books

The cost of blind ambition

Plastic Fantastic

How the Biggest Fraud in Physics Shook the Scientific World

Eugenie Samuel Reich
Palgrave MacMillan, New York, 2009. $26.95 (266 pp.). ISBN 978-0-230-22467-4

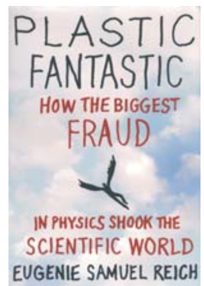
Reviewed by Myriam P. Sarachik

The gripping tale of the Jan Hendrik Schön scandal is told in Eugenie Samuel Reich's new book *Plastic Fantastic: How the Biggest Fraud in Physics Shook the Scientific World*. From 1998 to 2002, Schön, a young investigator working at Bell Labs, misled the physics community with a breathtaking series of extraordinary claims. He reported achieving spectacular, ground-breaking advances that included a field-effect transistor based on organic crystals, the quantum Hall effect and zero-field metal-insulator transition in that device, superconductivity where others had failed to find it, the first organic laser, the first light-emitting field-effect transistor, "behavior indicative of transistor action in single molecules," and more. They all turned out to be sheer fabrications.

I am a condensed-matter physicist working close to Schön's area of interest. Although I have not met him personally, I know a number of people who knew him well, including some of his coauthors, and I was sharply aware of the events as they unfolded. Moreover, as president of the American Physical Society in 2003, I was engaged in the ensuing debate over the scandal and was involved in the formation of a task force to reexamine and strengthen the society's policies on ethical conduct.

Familiar though they were, I found the retelling of those astonishing events completely engrossing. In great detail, Reich describes the rise and fall of Schön's short-lived scientific career, from his work as a graduate student in a large group at the University of Konstanz to his arrival at Bell Labs, where he made those incredible scientific claims, through his papers' enthusiastic acceptance, the growing skepticism, and the final unraveling.

Myriam Sarachik is a Distinguished Professor in the physics department at the City College of the City University of New York. In addition to conducting condensed-matter research, she has served as president of the American Physical Society.



Reich's narrative of the most sensational case of scientific fraud in physics in recent memory is a riveting, suspenseful must-read. Schön, sometimes unwittingly guided by his colleagues' ready acceptance and enthusiasm, was clever enough to know which claims would be viewed with the greatest excitement. Yet he was not smart enough to realize that some of his devices required the unachievable—for example, voltages that exceed breakdown potentials and electric fields that extend farther than Coulomb's law allows. When faced with questions he could not answer, Schön quickly announced yet another finding even more dramatic than the last. The pace of his publications accelerated—45 of them in 2001—and healthy skepticism grew. The entire magical superstructure finally came crashing down when colleagues noticed that Schön's papers on different devices contained identical data, down to the noise. The denouement followed quickly and, in concert with it, the book hastens its pace and ends rather abruptly, as if the author had grown impatient to finish it. Had Reich taken more time to summarize and discuss the questions she raises in her introduction, her compelling book would have been even better.

Schön's role in the whole affair is beyond comprehension. One gets a rather vague, foggy impression of him—a very pleasant fellow, by all accounts mild-mannered and eager to please. How could such a seemingly ordinary, self-effacing person have committed fraud on so massive a scale? More to the point, how could we in the physics community have allowed him to get away with it? Clearly, the responsibility extends well beyond Schön himself. Our reluctance to question the basic integrity of colleagues, the self-interest of journals and institutions—Bell Labs in this instance—our own wishful thinking, our ambitions, and our failure to set standards for recording and storing data are all factors that enabled those fraudulent claims to go unrecognized for too long.

Reich challenges our reliance on the premise that science is self-correcting—that is, that wrong results or theories are ultimately corrected and superseded. Although it became clear in fairly short order that Schön's results were all hatched in his head rather than in his lab, his deception was nevertheless enormously costly to many investigators who spent substantial time and resources in vain attempts to replicate his results. It had a particularly devastating effect on young postdocs and graduate students who lost valuable time at a crucial juncture in their careers. Although a number of Schön's claims have now been realized using different methods and materials, Reich points out that fraudsters like Schön could get credit for "first discovery" if, before they are caught, their false claims are confirmed by others on the basis of genuine data.

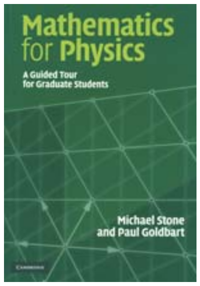
Clearly, *Plastic Fantastic* challenges the scientific community to identify and implement ways to police ourselves more effectively in order to obviate attempts by others to do it for us.

Mathematics for Physics

A Guided Tour for Graduate Students

Michael Stone and Paul Goldbart
Cambridge U. Press, New York, 2009. $90.00 (820 pp.). ISBN 978-0-521-85403-0

Without textbooks, the education of scientists is unthinkable. Textbook authors rearrange, repackage, and present established facts and discoveries—along the way straightening logic, excluding unnecessary details, and, finally, shrinking the volume of preparatory reading for the next generation. Writing them is therefore one of the most important collective tasks of the academic community, and an often underrated one at that. Textbooks are not easy to create, but once they are, the good ones become cornerstones, often advancing and redefining common knowledge. That is why I welcome the recent appearance of *Mathematics for Physics: A Guided Tour for Graduate Students* by Michael Stone and Paul Goldbart.



At the end of World War II, a scientist's standard mathematical arsenal consisted of calculus, differential and integral equations, and complex analysis, as presented, for instance, in *Methods of Theoretical Physics* (McGraw-Hill, 1953) by Philip McCord Morse and Herman Feshbach. Even now, those topics remain the core of mathematics taught to scientists. But many physicists felt the need to include in the compulsory scope such modern topics as Lie algebras and groups, differential geometry, and topology. Some "mathematics for physicists" authors have made meaningful attempts to include the new topics; those additions are discussed in a number of recent textbooks. Still, only a minority of physicists are using those modern topics in their practice.

Stone and Goldbart's "Guided Tour" has the potential to change that. The authors have drawn from material they've taught for many years to first-year graduate students at the University of Illinois at Urbana-Champaign. That experience has resulted in a text that is unique in its construction and approach and filled with high-quality examples. The book begins with traditional material, including the calculus of variations, Sturm–Liouville theory, and integral equations. But even here, the authors manage to introduce original pedagogical elements and examples. Subsequent sections discuss modern topics such as differential and integral calculus on manifolds, differential topology, and Lie algebras and groups. The book ends with an original complex analysis that combines the ideas of geometry and topology with purely analytical material. Some of the aforementioned topics are found in other texts, but in *Mathematics for Physics* they are combined into a single, and relatively thin, volume. That achievement may well become the foundation of a modern mathematical minimum for such textbooks.

Remarkably, the authors have mastered the pedagogical art of making their material both inspiring and digestible. Stone and Goldbart are both theoretical physicists, and their presentation is closer to the manner in which physicists communicate mathematics: They pay less attention to proofs and place more emphasis on concepts and examples. One important element of the book is the large number of exercises. The authors' refined judgment and broad knowledge of physics allow them to bring to their exercises material from distant areas of physics. I have no doubt that readers will be inspired in their study of nontrivial mathematics once they are exposed to such physics applications as solitary waves on shallow water, faceting of crystals, electron energy levels of the C_{60} molecule, and supersymmetric quantum mechanics.

The amount of material in *Mathematics for Physics* is definitely more than enough for two single-term courses; that provides a potential lecturer considerable flexibility. It also gives students an opportunity to go beyond what is presented in the lectures. The many features that make the book valuable to students and teachers also represent a substantial step toward making modern mathematics a part of the working arsenal of practicing physicists. I strongly recommend it to those who feel the need to upgrade their mathematics repertoire.

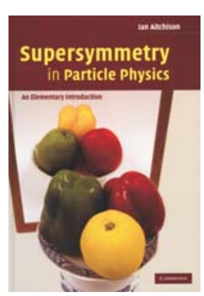
David Khmelnitskii
Trinity College
Cambridge, UK

Supersymmetry in Particle Physics

An Elementary Introduction

Ian Aitchison
Cambridge U. Press, New York, 2007. $65.00 (222 pp.).
ISBN 978-0-521-88023-7

Supersymmetry extends the Poincaré symmetry group to include transformations that pair fermions with bosons. First discovered in the 1970s in the context of string theory, supersymmetry was later found to have many theoretical advantages when applied to the standard model of particle physics. In the minimal supersymmetric standard model (MSSM), every particle has a superpartner whose spin differs by one half; the superpartners are expected to have masses around the TeV scale. In recent decades, TeV-scale supersymmetry has emerged as the leading candidate for new physics that will be tested thoroughly at CERN's Large Hadron Collider.



Given its appeal, it is not surprising that there have been a number of excellent modern pedagogical texts on the subject, of which Ian Aitchison's *Supersymmetry in Particle Physics: An Elementary Introduction* is a welcome addition. The book aims to provide a practical introduction to the basics of supersymmetry and the MSSM, and it succeeds admirably at that task. The book is a worthy companion to such texts as *Weak Scale Supersymmetry: From Superfields to Scattering Events* (Cambridge University Press, 2006) and *Theory and Phenomenology of Sparticles: An Account of Four-Dimensional* N = 1 *Supersymmetry in High Energy Physics* (World Scientific, 2005), both of which were reviewed in PHYSICS TODAY in December 2006. Aitchison's text is a slim volume consisting essentially of two parts: an introduction to global supersymmetry and an overview of the MSSM. The primary strength of the text is its accessible treatment of supersymmetry theory; Aitchison bases his presentation on a "do-it-yourself" approach that emphasizes intuition and physical understanding rather than on the more formal deductive approach of most texts. One highlight is the presentation of the 4D spinor manipulations needed for discussing the MSSM—the reader will not be required to master any additional formalism beyond that of basic quantum field theory. Starting from the Dirac equation, Aitchison guides the reader through a detailed treatment, including the notational complexities, of spinors associated with Hermann Weyl and Ettore Majorana. Although the notation and conventions in *Supersymmetry in Particle Physics* occasionally differ from many of the standard references, for newcomers to TeV-scale supersymmetry, the clear presentation of the spinor formalism may alone be worth the price of the book.

Aitchison's intuitive approach carries through the rest of the text. Supersymmetry is introduced through the explicit construction of a toy theory involving one complex scalar field and one Weyl fermion—familiar to some as the Wess–Zumino model, but without interactions or auxiliary fields. The supersymmetry algebra and the full Wess–Zumino model are then developed through familiar analogies with ordinary quantum field theories. Though not much discussion is devoted to the technically