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The Infinity Puzzle: How the quest to understand quantum field theory led to extraordinary science, high politics and the world's most expensive experiment

By Frank Close

Frank Close

Hardback: £16.99

Frank Close is a prolific author – *Neutrino*, *Antimatter*, *Nothing*, *The New Cosmic Onion*, *Void*, *The Particle Odyssey*, *Lucifer's Legacy* and more, have already appeared this century. *The Infinity Puzzle* is his ingenious name for the vital but recondite procedure called “renormalization” in physics-speak, but his latest book covers much more ground than just this.

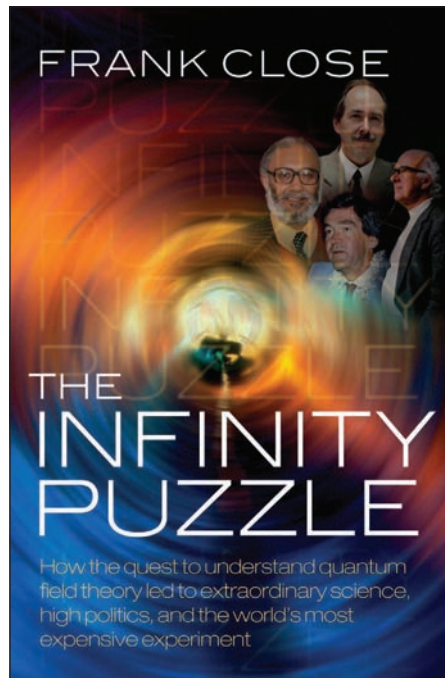
Setting off to trace the evolution of quantum field theory in the 20th century, Close needs to run, leaping from Niels Bohr to Paul Dirac without pausing at Erwin Schrödinger and Werner Heisenberg. However, he occasionally pauses for breath: his descriptions of difficult ideas such as gauge invariance and renormalization are themselves valuable. Equally illuminating are the vivid portraits of some of the players, many major – Abdus Salam, Sheldon Glashow, Gerard 't Hooft and John Ward – as well as others, such as Ron Shaw, who played smaller roles. Other key contributors, notably Steven Weinberg, appear on the scene unheralded.

The core of the book is the re-emergence in the 1960s of field theory, which had lapsed into disgrace after its initial triumph with quantum electrodynamics. Its new successes came with a unified electroweak theory and with quantum chromodynamics for the strong interactions.

Embedded in this core is a scrutiny of spontaneous symmetry breaking as a physics tool. Here Close presents the series of overlapping contributions that led to the emergence of what is now universally called the “Higgs mechanism”, together with the various claims and counterclaims.

Electroweak unification gained recognition through the Nobel Prize in Physics twice: in 1979 with Glashow, Salam and Weinberg; and in 1999 with 't Hooft and Martinus Veltman. Having assigned credit where he sees fit, Close also confiscates much of that accorded to Salam, stressing the latter's keen ambition and political skills to the detriment of enormous contributions to world science. (His International Centre for Theoretical Physics in Trieste was launched with initial support from IAEA, not from UNESCO, as stated in the book.)

In this electroweak saga, Close gives

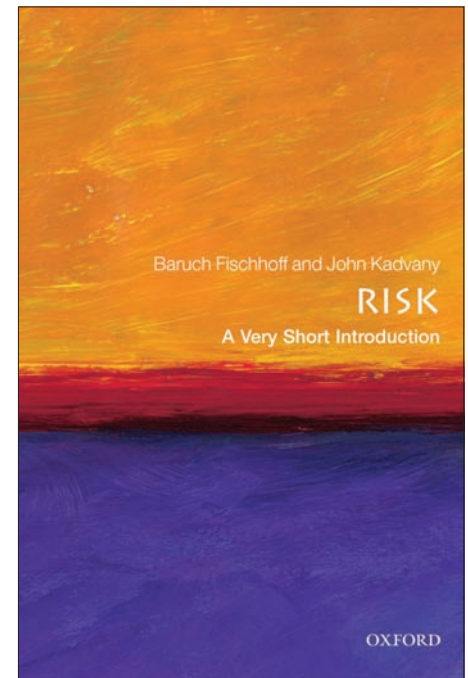


an impression that understanding weak interactions was at the forefront of people's minds in the mid-1960s, when many were, in fact, initially blinded by the dazzle of group theory for strong interactions and the attendant quark picture. In those days, spontaneous symmetry breaking became muddled with ideas of approximate symmetries of strong interactions. Many struggled to reconcile the lightness of the pion with massless Goldstone bosons. Close mentions Weinberg's efforts in this direction and the sudden realization that he had been applying the right ideas to the wrong problem.

As the electroweak theory emerged, its protagonists danced round its renormalization problems, whose public resolution came in a 1971 presentation in Amsterdam by 't Hooft, carefully stage-managed by Veltman, which provides a dramatic prologue to the book. For the strong interactions, Close sees Oxford with Dick Dalitz as a centre of quark-model developments but there was also a colourful quark high priest in the form of Harry Lipkin of the Weizmann Institute.

With the eponymous puzzle resolved, the book concludes with discoveries that confirmed the predictions of field theory redux and the subsequent effort to build big new machines, culminating in the LHC at CERN. The book's end is just as breathless as its beginning.

The Infinity Puzzle is illustrated with numerous amusing anecdotes, many



autobiographical. It displays a great deal of diligent research and required many interviews. At some 400 pages, it is thicker than most of Close's books. Perhaps this is because there are really two books here. One aims at the big audience that wants to understand what the LHC is and what it does, and will find the detailed field-theory scenarios tedious. On the other hand, those who will be enlightened, if not delighted, by this insight will already know about the LHC and not need explanations of atomic bar codes.

● Gordon Fraser, author of *Cosmic Anger*, a biography of Abdus Salam that is now available in paperback.

Risk – A very short Introduction

By Baruch Fischhoff and John Kadvany

Oxford University Press

Hardback: £7.99

Amazing. A book that should be read by everyone who is still thinking of investing in hedge funds or believing that the stock market is rational. The subject is well explained, covering risk types that we are all familiar with, as well as some that most of us probably never think of as risk. What I especially like is the large number of recent events that are discussed, deep into the year 2011.

The range of human activity covered is vast, and for many areas it is not so much risk as decision making that is discussed. There are many short sentences that were

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perfectly clear to me but still unexpected such as “people are [deemed] adequately informed when knowing more would not affect their choices”.

The language is clear and pleasant to read, though here and there I sensed that the authors struggled to remain within the “very short” framework. That also means that you should not expect to pick up the 162-page book after dinner and finish it before going to bed. Much of it invites reflection and slow savouring of the ideas, effects and correlations that make risks and deciding about them so intimately intertwined with our human psyche.

A very pleasant book indeed.

● Robert Cailliau, *Prévešin*.

Books received

Dark Energy: Theory and Observations

By Luca Amendola and Shinji Tsujikawa

Cambridge University Press

Hardback: £45

Introducing the relevant theoretical ideas, observational methods and results, this textbook is ideally suited to graduate courses on dark energy, as well as supplement advanced cosmology courses. It covers the cosmological constant, quintessence, k-essence, perfect fluid models, extra-dimensional models and modified gravity. Observational research is reviewed, from the cosmic microwave background to baryon acoustic oscillations, weak lensing and cluster abundances.

Neutron Physics for Nuclear Reactors: Unpublished Writings by Enrico Fermi

By S Esposito and O Pisanti (eds.)

World Scientific

Hardback: £76 \$111

E-book: \$144

This unique volume gives an accurate and detailed description of the functioning and operation of basic nuclear reactors, as emerging from previously unpublished papers by Enrico Fermi. The first part contains the entire course of lectures on neutron physics delivered by Fermi at Los Alamos in 1945, as recorded in notes by Anthony P French. Here, the fundamental physical phenomena are described comprehensively, giving the appropriate

physics underlying the functioning of nuclear piles. The second part contains the patents issued by Fermi (and co-workers) on the functioning, construction and operation of several different kinds of nuclear reactor.

Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis

By Ifan Hughes and Thomas Hase

Oxford University Press

Hardback: £39.95 \$85

Paperback: £19.95

This hands-on guide is primarily intended to be used in undergraduate laboratories in the physical sciences and engineering. It assumes no prior knowledge of statistics and introduces the necessary concepts where needed. Key points are shown with worked examples and illustrations. In contrast to traditional mathematical treatments, it uses a combination of spreadsheet and calculus-based approaches, suitable as a quick and easy on-the-spot reference.

The Nucleon–Nucleon Interaction and the Nuclear Many-Body Problem: Selected Papers of Gerald E Brown and T T S Kuo

By Gerald E Brown et al. (eds.)

World Scientific

Hardback: £87 \$140

E-book: \$182

These selected papers provide a comprehensive overview of some key developments in the understanding of the nucleon–nucleon interaction and nuclear many-body theory. With their influential 1967 paper, Brown and Kuo prepared the effective theory that allowed the description of nuclear properties directly from the underlying nucleon–nucleon interaction. Later, the addition of “Brown-Rho scaling” to the one-boson-exchange model deepened the understanding of nuclear matter saturation, carbon-14 dating and the structure of neutron stars.

Weaving the Universe: Is Modern Cosmology Discovered or Invented?

By Paul S Wesson

World Scientific

Hardback: £45 \$65

E-book: \$85

Aimed at a broad audience, *Weaving the Universe* provides a thorough but short

review of the history and current status of ideas in cosmology. The coverage of cosmological ideas focuses on the early 1900s, when Einstein formulated relativity and when Sir Arthur Eddington was creating relativistic models of the universe. It ends with the completion of the LHC in late 2008, after surveying modern ideas of particle physics and astrophysics – weaved together to form a whole account of the universe.

Symmetries and Conservation Laws in Particle Physics: An Introduction to Group Theory for Particle Physics

By Stephen Haywood

Imperial College Press

Hardback: £36 \$58

Paperback: £17 \$28

Group theory provides the language for describing how particles (and in particular, their quantum numbers) combine. This provides understanding of hadronic physics as well as physics beyond the Standard Model. The book examines symmetries and conservation laws in quantum mechanics and relates these to groups of transformations. The symmetries of the Standard Model associated with the electroweak and strong (QCD) forces are described by the groups U(1), SU(2) and SU(3). The properties of these groups are examined and the relevance to particle physics is discussed.

Primordial Cosmology

By Giovanni Montani, Marco Valerio Battisti,

Riccardo Benini and Giovanni Imponente

World Scientific

Hardback: £123 \$199

E-book: \$259

In this book the authors provide a self-consistent and complete treatment of the dynamics of the very early universe, passing through a concise discussion of the Standard Cosmological Model, a precise characterization of the role played by the theory of inflation, up to a detailed analysis of the anisotropic and inhomogeneous cosmological models. They trace clearly the backward temporal evolution of the universe, starting with the Robertson–Walker geometry and ending with the recent results of loop quantum cosmology on the “Big Bounce”.

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