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Introduction to General Relativity A Student's Manual for A First Course in General Relativity 300 Problems in Special and General Relativity Exact Solutions of Einstein's Field Equations General Relativity Without Calculus Special Relativity Problems and Solutions on Solid State Physics, Relativity and Miscellaneous Topics Solutions of Exercises of General Relativity Simplified & Assessed Colliding Plane Waves in General Relativity Exact Three-variable Solutions of the Field Equations of General Relativity Shock Wave Interactions in General Relativity Problem Book in Relativity and Gravitation Introduction to General Relativity Exact Space-Times in Einstein's General Relativity The General Theory of Relativity Helical Symmetry, Spinors and Periodic Solutions in General Relativity Introduction To General Relativity And Cosmology Ernst Equation and Riemann Surfaces Einstein's General Theory of Relativity Introduction to General Relativity and the Cosmological Constant Problem General Relativity A Short Course in General Relativity Introduction to General Relativity and Cosmology A Mathematical Journey to Relativity Nuclear Science Abstracts Philosophy of Physics The Cosmology of Extra Dimensions and Varying Fundamental Constants Diagnoseschlüssel für die Pädiatrie Pseudo-Complex General Relativity Evolution Equations Proceedings of the Ninth Asia-Pacific International Conference on Gravitation and Astrophysics Cosmology in Scalar-Tensor Gravity Computer Algebra In Physical Research: Memorial Volume For N N Govorun - Proceedings Of The Iv International Conference Literature 1984, Part 1 Fundamental Interactions Mathematical Physics and Complex Analysis Colliding wave solutions, duality, and diagonal embedding of general relativity in two-dimensional heterotic string theory Nuclear Science Abstracts Classical Field Theory Applied General Relativity

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Suitable for a one-semester course in general relativity for senior undergraduates or beginning graduate students, this text clarifies the mathematical aspects of Einstein's theory of relativity without sacrificing physical understanding. This textbook develops Special Relativity in a systematic way and offers the unique feature of having more than 200 problems with detailed solutions to empower students to gain a real understanding of this core subject in physics. This new edition has been thoroughly updated and has new sections on relativistic fluids, relativistic kinematics and on four-acceleration. The problems and solution section has been significantly expanded and short history sections have been included throughout the book. The approach is structural in the sense that it develops Special Relativity in Minkowski space following the parallel steps as the development of Newtonian Physics in Euclidian space. A second characteristic of the book is that it discusses the mathematics of the theory independently of the physical principles, so that the reader will appreciate their role in the development of the physical theory. The book is intended to be used both as a textbook for an advanced undergraduate teaching course in Special Relativity but also as a reference book for the future. In that respect it is linked to an online repository with more than 200 problems, carefully classified according to subject area and solved in detail, providing an independent problem book on Special Relativity. A collection of survey papers on the 50th anniversary of the institute. Cosmology in Scalar-Tensor Gravity covers all aspects of cosmology in scalar-tensor theories of gravity. Considerable progress has been made in this exciting area of physics and this book is the first to provide a critical overview of the research. Among the topics treated are: -Scalar-tensor gravity and its limit to general relativity, -Effective energy-momentum tensors and conformal frames, -Gravitational waves in scalar-tensor cosmology, -Specific scalar-tensor theories, -Exact cosmological solutions and cosmological perturbations, -Scalar-tensor scenarios of the early universe and inflation, -Scalar-tensor models of quintessence in the present universe and their far-reaching consequences for the ultimate fate of the cosmos. In the late 20th and beginning 21st century high-precision astronomy, positioning and metrology strongly rely on general relativity. Supported by exercises and solutions this book offers graduate students and researchers entering those fields a self-contained and exhaustive but accessible treatment of applied general relativity. The book is written in a homogenous (graduate level textbook) style allowing the reader to understand the arguments step by step. It first introduces the mathematical and theoretical foundations of gravity theory and then concentrates on its general relativistic applications: clock rates, clock sychronization, establishment of time scales, astronomical references frames, relativistic astrometry, celestial mechanics and metrology. The authors present up-to-date relativistic models for applied techniques such as Satellite LASER Ranging (SLR), Lunar LASER Ranging (LLR), Globale Navigation Satellite Systems (GNSS), Very Large Baseline Interferometry (VLBI), radar measurements, gyroscopes and pulsar timing. A list of acronyms helps the reader keep an overview and a mathematical appendix provides required functions and terms. 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. “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. It is important for every physicist today to have a working knowledge of Einstein's theory of general relativity. Introduction to General Relativity published in 2007 was aimed at first-year graduate students, or advanced undergraduates, in physics. Only a basic understanding of classical lagrangian mechanics is assumed; beyond that, the reader should find the material to be self-contained. The mechanics problem of a point mass constrained to move without friction on a two-dimensional surface of arbitrary shape serves as a paradigm for the development of the mathematics and physics of general relativity. Special relativity is reviewed. The basic principles of general relativity are then presented, and the most important applications are discussed. The final special topics section takes the reader up to a few areas of current research. An extensive set of accessible problems enhances and extends the coverage. As a learning and teaching tool, this current book provides solutions to those problems. This text and solutions manual are meant to provide an introduction to the subject. It is hoped that these books will allow the reader to approach the more advanced texts and monographs, as well as the continual influx of fascinating new experimental results, with a deeper understanding and sense of appreciation. 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 introduces the general theory of relativity and includes applications to cosmology. The book provides a thorough introduction to tensor calculus and curved manifolds. After the necessary mathematical tools are introduced, the authors offer a thorough presentation of the theory of relativity. Also included are some advanced topics not previously covered by textbooks, including Kaluza-Klein theory, Israel's formalism and branes. Anisotropic cosmological models are also included. The book contains a large number of new exercises and examples, each with separate headings. The reader will benefit from an updated introduction to general relativity including the most recent developments in cosmology. A student-friendly style, over 100 illustrations, and numerous exercises are brought together in this textbook for advanced undergraduate and beginning graduate students in physics and mathematics. Lewis Ryder develops the theory of general relativity in detail. Covering the core topics of black holes, gravitational radiation, and cosmology, he provides an overview of general relativity and its modern ramifications. The book contains chapters on gravitational radiation, cosmology, and connections between general relativity and the fundamental physics of the microworld. It explains the geometry of curved spaces and contains key solutions of Einstein's equations - the Schwarzschild and Kerr solutions. Mathematical calculations are worked out in detail, so students can develop an intuitive understanding of the subject, as well as learn how to perform calculations. The book also includes topics concerned with the relation between general relativity and other areas of fundamental physics. Password protected solutions for instructors are available at www.cambridge.org/9780521845632. This book is an extended version of the thesis defended by the author in 2011. It contains an introduction to the formalism of two-component spinors in general relativity and conformal techniques related to asymptotically flat spacetimes. These techniques are then applied to the problem of the non-existence of asympotically flat periodic solutions of Einstein's equations. It is shown that such solutions in fact do not exist which, roughly speaking, means that gravitational field of isolated gravitating systems cannot be periodic. Proof of this statement arose with the collaboration of the author, his former supervisor prof. Ji i Bi ak from Charles University in Prague and prof. Paul Tod from University of Oxford. In the book, the notion of helical symmetry is introduced as a special kind of periodicity and new helically symmetric solutions in electrodynamics and linearized gravity are presented. In the second part, the formalism of 2-spinors is introduced together with the Newman-Penrose formalism. Finally, in the third part, we present the proof of the non-existence of periodic solutions of Einstein's equations which was published in Classical and Quantum Gravity journal in 2010. Einstein's theory of general relativity is a theory of gravity and, as in the earlier Newtonian theory, much can be learned about the character of gravitation and its effects by investigating particular idealized examples. This book describes the basic solutions of Einstein's equations with a particular emphasis on what they mean, both geometrically and physically. New 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 analyzed. The book is an invaluable resource both for graduate students and academic researchers working in gravitational physics. The book describes Maxwell's equations first in their integral, directly testable form, then moves on to their local formulation. The first two chapters cover all essential properties of Maxwell's equations, including their symmetries and their covariance in a modern notation. Chapter 3 is devoted to Maxwell theory as a classical field theory and to solutions of the wave equation. Chapter 4 deals with important applications of Maxwell theory. It includes topical subjects such as metamaterials with negative refraction index and solutions of Helmholtz' equation in paraxial approximation relevant for the description of laser beams. Chapter 5 describes non-Abelian gauge theories from a classical, geometric point of view, in analogy to Maxwell theory as a prototype, and culminates in an application to the U(2) theory relevant for electroweak interactions. The last chapter 6 gives a concise summary of semi-Riemannian geometry as the framework for the classical field theory of gravitation. The chapter concludes with a discussion of the Schwarzschild solution of Einstein's equations and the classical tests of general relativity (perihelion precession of Mercury, and light deflection by the sun). ------ Textbook features: detailed figures, worked examples, problems and solutions, boxed inserts, highlighted special topics, highlighted important math etc., helpful summaries, appendix, index. Crystal structures and properties (1001-1027) - Electron theory, energy bands and semiconductors (1028-1051) - Electromagnetic properties, optical properties and superconductivity (1052-1076) - Other topics (1077-1081) - Special relativity (2001-2007) - General relativity 2008-2023) - Relativistic cosmology (2024-2028) - History of physics and general questions (3001-3025) - Measurements, estimations

and errors (3026-3048) - Mathematical techniques (3049-3056). This volume is a collection of notes from lectures given at the 2008 Clay Mathematics Institute Summer School, held in Zürich, Switzerland. The lectures were designed for graduate students and mathematicians within five years of the Ph.D., and the main focus of the program was on recent progress in the theory of evolution equations. Such equations lie at the heart of many areas of mathematical physics and arise not only in situations with a manifest time evolution (such as linear and nonlinear wave and Schrödinger equations) but also in the high energy or semi-classical limits of elliptic problems. The three main courses focused primarily on microlocal analysis and spectral and scattering theory, the theory of the nonlinear Schrödinger and wave equations, and evolution problems in general relativity. These major topics were supplemented by several mini-courses reporting on the derivation of effective evolution equations from microscopic quantum dynamics; on wave maps with and without symmetries; on quantum N-body scattering, diffraction of waves, and symmetric spaces; and on nonlinear Schrödinger equations at critical regularity. Although highly detailed treatments of some of these topics are now available in the published literature, in this collection the reader can learn the fundamental ideas and tools with a minimum of technical machinery. Moreover, the treatment in this volume emphasizes common themes and techniques in the field, including exact and approximate conservation laws, energy methods, and positive commutator arguments. Titles in this series are co-published with the Clay Mathematics Institute (Cambridge, MA). This monograph presents a self contained mathematical treatment of the initial value problem for shock wave solutions of the Einstein equations in General Relativity. It has a clearly outlined goal: proving a certain local existence theorem. Concluding remarks are added and commentary is provided throughout. The author is a well regarded expert in this area. This book explores the role of singularities in general relativity (GR): The theory predicts that when a sufficient large mass collapses, no known force is able to stop it until all mass is concentrated at a point. The question arises, whether an acceptable physical theory should have a singularity, not even a coordinate singularity. The appearance of a singularity shows the limitations of the theory. In GR this limitation is the strong gravitational force acting near and at a super-massive concentration of a central mass. First, a historical overview is given, on former attempts to extend GR (which includes Einstein himself), all with distinct motivations. It will be shown that the only possible algebraic extension is to introduce pseudo-complex (pc) coordinates, otherwise for weak gravitational fields non-physical ghost solutions appear. Thus, the need to use pc-variables. We will see, that the theory contains a minimal length, with important consequences. After that, the pc-GR is formulated and compared to the former attempts. A new variational principle is introduced, which requires in the Einstein equations an additional contribution. Alternatively, the standard variational principle can be applied, but one has to introduce a constraint with the same former results. The additional contribution will be associated to vacuum fluctuation, whose dependence on the radial distance can be approximately obtained, using semi-classical Quantum Mechanics. The main point is that pc-GR predicts that mass not only curves the space but also changes the vacuum structure of the space itself. In the following chapters, the minimal length will be set to zero, due to its smallness. Nevertheless, the pc-GR will keep a remnant of the pc-description, namely that the appearance of a term, which we may call "dark energy", is inevitable. The first application will be discussed in chapter 3, namely solutions of central mass distributions. For a non-rotating massive object it is the pc-Schwarzschild solution, for a rotating massive object the pc-Kerr solution and for a charged massive object it will be the Reissner-Nordström solution. This chapter serves to become familiar on how to resolve problems in pc-GR and on how to interpret the results. One of the main consequences is, that we can eliminate the event horizon and thus there will be no black holes. The huge massive objects in the center of nearly any galaxy and the so-called galactic black holes are within pc-GR still there, but with the absence of an event horizon! Chapter 4 gives another application of the theory, namely the Robertson-Walker solution, which we use to model different outcomes of the evolution of the universe. Finally the capability of this theory to predict new phenomena is illustrated. This memorial volume on the work of Wolfgang Kummer brings together articles devoted to the history of high energy physics with detailed coverage on the scientific concepts and scientific institutions, in particular CERN ? and the underlying physics involved. Covering recent advances and developments as well as giving a reminiscent overview in two rapidly evolving fields of high energy/particle physics, and gravitational physics, the commemorative volume contains more than 20 original invited paper contributions ? which will appear for the first time in print ? from eminent and renowned physicists who interacted and collaborated with Wolfgang Kummer, including Physics Nobel Laureate Jack Steinberger. Wolfgang Kummer was president of the CERN council from 1985 to 1987, among his numerous eminent academic and administrative positions which he held during his illustrious career. This volume also aims to demonstrate and highlight Wolfgang Kummer's significant contribution to the foundational work in gauge field theory, particle physics, and quantum gravity, and the tremendous impact leading to cutting-edge findings and advances at LHC. The International Conference on Gravitation and Astrophysics(ICGA) is to serve the needs of research workers in gravitation and astrophysics in the Asia-Pacific region. This proceedings covers a wide and hot area of research, including cosmological model, gravitational lensing, precision measurement of G, CMB, Kerr space-time, gravitational wave, the LISA, LIGO, LCGT projects in Japan, black hole, dark matter, Yangndash;Mills gravity, neutron star, type la supernovae, quasi-local energy, anti-de Sitter space-time. This book

is an introductory text in General Relativity, while also focusing some solutions to the cosmological constant problem, which consists in an amazing 100 orders of magnitude discrepancy between the value of this constant in the present Universe, and its estimated value in the very early epoch. The author suggests that the constant is in fact, a time-varying function of the age of the Universe. The book offers a wealth of cosmological models, treats up to date findings, like the verification of the Lense-Thirring effect in the year 2004, and the recently published research by Cooperstock and Tieu (2005) suggesting that "dark" matter is not a necessary concept in order to explain the rotational velocities of stars around galaxies' nuclei. This is a mathematical cosmology textbook that may lead undergraduates, and graduate students to one of the frontiers of research, while keeping the prerequisites to a minimum, because most of the theory in the book requires only prior knowledge of Calculus and a University Physics course. The ambition of this volume is twofold: to provide a comprehensive overview of the field and to serve as an indispensable reference work for anyone who wants to work in it. For example, any philosopher who hopes to make a contribution to the topic of the classical-quantum correspondence will have to begin by consulting Klaas Landsman's chapter. The organization of this volume, as well as the choice of topics, is based on the conviction that the important problems in the philosophy of physics arise from studying the foundations of the fundamental theories of physics. It follows that there is no sharp line to be drawn between philosophy of physics and physics itself. Some of the best work in the philosophy of physics is being done by physicists, as witnessed by the fact that several of the contributors to the volume are theoretical physicists: viz., Ellis, Emch, Harvey, Landsman, Rovelli, 't Hooft, the last of whom is a Nobel laureate. Key features - Definitive discussions of the philosophical implications of modern physics - Masterly expositions of the fundamental theories of modern physics - Covers all three main pillars of modern physics: relativity theory, quantum theory, and thermal physics - Covers the new sciences grown from these theories: for example, cosmology from relativity theory; and quantum information and quantum computing, from quantum theory - Contains special Chapters that address crucial topics that arise in several different theories, such as symmetry and determinism - Written by very distinguished theoretical physicists, including a Nobel Laureate, as well as by philosophers - Definitive discussions of the philosophical implications of modern physics - Masterly expositions of the fundamental theories of modern physics - Covers all three main pillars of modern physics: relativity theory, quantum theory, and thermal physics - Covers the new sciences that have grown from these theories: for example, cosmology from relativity theory; and quantum information and quantum computing, from quantum theory - Contains special Chapters that address crucial topics that arise in several different theories, such as symmetry and determinism - Written by very distinguished theoretical physicists, including a Nobel Laureate, as well as by philosophers This book contains detailed solutions of all the 606 exercises of my book: General Relativity Simplified & Assessed. These exercises represent an integral part of the original book as they fill many gaps and provide essential extensions and elaborations. The General Theory of Relativity: A Mathematical Exposition will serve readers as a modern mathematical introduction to the general theory of relativity. Throughout the book, examples, worked-out problems, and exercises (with hints and solutions) are furnished. Topics in this book include, but are not limited to: tensor analysis the special theory of relativity the general theory of relativity and Einstein’s field equations spherically symmetric solutions and experimental confirmations static and stationary space-time domains black holes cosmological models algebraic classifications and the Newman-Penrose equations the coupled Einstein-Maxwell-Klein-Gordon equations appendices covering mathematical supplements and special topics Mathematical rigor, yet very clear presentation of the topics make this book a unique text for both university students and research scholars. Anadijiban Das has taught courses on Relativity Theory at The University College of Dublin, Ireland, Jadavpur University, India, Carnegie-Mellon University, USA, and Simon Fraser University, Canada. His major areas of research include, among diverse topics, the mathematical aspects of general relativity theory. Andrew DeBenedictis has taught courses in Theoretical Physics at Simon Fraser University, Canada, and is also a member of The Pacific Institute for the Mathematical Sciences. His research interests include quantum gravity, classical gravity, and semi-classical gravity. This monograph is a survey of recent research on the collision and interaction of gravitational and electromagnetic waves, a topic of particular importance to general relativity. 1991 edition, with updated postscript. "This book is a supplementary book in the form of a "problem book" or "student's manual" in special and general relativity consisting of a total of 300 problems (150 problems each in special and general relativity) with complete and elaborate solutions. It is intended as a companion text to a main textbook, but does not assume any particular textbook. It may be used for self-studies by students, act as a source of problems for classes, or as inspiration for teachers and examiners looking to construct new problems for lectures, homework, and exams"-- Introduction to General Relativity and Cosmology gives undergraduate students an overview of the fundamental ideas behind the geometric theory of gravitation and spacetime. Through pointers on how to modify and generalise Einstein's theory to enhance understanding, it provides a link between standard textbook content and current research in the field.Chapters present complicated material practically and concisely, initially dealing with the mathematical foundations of the theory of relativity, in particular differential geometry. This is followed by a discussion of the Einstein field equations and their various properties. Also given is analysis of the important Schwarzschild solutions, followed by application of general

relativity to cosmology. Questions with fully worked answers are provided at the end of each chapter to aid comprehension and guide learning. This pared down textbook is specifically designed for new students looking for a workable, simple presentation of some of the key theories in modern physics and mathematics. Solutions and hints to selected exercises Introduction to General Relativity and Cosmology gives undergraduate students an overview of the fundamental ideas behind the geometric theory of gravitation and spacetime. Through pointers on how to modify and generalise Einstein's theory to enhance understanding, it provides a link between standard textbook content and current research in the field. Chapters present complicated material practically and concisely, initially dealing with the mathematical foundations of the theory of relativity, in particular differential geometry. This is followed by a discussion of the Einstein field equations and their various properties. 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Includes all the developments in the field since the first edition and contains six completely new chapters, covering topics including generation methods and their application, colliding waves, classification of metrics by invariants and treatments of homothetic motions. This book is an important resource for graduates and researchers in relativity, theoretical physics, astrophysics and mathematics. It can also be used as an introductory text on some mathematical aspects of general relativity. The workshop on The Cosmology of Extra Dimensions and Varying Fundamental Constants, which was part of JENAM 2002, was held at the Physics Department of the University of Porto (FCUP) from the 3rd to the 5th of September 2002. It was regularly attended by about 110 participants, of which 65 were officially registered in the VFC workshop, while the others came from the rest of the JENAM workshops. There were also a few science correspondents from the national and international press. During the 3 days of the scientific programme, 8 Invited Reviews and 30 Oral Communications were presented. The speakers came from 11 different European countries, and also from Argentina, Australia, Canada, Japan and the U.S.A. There were also speakers from six Portuguese research institutions, and nine of the speak ers were Ph.D. students. The contributions are presented in these proceedings in chronological order. The workshop brought together string theorists, particle physicists, theoretical and observational cosmologists, relativists and observational astrophysicists. It was generally agreed that this inter-disciplinarity was the greatest strength of the work shop, since it provided people coming into this very recent topic from the various different backgrounds with an opportunity to understand each other's language and thereby gain a more solid understanding of the overall picture. Exact solutions to Einstein’s equations have been useful for the understanding of general relativity in many respects. They have led to such physical concepts as black holes and event horizons, and helped to visualize interesting features of the theory. This volume studies the solutions to the Ernst equation associated to Riemann surfaces in detail. In addition, the book discusses the physical and mathematical aspects of this class analytically as well as numerically. This comprehensive student manual has been designed to accompany the leading textbook by Bernard Schutz, A First Course in General Relativity, and uses detailed solutions, cross-referenced to several introductory and more advanced textbooks, to enable self-learners, undergraduates and postgraduates to master general relativity through problem solving. The perfect accompaniment to Schutz's textbook, this manual guides the reader step-by-step through over 200 exercises, with clear easy-to-follow derivations. It provides detailed solutions to almost half of Schutz's exercises, and includes 125 brand new supplementary problems that address the subtle points of each chapter. It includes a comprehensive index and collects useful mathematical results, such as transformation matrices and Christoffel symbols for commonly studied spacetimes, in an appendix. Supported by an online table categorising exercises, a Maple worksheet and an instructors' manual, this text provides an invaluable resource for all students and instructors using Schutz's textbook. Professor Nicholas N Govorun, corresponding member of the USSR Academy of Sciences, was the principal organizer of the precedent meetings held at Dubna (1979, 1983, 1985). Unfortunately, he passed away in 1989. This volume is to honor his support in Computer Algebra.This is perhaps the only meeting of the entire soviet union computer algebra community and foreign scientists. The meeting presented scientific results, plans for research facilities, and status reports of the basic areas of investigations. The fields covered include computer algebra systems and general algorithms as well as applied algorithms, programs and results in computer algebra applications (mainly in physics).

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