



Mercury's Perihelion from Le Verrier to Einstein

N. T. Roseveare

Mercurys Perihelion From Le Verrier To Einstein

Michel Janssen, Jürgen Renn



Mercurys Perihelion From Le Verrier To Einstein:

Mercury's Perihelion, from Le Verrier to Einstein N. T. Roseveare, 1982 **How Einstein Created Relativity out of Physics and Astronomy** David Topper, 2012-09-27 This book tracks the history of the theory of relativity through Einstein's life with in depth studies of its background as built upon by ideas from earlier scientists The focus points of Einstein's theory of relativity include its development throughout his life the origins of his ideas and his indebtedness to the earlier works of Galileo Newton Faraday Mach and others the application of the theory to the birth of modern cosmology and his quest for a unified field theory Treading a fine line between the popular and technical but not shying away from the occasional equation this book explains the entire range of relativity and weaves an up to date biography of Einstein throughout The result is an explanation of the world of relativity based on an extensive journey into earlier physics and a simultaneous voyage into the mind of Einstein written for the curious and intelligent reader 100 Years of Gravity and Accelerated Frames Jong-Ping Hsu, Dana Fine, 2005 This collection of papers presents ideas and problems arising over the past 100 years regarding classical and quantum gravity gauge theories of gravity and spacetime transformations of accelerated frames Both Einstein's theory of gravity and the Yang-Mills theory are gauge invariant The invariance principles in physics have transcended both kinetic and dynamic properties and are at the very heart of our understanding of the physical world In this spirit this book attempts to survey the development of various formulations for gravitational and Yang-Mills fields and spacetime transformations of accelerated frames and to reveal their associated problems and limitations The aim is to present some of the leading ideas and problems discussed by physicists and mathematicians We highlight three aspects formulations of gravity as a Yang-Mills field first discussed by Utiyama problems of gravitational theory discussed by Feynman Dyson and others spacetime properties and the physics of fields and particles in accelerated frames of reference These unfulfilled aspects of Einstein and Yang-Mills profound thoughts present a great challenge to physicists and mathematicians in the 21st century **How Einstein Found His Field Equations** Michel Janssen, Jürgen Renn, 2022-07-29 Einstein's field equations of gravitation are a core element of his general theory of relativity In four short communications to the Prussian Academy of Sciences in Berlin in November 1915 we can follow the final steps toward these equations and the resulting theory's spectacular success in accounting for the anomalous motion of Mercury's perihelion This source book provides an expert guide to these four groundbreaking papers Following an introductory essay placing these papers in the context of the development of Einstein's theory it presents and analyzes in addition to the four papers of November 1915 a careful selection of critical excerpts from papers letters and manuscripts documenting the path that early on led Einstein to the field equations of the first November 1915 paper but then took a turn away from them only to lead back to them in the end Drawing on extensive research at the Einstein Papers Project and the Max Planck Institute for History of Science this volume traces the intricate interplay between considerations of physics and considerations of mathematics that guided Einstein along this path

It thus presents a concise yet authoritative account of how Einstein found his field equations affording readers who are prepared to immerse themselves in these intricacies a unique glimpse of Einstein at work at the height of his creative prowess Highlights of this journey in Einstein's footsteps include the crucial pages with detailed annotation from the Zurich Notebook the record of Einstein's early search for field equation with his mathematician friend Marcel Grossmann and the Einstein Besso manuscript documenting Einstein's attempts with his friend and confidant Michele Besso to explain the Mercury anomaly on the basis of the equations that he and Grossmann had eventually settled on in the Zurich Notebook

Relativity Principles and Theories from Galileo to Einstein Olivier Darrigol, 2021-12-22 This book is a full long term history of relativity thinking in physics from Galileo's early reflections on the proper reference of mechanical motion to Einstein's exploitation of relativity principles in his theories of special and general relativity

Enchantment Of Urania, The: 25 Centuries Of Exploration Of The Sky Massimo Capaccioli, 2024-03-19 Today we know much about the sky how stars are born how they live and die and how the universe as a whole evolves We have learned of the existence of another type of matter indifferent to light and yet decisive for the formation of galaxies and we have a hint of a dark energy that since the last 4 5 billion years has taken over the control of the cosmos We postulated and then discovered and even photographed black holes and listened to the faint rustle of the space time ripple produced when these monsters devour each other We reached these astonishing results recognized by a bunch of Nobel Prizes and filling every day the media with wonders for the eyes and the mind by the marriage of physics and astronomy that unified the Earth with the sky and then by the leap forward of science and technology in the Twentieth Century This rich heritage has ancient roots It was built by accumulating discoveries with errors observations with fantasies myths and superstitions with flashes of genius over a span of millennia since Homo sapiens turning his eyes to the immutable and perfect sky began to ask questions The book is a narration of the answers to these questions that had evolved over time a progressive path inserted in the general history with some second thoughts and many obstacles This is a saga of men and machines where greatness sometimes mixes with misery and passion often borders on sacrifice and even martyrdom Why should we know it Because our current knowledge is the result of these efforts and of the preconceptions that accompanied them The challenge has been to present this complex and intricate subject without resorting to any formulas so that it can be accessible to a wide audience of curious people including high school and university students and in general all those who normally keep themselves informed of scientific things A rich bibliography has also been added in the appendix for those wishing to learn more on one or more topics

Physics and National Socialism Klaus Hentschel, 2011-10-03 1 Aim and General Description of the Anthology The purpose of this anthology is to introduce the English speaking public to the wide spectrum of texts authored predominantly by physicists portraying the actual and perceived role of physics in the Nazi state Up to now no broad and well balanced documentation of German physics during this time has been available in English despite the significant role physics has played both politically

e.g. in weaponry planning and ideologically e.g. in the controversy over the value of theoretical Jewish vs. experimental Aryan physics and even though prominent figures like the scientist philosopher and emigré Albert Einstein and the controversial nuclear physicist Werner Heisenberg have become household names. This anthology will attempt to bridge this gap by presenting contemporary documents and eye witness accounts by the physicists themselves. Authors were chosen to represent the various political opinions and specialties within the physics community omitting some of the more readily accessible texts by leading physicists e.g. Einstein, Heisenberg, Lenard in favor of those by less well known but nonetheless important figures e.g. Finkelburg, Max Wien, Ramsauer. In this way we hope not only to circumvent the constricted Great Men approach to history but also to offer a broader picture of the activities and conflicts within the field and the effects of the political forces exerted upon them.

Gravitation & Astrophysics, 4th Intl Workshop Jong-ping Hsu, Xin Zhou, Li, Liao Liu, Jun Luo, 2000-10-31. It is the tradition of this series of workshops that theorists and experimentalists sharing common interests discuss a variety of issues relevant to promoting the quest to unify microscopic physics and gravitation. This proceedings volume embodies that tradition. It included current hot topics such as superconducting accelerometers, low temperature long distance telescopes for gravitational waves, gravitational experiment with high precision torsion pendulums and modern high technology physics of neutron stars, the theory of accretion disc, Ashtekar's theory, physics of wormholes and black holes and entropy.

Einstein and the Universe Charles Nordmann, 1922. **Einstein's Monsters** Chris Impey, 2018-11-13. A skillfully told history of the quest to find black holes. Manjit Kumar, Financial Times. Black holes are the best known and least understood objects in the universe. In Einstein's Monsters, distinguished astronomer Chris Impey takes readers on a vivid tour of these enigmatic giants. He weaves a fascinating tale out of the fiendishly complex math of black holes and the colorful history of their discovery. Impey blends this history with a poignant account of the phenomena scientists have witnessed while observing black holes: stars swarming like bees around the center of our galaxy, black holes performing gravitational waltzes with visible stars, the cymbal clash of two black holes colliding, releasing ripples in space time. Clear, compelling and profound, Einstein's Monsters reveals how our comprehension of black holes is intrinsically linked to how we make sense of the universe and our place within it.

The Genesis of General Relativity Jürgen Renn, 2007-06-17. The transition from classical to modern physics in the first half of the twentieth century by quantum and relativity theories affected some of the most fundamental notions of physical thinking such as matter, radiation, space and time. This transition thus represents a challenge for any attempt to understand the structures of a scientific revolution. The present four volume work aims at a comprehensive account of the way in which the work of Albert Einstein and his contemporaries changed our understanding of space time and gravitation. The conceptual framework of classical nineteenth century physics had to be fundamentally restructured and reinterpreted in order to arrive at a theory of gravitation compatible with the new notions of space and time established in 1905 by Einstein's special theory of relativity. Whereas the

classical theory of gravitation postulated an instantaneous action at a distance Einstein's new relativistic kinematics rather suggested an analogy between the gravitational field and the electromagnetic field propagating with a finite speed It is therefore not surprising that Einstein was not alone in addressing the problem of formulating a theory of gravitation that complies with the kinematics of relativity theory The analysis of these alternative approaches as well as of earlier alternative approaches to gravitation within classical physics turns out to be crucial for identifying the necessities and contingencies in the actual historical development

The First Law of Mechanics in General Relativity & Isochrone Orbits in Newtonian Gravity Paul Ramond, 2023-04-30 The thesis tackles two distinct problems of great interest in gravitational mechanics one relativistic and one Newtonian The relativistic one is concerned with the first law of binary mechanics a remarkably simple variational relation that plays a crucial role in the modern understanding of the gravitational two body problem thereby contributing to the effort to detect gravitational wave signals from binary systems of black holes and neutron stars The work reported in the thesis provides a mathematically elegant extension of previous results to compact objects that carry spin angular momentum and quadrupolar deformations which more accurately represent astrophysical bodies than mere point particles The Newtonian problem is concerned with the isochrone problem of celestial mechanics namely the determination of the set of radial potentials whose bounded orbits have a radial period independent of the angular momentum The thesis solves this problem completely in a geometrical way and explores its consequence on a variety of levels in particular with a complete characterisation of isochrone orbits The thesis is exceptional in the breadth of its scope and achievements It is clearly and eloquently written makes excellent use of images provides careful explanations of the concepts and calculations and it conveys the author's personality in a way that is rare in scientific writing while never sacrificing academic rigor

Everything's Relative Tony Rothman, 2008-05-02 The surprising truth behind many of the most cherished facts in science history Morse invented the telegraph Bell the telephone Edison the light bulb and Marconi the radio right Well the truth is slightly more complicated The history of science and technology is riddled with apocrypha inaccuracies and falsehoods and physicist Tony Rothman has taken it upon himself to throw a monkey wrench into the works Combining a storyteller's gifts with a scientist's focus and hardheaded devotion to the facts such as they may be Rothman breaks down many of the most famous just so stories of physics astronomy chemistry biology and technology to give credit where credit is truly due From Einstein's possible misunderstanding of his own theories to actress Hedy Lemarr's role in the invention of the radio controlled torpedo he dredges his way through the legends of science history in relating the fascinating stories behind some of the most important and often unsung breakthroughs in science Tony Rothman PhD Bryn Mawr PA is a Research Associate at Bryn Mawr College He is the author of seven other critically acclaimed science books and a frequent contributor to leading science publications including Scientific American and Discover

Einstein and the Changing Worldviews of Physics Christoph Lehner, Jürgen Renn, Matthias Schemmel, 2012-02-02 This volume reviews conceptual conflicts at the foundations of

physics now and in the past century The focus is on the conditions and consequences of Einstein's pathbreaking achievements that sealed the decline of the classical notions of space time radiation and matter and resulted in the theory of relativity Particular attention is paid to the implications of conceptual conflicts for scientific views of the world at large thus providing the basis for a comparison of the demise of the mechanical worldview at the turn of the 20th century with the challenges presented by cosmology at the turn of the 21st century Throughout the work Einstein's contributions are not seen in isolation but instead set into the wider intellectual context of dealing with the problem of gravitation in the twilight of classical physics the investigation of the historical development is carried out with a number of epistemological questions in mind concerning in particular the transformation process of knowledge associated with the changing worldviews of physics

Einstein Thomas Ryckman, 2017-05-18 Albert Einstein 1879-1955 was the most influential physicist of the 20th century Less well known is that fundamental philosophical problems such as concept formation the role of epistemology in developing and explaining the character of physical theories and the debate between positivism and realism played a central role in his thought as a whole Thomas Ryckman shows that already at the beginning of his career at a time when the twin pillars of classical physics Newtonian mechanics and Maxwell's electromagnetism were known to have but limited validity Einstein sought to advance physical theory by positing certain physical principles as secure footholds That philosophy produced his greatest triumph the general theory of relativity and his greatest failure an unwillingness to accept quantum mechanics This book shows that Einstein's philosophy grew from a lifelong aspiration for a unified theoretical representation encompassing all physical phenomena It also considers how Einstein's theories of relativity and criticisms of quantum theory shaped the course of 20th century philosophy of science Including a chronology glossary chapter summaries and suggestions for further reading Einstein is an ideal introduction to this iconic figure in 20th century science and philosophy It is essential reading for students of philosophy of science and is also suitable for those working in related areas such as physics history of science or intellectual history

Epistemology of Experimental Gravity - Scientific Rationality Nicolae Sfetcu, 2019 The evolution of gravitational tests from an epistemological perspective framed in the concept of rational reconstruction of Imre Lakatos based on his methodology of research programmes Unlike other works on the same subject the evaluated period is very extensive starting with Newton's natural philosophy and up to the quantum gravity theories of today In order to explain in a more rational way the complex evolution of the gravity concept of the last century I propose a natural extension of the methodology of the research programmes of Lakatos that I then use during the paper I believe that this approach offers a new perspective on how evolved over time the concept of gravity and the methods of testing each theory of gravity through observations and experiments I argue based on the methodology of the research programmes and the studies of scientists and philosophers that the current theories of quantum gravity are degenerative due to the lack of experimental evidence over a long period of time and of self immunization against the possibility of falsification Moreover a methodological current is

being developed that assigns a secondary unimportant role to verification through observations and or experiments For this reason it will not be possible to have a complete theory of quantum gravity in its current form which to include to the limit the general relativity since physical theories have always been adjusted during their evolution based on observational or experimental tests and verified by the predictions made Also contrary to a widespread opinion and current active programs regarding the unification of all the fundamental forces of physics in a single final theory based on string theory I argue that this unification is generally unlikely and it is not possible anyway for a unification to be developed based on current theories of quantum gravity including string theory In addition I support the views of some scientists and philosophers that currently too much resources are being consumed on the idea of developing quantum gravity theories and in particular string theory to include general relativity and to unify gravity with other forces as long as science does not impose such research programs

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Practical Astrodynamics Alessandro de Iaco Veris,2017-11-28 This modern textbook guides the reader through the theory and practice of the motion and attitude control of space vehicles It first presents the fundamental principles of spaceflight mechanics and then addresses more complex concepts and applications of perturbation theory orbit determination and refinement space propulsion orbital maneuvers interplanetary trajectories gyroscope dynamics attitude control and rocket performance Many algorithms used in the modern practice of trajectory computation are also provided The numerical treatment of the equations of motion the related methods and the

tables needed to use them receive particular emphasis A large collection of bibliographical references including books articles and items from the gray literature is provided at the end of each chapter and attention is drawn to many internet resources available to the reader The book will be of particular value to undergraduate and graduate students in aerospace engineering

The Road to Relativity Hanoch Gutfreund, Jürgen Renn, 2017-05-09 An annotated facsimile edition of Einstein's handwritten manuscript on the foundations of general relativity This richly annotated facsimile edition of *The Foundation of General Relativity* introduces a new generation of readers to Albert Einstein's theory of gravitation Written in 1915 this remarkable document is a watershed in the history of physics and an enduring testament to the elegance and precision of Einstein's thought Presented here is a beautiful facsimile of Einstein's original handwritten manuscript along with its English translation and an insightful page by page commentary that places the work in historical and scientific context Hanoch Gutfreund and Jürgen Renn's concise introduction traces Einstein's intellectual odyssey from special to general relativity and their essay *The Charm of a Manuscript* provides a delightful meditation on the varied afterlife of Einstein's text Featuring a foreword by John Stachel this handsome edition also includes a biographical glossary of the figures discussed in the book a comprehensive bibliography suggestions for further reading and numerous photos and illustrations throughout

Recent Advances And Cross-century Outlooks In Physics: Interplay Between Theory And Experiment Cheuk-yin Wong, Pisin Chen, 2000-04-05

Mathematical Aspects of Paradoxes in Cosmology Michal Křížek, Lawrence Somer, 2023-07-05 This book provides a mathematical and numerical analysis of many problems which lead to paradoxes in contemporary cosmology in particular the existence of dark matter and dark energy It is shown that these hypothetical quantities arise from excessive extrapolations of simple mathematical models to the whole physical universe Written in a completely different style to most books on General Relativity and cosmology the important results take the form of mathematical theorems with precise assumptions and statements All theorems are followed by a corresponding proof or an exact reference to the proof Some nonstandard topics are also covered including violation of the causality principle in Newtonian mechanics a critical mathematical and numerical analysis of Mercury's perihelion shift inapplicability of Einstein's equations to the classical two body problem due to computational complexity non uniqueness of the notion of universe the topology of the universe various descriptions of a hypersphere regular tessellations of hyperbolic spaces local Hubble expansion of the universe neglected gravitational redshift in the detection of gravitational waves and the possible distribution of mass inside a black hole The book also dispels some myths appearing in the theory of relativity and in contemporary cosmology For example although the hidden assumption that Einstein's equations provide a good description of the evolution of the whole universe is considered to be obvious it is just a null hypothesis which has not been verified by any experiment and has only been postulated by excessive extrapolations of many orders of magnitude

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