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Soon afterwards, Hermann Minkowski recast special relativity essentially as a new geometric structure for spacetime. These ideas are the subject of the first part of the book. The second part develops the main implications of Einstein's general relativity as a theory of gravity rooted in the differential geometry of surfaces.

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The Geometry of Spacetime: An Introduction to Special and General Relativity (Undergraduate Texts in Mathematics) James J. Callahan. 4.6 out of 5 stars 13. Hardcover. \$73.96. Only 1 left in stock - order soon.

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The Geometry of Spacetime: An Introduction to Special and General Relativity James J. Callahan In 1905, Albert Einstein offered a revolutionary theory - special relativity - to explain some of the most troubling problems in current physics

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concerning electromagnetism and motion.

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Mathematically rigorous treatment of special relativity with precise statement of the physical interpretation Detailed introduction to the the theory of spinors in Minkowski spacetime ...

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The Geometry of Space-Time Recall that a great deal of simplification of the kinematics of classical non-relativistic mechanics occurs when one considers the group structure of transformations with respect to the underlying coordinates.

The Geometry of Space-Time

Einstein's Genius: Describing the Geometry of Space-Time General relativity is a complex theory, but imagining falling objects can help trace its contours. (Here, GPS satellites are shown around...

Einstein's Genius: Describing the Geometry of Space-Time ...

the geometry of the spacetime manifold in the General Theory of Relativity with particular reference to the occurrence of singularities in cosmological solutions and

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their relation with other global properties. Section 2 gives a brief outline of Riemannian geometry. In Section 3, the General Theory of Relativity is presented in the form of two

Singularities and the geometry of spacetime

curved space-time. The four dimensional space-time continuum itself is distorted in the vicinity of any mass, with the amount of distortion depending on the mass and the distance from the mass. Thus, relativity accounts for Newton's inverse square law of gravity through geometry and thereby does away with the need for any mysterious "action at a distance."

Relativity - Curved space-time and geometric gravitation ...

In physics, spacetime is any mathematical model which fuses the three dimensions of space and the one dimension of time into a single four-dimensional manifold. Spacetime diagrams can be used to visualize relativistic effects, such as why different observers perceive differently where and when events occur.. Until the 20th century, it was assumed that the 3-dimensional geometry of the universe ...

Spacetime - Wikipedia

Every set of coordinates, or particular space-time event, in such a universe is described as a "here-now" or a world point. In every inertial reference frame, all physical laws remain unchanged. Einstein's general theory of relativity (1916)

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again makes use of a four-dimensional space-time, but incorporates gravitational effects. Gravity is no longer thought of as a force, as in the Newtonian system, but as a cause of a “warping” of space-time, an effect described explicitly by a ...

space-time | Definition & Facts | Britannica

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The Geometry of Spacetime: An Introduction to Special and ...

Newton's law of gravity assumes that the geometry of spacetime is flat while Einstein's General Relativity allows any geometry to apply to spacetime. In weak gravity conditions, the curvature of spacetime is so small that Newton's law of gravity works just fine.

Curved Spacetime - Astronomy Notes

In general relativity, gravity can be regarded as not a force but a consequence of a curved spacetime geometry where the source of curvature is the stress-energy tensor (representing matter, for instance). Thus, for example, the path of a planet orbiting around a star is the projection of a geodesic of the curved 4-dimensional

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spacetime ...

Introduction to the mathematics of general relativity ...

The fabric of space-time is a conceptual model combining the three dimensions of space with the fourth dimension of time. According to the best of current physical theories, space-time explains the...

What Is Space-Time? | Live Science

The geometry of our Grand Unified Theory, encoded in the metric causal structure of spacetime, connects us to here and there and now and then. It is a four plus seven-dimensional map of our rationally comprehended objective reality where the concept of extended matter is fully integrated with the concept of spacetime by eliminating the ...

Gravity as geometry of the quantum structure of spacetime

Studies of anti de Sitter space suggest, for instance, that the math describing gravity (that is, spacetime geometry) can be equivalent to the math of quantum physics in a space of one less dimension. Think of a hologram — a flat, two-dimensional surface that incorporates a three-dimensional image.

A quantum origin for spacetime - Knowable Magazine

A Minkowski spacetime has a geometry in a sense that is analogous to the

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geometry of an ordinary Euclidean space. They are both "metrical" geometries. That means that they are geometries that deal with distances. Euclidean geometry is the familiar case.

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.

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.

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

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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.

This book offers a presentation of the special theory of relativity that is mathematically rigorous and yet spells out in considerable detail the physical significance of the mathematics. It treats, in addition to the usual menu of topics one is accustomed to finding in introductions to special relativity, a wide variety of results of more contemporary origin. These include Zeeman's characterization of the causal automorphisms of Minkowski spacetime, the Penrose theorem on the apparent shape of a relativistically moving sphere, a detailed introduction to the theory of spinors, a Petrov-type classification of electromagnetic fields in both tensor and spinor form, a topology for Minkowski spacetime whose homeomorphism group is essentially the Lorentz group, and a careful discussion of Dirac's famous Scissors Problem and its relation to the notion of a two-valued representation of the Lorentz group. This second edition includes a new chapter on the de Sitter universe which is intended to serve two purposes. The first is to provide a gentle prologue to the steps one must take to move beyond special relativity and adapt to the presence of gravitational fields that cannot be considered negligible. The second is to understand some of the basic features of a

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model of the empty universe that differs markedly from Minkowski spacetime, but may be recommended by recent astronomical observations suggesting that the expansion of our own universe is accelerating rather than slowing down. The treatment presumes only a knowledge of linear algebra in the first three chapters, a bit of real analysis in the fourth and, in two appendices, some elementary point-set topology. The first edition of the book received the 1993 CHOICE award for Outstanding Academic Title. Reviews of first edition: "... a valuable contribution to the pedagogical literature which will be enjoyed by all who delight in precise mathematics and physics." (American Mathematical Society, 1993) "Where many physics texts explain physical phenomena by means of mathematical models, here a rigorous and detailed mathematical development is accompanied by precise physical interpretations." (CHOICE, 1993) "... his talent in choosing the most significant results and ordering them within the book can't be denied. The reading of the book is, really, a pleasure." (Dutch Mathematical Society, 1993)

This is an introductory book on the general theory of relativity based partly on lectures given to students of M.Sc. Physics at my university. The book is divided into three parts. The first part is a preliminary course on general relativity with minimum preparation. The second part builds the mathematical background and the third part deals with topics where mathematics developed in the second part is needed. The first chapter gives a general background and introduction. This is followed by an introduction to curvature through Gauss' Theorema Egregium. This

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theorem expresses the curvature of a two-dimensional surface in terms of intrinsic quantities related to the infinitesimal distance function on the surface. The student is introduced to the metric tensor, Christoffel symbols and Riemann curvature tensor by elementary methods in the familiar and visualizable case of two dimensions. This early introduction to geometric quantities equips a student to learn simpler topics in general relativity like the Newtonian limit, red shift, the Schwarzschild solution, precession of the perihelion and bending of light in a gravitational field. Part II (chapters 5 to 10) is an introduction to Riemannian geometry as required by general relativity. This is done from the beginning, starting with vectors and tensors. I believe that students of physics grasp physical concepts better if they are not shaky about the mathematics involved.

This historic book may have numerous typos, missing text, images, or index. Purchasers can download a free scanned copy of the original book (without typos) from the publisher. 1906. Not illustrated. Excerpt: ... SPACE AND GEOMETRY FROM THE POINT OF VIEW OF PHYSICAL INQUIRY.¹ Our notions of space are rooted in our physiological organism. Geometric concepts are the product of the idealization of physical experiences of space. Systems of geometry, finally, originate in the logical classification of the conceptual materials so obtained. All three factors have left their indubitable traces in modern geometry. Epistemological inquiries regarding space and geometry accordingly concern the physiologist, the psychologist, the physicist, the mathematician, the philosopher, and the logician alike, and they can

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be gradually carried to their definitive solution only by the consideration of the widely disparate points of view which are here offered. Awakening in early youth to full consciousness, we find ourselves in possession of the notion of a space surrounding and encompassing our body, in which space move divers bodies, now altering and now retaining their size and shape. It is impossible for us to ascertain how this notion has been begotten. Only the most thoroughgoing analysis of experiments purposefully and methodically performed has enabled us to conjecture that inborn idiosyncracies of the body have cooperated to this end with simple and crude experiences of a purely physical character. Sensational And Locative Qualities. An object seen or touched is distinguished not only by a sensational quality (as "red," "rough," "cold," etc.), but also by a locative quality (as "to the left," "above," "before," etc.). The sensational quality may remain the same, while the locative quality continuously changes; that is, the same sensuous object may move in space. Phenomena of this kind being again and again induced by physico-physiological circumstances, it is found that however ...

One of the most of 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

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singul- theorem and this ity 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.

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

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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.

A fascinating exploration of the correlation between geometry and linear algebra, this text portrays the former as a subject better understood by the use and development of the latter rather than as an independent field. The treatment offers elementary explanations of the role of geometry in other branches of math and science — including physics, analysis, and group theory — as well as its value in understanding probability, determinant theory, and function spaces. Outstanding features of this volume include discussions of systematic geometric motivations in vector space theory and matrix theory; the use of the center of mass in geometry, with an introduction to barycentric coordinates; axiomatic development of determinants in a chapter dealing with area and volume; and a careful consideration of the particle problem. Students and other mathematically inclined readers will find that this inquiry into the interplay between geometry and other areas offers an enriched appreciation of both subjects.

The Geometry of Special Relativity provides an introduction to special relativity that encourages readers to see beyond the formulas to the deeper geometric

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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.

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