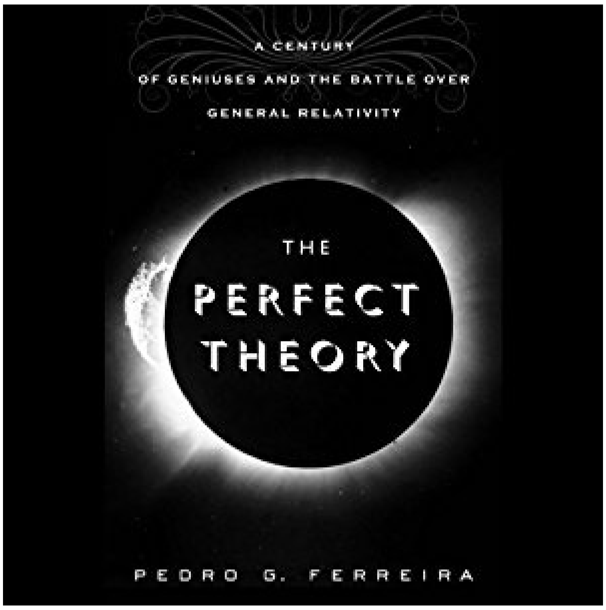
The Perfect Theory: A Century Of Geniuses And The Battle Over General Relativity



Synopsis

How did one elegant theory incite a scientific revolution?Physicists have been exploring, debating, and questioning the general theory of relativity ever since Albert Einstein first presented it in 1915. Their work has uncovered a number of the universe’s more surprising secrets, and many believe further wonders remain hidden within the theory’s tangle of equations, waiting to be exposed. In this sweeping narrative of science and culture, astrophysicist Pedro Ferreira brings general relativity to life through the story of the brilliant physicists, mathematicians, and astronomers who have taken up its challenge. For these scientists, the theory has been both a treasure trove and an enigma, fueling a century of intellectual struggle and triumph.Einstein’s theory, which explains the relationships among gravity, space, and time, is possibly the most perfect intellectual achievement of modern physics, yet studying it has always been a controversial endeavor. Relativists were the target of persecution in Hitler’s Germany, hounded in Stalin’s Russia, and disdained in 1950s America. Even today, doctorate students are warned that specializing in general relativity will make them unemployable.Despite these pitfalls, general relativity has flourished, delivering key insights into our understanding of the origin of time and the evolution of all the stars and galaxies in the cosmos. Its adherents have revealed what lies at the farthest reaches of the universe, shed light on the smallest scales of existence, and explained how the fabric of reality emerges. Dark matter, dark energy, black holes, and string theory are all progeny of Einstein’s theory.We are in the midst of a momentous transformation in modern physics. As scientists look farther and more clearly into space than ever before, The Perfect Theory reveals the greater relevance of general relativity, showing us where it started, where it has led, and where it can still take us.

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Customer Reviews

Absolutely a great read. I have been searching for a book like this for years. I have always been curious about the theory of general relativity, knowing it only in the most basic terms. It is at the same time casual read, and perfectly accessible for my (rather limited) scientific knowledge. I was surprised how the author manages to follow both the history of the theory, the personal lives of some of the key participants, and the evolution of the content and ideas connected to the theory.Incredibly well written and accessible. I will be looking for other works from this author in the future.

This is a wonderful book written for the general public whose topic is the history of general relativity, its evolution as a theory, and the modern evolution of gravitational theory to present attempts to obtain quantum gravity. It is a very well written book by an astrophysicist at Oxford who works in this area. The author has his personal experiences with the theory mixed in throughout the book.Its first chapter is entitled "If a Person falls Freely". This is part of a thought experiment that Einstein used in order to come up with his ideas for general relativity. It discusses his ideas interspersed with Einstein’s personal history as a Swiss patent clerk up to his becoming a physics professor at Berlin, then spending his later years at the Institute for Advanced Study at Princeton.One of the earliest solution’s of general relativity was Schwarzschild’s showing the existence of black holes. As expected black holes are a large topic with Oppenheimer, Synder, Wheeler. Penrose, Hawking, Bekenstein, Zel’dovich and other discussed. Cosmological implications from general relativity are also a big topic with the expanding universe of Friedmann and Lemaitre, Einstein’s introduction of the cosmological constant in order to have a static universe, up to present day modification to gravitational theory. The history of general relativity is intermingled with experimental developments in astronomy which is explained very well. This book shows how a theory and experiments grow off of one another and shows how science is advanced in this way. One example of many in the book is shown very well with the work of Jim Peebles over many years. The book discusses a variety of personalities involved in the development of general relativity and also shows how it was carried on in the secretive Soviet society.The history to obtain a quantum theory of gravity as explained in this book and is very interesting and informative. All the big names in physics that you can think of have tried their hand at this problem and none have come up with a solution. The reasons why are discussed. This book has others that you might not have heard of such as DeWitt and their tales.If you are curious about Einstein’s theory of general relativity and its implications in astronomy, cosmology along with recent attempts to obtain a quantum theory of gravity this is a wonderful book to read and well worth your time.

This book in a superb history of General Relativity up to about the current time. Excellent reading and well written. It’s emphasis on the best of our species brain power being able to equally deny that which was outside their bubble of thinking provides many lessons about in-box thinking. This book does little to address current forward thinking about our Universe(es) .. .that is left to other books. I recommend this book without qualification.

So intriguing... even for an elementary school teacher to read. What an amazing story line of all the efforts put in to one theory. This book makes it easy to understand more advanced physics and the theory of relativity through the development of one of Einstein’s greatest contributions.

This book is delightful for its whirlwind tour of the people and thinking related to general relativity. Frequently vastly oversimplified, but blessed with extensive notes, references, and index. Can be read just for enjoyment, or used as a literature guide to expand one’s understanding.Intended for persons who already have some knowledge of general relativity.

Pedro Ferreira’s book "The Perfect Theory: A Century of Geniuses and the Battle over General Relativity" essentially tells us what other people did with Einstein’s general theory of relativity after he developed it. While one chapter is devoted to Einstein’s hard struggle with learning the non-Euclidean geometry and building the field equations that define the theory, the book really takes off after 1917 when a series of men and women discovered the awesome implications of these equations. The book is a fast read and it does a very good job portraying the colorful personalities and exciting discoveries unearthed by general relativity.By 1919 the theory had been well-established as part of the scientific enterprise, especially after it retrodicted the correct value of the perihelion of mercury and predicted the bending of starlight observed by Arthur Eddington, a discovery that splashed Einstein’s name on the front pages of the world’s leading newspapers. Eddington was Einstein’s heir, thoroughly learning the theory and grasping its implications for stellar structure. Ironically he did not dare to take these implications to their logical conclusion. That task was left to a young Indian astrophysicist named Subrahmanyan Chandrasekhar who paved the way toward the discovery of black holes by considering what happens when stars run out of fuel and collapse under gravitational contraction. Famously Eddington rebuked Chandrasekhar's findings and revealed himself to be much like Einstein, a revolutionary in young age and a reactionary in old age.The story of black holes is one important thread that the book follows. Chandrasekhar's ideas were further developed by Lev Landau, Fritz Zwicky and Robert Oppenheimer in the 30s. Oppenheimer's story is especially interesting since he was the one who theoretically discovered black holes but later completely dissociated himself from them, showing no interest in general relativity until the end of his life. In fact Oppenheimer's view of relativity was similar to that of the vast majority of physicists who were caught up in the revolutions in nuclear and quantum physics in the 30s and 40s. Quantum mechanics and particle physics were the new frontiers; relativity was a speculative backwater.It was the eminent Princeton University physicist John Wheeler who picked up where Oppenheimer had left off. Wheeler is really the father of modern relativity since he was the one who rejuvenated interest in the topic in the 50s and 60s. Many of his students like Jacob Bekenstein and Kip Thorne became leaders in the field. In Britain the field was fathered by Dennis Sciama, whose students Roger Penrose and Stephen Hawking led the way in understanding singularities and the Big Bang. Hawking especially forged a very important link between information, relativity, thermodynamics and quantum mechanics through his exploration of what we now call the "black hole information paradox".Hawking's work on singularities connects to the second major thread of the book, this time involving the applications of general relativity to the entire universe. The story begins right after Einstein developed his framework when Russian bomber pilot Alexander Friedmann and Belgian priest Georges Lemaitre found out that one of the solutions of the equations would be an expanding universe. In a famous mistake which Einstein called "the greatest blunder of my life", Einstein had found this solution but, based on the observation of a locally static universe, had applied a fudge factor - a "cosmological constant"- to halt the expansion which turned out to have great significance almost eight decades later. Lemaitre and Friedmann's story logically leads to that of Edwin Hubble who in 1929 observed the redshifting of galaxies, thereby inaugurating one of the great eras in the exploration of the cosmos. This era culminated in the discovery of dark matter and dark energy and the transformation of cosmology into a precision science, all of which has opened up frontiers undreamt of by Einstein. And Ferreira hopes there's much more in store than can flow from those beautiful equations.Ferreira is quite adept at describing these two main threads. One of the most important aspects of the development of relativity was the shot in the arm which the theory received from experimental observations of distant objects by radio telescopes made by Martin Ryle, Jocelyn Bell and others. In fact the book underscores the fact that without these observations relativity would have continued to be considered mathematical doodling at worst and speculative science at best. The grounding of relativity in the real world through the discoveries of quasars, pulsars, neutron stars and black holes makes the paramount significance of experimental evidence in lending respectability to a theory quite clear. Personally I would have appreciated it if Ferreira had also considered some other evidence for general relativity, such as the observation of frame-dragging by Gravity Probe B, a technical marvel and a jaw-dropping exercise in accurate measurement if there ever was one.The last part of the book concerns the quest over the last four decades to combine general relativity with quantum mechanics, an effort that was started by Wheeler and his student Bryce DeWitt in the 60s. The same techniques of field theory that led to such spectacular successes in particle physics - culminating in the Standard Model - failed abysmally when applied to relativity. One possible way out is string theory whose virtue is that gravity emerges naturally from the theoretical framework. Another promising framework is loop quantum gravity. The problem with string theory, as well known by now, is that it makes no testable predictions and its solution space is so vast that virtually anything can be accommodated in its expansive embrace. In science, a theory that can explain anything and everything is usually considered a theory that can explain nothing.One thing that again struck me is how important experiment and observation are for actually taking a theory from a realm of fanciful speculation to hard reality. It’s worth comparing the progress of quantum mechanics, general relativity and string theory in this context. Quantum mechanics was fully developed in the 1920s and immediately explained scores of previously confusing experimental facts. Its success only grew in the 30s and 40s as it was applied to solid-state physics, chemistry and nuclear physics, always amply supported by experiment. The philosophical conundrums in the theory - which we still struggle with - did not harm the theory because of its great experimental success. In contrast, general relativity was developed about ten years earlier. By 1940 or so it had two major experimental predictions to its credit: the bending of starlight and the expansion of the universe. But even by the late 1950s it had not become part of mainstream physics and was considered more mathematics than physics, mainly because the experimental evidence was lacking. As mentioned above, it was only the development of radio astronomy that really put the whole framework on a firm pedestal.Thus it took quantum mechanics no time at all and relativity almost forty years to become respectable, even when there were two astonishing experimental observations which the latter had successfully predicted. The great difference was the experimental evidence, copious in case of the former and spotty and only slowly emerging in case of the latter. Compared to this, string theory has been around for about forty years and there is still no unambiguous experimental evidence in its favor.

Purely on a historical basis this might hint that it may be on the wrong track. There's a reason why Feynman said that the only true test of a scientific theory is experiment.

The Perfect Theory: A Century of Geniuses and the Battle over General Relativity Theory of Relativity for the Rest of Us but not for Dummies: Theory of Relativity Simplified The Road to Relativity: The History and Meaning of Einstein's "The Foundation of General Relativity", Featuring the Original Manuscript of Einstein's Masterpiece Ace General Chemistry I and II (The EASY Guide to Ace General Chemistry I and II): General Chemistry Study Guide, General Chemistry Review Relativity: The Special and the General Theory Relativity; the Special and General Theory Relativity: The Special and General Theory [New Edition with Readable Equations] Relativity: The Special and the General Theory, 100th Anniversary Edition Relativity: The Special and General Theory [Illustrated] Clinical Anesthesia Procedures of the Massachusetts General Hospital: Department of Anesthesia, Critical Care and Pain Medicine, Massachusetts General ... of the Massachusetts General Hospital) Spacetime and Geometry: An Introduction to General Relativity Introduction to General Relativity, Black Holes and Cosmology General Relativity for Babies (Baby University) Gravity: An Introduction to Einstein's General Relativity General Relativity: An Introduction for Physicists Chern Simons (Super)Gravity (100 Years of General Relativity) General Relativity A General Relativity Workbook A Student's Manual for A First Course in General Relativity A First Course in General Relativity