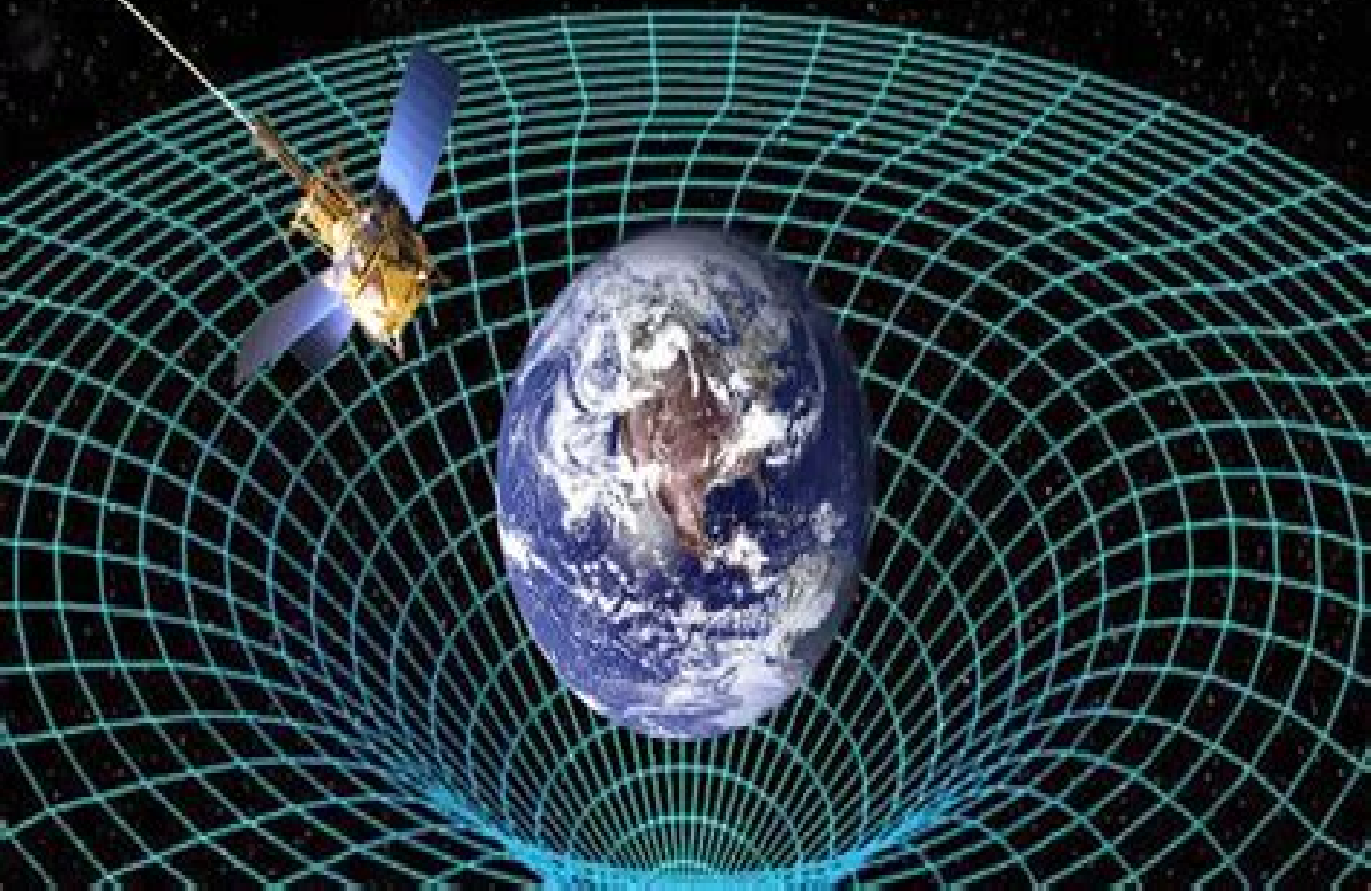


WHAT IS THE GENERAL THEORY OF RELATIVITY?



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Alan P. Lightman



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Introduction To General Relativity: Solutions To Problems John Dirk Walecka, 2017-06-16 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.

Problems in the General Theory of Relativity and Theory of Group Representations N. G. Basov, 2012-12-06 This collection contains survey articles dealing with the following topics: The Mach principle and its role in the general theory of relativity, the modern conception of the vacuum, new methods in the theory of Lie group representations, the coherent state method and its application to physical problems and the Newman Penrose method and its application to problems in general relativity theory.

Introduction To General Relativity John Dirk Walecka, 2007-04-16 A working knowledge of Einstein's theory of general relativity is an essential tool for every physicist today. This self contained book is an introductory text on the subject aimed at first year graduate students or advanced undergraduates in physics that assumes only a basic understanding of classical Lagrangian mechanics. 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. After reviewing special relativity the basic principles of general relativity are presented and the most important applications are discussed. The final special topics section guides the reader through a few important areas of current research. This book 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.

A Short Course in General Relativity James A. Foster, J. David Nightingale, 2010-04-30 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. The text begins with an exposition of those aspects of tensor calculus and differential geometry needed for a proper treatment of the subject. The discussion then turns to the spacetime of general

relativity and to geodesic motion A brief consideration of the field equations is followed by a discussion of physics in the vicinity of massive objects including an elementary treatment of black holes and rotating objects The main text concludes with introductory chapters on gravitational radiation and cosmology This new third edition has been updated to take account of fresh observational evidence and experiments It includes new sections on the Kerr solution in Chapter 4 and cosmological speeds of recession in Chapter 6 A more mathematical treatment of tensors and manifolds included in the 1st edition but omitted in the 2nd edition has been restored in an appendix Also included are two additional appendixes Special Relativity Review and The Chinese Connection and outline solutions to all exercises and problems making it especially suitable for private study

Problem Book in Relativity and Gravitation

Alan P. Lightman, 1975-12-21 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

A Student's Manual for A First Course in General

Relativity Robert B. Scott, 2016 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

The Cauchy Problem

in General Relativity Hans Ringström, 2009 The general theory of relativity is a theory of manifolds equipped with Lorentz metrics and fields which describe the matter content Einstein's equations equate the Einstein tensor a curvature quantity associated with the Lorentz metric with the stress energy tensor an object constructed using the matter fields In addition there are equations describing the evolution of the matter Using symmetry as a guiding principle one is naturally led to the Schwarzschild and Friedmann Lemaitre Robertson Walker solutions modelling an isolated system and the entire universe respectively In a different approach formulating Einstein's equations as an initial value problem allows a closer study of their solutions This book first provides a definition of the concept of initial data and a proof of the correspondence between initial data and development It turns out that some initial data allow non isometric maximal developments complicating the uniqueness issue The second half of the book is concerned with this and related problems such as strong cosmic censorship The book presents complete proofs of several classical results that play a central role in mathematical relativity but are not easily accessible to those without prior background in the subject Prerequisites are a good knowledge of basic measure and

integration theory as well as the fundamentals of Lorentz geometry The necessary background from the theory of partial differential equations and Lorentz geometry is included **300 Problems in Special and General Relativity** Mattias Blennow, Tommy Ohlsson, 2021-12-09 A textbook neutral problems and solutions book that complements any relativity textbook at advanced undergraduate or masters level **Pseudo-Complex General Relativity** Peter O. Hess, Mirko Schäfer, Walter Greiner, 2015-10-31 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 **The General Theory of Relativity** Anadijiban Das, Andrew DeBenedictis, 2012-06-26 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

A Mathematical Journey to Relativity Wladimir-Georges Boskoff, Salvatore Capozziello, 2020-06-01 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 Lema tre Robertson Walker and G del ones Some current problems like dark energy are also sketched 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

Unsolved Problems in Special and General Relativity Florentin Smarandache, Fu Yuhua, Zhao Fengjuan, 2013

Special Relativity Michael Tsamparlis, 2019-11-26 This textbook develops Special Relativity in a systematic way and offers 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

Solutions of Some Selected Problems in General Relativity Ming-Yang Wang,1974 **A General Relativity Workbook**

Thomas A. Moore,2012-12-10 A General Relativity Workbook is a textbook intended to support a one semester upper division undergraduate course on general relativity. General relativity which lies at the heart of contemporary physics has recently become the focus of a number of lively theoretical, experimental, and computational research programs. As a result, undergraduates have become increasingly excited to learn about the subject. A General Relativity Workbook is a textbook intended to support a one semester upper division undergraduate course on general relativity. Through its unique workbook based design, it enables students to develop a solid mastery of both the physics and the supporting tensor calculus by pushing and guiding them to work through the implications. Each chapter, which is designed to correspond to one class session, involves a short overview of the concepts without obscuring derivations or details, followed by a series of boxes that guide students through the process of working things out for themselves. This active learning approach enables students to develop a more secure mastery of the material than more traditional approaches. More than 350 homework problems support further learning. This book more strongly emphasizes the physics than many of its competitors, and while it provides students a full grounding in the supporting mathematics, unlike certain other competitors, it introduces the mathematics gradually and in a completely physical context.

Introduction to General Relativity and the Cosmological Constant Problem

Marcelo Samuel Berman,2007 This book is an introductory text in General Relativity while also focusing on 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.

A Short Course in General Relativity J. Foster,2006 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. The text begins with an exposition of those aspects of tensor calculus and differential geometry needed for a proper treatment of the subject. The discussion then turns to the spacetime of general relativity and to geodesic motion. A brief consideration of the field equations is followed by a discussion of physics in the vicinity of massive objects, including an elementary treatment of black holes and rotating objects. The main text concludes with introductory chapters on gravitational radiation and cosmology. This new third edition has been updated to take account of fresh observational evidence and

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Applied General Relativity Michael H. Soffel, Wen-Biao Han, 2019-09-23 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 synchronization 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

General Relativity Without Calculus Jose Natario, 2011-07-30 *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

Introduction To General Relativity And Cosmology Christian G Boehmer, 2016-10-06 *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

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