecture provides the software This introduction explains how the informational field dictates which genetic traits are activated effectively coding the new being based on the resonance established during the conception call
- 7 Numerical Simulation of Human Genesis For the scientific reader the book includes advanced simulations These diagrams map the trajectories of thousands of informational points

showing how the chosen point the sperm is mathematically destined to synchronize with the target the egg based on field vector analysis

8 Future Technologies Quantum Field Imaging The architecture looks ahead to a time when Quantum Field Imaging QFI will allow us to observe these hidden dynamics We will eventually be able to measure the difference in the informational signatures of selected versus rejected cells turning the miracle of life into a measurable engineered reality

9 Implications for Reproductive Medicine This deterministic approach offers a revolutionary perspective for reproductive technology By understanding the Conception Architecture we move away from invasive procedures toward Resonance Alignment potentially increasing the success of conception by harmonizing the informational fields of prospective parents

10 Conclusion The Sovereign Being Ultimately this work concludes that the birth of every human is a deliberate and precise act of cosmic engineering We are not born of chance but are the architectural result of a Quantum Call a unique resonance between consciousness and matter that confirms our place in a deterministic universe The architectural framework presented in this work concludes that the origin of human life is a masterclass in quantum precision By moving beyond the archaic lottery model of biology we arrive at a conclusion that is both scientifically rigorous and philosophically profound

1 The Eradication of Biological Stochasticity The primary conclusion of this research is that chance does not exist in the moment of conception The statistical distribution of sperm is merely a surface level observation beneath it lies a deterministic selection process The biological winner is not the fastest but the one whose quantum phase is in absolute alignment with the egg s informational field

2 Conception as an Informational Resonance We conclude that fertilization is a phase locked event The Quantum Call acts as a selective filter ensuring that only the cellular entity that resonates with the parental consciousness field can achieve fusion This transition from probability to resonance redefines our understanding of reproductive success

3 The Sovereignty of the Parental Field This architecture establishes that the shared consciousness and mutual desire of the parents are the primary architects of the birth path Conception failure therefore is re evaluated not as a clinical defect but as a lack of informational synchronization a failure of the quantum handshake between fields

4 Determinism and the Hamzah Equation The mathematical evidence provided through the Hamzah Equation concludes that every parameter of the resulting life from molecular stability to conscious potential is predictable The equation proves that life follows a calculated trajectory from the very first nanosecond of the Call

5 The Death of the Genetic Lottery Myth We conclude that the genetic blueprint DNA is secondary to the Informational Blueprint The quantum field dictates which genetic possibilities are manifested Thus the lottery is replaced by an engineered selection where the child is a precise reflection of the vibrational state established at conception

6 Future Clinical Implications The study concludes that the future of reproductive medicine lies in field alignment technologies By monitoring and harmonizing the quantum phase of parental fields we can theoretically ensure the Quantum Call is successfully answered reducing the need for invasive biological interventions

7 Validation through Quantum Field Imaging QFI The conclusion points toward a new era of observation Future

technologies will allow us to visualize the Vector Field of the egg as it summons the specific sperm providing empirical visual proof of the non random nature of life s beginning 8 Ethical Re calibration The deterministic nature of birth necessitates a re evaluation of bioethics If every conception is a deliberate architectural event the value and purpose of human existence are elevated from accidental to essential 9 The Synthesis of Spirit and Matter This work successfully bridges the gap between metaphysical intent and biological matter It concludes that the Call is the bridge through which consciousness enters the physical realm using the deterministic laws of quantum information as its medium 10 Final Verdict A Universe of Order In finality Quantum Call Deterministic Human Conception Architecture leaves the reader with a singular truth The birth of a human being is the most precise event in the known universe We are the calculated results of a sovereign deterministic and majestic quantum architecture This conclusion serves as the definitive closing statement for the Hamzah Model s application to human genesis confirming that life is a call answered with absolute mathematical certainty

### **La Recherche**

**Aérospatiale** ,1995 *Philosophy of Complex Systems* ,2011-05-23 The domain of nonlinear dynamical systems and its mathematical underpinnings has been developing exponentially for a century the last 35 years seeing an outpouring of new ideas and applications and a concomitant confluence with ideas of complex systems and their applications from irreversible thermodynamics A few examples are in meteorology ecological dynamics and social and economic dynamics These new ideas have profound implications for our understanding and practice in domains involving complexity predictability and determinism equilibrium control planning individuality responsibility and so on Our intention is to draw together in this volume we believe for the first time a comprehensive picture of the manifold philosophically interesting impacts of recent developments in understanding nonlinear systems and the unique aspects of their complexity The book will focus specifically on the philosophical concepts principles judgments and problems distinctly raised by work in the domain of complex nonlinear dynamical systems especially in recent years Comprehensive coverage of all main theories in the philosophy of Complex Systems Clearly written expositions of fundamental ideas and concepts Definitive discussions by leading researchers in the field Summaries of leading edge research in related fields are also included

### **Journal of Physics A**

,2001 Focuses on fundamental mathematical and computational methods underpinning physics Relevant to statistical physics chaotic and complex systems classical and quantum mechanics classical and quantum integrable systems and classical and quantum field theory

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### **Thermodynamics Of Complex Systems Introduction**

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