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How Did Modern Global Symplectic Geometry Start?
Symplectic Geometry is a geometry where the fundamental notion is signed area, rather than length or distance as it occurs in metric geometry
A reversible T which preserves area on the disk without boundary has a fixed point.
We can associate AREA to a closed curve in the plane R?!
R2 skew-symmetric non-degenerate bilinear form
What are the machineries and useful concepts we do have?
A basic fact is that symplectic embedding obstructions are related to the dynamics on the boundary
If the squeezing is optimal we have to see a cross-section like this
Periodic orbits carry embedding obstructions. Holomorphic curves define relations
Symplectic Dynamics
The dynamics of X is embedded by: Plane spanned by an orbit
Let M be a star-shaped energy surface with non-degenerate periodic orbits
What kind of foliations can we construct?
Projected finite energy foliation and cross-section
The sequence (a) is a complete set of symplectic invariants for ellipsoids
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Elements of Topological Dynamics

This book is designed as an introduction into what I call 'abstract' Topological Dynamics (TO): the study of topological transformation groups with respect to problems that can be traced back to the qualitative theory of differential equa is in the tradition of the books [GH] and [EW. The title tions. So this book (‚Elements . . . ' rather than 'Introduction . . . ') does not mean that this book should be compared, either in scope or in (intended) impact, with the 'Ele ments' of Euclid or Bourbaki. Instead, it reflects the choice and organisation of the material in this book: elementary and basic (but sufficient to understand recent research papers in this field). There are still many challenging prob lems waiting for a solution, and especially among general topologists there is a growing interest in this direction. However, the technical inaccessability of many research papers makes it almost impossible for an outsider to under stand what is going on. To a large extent, this inaccessability is caused by the lack of a good and systematic exposition of the fundamental methods and techniques of abstract TO. This book is an attempt to fill this gap. The guiding principle for the organization of the material in this book has been the exposition of methods and techniques rather than a discussion of the leading problems and their solutions. though the latter are certainly not neglected: they are used as a motivation wherever possible.

Elements of Analytical Dynamics

Elements of Analytical Dynamics deals with dynamics, which studies the relationship between motion of material bodies and the forces acting on them. This book is a compilation of lectures given by the author at the Georgia and Institute of Technology and formed a part of a course in Topological Dynamics. The book begins by discussing the notions of space and time and their basic properties. It then discusses the Hamilton-Jacobi theory and Hamilton's principle and first integrals. The text concludes with a discussion on Jacobi's geometric interpretation of conservative systems. This book will be of direct use to graduate students of Mathematics with minimal background in Theoretical Mechanics.

The User's Approach to Topological Methods in 3D Dynamical Systems

This book presents the development and application of some topological methods in the analysis of data coming from 3D dynamical systems (or related objects). The aim is to emphasize the scope and limitations of the methods, what they provide and what they do not provide. Braid theory, the topology of surface homeomorphisms, data analysis and the reconstruction of phase-space dynamics are thoroughly addressed.

The General Topology of Dynamical Systems

Recent work in dynamical systems theory has both highlighted certain topics in the pre-existing subject of topological dynamics (such as the construction of Lyapunov functions and various notions of stability) and also generated new concepts and results. This book collects these results, both old and new, and organises them into a natural foundation for all aspects of dynamical systems theory.

Elements of Dynamical Systems

This book stems from lectures that were delivered at the three-week Advanced Instructional School on Ergodic Theory and Dynamical Systems held at the Indian Institute of Technology Delhi, from 4–23 December 2017, with the support of the National Centre for Mathematics, National Board for Higher Mathematics, Department of Atomic Energy, Government of India. The book discusses various aspects of dynamical systems. Each chapter of this book specializes in one aspect of dynamical systems and thus begins at an elementary level and goes on to cover fairly advanced material. The book helps researchers be familiar with and navigate through different parts of ergodic theory and dynamical systems.

Elements of Analytical Dynamics

This monograph aims to provide an advanced account of some aspects of dynamical systems in the framework of general topology, and is intended for use by interested graduate students and working mathematicians. Although some of the topics discussed are relatively new, others are not: this book is not a collection of research papers, but a textbook to present recent developments of the theory that could be the foundations for future developments. This book contains a new theory developed by the authors to deal with problems occurring in diffentiable dynamics that are within the scope of general topology. To follow it, the book provides an adequate foundation for topological theory of dynamical systems, and contains tools which are sufficiently powerful throughout the book. Graduate students

(and some undergraduates) with sufficient knowledge of basic general topology, basic topological dynamics, and basic algebraic topology will find little difficulty in reading this book.

Topological Theory of Dynamical Systems

In the long run of a dynamical system, after transient phenomena have passed away, what remains is recurrence. An orbit is recurrent when it returns repeatedly to each neighborhood of its initial position. We can sharpen the concept by insisting that the returns occur with at least some prescribed frequency. For example, an orbit lies in some minimal subset if and only if it returns almost periodically to each neighborhood of the initial point. That is, each return time set is a so-called syndetic subset ofT= the positive reals (continuous time system) or T = the positive integers (discrete time system). This is a prototype for many of the results in this book. In particular, frequency is measured by membership in a family of subsets of the space modeling time, in this case the family of syndetic subsets of T. In applying dynamics to combinatorial number theory, Furstenberg introduced a large number of such families. Our first task is to describe explicitly the calculus of families implicit in Furstenberg's original work and in the results which have proliferated since. There are general constructions on families, e. g. , the dual of a family and the product of families. Other natural constructions arise from a topology or group action on the underlying set. The foundations are laid, in perhaps tedious detail, in Chapter 2. The family machinery is then applied in Chapters 3 and 4 to describe family versions of recurrence, topological transitivity, distality and rigidity.

Recurrence in Topological Dynamics

In last thirty years an explosion of interest in the study of nonlinear dynamical systems occured. The theory of one-dimensional dynamical systems has grown out in many directions. One of them has its roots in the Sharkovski0 Theorem. This beautiful theorem describes the possible sets of periods of all cycles of maps of an interval into itself. Another direction has its main objective in measuring the complexity of a system, or the amount of chaos present in it. A good way of doing this is to compute topological entropy of the system. The aim of this book is to provide graduate students and researchers with a unified and detailed exposition of these developments for interval and circle maps. Many comments are added referring to related problems, and historical remarks are made. Request Inspection Copy

Topological Dynamics

This book is the first systematic treatment of the theory of topological dynamics of random dynamical systems. A relatively new field, the theory of random dynamical systems unites and develops the classical deterministic theory of dynamical systems and probability theory, finding numerous applications in disciplines ranging from physics and biology to engineering, finance and economics. This book presents in detail the solutions to the most fundamental problems of topological dynamics: linearization of nonlinear smooth systems, classification, and structural stability of linear hyperbolic systems. Employing the tools and methods of algebraic ergodic theory, the theory presented in the book has surprisingly beautiful results showing the richness of random dynamical systems as well as giving a gentle generalization of the classical deterministic theory.

Combinatorial Dynamics And Entropy In Dimension One

This book is devoted to group-theoretic aspects of topological dynamics such as studying groups using their actions on topological spaces, using group theory to study symbolic dynamics, and other connections between group theory and dynamical systems. One of the main applications of this approach to group theory is the study of asymptotic properties of groups such as growth and amenability. The book presents recently developed techniques of studying groups of dynamical origin using the structure of their orbits and associated groupoids of germs, applications of the iterated monodromy groups to hyperbolic dynamical systems, topological full groups and their properties, amenable groups, groups of intermediate growth, and other topics. The book is suitable for graduate students and researchers interested in group theory, transformations defined by automata, topological and holomorphic dynamics, and theory of topological groupoids. Each chapter is supplemented by exercises of various levels of complexity.

Topological Dynamics of Random Dynamical Systems

This volume consists of the written presentations of lectures given at two special sessions: the AMS Special Session on Topology in Dynamics (Winston-Salem, NC) and the AMS-AWM Special Session on Geometry in Dynamics (San Antonio, TX). Each article concerns aspects of the topology or geometry of dynamical systems. Topics covered include the following: foliations and laminations, iterated function systems, the three-body problem, isotopy stability, homoclinic tangles, fractal dimension, Morse homology, knotted orbits, inverse limits, contact structures, Grassmanians, blowups, and continua. New results are presented reflecting current trends in topological aspects of dynamical systems. The book offers a wide variety of topics of special interest to those working this area bridging topology and dynamical systems.

Groups and Topological Dynamics

This volume contains the proceedings of the conference Dynamics: Topology and Numbers, held from July 2–6, 2018, at the Max Planck Institute for Mathematics, Bonn, Germany.ÿ The papers cover diverse fields of mathematics with a unifying theme of relation to dynamical systems. These include arithmetic geometry, flat geometry, complex dynamics, graph theory, relations to number theory, and topological dynamics. The volume is dedicated to the memory of Sergiy Kolyada and also contains some personal accounts of his life and mathematics.

Geometry and Topology in Dynamics

This book collects the notes of the lectures given at an Advanced Course on Dynamical Systems at the Centre de Recerca Matemàtica (CRM) in Barcelona. The notes consist of four series of lectures. The first one, given by Andrew Toms, presents the basic properties of the Cuntz semigroup and its role in the classification program of simple, nuclear, separable C*-algebras. The second series of lectures, delivered by N. Christopher Phillips, serves as an introduction to group actions on C*-algebras and their crossed products, with emphasis on the simple case and when the crossed products are classifiable. The third one, given by David Kerr, treats various developments related to measure-theoretic and topological aspects of crossed products, focusing on internal and external approximation concepts, both for groups and C*-algebras. Finally, the last series of lectures, delivered by Thierry Giordano, is devoted to the theory of topological orbit equivalence, with particular attention to the classification of minimal actions by finitely generated abelian groups on the Cantor set.

Dynamics: Topology and Numbers

This volume presents a broad collection of current research by leading experts in the theory of dynamical systems.

Crossed Products of C*-Algebras, Topological Dynamics, and Classification

This book provides a broad introduction to the subject of dynamical systems, suitable for a one- or two-semester graduate course. In the first chapter, the authors introduce over a dozen examples, and then use these examples throughout the book to motivate and clarify the development of the theory. Topics include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics, one-dimensional dynamics, complex dynamics, and measure-theoretic entropy. The authors top off the presentation with some beautiful and remarkable applications of dynamical systems to such areas as number theory, data storage, and Internet search engines. This book grew out of lecture notes from the graduate dynamical systems course at the University of Maryland, College Park, and reflects not only the tastes of the authors, but also to some extent the collective opinion of the Dynamics Group at the University of Maryland, which includes experts in virtually every major area of dynamical systems.

Modern Dynamical Systems and Applications

Volumes 1A and 1B. These volumes give a comprehensive survey of dynamics written by specialists in the various subfields of dynamical systems. The presentation attains coherence through a major introductory survey by the editors that organizes the entire subject, and by ample cross-references between individual surveys. The volumes are a valuable resource for dynamicists seeking to acquaint themselves with other specialties in the field, and to mathematicians active in other branches of mathematics who wish to learn about contemporary ideas and results dynamics. Assuming only general mathematical knowledge the surveys lead the reader towards the current state of research in dynamics. Volume 1B will appear 2005.

Introduction to Dynamical Systems

Higher-order networks describe the many-body interactions of a large variety of complex systems, ranging from the the brain to collaboration networks. Simplicial complexes are generalized network structures which allow us to capture the combinatorial properties, the topology and the geometry of higher-order networks. Having been used extensively in quantum gravity to describe discrete or discretized space-time, simplicial complexes have only recently started becoming the representation of choice for capturing the underlying network topology and geometry of complex systems. This Element provides an in-depth introduction to the very hot topic of network theory, covering a wide range of subjects ranging from emergent hyperbolic geometry and topological data analysis to higher-order dynamics. This Elements aims to demonstrate that simplicial complexes provide a very general mathematical framework to reveal how higher-order dynamics depends on simplicial network topology and geometry.

Handbook of Dynamical Systems

This book is an introduction to the theory of calculus in the style of inquiry-based learning. The text guides students through the process of making mathematical ideas rigorous, from investigations and problems to definitions and proofs. The format allows for various levels of rigor as negotiated between instructor and students, and the text can be of use in a theoretically oriented calculus course or an analysis course that develops rigor gradually. Material on topology (e.g., of higher dimensional Euclidean spaces) and discrete dynamical systems can be used as excursions within a study of analysis or as a more central component of a course. The themes of bisection, iteration, and nested intervals form a common thread throughout the text. The book is intended for students who have studied some calculus and want to gain a deeper understanding of the subject through an inquiry-based approach.

Higher-Order Networks

Essentially a self-contained text giving an introduction to topological dynamics and ergodic theory.

Explorations in Analysis, Topology, and Dynamics: An Introduction to Abstract Mathematics

This book presents a panorama of recent developments in the theory of tilings and related dynamical systems. It contains an expanded version of courses given in 2017 at the research school associated with the Jean-Morlet chair program. Tilings have been designed, used and studied for centuries in various contexts. This field grew significantly after the discovery of aperiodic self-similar tilings in the 60s, linked to the proof of the undecidability of the Domino problem, and was driven futher by Dan Shechtman's discovery of quasicrystals in 1984. Tiling problems establish a bridge between the mutually influential fields of geometry, dynamical systems, aperiodic order, computer science, number theory, algebra and logic. The main properties of tiling dynamical systems are covered, with expositions on recent results in self-similarity (and its generalizations, fusions rules and S-adic systems), algebraic developments connected to physics, games and undecidability questions, and the spectrum of substitution tilings.

Dynamical Systems and Ergodic Theory

Both fractal geometry and dynamical systems have a long history of development and have provided fertile ground for many great mathematicians and much deep and important mathematics. This book offers an introduction to these two fields, with an emphasis on the relationship between them.

Substitution and Tiling Dynamics: Introduction to Self-inducing Structures

Elements of Differentiable Dynamics and Bifurcation Theory provides an introduction to differentiable dynamics, with emphasis on bifurcation theory and hyperbolicity that is essential for the understanding of complicated time evolutions occurring in nature. This book discusses the differentiable dynamics, vector fields, fixed points and periodic orbits, and stable and unstable manifolds. The bifurcations of fixed points of a map and periodic orbits, case of semiflows, and saddle-node and Hopf bifurcation are also elaborated. This text likewise covers the persistence of normally hyperbolic manifolds, hyperbolic sets, homoclinic and heteroclinic intersections, and global bifurcations. This publication is suitable for mathematicians and mathematically inclined students of the natural sciences.

Lectures on Fractal Geometry and Dynamical Systems

This book provides an introduction to the topological classification of smooth structurally stable diffeomorphisms on closed orientable 2- and 3-manifolds.The topological classification is one of the main problems of the theory of dynamical systems and the results presented in this book are mostly for dynamical systems satisfying Smale's Axiom A. The main results on the topological classification of discrete dynamical systems are widely scattered among many papers and surveys. This book presents these results fluidly, systematically, and for the first time in one publication. Additionally, this book discusses the recent results on the topological classification of Axiom A diffeomorphisms focusing on the nontrivial effects of the dynamical systems on 2- and 3-manifolds. The classical methods and approaches which are considered to be promising for the further research are also discussed.“br> The reader needs to be familiar with the basic concepts of the qualitative theory of dynamical systems which are presented in Part 1 for convenience. The book is accessible to ambitious undergraduates, graduates, and researchers in dynamical systems and low dimensional topology. This volume consists of 10 chapters; each chapter contains its own set of references and a section on further reading. Proofs are presented with the exact statements of the results. In Chapter 10 the authors briefly state the necessary definitions and results from algebra, geometry and topology. When stating ancillary results at the beginning of each part, the authors refer to other sources which are readily available.

Elements of Differentiable Dynamics and Bifurcation Theory

An Ellis semigroup is a compact space with a semigroup multiplication which is continuous in only one variable. An Ellis action is an action of an Ellis semigroup on a compact space such that for each point in the space the evaluation map from the semigroup to the space is continuous. At first the weak linkage between the topology and the algebra discourages expectations that such structures will have much utility. However, Ellis has demonstrated that these actions arise naturallyfrom classical topological actions of locally compact groups on compact spaces and provide a useful tool for the study of such actions. In fact, via the apparatus of the enveloping semigroup the classical theory of topological dynamics is subsumed by the theory of Ellis actions. The authors'exposition describes and extends Ellis' theory and demonstrates its usefulness by unifying many recently introduced concepts related to proximality and distality. Moreover, this approach leads to several results which are new even in the classical setup.

Dynamical Systems on 2- and 3-Manifolds

An accessible yet systematic account of reversibility that demonstrates its impact throughout many diverse areas of mathematics.

The Topological Dynamics of Ellis Actions

In 2003, Kechris, Pestov and Todorcevic showed that the structure of certain separable metric spaces--called ultrahomogeneous--is closely related to the combinatorial behavior of the class of their finite metric spaces. The purpose of the present paper is to explore different aspects of this connection.

Dynamical Systems: Stability Theory and Applications

A survey of some of the results, models, and problems of topological dynamics. For simplicity of presentation, attention is mostly confined to flows.

Reversibility in Dynamics and Group Theory

This book treats the theory of global attractors, a recent development in the theory of partial differential equations, in a way that also includes much of the traditional elements of the subject. As such it gives a quick but directed introduction to some fundamental concepts, and by the end proceeds to current research problems. Since the subject is relatively new, this is the first book to attempt to treat these various topics in a unified and didactic way. It is intended to be suitable for first year graduate students.

Structural Ramsey Theory of Metric Spaces and Topological Dynamics of Isometry Groups

The purpose of this work is to prove a theorem for topological entropy analogous to Ornstein's result for measure entropy. For this a natural class of dynamical systems is needed to play the same role for topological entropy as the Bernoulli shifts do for measure entropy. Fortunately there is just such a class--the topological Markov shifts. The main result of this paper is that topological entropy along with

another number, called the ergodic period, is a complete set of invariants under this new equivalence relation for the class of topological Markov shifts.

Minimal Sets

This book covers a new explanation of the origin of Hamiltonian chaos and its quantitative characterization. The author focuses on two main areas: Riemannian formulation of Hamiltonian dynamics, providing an original viewpoint about the relationship between geodesic instability and curvature properties of the mechanical manifolds; and a topological theory of thermodynamic phase transitions, relating topology changes of microscopic configuration space with the generation of singularities of thermodynamic observables. The book contains numerous illustrations throughout and it will interest both mathematicians and physicists.

Infinite-Dimensional Dynamical Systems

This book introduces the reader to the two main directions of one-dimensional dynamics. The first has its roots in the Sharkovskii theorem, which describes the possible sets of periods of all cycles (periodic orbits) of a continuous map of an interval into itself. The whole theory, which was developed based on this theorem, deals mainly with combinatorial objects, permutations, graphs, etc.; it is called combinatorial dynamics. The second direction has its main objective in measuring the complexity of a system, or the degree of “chaos” present in it; for that the topological entropy is used. The book analyzes the combinatorial dynamics and topological entropy for the continuous maps of either an interval or the circle into itself.

Topological Entropy and Equivalence of Dynamical Systems

This book is a very readable exposition of the modern theory of topological dynamics and presents diverse applications to such areas as ergodic theory, combinatorial number theory and differential equations. There are three parts: 1) The abstract theory of topological dynamics is discussed, including a comprehensive survey by Furstenberg and Glasner on the work and influence of R. Ellis. Presented in book form for the first time are new topics in the theory of dynamical systems, such as weak almost-periodicity, hidden eigenvalues, a natural family of factors and topological analogues of ergodic decomposition. 2) The power of abstract techniques is demonstrated by giving a very wide range of applications to areas of ergodic theory, combinatorial number theory, random walks on groups and others. 3) Applications to non-autonomous linear differential equations are shown. Exposition on recent results about Floquet theory, bifurcation theory and Lyapanov exponents is given.

Geometry and Topology in Hamiltonian Dynamics and Statistical Mechanics

This book is devoted to group-theoretic aspects of topological dynamics such as studying groups using their actions on topological spaces, using group theory to study symbolic dynamics, and other connections between group theory and dynamical systems. One of the main applications of this approach to group theory is the study of asymptotic properties of groups such as growth and amenability. The book presents recently developed techniques of studying groups of dynamical origin using the structure of their orbits and associated groupoids of germs, applications of the iterated monodromy groups to hyperbolic dynamical systems, topological full groups and their properties, amenable groups, groups of intermediate growth, and other topics. The book is suitable for graduate students and researchers interested in group theory, transformations defined by automata, topological and holomorphic dynamics, and theory of topological groupoids. Each chapter is supplemented by exercises of various levels of complexity.

Combinatorial Dynamics and Entropy in Dimension One

This book concerns areas of ergodic theory that are now being intensively developed. The topics include entropy theory (with emphasis on dynamical systems with multi-dimensional time), elements of the renormalization group method in the theory of dynamical systems, splitting of separatrices, and some problems related to the theory of hyperbolic dynamical systems. Originally published in 1993. The Princeton Legacy Library uses the latest print-on-demand technology to again make available previously out-of-print books from the distinguished backlist of Princeton University Press. These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions. The goal of the Princeton Legacy Library is to vastly increase access

to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905.

Topological Dynamics and Applications

This book deals with the dynamics of general systems such as foliations, groups and pseudogroups, systems which are closely related via the notion of holonomy. It concentrates on notions and results related to different ways of measuring complexity of systems under consideration. More precisely, it deals with different types of growth, entropies and dimensions of limiting objects. Problems related to the topics covered are provided throughout the book.

Groups and Topological Dynamics

Recent Advances in Topological Ferroics and Their Dynamics, Volume 70 in the Solid State Physics series, provides the latest information on the branch of physics that is primarily devoted to the study of matter in its solid phase, especially at the atomic level. This prestigious serial presents timely and state-of-the-art reviews pertaining to all aspects of solid state physics. Contains contributions from leading authorities in the study of solid state physics, especially at the atomic level Informs and updates on all the latest developments in the field Presents timely, state-of-the-art reviews pertaining to all aspects of solid state physics

Topics in Ergodic Theory (PMS-44), Volume 44

Topological Dynamics and Applications