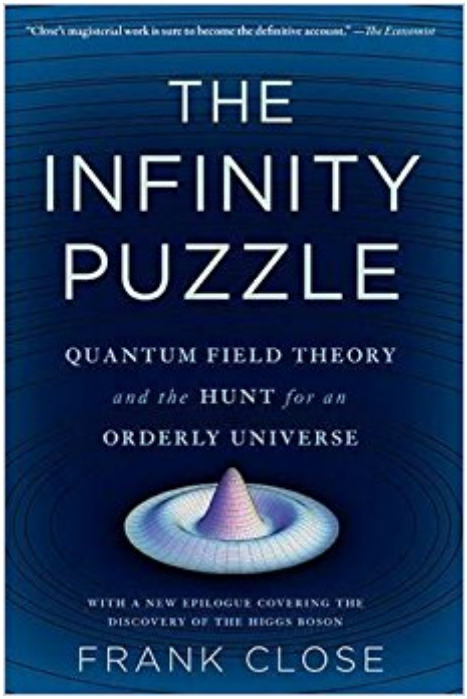
The Infinity Puzzle: Quantum Field Theory And The Hunt For An Orderly Universe



Synopsis

Speculation is rife that by 2012 the elusive Higgs boson will be found at the Large Hadron Collider. If found, the Higgs boson would help explain why everything has mass. But there's more at stake—what we're really testing is our capacity to make the universe reasonable. Our best understanding of physics is predicated on something known as quantum field theory. Unfortunately, in its raw form, it doesn't make sense—its outputs are physically impossible infinite percentages when they should be something simpler, like the number 1. The kind of physics that the Higgs boson represents seeks to “renormalizeÃ¢â ¬Â• field theory, forcing equations to provide answers that match what we see in the real world.The Infinity Puzzle is the story of a wild idea on the road to acceptance. Only Close can tell it.

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Customer Reviews

Ars Technica“The Infinity Puzzle is eminently readable. It has no equations—only a few Feynman diagrams—and a glossary in the back so you don't get your bosons confused with your hadrons.... All of the luminaries of twentieth century particle physics are here, along with many unsung heroes whose contributions Dr. Close explains and puts into context so they can be better appreciated by a public hitherto ignorant of their work.... [T]he entire book is a very manageable introduction to quantum physics for those who are interested in, but possibly intimidated by, understanding the inner workings of the fabric of our Universe.Ã¢â ¬Â•Science News“Building the standard model, the flagship theory of modern particle physics, was no mean task. It took decades of painstaking work to bring the forces and elementary particles that

make up the universe together in a single framework (which still doesn't include gravity). Close, a theoretical physicist, chronicles this history from an insider's perspective.... the story doesn't unfold as a simple, clearly developing line of thought. Instead, the reader witnesses scientific progress in all its real-world messiness. It's a comedy of errors at times, full of dead ends, missed opportunities and ideas that lie dormant for years, unproven or unnoticed.Ã¢â ¬Â•Kirkus Reviews“Close chronicles the search for the elusive Higgs Boson particle (the ‘God Particle').... Throughout, the author chronicles the winners and losers in the annual Nobel sweepstakes, giving them recognition for their achievements and providing a lively thread for readers.Ã¢â ¬Â•Peter Higgs, Emeritus Professor of Physics, The University of Edinburgh“It is a pleasure to read a book on recent advances in our understanding of the structure of matter by an author who not only understands the subject but also takes care to investigate conflicting accounts of how these advances came about.Ã¢â ¬Â•Steve Nadis, coauthor of The Shape of Inner Space“As someone who can deftly explain abstruse quantum field theory to a lay reader, Frank Close is a rarity among physicists. Rarer still, he knows how to weave a compelling tale—that of the ‘infinity problem,' which has bedeviled the field of quantum electrodynamics and subsequent attempts to unify the forces of nature. The result is a great scientific whodunit, replete with a large, engaging cast of characters, behind-the-scenes maneuvering, and unexpected twists and turns. Here is proof that Close belongs among the very first rank of scientist-authors. I strongly recommend The Infinity Puzzle.Ã¢â ¬Â•Peter Woit, Not Even Wrong“[A] fascinating new book.... Knowing the history of a subject has always seemed to me an integral part of really understanding it, so I'd argue that anyone who wants to really understand modern particle physics should spend some time with a book like this…. [I]f like me, you're fascinated by this history and want to learn something new about it, go out and get a copy soon.Ã¢â ¬Â•Publishers Weekly“Close voyages through the major scientific discoveries in high energy physics that began in 1928, when Paul Dirac married quantum mechanics with Special Relativity, laying the basis for the major technical advances from which we benefit in today's digital world. Along the way we meet some major figures in the field whose breakthroughs have illuminated the deepest mysteries of physics and cosmology, resulting in an engrossing history that's also accessible for a general audience.Ã¢â ¬Â•Dan Hooper, Fermi National Accelerator Laboratory and University of Chicago; author of Dark Cosmos and Nature's Blueprint“The development of quantum field theory is among the very greatest achievements of humankind, on par with those of Einstein, Newton and Darwin. Frank Close introduces these difficult ideas with a rare clarity and simplicity. Ã Â Anyone who wants to

understand why we built the LHC and what we hope to learn from it should read this book.Ã¢â ¬Â•Booklist“[Close's] presentation lucidly acquaints readers with physicists' quest for the Higgs boson (theorized to cause mass) that Europe's Large Hadron Collider was built to find.Ã¢â ¬Â•Nature“[A] fascinating book.... [A] compelling history and sociology of modern particle theory. We discover the motivations and achievements of a rich cast of brilliant individuals, and get enough of the science to grasp what they were trying to do. Where Close really shines is in exposing the fraught process of recognition in science.... Close's history of the field is engaging and gives insight into how great theories are created.Ã¢â ¬Â•Alan Boyle, MSNBC.com's Cosmic Log“In his new book, Oxford physicist Frank Close reviews decades' worth of brain-teasing theories and looks ahead to puzzles yet to be solved.... Close's tale illustrates that the course of true science doesn't always run smooth. It may well turn out that the long-sought Higgs boson is a will-o'-the-wisp, and physicists will have to go back to square one. But even that won't render The Infinity Puzzle out of date.Ã¢â ¬Â•American Scientist“[An] intriguing tale.... A treasure trove.Ã¢â ¬Â•Chad Orzel, Uncertain Principles“[A]bsolutely fascinating.... a highly readable and detailed history of what is arguably the best-tested theory in the history of science.... If you're interested in what we know to be true about the universe and how it works, and how we put that knowledge together, I highly recommend this book.Ã¢â ¬Â•MAA Reviews“Superb.... The Infinity Puzzle presents in light and fetching prose a (and you should pardon the pun) close-up of a wonderful set of episodes in contemporary science centered around one of the single most beautiful edifices of modern theoretical physics, quantum field theory, and leading up to the hottest example of big science to be found on the globe today.Ã¢â ¬Â•The Economist“Mr Close, an accomplished particle physicist in his own right, enjoyed unprecedented access to all the principal players, many of whom he either knows well or, like Mr Higgs, has spoken to at length. He also appears to have left no relevant academic paper, no conference proceedings, memoir or other publicly available source unturned. This painstaking attention to historical detail yields many gems.... Mr Close's magisterial work is sure to become the definitive account of the story. It offers no unambiguous advice to the Nobel committee. But the judges would be wise to give it a thorough read anyway.Ã¢â ¬Â•CHOICE“A detailed and compelling account of advances in particles physics over the last 60 years. Close's distinguished career as a professional physicist has enabled him to meet many of the protagonists who made these advances, giving his account the personal perspective of an insider.... Through careful use of analogies and precise prose, Close explains how the infinity puzzle was confronted and overcome repeatedly in the last

few decades.... A wonderfully written book that is valuable for all readers. Highly recommended.Ã¢â ¬Â•New Scientist“[A] thoroughly researched and well-crafted narrative.... [Close] focuses on the triumphs and failures of the physicists behind the equations, providing a realistic view of how theoretical physics really progresses – the all-too-human endeavour fraught with personal ambitions, rivalries, alliances, errors and plain historical accident.... It's refreshing to read a popular physics book that doesn't revisit the same well-trodden ground of so many before it.Ã¢â ¬Â•BBC Focus“[A] masterpiece.... Close has done his homework thoroughly, interviewing just about all the protagonists that are still alive and going back to original source material for his facts, which often contradict the memories of even the most reliable of those survivors.... This book is essential reading—I never normally give five stars, but for this I'll make an exception.Ã¢â ¬Â•The American Scholar“The book brims with charming anecdotes about particle physics between the 1950s and 1980s, when breakthroughs came almost too fast to be comprehended and every scientist seemed to be maneuvering (and occasionally begging) for Nobel prizes. But the book also plumbs the origins of modern physics, especially troubles with the concept of infinity.Ã¢â ¬Â•Discovery News“Close's book veers from the usual popular science treatment of the topic to focus on quantum field theory, described as ‘our best understanding of physics'—and yet very few folks outside of physics have a clear grasp of what it is, and why it's so significant. A great read for those who've been following the Higgs story closely and are intrigued by some of the deeper questions.Ã¢â ¬Â•Manjit Kumar, author of Quantum“The nature of the problem, how it was solved, and the inevitable jostling for Nobel Prizes are major themes of Close's gripping and extensively researched narrative history of particle physics over the last sixty years.... Close has succeeded in humanising a dramatic era of physics in what is my science book of the year.... ‘Hold Infinity in the palm of your hand,' William Blake wrote in the Auguries of Innocence. Frank Close does a fabulous job of reconstructing how physicists like Feynman and 't Hooft managed to do exactly that.Ã¢â ¬Â•

Frank Close is a Professor of Theoretical Physics at Oxford University and Fellow and Tutor in Physics at Exeter College, Oxford. He is the winner of the Kelvin Medal for the public understanding of physics and the author of ten books. He lives in Abingdon, England.

I’m not a scientist so my comments are those of a layman. I found Dr. Close’s book to be well-written and worth reading.The book takes as its focus the development of quantum mechanics into quantum electrodynamics, quantum chromodynamics and, what I hadn’t encountered before,

quantum flavordynamics. The original mathematical models led to numerous infinities which the scientific community that developed these models sought to eliminate at least in part by a process called renormalization. In renormalization, experimental physicists told the theoretical physicists what the answer was and, from what I could tell, the theoretical physicists made the math fit the answer developed by the experimental physicists. Not surprisingly the theoretical physicists found this somewhat unsatisfying. The theoretical physicists struggled to make their theories and the supporting math fit the reality being uncovered by experiment. If you're interested in what these theories propose about physical reality, Dr. Close largely waits until the end of the book to consider some of the nature of our universe as suggested by current scientific understanding.The book really focuses on who received the Nobel prize or who didn't receive the Nobel prize and why this may have occurred. Dr. Close provides insight on the effect of ambition, ego, and personality in the pursuit of the highest prize in science. The book is worth reading for this alone. Feynman,Weinberg, Salam, Gell-Mann,Oppenheimer and others who dominated the development of the Standard Model and quantum mechanics largely from the middle to the end of the twentieth century find their place in the story. Others, less familiar or unfamiliar to me, t'Hooft, Higgs and Bjorken have their substantial contributions explained.

The Infinity Puzzle is a good introduction to the Quantum Field Theory for those who are interested in the subject.It's difficult to find a book which explains the physics and math in a way that everyone can understand. My interest as an RN lies with the relationship of Quantum Field Theory and shamanistic healing. I read The Eagle's Quest by Fred Alan Wolf, a physicist who ties Quantum Physics with Shamanism and Shamanistic healing practices.There are cases of unexplained reversals of cancer which could explain an area in physics not very well understood. It is possible that a medical application eventually will be tied to the Quantum Field Theory. It is a fascinating subject.Another aspect which has fascinated me is how complex the atom is. To me it's like a Chinese puzzle which when one layer is discovered other layers are found.Good book for those who want a clear description of a difficult topic.

The theory of quantum electrodynamics (QED) which describes the interaction of light and matter is the most accurate theory in all of science, providing almost unbelievably accurate agreement with experiment. Yet in the middle of the twentieth century the theory was in a deep crisis. Calculations of even the simplest of events in the subatomic world, like the absorption and emission of a photon by an electron, seemed to give nonsensical infinite results that flew in the face of finite values from

experiment. These infinities dotted the landscape of physics like ugly tumors, leading some to believe that physics was fundamentally on the wrong track. But hope was at hand. It took a whole post-war breed of brilliant young scientists to invent an ingenious set of tricks collectively called "renormalization" to get rid of these infinities and restore the theory to a complete form. Renormalization not only axed the infinities in QED but became the test that any fundamental theory of physics had to pass before being deemed acceptable. In a stunning set of successes, it was applied to the unification of the weak and electromagnetic forces and then to the strong force holding protons and neutrons together. In this book Frank Close tells us how all this happened.Close's book is not only a clear description of renormalization but is also probably the most detailed popular history of post-war particle physics that I have read. Close starts with QED and how its brilliant expositors like Julian Schwinger and Richard Feynman developed renormalization techniques to exorcise its infinities. After this, the major part of the book deals with comprehensively describing one of the great triumphs of modern physics - the unification of the weak and electromagnetic forces by Sheldon Glashow, Steven Weinberg and Abdus Salam. This theory had to be again shown to be renormalizable, a momentous feat that was achieved by Dutch physicists Gerard 't Hooft and Martin Veltman. Along the way we are also treated to a fast-paced account of developments leading to the conjecture of the Higgs boson which was originally proposed to explain the difference in masses between the carriers of the electroweak force (the massive Z and W bosons) and the electromagnetic force (the massless photon). And finally Close describes one of the last pieces of the subatomic puzzle, the unraveling of the strong force inside atomic nuclei and the structure of protons and neutrons. These developments capping the understanding of the strong, weak and electromagnetic interactions paved the way to the creation of the Standard Model of particle physics, the crowning glory of physics that encompasses all known particles and forces except gravity and predicts the Higgs boson.However, the most fascinating aspect of Close's book in my opinion is not the lucid description of these technical details but the way it sheds light on both the nature of discovery and most importantly, the human side of science. As Close himself says, science as it appears to the public seems to consist of a few heroes marching resolutely on a linear trajectory to the truth. But as he marvelously documents, the truth is very different and way more messy and non-linear. Science is as much an unpredictable human drama as an exploration of nature's secrets. In every part of the story we see fallible human beings with all their ambitions, prejudices and flaws. There are lots of cases where scientists give up promising leads because of unfavorable remarks or neglect by others and have their discoveries scooped up later by fellow scientists who then win a Nobel Prize. We also read about the Nobel

Laureate P. W. Anderson using insights from a very different field (superconductivity) to make key contributions to the ideas leading to the Higgs. Then there are little-known brilliant scientists like J. C. Ward and Ronald Shaw who have their fundamental ideas ignored because they are relatively unknown junior researchers who are lower in the hierarchy. Nobel Prizes are eagerly sought after, narrowly missed and even lobbied for. Sometimes one can see the almost eerie simultaneous germination of ideas in multiple minds, with some of them blossoming under the right circumstances and others fizzling out because of lack of interest or context. In many such cases, so many people end up contributing to a discovery in so many different ways that assigning credit becomes difficult or impossible. For instance, although Higgs's name is attached to the famous particle, it's clear that at least five others independently had the same ideas. Furthermore, in almost every case that Close documents, there are mutually conflicting accounts by scientists of the exact time, place and source leading to the conception of a key idea. Chance encounters and fortuitous attendances at the right scientific meetings seem to contribute to scientists' thought processes to a disproportionate extent. To his credit Close goes into considerable detail when describing all this and it's truly incredible to realize by reading his account how messy, haphazard and subject to sheer luck the actual process of scientific discovery is. Far from being the sure path to knowledge often depicted by the media, science resembles a zigzag, unpredictable climb over hills and valleys obscured by fog.Yet the beauty of it is that the truth, whatever it is, is surely out there, and an alert and intelligent mind can recognize it through hard-work, curiosity and mathematical prowess. The emphasis on the latter is especially clear in the book, and it's remarkable to realize the almost terrifying power of mathematics that allowed scientists to conjecture the existence of new fundamental particles of nature through sheer thought alone. In many cases it took fifteen or twenty years before these particles were actually found by experiment. The history of particle physics in this sense shows us what the human mind is capable of.As Close tells us in the end, these adventures are far from over. The last part of the book is dedicated to the equally heroic and imaginative experimental efforts devoted to verifying the predictions of the theorists, many of which gathered Nobel Prizes. As the Large Hadron Collider (LHC) spews out massive amounts of data, scientists are waiting with bated breath for the Higgs or its absence. Either way it would be a momentous event and would point to new, hitherto unexplored directions. Overall I would strongly recommend Close's book as one of the best accounts of both the post-war development of particle physics and of the idiosyncratic human side of science that I have read. The story is as epic as any great novel and packed with fascinating characters. Close tells it exceedingly well.

Of the last ten books IÃƒÂ¢Ã â ¬Ã â„¢ve read, this was the best. It was very well-written science/history/drama, very clear and logical, and tells a smoothly progressing story. And, it also gives great insight into the deep puzzles of modern physics. I wrote many notes of key insights and feel that it took me closer to my goal of eventually understanding Higgs physics.

Frank close makes the physics of QED digestible and gives you an inside seat on the history of the making of this beautiful theory. The book reads like a thriller and a mystery novel all at once and keeps you on the edge of your seat waiting for the next piece of the puzzle that came together. The actors are the brilliant men who put the infinity puzzle together. Do not miss out on this read.