Differential Geometry And Relativity A Volume In Honour Of Andri 1 2 Lichnerowicz On His 60th Birthday Mathematical Physics And Applied Mathematics

The principal aim of analysis of tensors is to investigate those relations which remain valid when we change from one coordinate system to another. This book on Tensors requires only a knowledge of elementary calculus, differential equations and classical mechanics as pre-requisites. It provides the readers with all the information about the tensors along with the derivation of all the tensorial relations/equations in a simple manner. The book also deals in detail with topics of importance to the study of special and general relativity and the geometry of differentiable manifolds with a crystal clear exposition. The concepts dealt within the book are well supported by a number of solved examples. A carefully selected set of unsolved problems is also given at the end of each chapter, and the answers and hints for the solution of these problems are given at the end of the book. The applications of tensors to the fields of differential geometry, relativity, cosmology and electromagnetism is another attraction of the present book. This book is intended to serve as text for postgraduate students of mathematics, physics and engineering. It is ideally suited for both students and teachers who are engaged in research in General Theory of Relativity and Differential Geometry.

“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.

This book is an exposition of semi-Riemannian geometry (also called pseudo-Riemannian geometry)--the study of a smooth manifold furnished with a metric tensor of arbitrary signature. The principal special cases are Riemannian geometry, where the metric is positive definite, and Lorentz geometry. For many years these two geometries have developed almost independently: Riemannian geometry reformulated in coordinate-free fashion and directed toward global problems, Lorentz geometry in classical tensor notation devoted to general relativity. More recently, this divergence has been reversed as physicists, turning increasingly toward invariant methods, have produced results of compelling mathematical interest.

An introduction to semi-Riemannian geometry as a foundation for general relativity Semi-Riemannian Geometry: The Mathematical Language of General Relativity is an accessible exposition of the mathematics underlying general relativity. The book begins with background on linear and multilinear algebra, general topology, and real analysis. This is followed by material on the classical theory of curves and surfaces, expanded to include both the Lorentz and Euclidean signatures. The remainder of the book is devoted to a discussion of smooth manifolds, smooth manifolds with boundary, smooth manifolds with a connection, semi-Riemannian manifolds, and differential operators, culminating in applications to Maxwell’s equations and the Einstein tensor. Many worked examples and detailed diagrams are provided to aid understanding. This book will appeal especially to physics students wishing to learn more differential geometry than is usually provided in texts on general relativity.

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.

An explanation of the mathematics needed as a foundation for a deep understanding of general relativity or quantum field theory. Physics is naturally expressed in mathematical language. Students new to the subject must simultaneously learn an idiomatic mathematical language and the content that is expressed in that language. It is as if they were asked to read Les Misérables while struggling with French grammar. This book offers an innovative way to learn the differential geometry needed as a foundation for a deep understanding of general relativity or quantum field theory as taught at the college level. The approach taken by the authors (and used in their classes at MIT for many years) differs from the conventional one in several ways, including an emphasis on the development of the covariant derivative and an avoidance of the use of traditional index notation for tensors in favor of a semantically richer language of vector fields and differential forms. But the biggest single difference is the authors' integration of computer programming into their explanations. By programming a computer to interpret a formula, the student soon learns whether or not a formula is correct. Students are led to improve their program, and as a result improve their understanding.

This volume presents a collection of problems and solutions in differential geometry with applications. Both introductory and advanced topics are introduced in an easy-to-digest manner, with the materials of the volume being self-contained. In particular, curves, surfaces, Riemannian and pseudo-Riemannian manifolds, Hodge duality operator, vector fields and Lie series, differential forms, matrix-valued differential forms, Maurer–Cartan form, and the Lie derivative are covered. Readers will find useful applications to special and general relativity, Yang–Mills theory, hydrodynamics and field theory. Besides the solved problems, each chapter contains stimulating supplementary problems and software implementations are also included. The volume will not only benefit students in mathematics, applied mathematics and theoretical physics, but also researchers in the field of differential geometry. Request Inspection Copy

The aim of this book is to provide a short but complete exposition of the logical structure of classical relativistic electrodynamics written in the language and spirit of coordinate-free differential geometry. The intended audience is primarily mathematicians who want a bare-bones account of the foundations of electrodynamics written in language with which they are familiar and secondarily physicists who may be curious how their old friend looks in the new clothes of the differential-geometric viewpoint which in recent years has become an important language and tool for theoretical physics. This work is not intended to be a textbook in electrodynamics in the usual sense; in particular no applications are treated, and the focus is exclusively the equations of motion of charged particles. Rather, it is hoped that it may serve as a bridge between mathemat ics and physics. Many non-physicists are surprised to learn that the correct equation to describe the motion of a classical charged particle is still a matter of some controversy. The most mentioned candidate is the Lorentz-Dirac equation t . However, it is experimentally unverified, is known to have no physically reasonable solutions in certain circumstances, and its usual derivations raise serious foundational issues. Such difficulties are not extensively discussed in most electrodynamics texts, which quite naturally are oriented toward applying the well-verified part of the subject to con crete problems.

This book provides a lucid introduction to both modern differential geometry and relativity for advanced undergraduates and first-year graduate students of applied mathematics and physical sciences. This book meets an overwhelming need for a book on modern differential geometry and relativity that is student-friendly, and which is also suitable for self-study. The book presumes a minimal level of mathematical maturity so that any student who has completed the standard Calculus sequence should be able to read and understand the book. The key features of the book are: * Detailed solutions are provided to the Exercises in each chapter. * Many of the 'missing steps' that are often omitted from standard mathematical derivations have been provided to make the book easier to read and understand. * A detailed introduction to Electrodynamics is provided so that the book is accessible to students who have not had a formal course in this area. * In its treatment of modern differential geometry, the book employs both a modern, coordinate-free approach, and the standard coordinate-based approach. This makes the book attractive to a large audience of readers. Also, the book is particularly attractive to professional non-specialists who would like an easy to read introduction to the subject

This volume consists of expanded versions of invited lectures given at The Beemfest: Advances in Differential Geometry and General Relativity (University of Missouri-Columbia) on the occasion of Professor John K. Beem's retirement. The articles address problems in differential geometry in general and in particular, global Lorentzian geometry, Finsler geometry, causal boundaries, Penrose's cosmic censorship hypothesis, the geometry of differential operators with variable coefficients on manifolds, and asymptotically de Sitter spacetimes satisfying Einstein's equations with positive cosmological constant. The book is suitable for graduate students and research mathematicians interested in differential geometry.

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 ? 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.

Unlike many other texts on differential geometry, this textbook also offers interesting applications to geometric mechanics and general relativity. The first part is a concise and self-contained introduction to the basics of manifolds, differential forms, metrics and curvature. The second part studies applications to mechanics and relativity including the proofs of the Hawking and Penrose singularity theorems. It can be independently used for one-semester courses in either of these subjects. The main ideas are illustrated and further developed by numerous examples and over 300 exercises. Detailed solutions are provided for many of these exercises, making An Introduction to Riemannian Geometry ideal for self-study.

One of the most of exciting aspects is the general relativity pred- tion 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 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.

This book lays the mathematical foundations required to understand the majestic grandeur and essence of General Relativity (GR). This book provides a basic introduction to Differential Geometry required for studying GR. It's unique pictorial and analogy-driven approach provides a vivid experience to the reader. This book is for the highly-motivated undergraduate students of maths or physics who want to learn advanced concepts of maths and it's applications in physics in a unique and intuitive way. The mathematical level of the seven chapters of the book is that of undergraduates of mathematics or physics. The book assumes the reader to possess a fair knowledge of Special Relativity and Electromagnetism and aims at communicating the concepts as intuitively as possible, constantly promoting the avant-garde and consciously avoiding the vicissitudes one faces in the conventionalist approach to physics and the labyrinthine choice of words in archaic texts.

This text presents a graduate-level introduction to differential geometry for mathematics and physics students. The exposition follows the historical development of the concepts of connection and curvature with the goal of explaining the Chern–Weil theory of characteristic classes on a principal bundle. Along the way we encounter some of the high points in the history of differential geometry, for example, Gauss' Theorema Egregium and the Gauss–Bonnet theorem. Exercises throughout the book test the reader’s understanding of the material and sometimes illustrate extensions of the theory. Initially, the prerequisites for the reader include a passing familiarity with manifolds. After the first chapter, it becomes necessary to understand and manipulate differential forms. A knowledge of de Rham cohomology is required for the last third of the text. Prerequisite material is contained in author's text An Introduction to Manifolds, and can be learned in one semester. For the benefit of the reader and to establish common notations, Appendix A recalls the basics of manifold theory. Additionally, in an attempt to make the exposition more self-contained, sections on algebraic constructions such as the tensor product and the exterior power are included. Differential geometry, as its name implies, is the study of geometry using differential calculus. It dates back to Newton and Leibniz in the seventeenth century, but it was not until the nineteenth century, with the work of Gauss on surfaces and Riemann on the curvature tensor, that differential geometry flourished and its modern foundation was laid. Over the past one hundred years, differential geometry has proven indispensable to an understanding of the physical world, in Einstein's general theory of relativity, in the theory of gravitation, in gauge theory, and now in string theory. Differential geometry is also useful in topology, several complex variables, algebraic geometry, complex manifolds, and dynamical systems, among other fields. The field has even found applications to group theory as in Gromov's work and to probability theory as in Diaconis's work. It is not too far-fetched to argue that differential geometry should be in every mathematician's arsenal.

A warped product manifold is a Riemannian or pseudo-Riemannian manifold whose metric tensor can be decomposed into a Cartesian product of the y geometry and the x geometry — except that the x-part is warped, that is, it is rescaled by a scalar function of the other coordinates y. The notion of warped product manifolds plays very important roles not only in geometry but also in mathematical physics, especially in general relativity. In fact, many basic solutions of the Einstein field equations, including the Schwarzschild solution and the Robertson–Walker models, are warped product manifolds. The first part of this volume provides a self-contained and accessible introduction to the important subject of pseudo-Riemannian manifolds and submanifolds. The second part presents a detailed and up-to-date account on important results of warped product manifolds, including several important spacetimes such as Robertson–Walker's and Schwarzschild's. The famous John Nash's embedding theorem published in 1956 implies that every warped product manifold can be realized as a warped product submanifold in a suitable Euclidean space. The study of warped product submanifolds in various important ambient spaces from an extrinsic point of view was initiated by the author around the beginning of this century. The last part of this volume contains an extensive and comprehensive survey of numerous important results on the geometry of warped product submanifolds done during this century by many geometers.

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.

Emphasizing the applications of differential geometry to gauge theories in particle physics and general relativity, this work will be of special interest for researchers in applied mathematics or theoretical physics.

On the occasion of the sixtieth birthday of Andre Lichnerowicz a number of his friends, many of whom have been his students or coworkers, decided to celebrate this event by preparing a jubilee volume of contributed articles in the two main fields of research marked by Lichnerowicz's work, namely differential geometry and mathematical physics. Limitations of space and time did not enable us to include papers from all Lichnerowicz's friends nor from all his former students. It was equally impossible to reflect in a single book the great variety of subjects tackled by Lichnerowicz. In spite of these limitations, we hope that this book reflects some of the present trends of fields in which he worked, and some of the subjects to which he contributed in his long - and not yet finished - career. This career was very much marked by the influence of his masters, Elie Cartan who introduced him to research in mathematics, mainly in geometry and its relations with mathematical physics, and Georges Darmois who developed his interest for mechanics and physics, especially the theory of relativity and electromagnetism. This par ticular combination, and his personal talent, made of him a natural scientific heir and continuator of the French mathematical physics school in the tradition of Henri Poincare. Some of his works would even be best qualified by a new field name, that of physical ma thematics: branches of pure mathematics entirely motivated by physics.

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

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.
An introduction to geometrical topics used in applied mathematics and theoretical physics.
Many problems in general relativity are essentially geometric in nature, in the sense that they can be understood in terms of Riemannian geometry and partial differential equations. This book is centered around the study of mass in general relativity using the techniques of geometric analysis. Specifically, it provides a comprehensive treatment of the positive mass theorem and closely related results, such as the Penrose inequality, drawing on a variety of tools used in this area of research, including minimal hypersurfaces, conformal geometry, inverse mean curvature flow, conformal flow, spinors and the Dirac operator, marginally outer trapped surfaces, and density theorems. This is the first time these topics have been gathered into a single place and presented with an advanced graduate student audience in mind; several dozen exercises are also included. The main prerequisite for this book is a working understanding of Riemannian geometry and basic knowledge of elliptic linear partial differential equations, with only minimal prior knowledge of physics required. The second part of the book includes a short crash course on general relativity, which provides background for the study of asymptotically flat initial data sets satisfying the dominant energy condition.
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.

Carefully documenting the different formulations of general relativity, the author reveals valuable insight into the nature of the gravitational force and its interaction with matter. This book will interest graduate students and researchers in the fields of general relativity, gravitational physics and differential geometry.

This Thesis deals with recent progress regarding singularities in General Relativity. Singularities are predicted by the theory, but raise difficult problems, because they make the usual equations to be plagued with infinities and to break down. To resolve some of these problems, extensions of differential geometry and of Einstein's equation to singularities were needed, and were constructed by the author. This generalization works easily at the Big-Bang singularity, which gained by this a description in terms of finite quantities which have both geometric and physical meaning. Moreover, a large class of Big-Bang singularities which are not necessarily homogeneous or isotropic is presented. In addition, these singularities satisfy the Weyl curvature hypothesis, emitted by Penrose to explain the arrow of time. The black hole singularities apparently are more difficult to deal with, but by applying a special procedure they turn out as well to admit a description in terms of finite quantities. In addition, these singularities exhibit a (geo)metric dimensional reduction, which might act as a regulator for the quantum fields, including for quantum gravity, in the high-energy limit. This opens the perspective of perturbative quantum gravity without modifying General Relativity.

Differential Geometry in Physics is a treatment of the mathematical foundations of the theory of general relativity and gauge theory of quantum fields. The material is intended to help bridge the gap that often exists between theoretical physics and applied mathematics. The approach is to carve an optimal path to learning this challenging field by appealing to the much more accessible theory of curves and surfaces. The transition from classical differential geometry as developed by Gauss, Riemann and other giants, to the modern approach, is facilitated by a very intuitive approach that sacrifices some mathematical rigor for the sake of understanding the physics. The book features numerous examples of

beautiful curves and surfaces often reflected in nature, plus more advanced computations of trajectory of particles in black holes. Also embedded in the later chapters is a detailed description of the famous Dirac monopole and instantons. Features of this book: * Chapters 1-4 and chapter 5 comprise the content of a one-semester course taught by the author for many years. * The material in the other chapters has served as the foundation for many master's thesis at University of North Carolina Wilmington for students seeking doctoral degrees. * An open access ebook edition is available at Open UNC (https: //openunc.org) * The book contains over 80 illustrations, including a large array of surfaces related to the theory of soliton waves that does not commonly appear in standard mathematical texts on differential geometry.
Differential Forms and the Geometry of General Relativity provides readers with a coherent path to understanding relativity. Requiring little more than calculus and some linear algebra, it helps readers learn just enough differential geometry to grasp the basics of general relativity. The book contains two intertwined but distinct halves. Designed for advanced undergraduate or beginning graduate students in mathematics or physics, most of the text requires little more than familiarity with calculus and linear algebra. The first half presents an introduction to general relativity that describes some of the surprising implications of relativity without introducing more formalism than necessary. This nonstandard approach uses differential forms rather than tensor calculus and minimizes the use of "index gymnastics" as much as possible. The second half of the book takes a more detailed look at the mathematics of differential forms. It covers the theory behind the mathematics used in the first half by emphasizing a conceptual understanding instead of formal proofs. The book provides a language to describe curvature, the key geometric idea in general relativity.

An essential resource for learning about general relativity and much more, from four leading experts Important and useful to every student of relativity, this book is a unique collection of some 475 problems--with solutions--in the fields of special and general relativity, gravitation, relativistic astrophysics, and cosmology. The problems are expressed in broad physical terms to enhance their pertinence to readers with diverse backgrounds. In their solutions, the authors have attempted to convey a mode of approach to these kinds of problems, revealing procedures that can reduce the labor of calculations while avoiding the pitfall of too much or too powerful formalism. Although well suited for individual use, the volume may also be used with one of the modem textbooks in general relativity.

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.

This book explores the work of Bernhard Riemann and its impact on mathematics, philosophy and physics. It features contributions from a range of fields, historical expositions, and selected research articles that were motivated by Riemann's ideas and demonstrate their timelessness. The editors are convinced of the tremendous value of going into Riemann's work in depth, investigating his original ideas, integrating them into a broader perspective, and establishing ties with modern science and philosophy. Accordingly, the contributors to this volume are mathematicians, physicists, philosophers and historians of science. The book offers a unique resource for students and researchers in the fields of mathematics, physics and philosophy, historians of science, and more generally to a wide range of readers interested in the history of ideas.

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.