On Fact and Fraud: Cautionary Tales from the Front Lines of Science FREE

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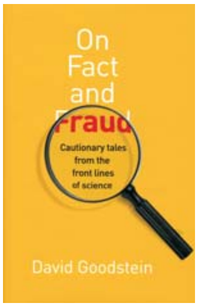
On Fact and Fraud

Cautionary Tales from the Front Lines of Science

David Goodstein
Princeton U. Press, Princeton, NJ, 2010. $22.95 (168 pp.).
ISBN 978-0-691-13966-1

David Goodstein discusses the science enterprise and its strengths and weaknesses in his latest offering, *On Fact and Fraud: Cautionary Tales from the Front Lines of Science*. In this short book, he draws from a series of anecdotes, many of which are based on his extensive experiences as an experimental physicist and as a vice provost at Caltech. As vice provost, Goodstein handled the cases of faculty members accused of scientific fraud.

On Fact and Fraud, the result of a course the author taught on scientific ethics, is easily accessible to physicists of all disciplines. Goodstein starts by pointing out the flaws in some of the reasonable ethical principles suggested for the practice of science. He addresses the federal government's attempt to define scientific fraud, then presents the accepted definition of scientific fraud and the three psychological characteristics that most cases contain. Later, he discusses at length the histories of high-temperature superconductivity and cold fusion as examples of the range of episodes in the science enterprise that reveal surprising, courageous, and sometimes misguided actions.



The book's primary strength is the telling of those individual stories, which the author does with keen insight and understanding. Of particular value is the history of Robert Millikan's measurement of the charge on the electron—Millikan has been accused of fraudulently manipulating his data. The author analyzes that accusation in depth and comes to a persuasive conclusion that fraud was not committed. However, I strongly disagree with some of the general principles the author draws from other histories. In particular, I take issue with two of his stances.

The first involves reproducibility in experimental measurements, a principle that the author seems to consider of secondary importance. He takes a sympathetic view toward scientists working in cold fusion—a prime example of a field characterized by unverified results. By contrast, I strongly believe that reproducibility of experimental measurements should be at the heart of science. Simply put, if an experimental group cannot reliably reproduce a result in its own laboratory, it should never submit the result for publication in a scientific journal, and no scientific journal should ever publish a paper based on such unverified experiments. That is more than a philosophical difference I have with the author. There are serious consequences to publishing unverified results; for example, other scientists will read those papers and try to reproduce the results, almost always unsuccessfully. Those unsuccessful attempts are not only a waste of a scientist's precious time and resources but, in some cases, can even end a scientific career.

The second point on which I part ways with the author is whether full disclosure is required in a publication. If, for example, collaborating researchers conduct five different experiments and four support their thesis, are they required to mention the fifth experiment that doesn't? The author says that is too much to expect, but I think it is absolutely required. The reason is more than just honesty. That missing information could be invaluable to other scientists working in the field in helping them choose which experiments to run or how to interpret past ones.

Despite our differences, I strongly recommend Goodstein's *On Fact and Fraud* to all physicists. The issues raised by this book are extremely important and need to be discussed. Also, physicists who read this review should also read Goodstein's positions on the specific issues I've highlighted before they come to their own conclusions. If his book generates a healthy debate about those issues, it will have served a valuable service to the physics community.

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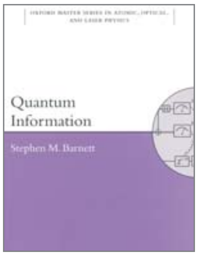
Quantum Information

Stephen M. Barnett
Oxford U. Press, New York, 2009. $100.00 (300 pp.).
ISBN 978-0-19-852762-6

From the earliest proposals by Richard Feynman and David Deutsch almost 30 years ago, quantum information has emerged as a well-defined discipline. Since then, many novel quantum-computation and secure-communication proposals have been made. For example, quantum computing procedures would permit the search for an object in an unsorted database of N objects in $\sqrt{N}$ steps; and quantum cryptography allows for the secure exchange of an encryption key on a public channel, which ensures that the exponentially fast Shor algorithm for factoring a prime number does *not* put the present-day communication security protocols in jeopardy of being breached.



Such proposals have helped to lay the foundation of an exciting, active field that spans physics, mathematics, computer science, and electrical engineering. Experimental progress has been modest, due to the inherent problems associated with decoherence—the inevitable loss of information that results from the system's interactions with its surroundings. Nonetheless, the field is still evolving and holds great promise.

Stephen Barnett's *Quantum Information* is a concise and remarkably readable account of most of the developments in the field. Barnett is a leading researcher who has made wide-ranging and fundamental contributions to quantum optics and quantum information science. His book touches on almost all aspects of quantum information and quantum computing, including communication and measurement theory, entanglement, and computing algorithms.

Quantum Information includes 21 appendices on topics such as number theory for cryptography, quantum copying, and the Araki–Lieb inequalities. The strategy is successful: a text accessible to an advanced undergraduate student with a decent background in elementary quantum mechanics followed by a set of sophisticated appendices for the more advanced reader. Also, at the end of each chapter are 30–40 exercise problems; most of them consolidate the topics discussed in the text and help to expand understanding.

But how much of quantum information can one grasp armed with just the basic postulates of quantum mechanics? It turns out that no knowledge of the Schrödinger equation and its solutions is required to understand the basic algorithms of quantum computing and quantum information. For example, a basic comprehension of light polarization and complementarity is enough to understand quantum cryptography's Bennett–Brassard protocol, which guarantees completely secure channels of communication.

The required level of background is