

Physics As Spacetime Geometry

Suitable for advanced undergraduates and graduate students of mathematics as well as for physicists, this unique monograph and self-contained treatment constitutes an introduction to modern techniques in differential geometry. 1995 edition.

One of the most exciting aspects is the general relativity prediction of black holes and the Such Big Bang. predictions gained weight the theorems through Penrose. singularity pioneered In various by te- books on theorems general relativity singularity are and then presented used to that black holes exist and that the argue universe started with a To date what has big been is bang. a critical of what lacking analysis these theorems predict- ' We of really give a proof a typical singul- theorem and this use theorem to illustrate problems arising through the of possibilities violations" and "causality weak "shell very crossing These singularities". add to the problems weight of view that the point theorems alone singularity are not sufficient to the existence of predict physical singularities. The mathematical theme of the book In order to both solid gain a of and intuition understanding good for any mathematical theory, one, should to realise it as model of try a a fam- iar non-mathematical theories have had concept. Physical an especially the important on of and impact development mathematics, conversely various modern theories physical rather require sophisticated mathem- ics for their formulation. both and mathematics Today, physics are so that it is often difficult complex to master the theories in both very s- in the of jects. However, case differential pseudo-Riemannian geometry or the general relativity between and mathematics relationship physics is and it is therefore especially close, to from interd- possible profit an ciplinary approach.

Collaboration on the First Edition of Spacetime Physics began in the mid-1960s when Edwin Taylor took a junior faculty sabbatical at Princeton University where John Wheeler was a professor. The resulting text emphasized the unity of spacetime and those quantities (such as proper time, proper distance, mass) that are invariant, the same for all observers, rather than those quantities (such as space and time separations) that are relative, different for different observers. The book has become a standard introduction to relativity. The Second Edition of Spacetime Physics embodies what the authors have learned during an additional quarter century of teaching and research. They have updated the text to reflect the immense strides in physics during the same period and modernized and increased the number of exercises, for which the First Edition was famous. Enrichment boxes provide expanded coverage of intriguing topics. An enlarged final chapter on general relativity includes new material on gravity waves, black holes, and cosmology. The Second Edition of Spacetime Physics provides a new generation of readers with a deep and simple overview of the principles of relativity.

This book evaluates and suggests potentially critical improvements to causal set theory, one of the best-motivated approaches to the outstanding problems of fundamental physics. Spacetime structure is of central importance to physics beyond general relativity and the standard model. The causal metric hypothesis treats causal relations as the basis of this structure. The book develops the consequences of this hypothesis under the assumption of a fundamental scale, with smooth spacetime geometry viewed as

emergent. This approach resembles causal set theory, but differs in important ways; for example, the relative viewpoint, emphasizing relations between pairs of events, and relationships between pairs of histories, is central. The book culminates in a dynamical law for quantum spacetime, derived via generalized path summation.

Geometrical Physics in Minkowski Spacetime

Foundations of General Relativity and Differential Geometry

Flat Spacetime

An Introduction to Einstein's Theory

An Introduction to Spacetime Physics

Space Time Geometry and Quantum Events

Novel interpretation of the relationship between space, time, gravitation, and their cosmological implications; based on author's discovery of a value in gravitation overlooked by both Newton and Einstein. 1982 edition.

*Einstein's Special Theory of Relativity, first published in 1905, radically changed our understanding of the world. Familiar notions of space and time and energy were turned on their head, and our struggle with Einstein's counterintuitive explanation of these concepts was under way. The task is no easier today than it was a hundred years ago, but in this book Sander Bais has found an original and uniquely effective way to convey the fundamental ideas of Einstein's Special Theory. Bais's previous book, *The Equations*, was widely read and roundly praised for its clear and commonsense explanation of the math in physics. *Very Special Relativity* brings the same accessible approach to Einstein's theory. Using a series of easy-to-follow diagrams and employing only elementary high school geometry, Bais conducts readers through the quirks and quandaries of such fundamental concepts as simultaneity, causality, and time dilation. The diagrams also illustrate the difference between the Newtonian view, in which time was universal, and the Einsteinian, in which the speed of light is universal.*

Following Bais's straightforward sequence of simple, commonsense arguments, readers can tinker with the theory and its great paradoxes and, finally, arrive at a truly deep understanding of Einstein's interpretation of space and time. An intellectual journey into the heart of the Special Theory, the book offers an intimate look at the terms and ideas that define our reality.

The Springer Handbook of Spacetime is dedicated to the ground-breaking paradigm shifts embodied in the two relativity theories, and describes in detail the profound reshaping of physical sciences they ushered in. It includes in a single volume chapters on foundations, on the underlying mathematics, on physical and astrophysical implications, experimental evidence and cosmological predictions, as well as chapters on efforts to unify general relativity and quantum physics. The Handbook can be used as a desk reference by researchers in a wide variety of fields, not only by specialists in relativity but also by researchers in related areas that either grew out of, or are deeply influenced by, the two relativity theories: cosmology, astronomy and astrophysics, high energy physics, quantum field theory, mathematics, and philosophy of science. It should also serve as a valuable resource for graduate students and young researchers entering these areas, and for instructors who teach courses on these subjects. The Handbook is divided into six parts. Part A: Introduction to Spacetime Structure. Part B: Foundational Issues. Part C: Spacetime Structure and Mathematics. Part D: Confronting Relativity theories with observations. Part E:

General relativity and the universe. Part F: Spacetime beyond Einstein.

“General Relativity Without Calculus” offers a compact but mathematically correct introduction to the general theory of relativity, assuming only a basic knowledge of high school mathematics and physics. Targeted at first year undergraduates (and advanced high school students) who wish to learn Einstein’s theory beyond popular science accounts, it covers the basics of special relativity, Minkowski space-time, non-Euclidean geometry, Newtonian gravity, the Schwarzschild solution, black holes and cosmology. The quick-paced style is balanced by over 75 exercises (including full solutions), allowing readers to test and consolidate their understanding.

The Alfred Schild Lectures

The Geometry of Kerr Black Holes

Springer Handbook of Spacetime

Geometry of Minkowski Space-Time

Relativity and Geometry

General Relativity Without Calculus

Relativity and Geometry aims to elucidate the motivation and significance of the changes in physical geometry brought about by Einstein, in both the first and the second phases of relativity. The book contains seven chapters and a mathematical appendix. The first two chapters review a historical background of relativity. Chapter 3 centers on Einstein's first Relativity paper of 1905. Subsequent chapter presents the Minkowskian formulation of special relativity. Chapters 5 and 6 deal with Einstein's search for general relativity from 1907 to 1915, as well as some aspects and subsequent developments of the theory. The last chapter explores the concept of simultaneity, geometric conventionalism, and a few other questions concerning space time structure, causality, and time.

This book provides a working knowledge of those parts of exterior differential forms, differential geometry, algebraic and differential topology, Lie groups, vector bundles and Chern forms that are essential for a deeper understanding of both classical and modern physics and engineering. Included are discussions of analytical and fluid dynamics, electromagnetism (in flat and curved space), thermodynamics, the Dirac operator and spinors, and gauge fields, including Yang–Mills, the Aharonov–Bohm effect, Berry phase and instanton winding numbers, quarks and quark model for mesons. Before discussing abstract notions of differential geometry, geometric intuition is developed through a rather extensive introduction to the study of surfaces in ordinary space. The book is ideal for graduate and advanced undergraduate students of physics, engineering or mathematics as a course text or for self study. This third edition includes an overview of Cartan's exterior differential forms, which previews many of the geometric concepts developed in the text.

This book provides an original introduction to the geometry of Minkowski space-time. A hundred years after the space-time formulation of special relativity by Hermann Minkowski, it is shown that the kinematical consequences of special relativity are merely a manifestation of space-time geometry. The book is written with the intention of providing students (and teachers) of the first years of University courses with a tool which is easy to be applied and allows the solution of any problem of relativistic kinematics at the same time. The book treats in a rigorous way, but using a non-sophisticated mathematics, the Kinematics of Special Relativity. As an example, the famous "Twin Paradox" is

completely solved for all kinds of motions. The novelty of the presentation in this book consists in the extensive use of hyperbolic numbers, the simplest extension of complex numbers, for a complete formalization of the kinematics in the Minkowski space-time. Moreover, from this formalization the understanding of gravity comes as a manifestation of curvature of space-time, suggesting new research fields.

This small book started a profound revolution in the development of mathematical physics, one which has reached many working physicists already, and which stands poised to bring about far-reaching change in the future. At its heart is the use of Clifford algebra to unify otherwise disparate mathematical languages, particularly those of spinors, quaternions, tensors and differential forms. It provides a unified approach covering all these areas and thus leads to a very efficient 'toolkit' for use in physical problems including quantum mechanics, classical mechanics, electromagnetism and relativity (both special and general) – only one mathematical system needs to be learned and understood, and one can use it at levels which extend right through to current research topics in each of these areas. These same techniques, in the form of the 'Geometric Algebra', can be applied in many areas of engineering, robotics and computer science, with no changes necessary – it is the same underlying mathematics, and enables physicists to understand topics in engineering, and engineers to understand topics in physics (including aspects in frontier areas), in a way which no other single mathematical system could hope to make possible. There is another aspect to Geometric Algebra, which is less tangible, and goes beyond questions of mathematical power and range. This is the remarkable insight it gives to physical problems, and the way it constantly suggests new features of the physics itself, not just the mathematics. Examples of this are peppered throughout 'Space-Time Algebra', despite its short length, and some of them are effectively still research topics for the future. From the Foreward by Anthony Lasenby

The Geometry of Minkowski Spacetime

Spacetime and Geometry: An Introduction to General Relativity

Very Special Relativity

Differential Topology and Spacetime Models

Spacetime, Geometry and Gravitation

A College Course on Relativity and Cosmology

This book examines the geometrical notion of orthogonality, and shows how to use it as the primitive concept on which to base a metric structure in affine geometry. The subject has a long history, and an extensive literature, but whatever novelty there may be in the study presented here comes from its focus on geometries having lines that are self-orthogonal, or even singular (orthogonal to all lines). The most significant examples concern four-dimensional special-relativistic spacetime (Minkowskian geometry), and its various sub-geometries, and these will be prominent throughout. But the project is intended as an exercise in the foundations of geometry that does not presume a knowledge of physics, and so, in order to provide the appropriate intuitive background, an initial chapter has been included that gives a description of the different types of line (timelike, spacelike, lightlike) that occur in spacetime, and the physical meaning of the orthogonality relations that hold between them. The coordinatisation of affine spaces makes use of constructions from projective geometry, including standard results about the matrix representability of certain projective

transformations (involutions, polarities). I have tried to make the work sufficiently self contained that it may be used as the basis for a course at the advanced undergraduate level, assuming only an elementary knowledge of linear and abstract algebra.

Solutions and hints to selected exercises

This introductory textbook on the general theory of relativity presents a solid foundation for those who want to learn about relativity. The subject is presented in a physically intuitive, but mathematically rigorous style. The topic of relativity is covered in a broad and deep manner. Besides, the aim is that after reading the book a student should not feel discouraged when she opens advanced texts on general relativity for further reading. The book consists of three parts: An introduction to the general theory of relativity. Geometrical mathematical background material. Topics that include the action principle, weak gravitational fields and gravitational waves, Schwarzschild and Kerr solution, and the Friedman equation in cosmology. The book is suitable for advanced graduates and graduates, but also for established researchers wishing to be educated about the field.

From the reviews: "This attractive book provides an account of the theory of special relativity from a geometrical viewpoint, explaining the unification and insights that are given by such a treatment. [...] Can be read with profit by all who have taken a first course in relativity physics." ASLIB Book Guide

Asymptotic Behavior of Mass and Spacetime Geometry

Spacetime and Geometry

Spacetime And Geometry

Proceedings of the Conference Held at the Oregon State University, Corvallis, Oregon, USA, October 17-21, 1983

The Lanczos Tensor in Spacetime Geometry and the Canonical Formulation of General Relativity

Spinors and Space-Time: Volume 2, Spinor and Twistor Methods in Space-Time Geometry

Einstein's general theory of relativity is introduced in this advanced undergraduate textbook. Without an over emphasis on the difficult mathematics of tensor analysis, the book presents the curved spacetime theory of gravitation. The phenomena of gravitational light deflection, the precession of a planet's orbit, and black holes are discussed with technical detail. The book has an extensive treatment of cosmology from primordial inflation, cosmic microwavebackground to the dark energy that propels an accelerating universe. The book is the undergraduate edition of the author's previous work, Relativity, Gravitation and Cosmology: A Basic Introduction, published as part of the Oxford Master Series in Physics. This college edition concentrates on the core elements of the subject making it suitable for a one-semester course at the undergraduate level. It can also serve as an accessible introduction to general relativity and cosmology for those readers who want to study the subject on their own.

Provides the essential principles and results of special relativity as required by undergraduates. The text uses a geometric interpretation of space-time so that a general theory is seen as a natural extension of the special

theory. Although most results are derived from first principles, complex and distracting mathematics is avoided and all mathe

These reports, at the forefront of relativity theory when they were written, in particular the geometrical aspects of spacetime theory, were the result of the Alfred Schild Memorial Lecture Series presented at the University of Texas at Austin beginning in 1977. Each article is a self-contained summary of an important area of contemporary gravitational physics, while the book as a whole provides an overview of a wide variety of the problems of general relativity and gravitation.

"Wald's book is clearly the first textbook on general relativity with a totally modern point of view; and it succeeds very well where others are only partially successful. The book includes full discussions of many problems of current interest which are not treated in any extant book, and all these matters are considered with perception and understanding."—S. Chandrasekhar "A tour de force: lucid, straightforward, mathematically rigorous, exacting in the analysis of the theory in its physical aspect."—L. P. Hughston, Times Higher Education Supplement "Truly excellent. . . . A sophisticated text of manageable size that will probably be read by every student of relativity, astrophysics, and field theory for years to come."—James W. York, Physics Today

Spacetime Physics

A Geometric Approach

The Geometry of Physics

An Illustrated Guide

Relativity

The Geometry of Spacetime

The Geometry of Special Relativity provides an introduction to special relativity that encourages readers to see beyond the formulas to the deeper geometric structure. The text treats the geometry of hyperbolas as the key to understanding special relativity. This approach replaces the ubiquitous γ symbol of most standard treatments with the appropriate hyperbolic trigonometric functions. In most cases, this not only simplifies the appearance of the formulas, but also emphasizes their geometric content in such a way as to make them almost obvious. Furthermore, many important relations, including the famous relativistic addition formula for velocities, follow directly from the appropriate trigonometric addition formulas. The book first describes the basic physics of special relativity to set the stage for the geometric treatment that follows. It then reviews properties of ordinary two-dimensional Euclidean space, expressed in terms of the usual circular trigonometric functions, before

presenting a similar treatment of two-dimensional Minkowski space, expressed in terms of hyperbolic trigonometric functions. After covering special relativity again from the geometric point of view, the text discusses standard paradoxes, applications to relativistic mechanics, the relativistic unification of electricity and magnetism, and further steps leading to Einstein's general theory of relativity. The book also briefly describes the further steps leading to Einstein's general theory of relativity and then explores applications of hyperbola geometry to non-Euclidean geometry and calculus, including a geometric construction of the derivatives of trigonometric functions and the exponential function.

Einstein's General Theory of Relativity leads to two remarkable predictions: first, that the ultimate destiny of many massive stars is to undergo gravitational collapse and to disappear from view, leaving behind a 'black hole' in space; and secondly, that there will exist singularities in space-time itself. These singularities are places where space-time begins or ends, and the presently known laws of physics break down. They will occur inside black holes, and in the past are what might be construed as the beginning of the universe. To show how these predictions arise, the authors discuss the General Theory of Relativity in the large. Starting with a precise formulation of the theory and an account of the necessary background of differential geometry, the significance of space-time curvature is discussed and the global properties of a number of exact solutions of Einstein's field equations are examined. The theory of the causal structure of a general space-time is developed, and is used to study black holes and to prove a number of theorems establishing the inevitability of singularities under certain conditions. A discussion of the Cauchy problem for General Relativity is also included in this 1973 book.

Spacetime and Geometry: An Introduction to General Relativity provides a lucid and thoroughly modern introduction to general relativity for advanced undergraduates and graduate students. It introduces modern techniques and an accessible and lively writing style to what can often be a formal and intimidating subject. Readers are led from physics of flat spacetime (special relativity), through the intricacies of differential geometry and Einstein's equations, and on to exciting applications such as black holes, gravitational radiation, and cosmology. Subtle points are illuminated throughout the text by careful and entertaining exposition. A straightforward and lucid approach, balancing mathematical rigor and physical insight, are hallmarks of this important text. The full text downloaded to your computer With eBooks you

can: search for key concepts, words and phrases make highlights and notes as you study share your notes with friends eBooks are downloaded to your computer and accessible either offline through the Bookshelf (available as a free download), available online and also via the iPad and Android apps. Upon purchase, you'll gain instant access to this eBook. Time limit The eBooks products do not have an expiry date. You will continue to access your digital ebook products whilst you have your Bookshelf installed.

Differential geometry and topology have become essential tools for many theoretical physicists. In particular, they are indispensable in theoretical studies of condensed matter physics, gravity, and particle physics. Geometry, Topology and Physics, Second Edition introduces the ideas and techniques of differential geometry and topology at a level suitable for postgraduate students and researchers in these fields. The second edition of this popular and established text incorporates a number of changes designed to meet the needs of the reader and reflect the development of the subject. The book features a considerably expanded first chapter, reviewing aspects of path integral quantization and gauge theories. Chapter 2 introduces the mathematical concepts of maps, vector spaces, and topology. The following chapters focus on more elaborate concepts in geometry and topology and discuss the application of these concepts to liquid crystals, superfluid helium, general relativity, and bosonic string theory. Later chapters unify geometry and topology, exploring fiber bundles, characteristic classes, and index theorems. New to this second edition is the proof of the index theorem in terms of supersymmetric quantum mechanics. The final two chapters are devoted to the most fascinating applications of geometry and topology in contemporary physics, namely the study of anomalies in gauge field theories and the analysis of Polakov's bosonic string theory from the geometrical point of view. Geometry, Topology and Physics, Second Edition is an ideal introduction to differential geometry and topology for postgraduate students and researchers in theoretical and mathematical physics.

An Introduction

Foundations and Philosophy of Science and Technology Series

Geometry of Basic Physics

An Introduction to Special and General Relativity

Spacetime

Spacetime Geometry of the Kerr Metric

The recent revolution in differential topology related to the discovery of non-standard (OC exoticOCO) smoothness structures on topologically trivial manifolds such as R^4 suggests many exciting opportunities for applications of potentially deep importance for the spacetime models of theoretical physics, especially general relativity. This rich panoply of new differentiable structures lies in the previously unexplored region between topology and geometry. Just as physical geometry was thought to be trivial before Einstein, physicists have continued to work under the tacit OCo but now shown to be incorrect OCo assumption that differentiability is uniquely determined by topology for simple four-manifolds. Since diffeomorphisms are the mathematical models for physical coordinate transformations, EinsteinOCO's relativity principle requires that these models be physically inequivalent. This book provides an introductory survey of some of the relevant mathematics and presents preliminary results and suggestions for further applications to spacetime models."

This classic text and reference monograph applies modern differential geometry to general relativity. A brief mathematical introduction to gravitational curvature, it emphasizes the subject's geometric essence and stresses the global aspects of cosmology. Suitable for independent study as well as for courses in differential geometry, relativity, and cosmology. 1979 edition.

Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at students. Using a lucid style, Carroll first covers the foundations of the theory and mathematical formalism, providing an approachable introduction to what can often be an intimidating subject. Three major applications of general relativity are then discussed: black holes, perturbation theory and gravitational waves, and cosmology. Students will learn the origin of how spacetime curves (the Einstein equation) and how matter moves through it (the geodesic equation). They will learn what black holes really are, how gravitational waves are generated and detected, and the modern view of the expansion of the universe. A brief introduction to quantum field theory in curved spacetime is also included. A student familiar with this book will be ready to tackle research-level problems in gravitational physics.

The book aims to give a mathematical presentation of the theory of general relativity (that is, spacetime-geometry-based gravitation theory) to advanced undergraduate mathematics students. Mathematicians will find spacetime physics presented in the definition-theorem-proof format familiar to them. The given precise mathematical definitions of physical notions help avoiding pitfalls, especially in the context of spacetime physics describing phenomena that are counter-intuitive to everyday experiences. In the first part, the differential geometry of smooth manifolds, which is needed to present the spacetime-based gravitation theory, is developed

from scratch. Here, many of the illustrating examples are the Lorentzian manifolds which later serve as spacetime models. This has the twofold purpose of making the physics forthcoming in the second part relatable, and the mathematics learnt in the first part less dry. The book uses the modern coordinate-free language of semi-Riemannian geometry. Nevertheless, to familiarise the reader with the useful tool of coordinates for computations, and to bridge the gap with the physics literature, the link to coordinates is made through exercises, and via frequent remarks on how the two languages are related. In the second part, the focus is on physics, covering essential material of the 20th century spacetime-based view of gravity: energy-momentum tensor field of matter, field equation, spacetime examples, Newtonian approximation, geodesics, tests of the theory, black holes, and cosmological models of the universe. Prior knowledge of differential geometry or physics is not assumed. The book is intended for self-study, and the solutions to the (over 200) exercises are included.

Spacetime, Geometry, Cosmology

A Mathematical Introduction To General Relativity

Discrete Causal Theory

Emergent Spacetime and the Causal Metric Hypothesis

Orthogonality and Spacetime Geometry

Exotic Smoothness and Physics

Hermann Minkowski recast special relativity as essentially a new geometric structure for spacetime. This book looks at the ideas of both Einstein and Minkowski, and then introduces the theory of frames, surfaces and intrinsic geometry, developing the main implications of Einstein's general relativity theory.

Volume 2 introduces the theory of twistors and two-spinors and shows how it can be applied. Includes a comprehensive treatment of the conformal approach to space-time infinity with results on general relativistic mass and angular momentum.

This book continues the fundamental work of Arnold Sommerfeld and David Hestenes formulating theoretical physics in terms of Minkowski space-time geometry. We see how the standard matrix version of the Dirac equation can be reformulated in terms of a real space-time algebra, thus revealing a geometric meaning for the "number i" in quantum mechanics. Next, it is examined in some detail how electroweak theory can be integrated into the Dirac theory and this way interpreted in terms of space-time geometry. Finally, some implications for quantum electrodynamics are considered. The presentation of real quantum electromagnetism is expressed in an addendum. The book covers both the use of the complex and the real

languages and allows the reader acquainted with the first language to make a step by step translation to the second one.

In this concise primer it is shown that, with simple diagrams, the phenomena of time dilatation, length contraction and Lorentz transformations can be deduced from the fact that in a vacuum one cannot distinguish physically straight and uniform motion from rest, and that the speed of light does not depend on the speed of either the source or the observer. The text proceeds to derive the important results of relativistic physics and to resolve its apparent paradoxes. A short introduction into the covariant formulation of electrodynamics is also given. This publication addresses, in particular, students of physics and mathematics in their final undergraduate year.

The Geometry of Special Relativity

The Large Scale Structure of Space-Time

Elementary Theory

An Introduction to the Mathematics of the Special Theory of Relativity

Pearson New International Edition

General Relativity

Spacetime and Geometry Cambridge University Press

This unique book presents a particularly beautiful way of looking at special relativity. The author encourages students to see beyond the formulas to the deeper structure. The unification of space and time introduced by Einstein's special theory of relativity is one of the cornerstones of the modern scientific description of the universe. Yet the unification is counterintuitive because we perceive time very differently from space. Even in relativity, time is not just another dimension, it is one with different properties. The book treats the geometry of hyperbolas as the key to understanding special relativity. The author simplifies the formulas and emphasizes their geometric content. Many important relations, including the famous relativistic addition formula for velocities, then follow directly from the appropriate (hyperbolic) trigonometric addition formulas. Prior mastery of (ordinary) trigonometry is sufficient for most of the material presented, although occasional use is made of elementary differential calculus, and the chapter on electromagnetism assumes some more advanced knowledge. Changes to the Second Edition The treatment of Minkowski space and spacetime diagrams has been expanded. Several new topics have been added, including a geometric derivation of Lorentz transformations, a discussion of three-dimensional spacetime diagrams, and a brief geometric description of "area" and how it can be used to measure time and distance. Minor notational changes were made to avoid conflict with existing usage in the literature. Table of Contents Preface 1. Introduction. 2. The Physics of Special Relativity. 3. Circle Geometry. 4. Hyperbola Geometry. 5. The Geometry of Special Relativity. 6. Applications. 7. Problems III. 8. Paradoxes. 9. Relativistic Mechanics. 10. Problems II. 11. Relativistic Electromagnetism. 12. Problems III. 13. Beyond Special Relativity. 14. Three-Dimensional Spacetime Diagrams. 15. Minkowski Area via Light Boxes. 16. Hyperbolic Geometry. 17. Calculus. Bibliography. Author Biography Tevian Dray is a Professor of Mathematics at Oregon State University. His research lies at the interface between mathematics and physics, involving differential geometry and general relativity, as well as nonassociative algebra and particle physics; he also studies student understanding of "middle-division" mathematics and physics content. Educated at MIT and Berkeley, he held postdoctoral positions in both mathematics and physics in several countries prior to coming to OSU in 1988. Professor Dray is a Fellow of the American Physical Society for his work in relativity, and an award-winning teacher.

This mathematically rigorous treatment examines Zeeman's characterization of the causal automorphisms of Minkowski spacetime and the Penrose theorem concerning the apparent shape of a relativistically moving sphere. Other topics include the construction of a geometric theory of the electromagnetic field; an in-depth introduction to the theory of spinors; and a classification of electromagnetic fields in both tensor and spinor form. Appendixes introduce a topology for Minkowski spacetime and discuss Dirac's famous "Scissors Problem." Appropriate for graduate-level courses, this text presumes only a knowledge of linear algebra and elementary point-set topology. 1992 edition. 43 figures.

It is well-known that the fundamental problem in contemporary theoretical physics is the "pacific coexistence" between General Relativity and Quantum Mechanics. The scenarios of the explorable relationships between classical space-time and quantum land are various: the geometrodynamical one (by a proper extension of geometry), the stochastic fractal one (defining a middle land mediated by QFT-like hypotheses), the emergent one (from a physical viewpoint, by the collective behaviours of discrete entities, which mathematically means that the geometry derives from an algebraic structure of events). This anthology includes some of the most significant voices on the problem of the possible relations between the space-time dynamics and the quantum networks of events.

Quantum Mechanics in the Geometry of Space-Time

A Concise Introduction to the Geometry of Relativity

The Geometry of Special Relativity - a Concise Course

Gravitational Curvature

Geometry, Topology and Physics

Space-Time Algebra