Space Time And Geometry

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Orthogonality and Spacetime Geometry

PHOEBE CAMERON

Einstein's Space-Time Springer Science & Business Media
This book describes the growth of our understanding of gravity and the science on which it is based, from the early Greeks to Einstein's grand insights of curved space-time. Showing that science searches for the ultimate roots of natural phenomena and therefore pursues a kind of mysticism, the mysteries it unfolds are strange and enthralling.
Relativity American Mathematical Soc.
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 geometrodynamic 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.
Differential Geometry and Relativity Theory Springer Science & Business Media
This volume provides a detailed discussion of the mathematical aspects and physical

applications of a new geometrical structure of space-time, based on a generalization ("deformation") of the usual Minkowski space, as supposed to be endowed with a metric whose coefficients depend on the energy. This new five-dimensional scheme (Deformed Relativity in Five Dimensions, DR5) represents a true generalization of the usual Kaluza-Klein (KK) formalism.

Spacetime and Geometry Springer Science & Business Media

A description of the geometry of space-time with all the questions and issues explained without the need for formulas. As such, the author shows that this is indeed geometry, with actual constructions familiar from Euclidean geometry, and which allow exact demonstrations and proofs. The formal mathematics behind these constructions is provided in the appendices. The result is thus not a textbook introducing readers to the theory of special relativity so they may calculate formally, but rather aims to show the connection with synthetic geometry. It presents the relation to projective geometry and uses this to illustrate the starting points of general relativity. Written at an introductory level for undergraduates, this novel presentation will also benefit teaching staff.

Geometrical Physics in Minkowski Spacetime Cambridge University Press

This book introduces advanced undergraduates to Riemannian geometry and mathematical general relativity. The overall strategy of the book is to explain the concept of curvature via the Jacobi equation which, through discussion of tidal forces, further helps motivate the Einstein field equations. After addressing concepts in geometry such as metrics, covariant differentiation, tensor calculus and curvature, the book explains the mathematical framework for both special and general relativity. Relativistic concepts discussed include (initial value formulation of) the Einstein equations, stress-energy tensor, Schwarzschild space-time, ADM mass and geodesic incompleteness. The concluding chapters of the book introduce the reader to geometric analysis: original results of the author and her undergraduate student collaborators illustrate how methods of analysis and differential equations are used in addressing questions from geometry and relativity. The book is mostly self-contained and the reader is only expected to have a solid foundation in multivariable and vector calculus and linear algebra. The material in this book was first developed for the 2013 summer program in geometric analysis at the Park City Math Institute, and was recently modified and expanded to reflect the author's experience of teaching mathematical general relativity to advanced undergraduates at Lewis & Clark College.

Space-Time Geometries for Motion and Perception in the Brain and the Arts Springer Science & Business Media

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 focus of the book is on geometries having lines which are self-orthogonal, or even singular (orthogonal to all lines). The most significant examples concern the four-dimensional spacetime of special relativity, however no knowledge of physics is presumed. An initial chapter has been included which explains the physical interpretation of the different orthogonality relations. The mathematical background needed is basic abstract and linear algebra.

Space-Time Algebra Oxford University Press on Demand

This excellent textbook offers a unique take on relativity theory, setting it in its historical context. Ideal for those interested in relativity and the history of physics, the book contains a complete account of special relativity that begins with the historical analysis of the reasons that led to a change in our view of space and time. Its aim is to foster a deep understanding of relativistic spacetime and its consequences for Dynamics.

Geometry of Minkowski Space-Time Cambridge University Press

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

Spacetime, Geometry and Gravitation Springer Science & Business Media

This book is based on a two-day symposium at the Paris Institute of Advanced Study titled "space-time geometries and movement in the brain and the arts". It includes over 20 chapters written by the leading scientists and artists who presented their related research studies at the symposium and includes six sections; the first three focus on space-time geometries in perception, action and memory while the last three focus on specific artistic domains: drawing and painting, dance, music, digital arts and robotics. The book is accompanied by a dedicated webpage including related images and videos. There is an ever-growing interest in the topics covered by this book. Space and time are of fundamental importance for our understanding of human perception, action, memory and cognition, and are entities which are equally important in physics, biology, neuroscience and psychology. Highly prominent scientists and mathematicians have expressed their belief that our bodies and minds shape the ways we perceive space and time and the physical laws we formulate. Understanding how the brain perceives motion and generates -bodily movements is of great significance. There is also growing interest in studying how space, time and movement subserve artistic creations in different artistic modalities (e.g., fine arts, digital and performing arts and music). This interest is inspired by the idea that artists make intuitive use of the principles and simplifying strategies used by the brain in movement generation and perception. Building upon new understanding of the spatio-temporal geometries subserving movement generation and perception by the brain we can start exploring how artists make use of such neuro --geometrical and neuro-dynamic representations in order to express artistic concepts and emotionally affect the human observers and listeners. Scientists have also started formulating new ideas of how aesthetic judgements emerge from the principles and brain mechanisms subserving motor control and motion perception. Covering novel and multidisciplinary topics, this advanced book will be of interest to neuroscientists, behavioral scientists, artificial intelligence and robotics experts, students and artists.

The Large Scale Structure of Space-Time Courier Dover Publications
Einstein's theory of general relativity is a theory of gravity and, as in the earlier Newtonian theory, much can be learnt about the character of gravitation and its effects by investigating particular idealised examples. This book describes the basic solutions of Einstein's equations with a particular emphasis on what they mean, both geometrically and physically. Concepts such as big bang and big crunch-types of singularities, different kinds of horizons and gravitational waves, are described in the context of the particular space-times in which they naturally arise. These notions are initially introduced using the most simple and symmetric cases. Various important coordinate forms of each solution are presented, thus enabling the global structure of the corresponding space-time and its other properties to be analysed. The book is an invaluable resource both for graduate students and academic researchers working in gravitational physics.

The Geometry of Minkowski Spacetime Mohamed Haj Yousef
The articles in this volume have been stimulated in two different ways. More than two years ago the editor of Synthese, laakko Hintikka, an nounced a special issue devoted to space and time, and articles were solicited. Part of the reason for that announcement was also the second source of papers. Several years ago I gave a seminar on special relativity at Stanford, and the papers by Domotor, Harrison, Hudgin, Latzer and myself partially arose out of discussion in that seminar. All of the papers except those of Griinbaum, Fine, the second paper of Friedman, and the paper of Adams appeared in a special double issue of Synthese (24 (1972), Nos. 1-2). I am pleased to have been able to add the four additional papers mentioned in making the special issue a volume in the Synthese Library. Of these four additional articles, only the one by Fine has pre viously appeared in print (Synthese 22 (1971),448--481); its relevance to the present volume is apparent. In preparing the papers for publication and in carrying

out the various editorIal chores of such a task, I am very much indebted to Mrs. Lillian O'Toole for her extensive assistance. INTRODUCTION The philosophy of space and time has been of permanent importance in philosophy, and most of the major historical figures in philosophy, such as Aristotle, Descartes and Kant, have had a good deal to say about the nature of space and time.

The Geometry of Special Relativity Springer

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.

The Biggest Ideas in the Universe Univ of California Press

This book consists of two lecture notes on geometric flow equations (O. Schnürer) and Lorentzian geometry - holonomy, spinors and Cauchy Problems (H. Baum and T. Leistner) written by leading experts in these fields. It grew out of the summer school “Geometric flows and the geometry of space-time” held in Hamburg (2016) and provides an excellent introduction for students of mathematics and theoretical physics to important themes of current research in global analysis, differential geometry and mathematical physics

The Large Scale Structure of Space-Time University of Texas Press

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.

General Relativity CRC Press

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

Geometric Flows and the Geometry of Space-time Courier Corporation

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.

Duality of Time Springer Nature

The Duality of Time Theory is the result of more than two decades of ceaseless investigation and searching through ancient manuscripts of concealed philosophies and mystical traditions, comparing all that with the fundamental results of modern physics and cosmology, until all the contradicting jigsaw pieces were put together into this brilliant portrait. Without the overwhelming proofs and strong confirmations that accumulated over time, it would have been impossible to pursue this long research path, as it was extremely challenging to appreciate the unfathomable secret of time and the consequences of the ongoing perpetual creation of space, that result from the Single Monad Model of the Cosmos. The complex-time geometry of the Duality of Time Theory explains how the physical dimensions of space are sequentially being re-created in the inner levels of time, which makes the outward time genuinely imaginary with respect to the inner real levels. This is easily expressed in terms of the hyperbolic split-complex numbers, that characterize the Relativistic Lorentzian Symmetry. This will have deep implications because space-time has become naturally quantized in a way that explains and unites all the three principles of Relativity, leading to full Quantum Field Theory of Gravity, as well as explaining all the other fundamental interactions in terms of the new granular space-time geometry. This ultimate unification will solve many persisting problems in physics and cosmology. The homogeneity problem, for example, will instantly cease, since the Universe, no matter how large it could be, is re-created sequentially in the inner time, so all the states are updated and synchronized before they appear in the outer level that we encounter. Furthermore, the Duality of Time does not only unify all the fundamental interactions in terms of its genuinely-complex time-time geometry, but it unifies this whole physical world with the two other even more fundamental domains of the psychical and spiritual worlds. All these three conclusive and complementary realms are constructed on the same concept of space-time geometry that together form one single absolute and perfectly symmetrical space. This particular subject is treated at length in the Third Volume of this book series - the Ultimate Symmetry, which explores how the apparent physical and metaphysical multiplicity is emerging from the absolute Oneness of Divine Presence, descending through four fundamental levels of symmetry: ultimate, hyper, super and normal. Among many other astonishing consequences, this astounding conclusion means that the psychical world is composed of atoms and molecules that are identical with the physical world except that they are evolving in orthogonal time direction. It may appear initially impossible to believe how the incorporeal worlds may have the same atomic structure as the physical world, but it is more appropriate to say that physical structures are eventually incorporeal, because they become various wave phenomena and energy interactions as soon as we dive into their microscopic level, as it is now confirmed by Quantum Field Theories. In the Duality of Time Theory, since rigid space is created sequentially in the inner time, energy may become negative, imaginary and even multidimensional, which simply means that all things in creation are various kinds of energy moments that are spreading on different intersecting dimensions of time; so not only mass and energy are equivalent, but also charge and all other physical and metaphysical entities are interconvertible types of energy, including consciousness and information.

Spacetime Clarendon Press

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.

Exact Space-Times in Einstein's General Relativity Elsevier

In the two volumes that comprise this work Roger Penrose and Wolfgang Rindler introduce the calculus of 2-spinors and the theory of twistors, and discuss in detail how these powerful and elegant methods may be used to elucidate the structure and properties of space-time. In volume 1, Two-spinor calculus and relativistic fields, the calculus of 2-spinors is introduced and developed. Volume 2, Spinor and twistor methods in space-time geometry, introduces the theory of twistors, and studies in detail how the theory of twistors and 2-spinors can be applied to the study of space-time. This work will be of great value to all those studying relativity, differential geometry, particle physics and quantum field theory from beginning graduate students to experts in these fields.

Quantum Mechanics in the Geometry of Space-Time Cambridge University Press
In this book, Lawrence Sklar demonstrates the interdependence of science and philosophy by examining a number of crucial problems on the nature of space and time—problems that require for their resolution the resources of philosophy and of physics. The overall issues explored are our knowledge of the geometry of the world, the existence of spacetime as an entity over and above the material objects of the world, the relation between temporal order and causal order, and the problem of the direction of time. Without neglecting the most subtle philosophical points or the most advanced contributions of contemporary physics, the author has taken pains to make his explorations intelligible to the reader with no advanced training in physics, mathematics, or philosophy. The arguments are set forth step-by-step, beginning from first principles; and the philosophical discussions are supplemented in detail by nontechnical expositions of crucial features of physical theories.