The Geometry Of Special Relativity

The Geometry of Spacetime
The Special Theory of Relativity
Relativity and Geometry
The Geometry of Special Relativity
Flat and Curved Space-times
Hyperbolic Triangle Centers
The Geometry of Special Relativity
Einstein, 1905-2005
A Mathematical Journey to Relativity
The Geometry of Physics
Relativität, Gruppen, Teilchen
Relativity: An Introduction to the Special Theory
Geometry: from Isometries to Special Relativity
Geometry of Minkowski Space-Time
The Geometry of Special Relativity - a Concise Course
An Introduction to General Relativity
A Mathematical Introduction To General Relativity

Die spezielle Relativitätstheorie
Geometrical Physics in Minkowski Spacetime
Analytic Hyperbolic Geometry and Albert Einstein's Special Theory of Relativity
General Relativity Without Calculus
The Geometry of Special Relativity
Energy and Geometry
Geometry, Symmetry and Locality in the Philosophy of Special Relativity
Geometry of Special Relativity
Differential Geometry and Relativity Theory
The Geometry of Spacetime
Space, Time, and Geometry
Relativitätstheorie
The Geometry of Minkowski Spacetime
Very Special Relativity
Spacetime and Geometry
Die Relativitätstheorie Einsteins
Relativity
The Geometry of Time
The Special Theory of Relativity
The Mathematics of Minkowski Space-Time

Differential Forms and the Geometry of General Relativity
The Special Theory of Relativity for Mathematics Students

ZION MELENDEZ

The Geometry of Spacetime Springer Science & Business Media
Special Relativity (SR) is essentially grounded on the properties of space-time, i.e. isotropy of space and homogeneity of space and time (as a consequence of the equivalence of inertial frames) and on the Galilei principle of relativity.
The Special Theory of Relativity Springer Nature
An accessible introductory textbook on general relativity, covering the theory's foundations, mathematical formalism and major applications.
Relativity and Geometry Springer Nature
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
The Geometry of Special Relativity Springer Nature
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.

Flat and Curved Space-times World Scientific

More emphasis is placed on an intuitive grasp of the subject and calculational facility than on rigorous exposition in this introduction to general relativity for mathematics undergraduates or graduate physicists.

Hyperbolic Triangle Centers World Scientific

This book opens with an axiomatic description of Euclidean and non-Euclidean geometries. Euclidean geometry is the starting point to understand all other geometries and it is the cornerstone for our basic intuition of vector spaces. The generalization to non-Euclidean geometry is the following step to develop the language of Special and General Relativity. These theories are discussed starting from a full geometric point of view. Differential geometry is presented in the simplest way and it is applied to describe the physical world. The final result of this construction is deriving the Einstein field equations for gravitation and spacetime dynamics. Possible solutions, and their physical implications are also discussed: the Schwarzschild metric, the relativistic trajectory of planets, the deflection of light, the black holes, the cosmological solutions like de Sitter, Friedmann-Lemaître-Robertson-Walker, and Gödel ones. Some current problems like dark energy are also scketched. The book is self-contained and includes details of all proofs. It provides solutions or tips to solve problems and exercises. It is designed for undergraduate students and for all readers who want a first geometric approach to Special and General Relativity.

The Geometry of Special Relativity

Vieweg+Teubner Verlag

The present book explains special relativity and the basics of general relativity from a geometric viewpoint. Space-time geometry is emphasized throughout, and provides the basis of understanding of the special relativity effects of time dilation, length contraction, and the relativity of simultaneity. Bondi's K-calculus is introduced as a simple means of calculating the magnitudes of these effects, and leads to a derivation of the Lorentz transformation as a way of unifying these results. The invariant interval of flat space-time is generalised to that of curved space-times, and leads to an understanding of the basic properties of simple cosmological

models and of the collapse of a star to form a black hole. The appendices enable the advanced student to master the application of four-tensors to the relativistic study of energy and momentum, and of electromagnetism. In addition, this new edition contains up-to-date information on black holes, gravitational collapse, and cosmology.
Einstein, 1905-2005 Springer Science & Business Media
Geometry of Special RelativityBy Norbert Dragon
A Mathematical Journey to Relativity
Springer-Verlag
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. *The Geometry of Physics* Springer Nature After A. Ungar had introduced vector algebra and Cartesian coordinates into hyperbolic geometry in his earlier books, along with novel applications in Einstein’s special theory of relativity, the purpose of his new book is to introduce hyperbolic barycentric coordinates, another important concept to embed Euclidean geometry into hyperbolic geometry. It will be demonstrated that, in full analogy to classical mechanics where barycentric coordinates are related to the Newtonian mass, barycentric coordinates are related to the Einsteinian relativistic mass in hyperbolic geometry. Contrary to general belief, Einstein’s relativistic mass hence meshes up extraordinarily well with Minkowski’s four-vector formalism of special relativity. In Euclidean geometry, barycentric coordinates can be used to determine various triangle centers. While there are many known Euclidean triangle centers, only few hyperbolic triangle centers are known, and none of the known hyperbolic triangle centers has been determined analytically with respect to its hyperbolic triangle vertices. In his recent research, the author set the ground for investigating hyperbolic triangle centers via hyperbolic barycentric coordinates, and one of the purposes of this book is to initiate a study of hyperbolic triangle centers in full analogy with the rich study of Euclidean triangle centers. Owing to its novelty, the book is aimed at a large audience: it can be enjoyed equally by upper-level undergraduates, graduate students, researchers and academics in geometry, abstract algebra, theoretical physics and astronomy. For a fruitful reading of this book, familiarity with Euclidean geometry is assumed. Mathematical-physicists and theoretical physicists are likely to enjoy the study of Einstein’s special relativity in terms of its underlying hyperbolic geometry. Geometers may enjoy the hunt for new hyperbolic triangle centers and, finally, astronomers may use hyperbolic barycentric coordinates in the velocity space of cosmology.

Relativität, Gruppen, Teilchen Wiley-VCH This textbook expounds the major topics in the special theory of relativity. It provides a detailed examination of the mathematical foundation of the special theory of relativity, relativistic mass, relativistic mechanics, and relativistic electrodynamics. As well as covariant formulation of relativistic mechanics and electrodynamics, the text discusses the relativistic effect on photons. A new chapter on electromagnetic waves as well as several new problems and examples have been included in the second edition of the book. Using the mathematical approach, the text offers graduate students a clear, concise view of the special theory of relativity. Organized into 15 chapters and two appendices, the content is presented in a logical order, and every topic has been dealt with in a simple and lucid manner. To aid understanding of the subject, the text provides numerous relevant worked-out examples in every chapter. The mathematical approach of the text helps students in their independent study and motivates them to research the topic further.

Relativity: An Introduction to the Special Theory World Scientific

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.

Geometry: from Isometries to Special Relativity Cambridge University 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.
Geometry of Minkowski Space-Time World Scientific
This book arose out of original research on the extension of well-established applications of complex numbers related to Euclidean geometry and to the space-time symmetry of two-dimensional Special Relativity. The system of hyperbolic numbers is extensively studied, and a plain exposition of space-time geometry and trigonometry is given. Commutative hypercomplex systems with four unities are studied and attention is drawn to their interesting properties.
The Geometry of Special Relativity - a Concise Course Springer Nature

The Geometry of Special RelativityCRC Press
An Introduction to General Relativity World Scientific
This unique textbook offers a mathematically rigorous presentation of the theory of relativity, emphasizing the need for a critical analysis of the foundations of general relativity in order to best study the theory and its implications. The transitions from classical mechanics to special relativity and then to general relativity are explored in detail as well, helping readers to gain a more profound and nuanced understanding of the theory as a whole. After reviewing the fundamentals of differential geometry and classical mechanics, the text introduces special relativity, first using the physical approach proposed by Einstein and then via Minkowski's mathematical model. The authors then address the relativistic thermodynamics of continua and electromagnetic fields in matter – topics which are normally covered only very briefly in other treatments – in the next two chapters. The text then turns to a discussion of general relativity by means of the authors' unique critical approach, underlining the difficulty of recognizing the physical meaning of some statements, such as the physical meaning of coordinates and the derivation of physical quantities from those of space-time. Chapters in this section cover the model of space-time proposed by Schwarzschild; black holes; the Friedman equations and the different

cosmological models they describe; and the Fermi-Walker derivative. Well-suited for graduate students in physics and mathematics who have a strong foundation in real analysis, classical mechanics, and general physics, this textbook is appropriate for a variety of graduate-level courses that cover topics in relativity. Additionally, it will interest physicists and other researchers who wish to further study the subtleties of these theories and understand the contemporary scholarly discussions surrounding them.

A Mathematical Introduction To General Relativity The Geometry of Special Relativity

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.

Die spezielle Relativitätstheorie Springer Science & Business Media

This book concentrates on presenting the theory of special relativity as the geometry of space-time. The presentation is straightforward, complete and reader-friendly, with explanatory asides, that give historical context and links with other branches of physics and mathematics. The first four chapters give a complete description of the special theory and the nature of space and time, with the minimum use of mathematics. The mathematics necessary is introduced in the following five chapters, with the final fifteen chapters devoted to a comprehensive and detailed exposition of Einstein's special relativity. Features: * Concentrates on presenting the theory of special relativity as the geometry of space-time * The presentation is straightforward, complete and reader-friendly, with explanatory asides, which give historical context and links with other branches of physics and mathematics

Geometrical Physics in Minkowski Spacetime CRC Press

Differentilil Geometry and Relativity Theory: An Introduction approaches relativity asa geometric theory of space and time in which gravity is a manifestation of space-timecurvature, rathe1 than a force. Uniting differential geometry and both special and generalrelativity in a single source, this easy-to-understand text opens the general theory of relativityto mathematics majors having a backgr.ound only in multivariable calculus and linearalgebra.The book offers a broad overview of the physical foundations and mathematical details ofrelativity, and presents concrete physical interpretations of numerous abstract concepts inRiemannian geometry. The work is profusely illustrated with diagrams aiding in the understandingof proofs and explanations. Appendices feature important material on vectoranalysis and hyperbolic functions.Differential Geometry and Relativity Theory: An Introduction serves as the ideal textfor high-level undergraduate couues in mathematics and physics, and includes a solutionsmanual augmenting classroom study. It is an invaluable reference for mathematicians interestedin differential and IUemannian geometry, or the special and general theories ofrelativity

Analytic Hyperbolic Geometry and Albert Einstein's Special Theory of Relativity CRC Press

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 deformation tensors of elasticity, soap films, special and general relativity, 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; consequently, the book should be of interest also to mathematics students. Ideal for graduate and advanced undergraduate students of physics, engineering and mathematics as a course text or for self study.