Examining the Personality Behind the *Principia*

Isaac Newton

James Gleick
Pantheon Books, New York, 2003. $22.95 (272 pp.).
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Reviewed by Larry Stewart

For the author of *Chaos: Making a New Science* (Viking Press, 1987) and *Genius: The Life and Science of Richard Feynman* (Pantheon Books, 1992), it was perhaps natural to turn to the study of the remarkable achievements of Isaac Newton. It was Newton who, arguably, put an end to the last remnants of an Aristotelian universe, which had ruled European minds for well over two millennia. Such attention to Newton comes at a time when the greatest scientific achievements of Western culture are receiving much attention, as any trip to a decent bookstore will prove. Note the success, for example, of Dava Sobel's *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time* (Walker, 1995), which was subsequently made into a television documentary. Physicists and historians conversant with the triumphs of the icons of the scientific revolution should not sniff at such current, popular interest in science.

James Gleick brings to his biography of Newton a skillful prose and enthusiasm for which the author is already known. For many science writers, skill and enthusiasm may be enough in imparting to readers the brilliance, the significance—even the poetic inspiration—of great intellects at work. However, it seems to me that authors who have such skill at their disposal are obligated to deal with historical reality in ways that will not always flatter their subjects—unless their aim is to expand the limits of hagiography. Much in this biography is highly entertaining and beautifully written, but it has weaknesses that do the reader a disservice.

This short biography reads, in many respects, like an extension of the efforts of John Conduitt, who married Newton's niece and ultimately became successor to the physicist's position as master of the Royal Mint. After Newton's death in 1727, Conduitt immediately sought to enhance the reputation of the great sage, and Gleick appears to be following that lead. For example, according to Gleick, Newton is the one who "effectively discovered gravity," which might have come as a surprise to those who had debated the concept over the previous 2000 years. Gleick might as well have said that Newton invented gravity.

Gleick's biography especially glosses over the last phase of Newton's life, when his conflict was greatest with Gottfried Wilhelm Leibniz over issues that were as profoundly metaphysical as they were mathematical and philosophical. I saw no mention in Gleick's book of Newton's disciple, Samuel Clarke, a brilliant metaphysician and translator of the *Opticks* whose famous correspondence with Leibniz was clearly influenced by Newton. Moreover, when the furor over the invention of the calculus finally did surface, Newton deliberately used his presidency at the Royal Society of London to engineer the famous *Commercium Epistolicum*, which was launched in 1712 as an assault on Leibniz and those "Leibnizians" who had provoked Newton.

Indeed, both Newton and Leibniz used their acolytes as pawns in a great game; therefore, to propose, as Gleick has, that Newton did not mean "to lead a cult or a school" is disingenuous, because that is precisely what Newton did. The growing antipathy between Newton and the Royal Astronomer John Flamsteed that Gleick barely acknowledges in his book is another example of Newton's ruthlessness and influence, which led to the Royal Society's seizing control of Flamsteed's star catalog. Newton was, as the historian Frank Manuel once described him, an autocrat in early 18th-century science. Gleick, apparently, is not much interested in Newton's flaws.

Gleick does reveal the inventive Robert Hooke as Newton's great nemesis during the conflict over the composition of light and over claims to the foundation of universal gravitation. Newton had every right to complain about his treatment by Hooke, especially when Hooke served as secretary to the Royal Society. It was not until Hooke's death that Newton was chosen as president of the Royal Society and soon knighted.

As much as Newton sought to avoid controversy, he found that it haunted him. His revisions to his influential *Opticks* contained new "queries" that were effectively hints for future experimental research to be carried on by his disciples. His exploration of the construction of minute bodies created the foundation for further successes of 18th-century chemistry and electricity. However, his vivid description of his optical experiments, notably those with a prism in his rooms at Trinity College in Cambridge, did nothing to convince his enemies of the heterogeneity of white light or, ultimately, of particulate attractions. Even the most transparent descriptions did not make his experiments easy to reproduce, and the failure by many scientists to do so rendered his reputation highly problematic. It was Newton's first generation of disciples who would prove crucial to enhancing the Newtonian experimental program and ensure his victory over his philosophical enemies.

Gleick is quite right to describe Newtonianism as a growing orthodoxy in the 18th century. However, the author uses a belated example of Anton Mesmer's claims, in the 1780s, to being a Newtonian. In fact, if "Newtonianism" was not a word in the English lexicon until well after Newton's death, "Newtonian" certainly was. Many of Newton's contemporaries knew of Newtonianism as much as they did of Cartesianism and Aristotelianism. Hence, scholars like John Harris, author of the famous *Lexicon Technicum, or, an Universal Dictionary of Arts and Sciences: Explaining Not Only the Terms of Art But the Arts Themselves*, which was published in

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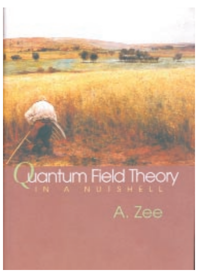
1704, recognized Newtonians as much as the Leibnizians did. That there was a Newtonian experimental program is not a minor point; Gleick, unfortunately, does little to address it.

One could, as some wish, attribute Newton's success solely to his genius. In one sense, his insights were clearly the work of an obsessive mind equally fascinated with alchemy, metaphysics, theology, and universality. But in another sense, such obsessions stretch the meaning of success for the author of the great *Principia*, which few read and even fewer understood. Newton's works—even in the simplest case involving his views on light—were often incomprehensible and controversial. Gleick could have better revealed a Newton who repelled as many people as he had attracted.

Quantum Field Theory in a Nutshell

A. Zee
Princeton U. Press, Princeton, NJ, 2003. $49.50 (518 pp.).
ISBN 0-691-01019-6

When writing a book on a subject in which a number of distinguished texts already exist, any would-be author should ask the following key question: What new perspectives can I offer that are not already covered elsewhere? Clearly, Anthony Zee thought the question through carefully. But perhaps foremost in his mind was how to make *Quantum Field Theory in a Nutshell* as much fun as possible. His game plan is to arrive at the neatest and most elegant field theory as quickly as possible without getting bogged down in formalism. Zee's book is written in the colloquial style of a good blackboard lecture, with gems of wisdom and amusing but relevant anecdotes scattered throughout. Zee has an infectious enthusiasm and a remarkable talent for slicing through technical mumbo jumbo to arrive at the heart of a problem. *Quantum Field Theory in a Nutshell* is quite simply a triumph. I have not had this much fun with a physics book since reading *The Feynman Lectures on Physics* (Addison-Wesley, 1963).



The book, weighing in at more than 500 pages, is perhaps more aptly called a coconut shell than a nutshell, as Zee acknowledges. Squeezed into its pages is a broad range of topics drawn from quantum electrodynamics, gravity, renormalization, symmetry breaking, collective phenomena, condensed matter physics, grand unification, and even a taste of supersymmetry and string theory. Each chapter, however, does fit into a nutshell as advertised.

The author starts with a brilliantly intuitive introduction to the Feynman path integral, after which gravity is introduced. By introducing the basic notions of the brane-world picture of the universe, Zee needs only 40 pages to bring the reader to the frontier of current research. Then, by page 80, the basics of Feynman diagrams, the Casimir force, Noether's theorem, and the more advanced topic of quantum field theory in curved spacetime are covered. From there on, the pace only quickens, sweeping through more topics than can possibly be mentioned in a short review. Throughout the book, the viewpoint is thoroughly modern, with open problems and exciting areas of current research highlighted.

In a certain sense, the book is easy to criticize. Why is a particular topic not covered, or why is it presented only superficially? However, such criticism completely misses the point: The purpose of Zee's book is not to turn students into experts—it is to make them fall in love with the subject. And Zee succeeds brilliantly. Moreover, there is nothing superficial about the depth of understanding or the choice of topics in Zee's book. The author speaks with the clarity and authority that come only from a leading practitioner in the field.

Take, for instance, Zee's treatment of asymptotic freedom in quantum chromodynamics. This crucial property of non-abelian gauge theories led to quantum chromodynamics being widely accepted by physicists as the theory of strong nuclear interactions. I firmly believe that every student of quantum field theory needs to become intimately familiar with the ins and outs of the calculation leading to this profound result. The book, however, relegates the key calculation to a footnote pointing to Steven Weinberg's magnum opus, *The Quantum Theory of Fields* (Cambridge U. Press, 1995–2000). But this is precisely the way Zee's book should be. Why include a somewhat lengthy computation that is well described elsewhere? One calculation of this sort is all it takes to burst the nutshell and shatter the book's wonderful form.

As another example, Zee hardly discusses particle scattering cross sections. But here one should consult Michael Peskin and Daniel Schroeder's *An Introduction to Quantum Field Theory* (Addison-Wesley, 1995), which is by now standard text on field theory from the particle physics viewpoint. Dozens of similar examples can be found throughout Zee's book.

Although the book focuses mainly on particle physics, Zee rightfully believes that the usual separation between condensed matter and particle quantum field theory is somewhat artificial. What better way to illustrate his view than with a set of problems in condensed matter physics that are elegantly solved using quantum field theory? The chapters on condensed matter physics are chock-full of fascinating topics, including fractional statistics and quantum Hall fluids.

Zee's book does not replace other, more formal texts on quantum field theory, such as Weinberg's or Peskin and Schroeder's books, but it is one that no student of quantum field theory should be without. *Quantum Field Theory in a Nutshell* is the ideal book for a graduate student to curl up with after having completed a course on quantum mechanics. But, mainly, it is for anyone who wishes to experience the sheer beauty and elegance of quantum field theory.

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Extreme Ultraviolet Astronomy

Martin A. Barstow and
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Before it became trendy to prefix practically any endeavor with "extreme," astronomers were challenging nature and pushing the limits of optics to observe radiation lying between 100 Å and 1000 Å—the shortest wavelengths of UV light. Due to the quirks of atomic physics, few materials either reflect well or transmit easily in that extreme UV region. In addition, the abundant neutral hydrogen in interstellar space naturally limits astronomers' ability to peer very far into the universe. Absorption at wavelengths shorter than the 912-Å Lyman limit of neutral hydrogen makes the interstellar