

# RELATIVITY AND COSMOLOGY

From First Principles to Interpretations



# **Relativity And Cosmology**

Jayant Vishnu Narlikar

# **Relativity And Cosmology:**

An Introduction to General Relativity and Cosmology Jerzy Plebanski, Andrzej Krasinski, 2024-05-31 Experts Pleba ski and Krasi ski provide a thorough introduction to the tools of general relativity and relativistic cosmology Assuming familiarity with advanced calculus classical mechanics electrodynamics and special relativity the text begins with a short course on differential geometry taking a unique top down approach Starting with general manifolds on which only tensors are defined the covariant derivative and affine connection are introduced before moving on to geodesics and curvature Only then is the metric tensor and the pseudo Riemannian geometry introduced specialising the general results to this case The main text describes relativity as a physical theory with applications to astrophysics and cosmology It takes the reader beyond traditional courses on relativity through in depth descriptions of inhomogeneous cosmological models and the Kerr metric Emphasis is given to complete and clear derivations of the results enabling readers to access research articles published in relativity journals General Relativity and Cosmology SUSHIL KUMAR SRIVASTAVA, 2008-06-10 The general theory of relativity and its applications to cosmology requires very deep understanding of mathematics and physics Keeping this in mind this self contained textbook is written which addresses to general relativity and cosmology In this book the attempts have been made to explain mathematicians notions in the language of a physicist Primarily intended for the postgraduate students of mathematics and physics it gives equal importance to mathematical and physical aspects and thus sharpens understanding of the theory The text covers many modern concepts and current developments in gravity and cosmology including Brans Dicke theory higher derivative gravity Kaluza Klein theory with extension to higher dimensions Besides PG students this book would also be useful for research scholars KEY FEATURES Highlights special features of general relativity and cosmology Discusses structure formation in the universe inflationary models and dark energy models with special focus on basic concepts Provides problems at the end of each chapter to stimulate thinking Reveals interconnections between required mathematical concepts Explains how to apply mathematical concepts to physical problems Discusses lagrangian formulation of the field theory and action principle as it provides a powerful tool to derive field equations and energy momentum tensor components 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 Space-Time, Relativity, and Cosmology Jose Wudka, 2006-07-20 Space Time Relativity and Cosmology provides a historical introduction to modern relativistic cosmology and traces its historical roots and evolution from antiquity to Einstein The topics are presented in a non mathematical manner with the emphasis on the ideas that underlie each theory rather than their detailed quantitative consequences A significant part of the book focuses on the Special and General theories of relativity The tests and experimental evidence supporting the theories are explained together with their predictions and their confirmation Other topics include a discussion of modern relativistic cosmology the consequences of Hubble's observations leading to the Big Bang hypothesis and an overview of the most exciting research topics in relativistic cosmology This textbook is intended for introductory undergraduate courses on the foundations of modern physics It is also accessible to advanced high school students as well as non science majors who are concerned with science issues General Relativity, Astrophysics, and Cosmology A.K. Raychaudhuri, S. Banerji, A. Banerjee, 2003-11-14 For about half a century the general theory of relativity attracted little attention from physicists However the discovery of compact objects such as guasars and pulsars as well as candidates for black holes on the one hand and the microwave background radiation on the other hand completely changed the picture In addition developments in elementary particle physics such as predictions of the behavior of matter at the ultrahigh energies that might have prevailed in the early stages of the big bang have greatly en hanced the interest in general relativity These developments created a large body of readers interested in general relativity and its applications in astrophysics and cosmology Having neither the time nor the inclination to delve deeply into the technical literature such readers need a general introduction to the subject before exploring applications It is for these readers that the present volume is intended Keeping in mind the broad range of interests and wanting to avoid mathematical complications as much as possible we have ventured to combine all three topics relativity astrophysics and cosmology in a single volume Naturally we had to make a careful selection of topics to be discussed in order to keep the book to a manageable length An Introduction to Tensor Calculus Derek F. Lawden, 2012-03-07 This elementary introduction pays special attention to aspects of tensor calculus and relativity that students tend to find most difficult Its use of relatively unsophisticated mathematics in the early chapters allows readers to develop their confidence within the framework of Cartesian coordinates before undertaking the theory of tensors in curved spaces and its application to general relativity theory Topics include the special principle of relativity and Lorentz transformations orthogonal transformations and Cartesian tensors special relativity mechanics and electrodynamics general tensor calculus and Riemannian space and the general theory of relativity including a focus on black holes and gravitational waves The text concludes with a chapter offering a sound background in applying the principles of general relativity to cosmology Numerous exercises advance the theoretical developments of the main text thus enhancing this

volume s appeal to students of applied mathematics and physics at both undergraduate and postgraduate levels Preface List of Constants References Bibliography General Relativity and Cosmology Ronald J. Adler, 2021-01-22 Gravitational physics has now become a mainstream topic in physics and physics teaching In particular cosmology and gravitational wave physics are at the focus of a great deal of current research Thus it is important to introduce students to General Relativity as soon as reasonable This textbook offers a brief but comprehensive treatment accessible to advanced undergraduate students graduate students and any physicist or mathematician interested in understanding the material in a short time The author an experienced teacher of the subject has included numerous examples and exercises to help students consolidate the ideas they have learned Solutions to the exercises are provided as supplementary material in the online chapters to General Relativity and Cosmology Jerzy Plebanski, Andrzej Krasinski, 2006-08-14 General relativity is a cornerstone of modern physics and is of major importance in its applications to cosmology Plebanski and Krasinski are experts in the field and in this book they provide a thorough introduction to general relativity guiding the reader through complete derivations of the most important results Providing coverage from a unique viewpoint geometrical physical and astrophysical properties of inhomogeneous cosmological models are all systematically and clearly presented allowing the reader to follow and verify all derivations For advanced undergraduates and graduates in physics and astronomy this textbook will enable students to develop expertise in the mathematical techniques necessary to study general relativity Relativity and Cosmology Kip S. Thorne, Roger D. Blandford, 2021-05-25 A groundbreaking textbook on twenty first century general relativity and cosmology Kip Thorne and Roger Blandford's monumental Modern Classical Physics is now available in five stand alone volumes that make ideal textbooks for individual graduate or advanced undergraduate courses on statistical physics optics elasticity and fluid dynamics plasma physics and relativity and cosmology Each volume teaches the fundamental concepts emphasizes modern real world applications and gives students a physical and intuitive understanding of the subject Relativity and Cosmology is an essential introduction to the subject including remarkable recent advances Written by award winning physicists who have made fundamental contributions to the field and taught it for decades the book differs from most others on the subject in important ways It highlights recent transformations in our understanding of black holes gravitational waves and the cosmos it emphasizes the physical interpretation of general relativity in terms of measurements made by observers it explains the physics of the Riemann tensor in terms of tidal forces differential frame dragging and associated field lines it presents an astrophysically oriented description of spinning black holes it gives a detailed analysis of an incoming gravitational wave s interaction with a detector such as LIGO and it provides a comprehensive in depth account of the universe s evolution from its earliest moments to the present While the book is designed to be used for a one guarter or full semester course it goes deep enough to provide a foundation for understanding and participating in some areas of cutting edge research Includes many exercise problems Features color figures suggestions for further reading extensive cross

references and a detailed index Optional Track 2 sections make this an ideal book for a one guarter or one semester course An online illustration package is available to professors The five volumes which are available individually as paperbacks and ebooks are Statistical Physics Optics Elasticity and Fluid Dynamics Plasma Physics and Relativity and Cosmology College Course on Relativity and Cosmology Ta-Pei Cheng, 2015-06-18 This advanced undergraduate text introduces Einstein s general theory of relativity The topics covered include geometric formulation of special relativity the principle of equivalence Einstein's field equation and its spherical symmetric solution as well as cosmology An emphasis is placed on physical examples and simple applications without the full tensor apparatus It begins by examining the physics of the equivalence principle and looks at how it inspired Einstein's idea of curved spacetime as the gravitational field At a more mathematically accessible level it provides a metric description of a warped space allowing the reader to study many interesting phenomena such as gravitational time dilation GPS operation light deflection precession of Mercury s perihelion and black holes Numerous modern topics in cosmology are discussed from primordial inflation and cosmic microwave background to the dark energy that propels an accelerating universe Building on Cheng's previous book Relativity Gravitation and Cosmology A Basic Introduction this text has been tailored to the advanced student It concentrates on the core elements of the subject making it suitable for a one semester course at the undergraduate level It can also serve as an accessible introduction of general relativity and cosmology for those readers who want to study the subject on their own The proper tensor formulation of Einstein's field equation is presented in an appendix chapter for those wishing to glimpse Gravity, Black Holes, and the Very Early Universe Tai L. Chow, 2007-10-24 Here further at the mathematical details it is in a nutshell the history of one genius s most crucial work discoveries that were to change the face of modern physics In the early 1900s Albert Einstein formulated two theories that would forever change the landscape of physics the Special Theory of Relativity and the General Theory of Relativity Respected American academic Professor Tai Chow tells us the story of these discoveries He details the basic ideas of Einstein including his law of gravitation Deftly employing his inimitable writing style he goes on to explain the physics behind black holes weaving into his account an explanation of the structure of the universe and the science of cosmology Tensors, Relativity, and Cosmology Mirjana Dalarsson, Nils Dalarsson, 2015-07-08 Tensors Relativity and Cosmology Second Edition combines relativity astrophysics and cosmology in a single volume providing a simplified introduction to each subject that is followed by detailed mathematical derivations The book includes a section on general relativity that gives the case for a curved space time presents the mathematical background tensor calculus Riemannian geometry discusses the Einstein equation and its solutions including black holes and Penrose processes and considers the energy momentum tensor for various solutions In addition a section on relativistic astrophysics discusses stellar contraction and collapse neutron stars and their equations of state black holes and accretion onto collapsed objects with a final section on cosmology discussing cosmological models observational tests and scenarios for the early universe This fully revised and updated second edition includes new material on relativistic effects such as the behavior of clocks and measuring rods in motion relativistic addition of velocities and the twin paradox as well as new material on gravitational waves amongst other topics Clearly combines relativity astrophysics and cosmology in a single volume Extensive introductions to each section are followed by relevant examples and numerous exercises Presents topics of interest to those researching and studying tensor calculus the theory of relativity gravitation cosmology quantum cosmology Robertson Walker Metrics curvature tensors kinematics black holes and more Fully revised and updated with 80 pages of new material on relativistic effects such as relativity of simultaneity and relativity of the concept of distance amongst other topics Provides an easy to understand approach to this advanced field of mathematics and modern physics by providing highly detailed derivations of all equations and results Lectures on General Relativity and Cosmology Jayant Vishnu Narlikar, 1979 Relativity, Thermodynamics, and Cosmology Richard Chace Tolman, 1987-01-01 Landmark study discusses Einstein's theory extends thermodynamics to special and general relativity and also develops the applications of relativistic mechanics and thermodynamics to cosmological models Einstein's General Theory of Relativity Øyvind Grøn, Sigbjorn Hervik, 2007-08-24 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

General Relativity and Cosmology Salvatore Capozziello, Mariafelicia De Laurentis, 2016-08-31 This book offers an excellent introduction to General Relativity and Cosmology It is designed to serve as a self contained text for graduate and advanced undergraduate students and also to provide a basic text for PhD courses Each of the four parts of the book two basic and two advanced can be used as an independent module In the first part the main concepts of General Relativity are presented while the second offers an introduction to the astrophysical applications The third part is advanced and discusses the extensions of General Relativity the contents represent ideal material for a short course at PhD level The final part of the book provides an introduction to Relativistic Cosmology and its applications Throughout the text all mathematical calculations are explained clearly in step by step detail Whenever appropriate the reader is guided to further specialized sources of information

A Short Course in General Relativity and Cosmology Reinhard Hentschke, Christian Hölbling, 2020-08-15 Unlike most traditional introductory textbooks on relativity and cosmology that answer questions like Does accelerated expansion pull our bodies apart Does the presence of dark matter affect the classical tests of general relativity in a qualitative manner the present text is intended as a foundation enabling students to read and understand the

textbooks and many of the scientific papers on the subject And above all the readers are taught and encouraged to do their own calculations check the numbers and answer the above and other questions regarding the most exciting discoveries and theoretical developments in general relativistic cosmology which have occurred since the early 1980s In comparison to these intellectual benefits the text is short In fact its brevity without neglect of scope or mathematical accessibility of key points is rather unique The authors connect the necessary mathematical concepts and their reward i e the understanding of an important piece of modern physics along the shortest path The unavoidable mathematical concepts and tools are presented in as straightforward manner as possible Even though the mathematics is not very difficult it certainly is beneficial to know some statistical thermodynamics as well as some quantum mechanics Thus the text is suitable for the upper undergraduate curriculum **Beyond Einstein** David E. Rowe, Tilman Sauer, Scott A. Walter, 2018-06-18 Beyond Einstein Perspectives on Geometry Gravitation and Cosmology explores the rich interplay between mathematical and physical ideas by studying the interactions of major actors and the roles of important research communities over the course of the last century

Gravitation and Cosmology Steven Weinberg, 1972 Weinberg s 1972 work in his description had two purposes The first was practical to bring together and assess the wealth of data provided over the previous decade while realizing that newer data would come in even as the book was being printed He hoped the comprehensive picture would prepare the reader and himself to that new data as it emerged The second was to produce a textbook about general relativity in which geometric ideas were not given a starring role for in his words too great an emphasis on geometry can only obscure the deep connections between gravitation and the rest of physics **Introduction to General Relativity and Cosmology** Christian G. Böhmer, 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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