



Gravitational Waves

Harry Collins



Gravitational Waves:

Physics of Gravitational Waves Arun Kenath, Chandra Sivaram, 2023-05-01 This book provides a concise introduction to the physics of gravitational waves. It is aimed at graduate level students and PhD scholars. Ever since the discovery of gravitational waves in 2016, gravitational wave astronomy has been adding to our understanding of the universe. Gravitational waves have been detected in the past few years from several transient events such as merging stellar mass black holes, binary neutron stars, etc. These waves have frequencies in a band ranging from a few hundred hertz to around a kilohertz to which LIGO type instruments are sensitive. LISA will be sensitive to much lower range of frequencies from SMBH mergers. Apart from these cataclysmic burst events, there are innumerable sources of radiation which are continuously emitting gravitational waves of all frequencies. These include a whole mass range of compact binary and isolated compact objects and close planetary stellar entities. This book discusses the gravitational wave background produced in typical frequency ranges from such sources emitting over a Hubble time and the fluctuations in the h values measured in the usual devices. Also discussed are the high frequency thermal background gravitational radiation from hot stellar interiors and newly formed compact objects. The reader will also learn how gravitational waves provide a testing tool for various theories of gravity, i.e. general relativity and extended theories of gravity and will be the definitive test for general relativity.

Gravity from the Ground Up Bernard Schutz, 2003-12-04 This book invites the reader to understand our Universe, not just marvel at it. From the clock-like motions of the planets to the catastrophic collapse of a star into a black hole, gravity controls the Universe. Gravity is central to modern physics, helping to answer the deepest questions about the nature of time, the origin of the Universe, and the unification of the forces of nature. Linking key experiments and observations through careful physical reasoning, the author builds the reader's insight step by step from simple but profound facts about gravity on Earth to the frontiers of research. Topics covered include the nature of stars and galaxies, the mysteries of dark matter and dark energy, black holes, gravitational waves, inflation, and the Big Bang. Suitable for general readers and for undergraduate courses, the treatment uses only high school level mathematics, supplemented by optional computer programs to explain the laws of physics governing gravity.

Gravitational Waves I I. Ciufolini, V. Gorini, U. Moschella, P. Fre, 2001-01-29 Gravitational waves (GWs) are a hot topic and promise to play a central role in astrophysics, cosmology, and theoretical physics. Technological developments have led us to the brink of their direct observation, which could become a reality in the coming years. The direct observation of GWs will open an entirely new field: GW astronomy. This is expected.

Understanding Gravitational Waves C. R. Kitchin, 2021-09-23 The birth of a completely new branch of observational astronomy is a rare and exciting occurrence. For a long time, our theories about gravitational waves proposed by Albert Einstein and others more than a hundred years ago could never be fully proven since we lacked the proper technology to do it. That all changed when on September 14, 2015, instruments at the LIGO Observatory detected gravitational waves for the first time. This book explores the nature of

gravitational waves what they are where they come from why they are so significant and why nobody could prove they existed before now Written in plain language and interspersed with additional explanatory tutorials it will appeal to lay readers science enthusiasts physical science students amateur astronomers and to professional scientists and astronomers

Gravitational Waves Explained Richard Gaughan,2018-12-15 In September of 2015 the scientific world was buzzing gravitational waves had been detected It was a dramatic and conclusive demonstration of Einstein's theory of general relativity the most complex and far reaching theory in the history of physics Through detailed diagrams relatable analogies and informative sidebars this text cuts through the complexity and sophistication providing an accessible introduction to the physics of waves the implications of general relativity and the ways in which gravitational waves can bring new understanding of the universe around us *General Relativity and Gravitational Waves* Sanjeev Dhurandhar,Sanjit

Mitra,2022-02-16 This book serves as a textbook for senior undergraduate students who are learning the subject of general relativity and gravitational waves for the first time Both authors have been teaching the course in various forms for a few decades and have designed the book as a one stop book at basic level including derivations and exercises A spectacular prediction of general relativity is gravitational waves Gravitational waves were first detected by the LIGO detectors in 2015 hundred years after their prediction Both authors are part of the LIGO Science Collaboration and were authors on the discovery paper Therefore a strong motivation for this book is to provide the essential concepts of general relativity theory and gravitational waves with their modern applications to students and to researchers who are new to the multi disciplinary field of gravitational wave astronomy One of the advanced topics covered in this book is the fundamentals of gravitational wave data analysis filling a gap in textbooks on general relativity The topic blends smoothly with other chapters in the book not only because of the common area of research but it uses similar differential geometric and algebraic tools that are used in general relativity **Nuclear Science Abstracts** ,1976 Gravitational Waves I. Ciufolini,V. Gorini,U. Moschella,P

Fre,2001-01-29 Gravitational waves GWs are a hot topic and promise to play a central role in astrophysics cosmology and theoretical physics Technological developments have led us to the brink of their direct observation which could become a reality in the coming years The direct observation of GWs will open an entirely new field GW astronomy This is expe

Gravity's Shadow Harry Collins,2010-08-15 According to the theory of relativity we are constantly bathed in gravitational radiation When stars explode or collide a portion of their mass becomes energy that disturbs the very fabric of the space time continuum like ripples in a pond But proving the existence of these waves has been difficult the cosmic shudders are so weak that only the most sensitive instruments can be expected to observe them directly Fifteen times during the last thirty years scientists have claimed to have detected gravitational waves but so far none of those claims have survived the scrutiny of the scientific community Gravity's Shadow chronicles the forty year effort to detect gravitational waves while exploring the meaning of scientific knowledge and the nature of expertise Gravitational wave detection involves recording the collisions

explosions and trembling of stars and black holes by evaluating the smallest changes ever measured Because gravitational waves are so faint their detection will come not in an exuberant moment of discovery but through a chain of inference for forty years scientists have debated whether there is anything to detect and whether it has yet been detected Sociologist Harry Collins has been tracking the progress of this research since 1972 interviewing key scientists and delineating the social process of the science of gravitational waves Engagingly written and authoritatively comprehensive Gravity's Shadow explores the people institutions and government organizations involved in the detection of gravitational waves This sociological history will prove essential not only to sociologists and historians of science but to scientists themselves

Black Holes, Gravitational Waves, and Cosmology Martin J. Rees, Remo Ruffini, John Archibald Wheeler, 1974 This volume first appeared in the English and Russian editions in 1974 as an introduction for new graduate students to the rapidly developing field of relativistic astrophysics and cosmology Some of the classic concepts introduced in the first edition included the lines of force of electric and magnetic fields near a black hole the ergosphere and effective potential techniques for a rotating black hole the details of rotational energy extraction from a black hole the basic estimates for the cross sections of gravitational wave detectors and for the energy sources of gravitational waves the scenario for gravitational collapse In cosmology the foundations of the hot big bang model the cosmic background radiation and cosmological nucleosynthesis were reviewed and the volume concluded with a lecture entitled Beyond the End of Time by J A Wheeler Since 1974 enormous progress has occurred in some of these areas and the corresponding treatments are complex This new edition provides a useful source of reference and presents the initial treatments of these topics and the ideas that motivated them thus providing a more complete picture of the development of this field for the reader In order to mark the progress made in the intervening years the authors have compiled a introduction to the new edition and an Appendix which comprises classic reprints which are related to the problems discussed in the original edition

Gravitational Waves David M. Feldbaum, 2020-08-04 Gravitational wave GW research is one of the most rapidly developing subfields in experimental physics today The theoretical underpinnings of this endeavor trace to the discussions of the speed of gravity in the 18th century but the modern understanding of this phenomena was not realized until the middle of the 20th century The minuteness of the gravitational force means that the effects associated with GWs are vanishingly small To detect the GWs produced by the most enormously energetic sources in the universe humans had to build devices capable of measuring the tiniest amounts of forces and displacements This book delves into the exploration of the basics of the theory of GW their generation propagation and detection by various methods It does not delve into the depths of Einstein's General Relativity but instead discusses successively closer approximations to the full theory As a result the book should be accessible to an ambitious undergraduate student majoring in physics or engineering It could be read concurrently with standard junior level textbooks in classical mechanics and electromagnetic theory

Overview Of Gravitational Waves, An: Theory, Sources And

Detection Gerard Auger, Eric Plagnol, 2017-02-15 This book describes detection techniques used to search for and analyze gravitational waves GW It covers the whole domain of GW science starting from the theory and ending with the experimental techniques both present and future used to detect them The theoretical sections of the book address the theory of general relativity and of GW followed by the theory of GW detection The various sources of GW are described as well as the methods used to analyse them and to extract their physical parameters It includes an analysis of the consequences of GW observations in terms of astrophysics as well as a description of the different detectors that exist and that are planned for the future With the recent announcement of GW detection and the first results from LISA Pathfinder this book will allow non specialists to understand the present status of the field and the future of gravitational wave science Workshop on the Search of

Gravitational Waves Eduardo Posada, E. Posada, G. Violini, 1983 Gravity! Pierre Binétruy, 2018-04-23 What force do the Big Bang the expansion of the Universe dark matter and dark energy black holes and gravitational waves all have in common This book uncovers gravity as a key to understanding these fascinating phenomena that have so captivated public interest in recent years Readers will discover the latest findings on how this familiar force in our everyday lives powers the most colossal changes in the Universe Written by the widely recognized French public scientist and leading astrophysicist Pierre Bin try the book also explains the recent experimental confirmation of the existence of gravitational waves

Gravitational Waves Michele Maggiore, 2007-10-05 The aim of this book is to become a major reference text for gravitational wave physics covering in detail both the experimental and the theoretical aspects It is the only existing book on gravitational waves to date and it will likely remain unique for its broadness and scope It brings the reader to the forefront of present day research both theoretical and experimental assuming no previous knowledge of gravitational wave physics Part I of Volume 1 is devoted to the theory of gravitational waves Here we have re derived in a coherent way most of the results that we present clarifying or streamlining existing derivations Part II of Volume 1 is devoted to a description of experimental gravitational wave physics We discuss in great detail existing and planned experiments as well as data analysis techniques

Gravitational Waves Ajit Kembhavi, Pushpa Khare, 2020-08-06 Gravitational waves were first predicted by Albert Einstein in 1916 a year after the development of his new theory of gravitation known as the general theory of relativity This theory established gravitation as the curvature of space time produced by matter and energy To be discernible even to the most sensitive instruments on Earth the waves have to be produced by immensely massive objects like black holes and neutron stars which are rotating around each other or in the extreme situations which prevail in the very early ages of the Universe This book presents the story of the prediction of gravitational waves by Albert Einstein the early attempts to detect the waves the development of the LIGO detector the first detection in 2016 the subsequent detections and their implications All concepts are described in some detail without the use of any mathematics and advanced physics which are needed for a full understanding of the subject The book also contains description of electromagnetism Einstein s special theory and

general theory of relativity white dwarfs neutron stars and black holes and other concepts which are needed for understanding gravitational waves and their effects Also described are the LIGO detectors and the cutting edge technology that goes into building them and the extremely accurate measurements that are needed to detect gravitational waves The book covers these ideas in a simple and lucid fashion which should be accessible to all interested readers The first detection of gravitational waves was given a lot of space in the print and electronic media So the curiosity of the non technical audience has been aroused about what gravitational waves really are and why they are so important This book seeks to answer such questions

10 M Prototype for the Laser Interferometer Gravitational Wave Antenna S. Kawamura,1989

Electrodynamics Wave-theory of Physical Forces Thomas Jefferson Jackson See,1917 **General Relativity and Gravitational Waves** Joseph Weber,2004-01-01 An internationally famous physicist and electrical engineer the author of this text was a pioneer in the investigation of gravitational waves Joseph Weber s *General Relativity and Gravitational Waves* offers a classic treatment of the subject Appropriate for upper level undergraduates and graduate students this text remains ever relevant Brief but thorough in its introduction to the foundations of general relativity it also examines the elements of Riemannian geometry and tensor calculus applicable to this field Approximately a quarter of the contents explores theoretical and experimental aspects of gravitational radiation The final chapter focuses on selected topics related to general relativity including the equations of motion unified field theories Friedman s solution of the cosmological problem and the Hamiltonian formulation of general relativity Exercises Index

Gravity's Kiss Harry Collins,2017-01-27 A fascinating account written in real time of the unfolding of a scientific discovery the first detection of gravitational waves

Reviewing **Gravitational Waves**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is truly astonishing. Within the pages of "**Gravitational Waves**," an enthralling opus penned by a very acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book's central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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Gravitational Waves Introduction

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