

the works of the quantum-computation clan. He has also been teaching the subject to an interdisciplinary crowd of students and faculty at Cornell University. The book is the outgrowth of those courses and has been evidently battle tested by six years of lectures.

Quantum Computer Science covers a subset of the topics that are treated in the classic Nielsen and Chuang book or in the recent *An Introduction to Quantum Computing* (Oxford University Press, 2007) by Phillip Kaye, Raymond Laflamme, and Michele Mosca (see the review in *PHYSICS TODAY*, February 2008, page 61). But what it treats, it treats extremely well, with rigor and attention to detail that reveals a deep understanding of the subject. In that sense, Mermin's book adheres to a "less is more" adage; it's light on formalism and clearly opts for clarity and precision over completeness. That characteristic makes the book quite pleasant to read, even for experts who are already familiar with the subject. Mermin has chosen to provide little background on classical computer science. His approach makes the book an ideal, self-contained introduction to quantum computation for a curious student studying the natural sciences. A computer-science student, however, may miss a connection to the theory of computation at large.

The main emphasis of the book is on how and why the essential quantum algorithms, some quantum error-correction codes, and some simple, few-qubit quantum protocols work the way they do. Mermin exposes those inner workings by extensive, sometimes overabundant, analysis of quantum circuits. Particularly outstanding are the self-contained treatments of Shor's factoring algorithm and its number-theoretic background and the discussion of the Greenberger-Horne-Zeilinger puzzle illustrating the nonintuitive, nonlocal aspects of quantum mechanics. The division between the main text and the 16 appendices feels seamless and natural.

In his book, Mermin introduces the heretical term "Qbits" to denote qubits. Even if Mermin's motivation is right and Qbits is superior nomenclature to qubits, its introduction appears to run counter to the theme in Leo Tolstoy's *War and Peace*: No individual can single-handedly change the course of history. An immediate corollary is that no individual, not even David Mermin, can make us say Qbits when we mean qubits.

Yet what if his book becomes a standard in the undergraduate physics cur-

riculum? Its chapters—I recommend 1, 2, and 6, and appendices A through G—would be used as a first introduction to quantum mechanics, used *before* the floodgates are opened to application of the quantum in physics. We'd have generations of scientists, an army of undergraduates, raised on and ready to defend their first love—Qbits.

I don't know who will win the Qbit versus qubit wars, but I truly hope that Mermin's book will nurture the next generations of scientists in their understanding of things quantum computational—or even just plain quantum.

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Experiments and Demonstrations in Physics

Bar-Ilan Physics Laboratory

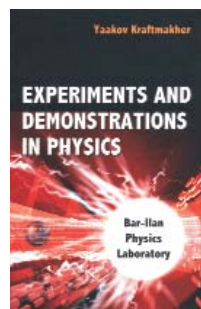
Yaakov Kraftmakher

World Scientific, Hackensack, NJ,
2007. \$128.00, \$68.00 paper
(533 pp.). ISBN 978-981-256-602-7,
ISBN 978-981-270-538-9 paper

Physics education research has amply demonstrated the importance of hands-on activities for students. Most high-school and introductory college physics courses include a laboratory component and lecture demonstrations. A modern innovation is to eliminate the lecture altogether, or at least integrate it with student experimentation. At the upper-undergraduate level, courses tend to be more theoretical and divorced from their experimental counterpart, probably to the detriment of learning.

Resources for physics teachers who want to include more or better experiments and demonstrations in their courses are relatively sparse. Classic references include Richard Sutton's *Demonstration Experiments in Physics* (McGraw-Hill, 1938), *Physics Demonstration Experiments* (Ronald Press, 1970) edited by Harry Meiners, and George Freir and Frances Anderson's

Demonstration Handbook for Physics (American Association of Physics Teachers, 1972). But those books tend not to exploit recent advances in instrumentation, especially computers. My own *Physics Demonstrations: A*



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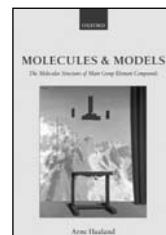
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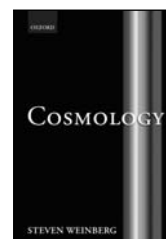


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Sourcebook for Teachers of Physics (University of Wisconsin Press, 2006) is aimed more at generating interest in the subject than at offering experimental experiences to students (see the review in *PHYSICS TODAY*, October 2006, page 67).

Yaakov Kraftmakher, a professor emeritus of physics at Bar-Ilan University in Israel, has written a nearly encyclopedic book containing 88 experiments and demonstrations that he has developed, adapted, or refined for his university. Having published extensively in physics education journals during the past 50 years, he is well qualified for the task. Most of the experiments require a computer and make extensive use of ScienceWorkshop data-acquisition equipment and DataStudio analysis software from PASCO Scientific, a manufacturer of scientific products for instructors; most of the additional equipment mentioned in the book can also be obtained from PASCO.

Kraftmakher's book is a truly impressive work, with something for everyone. The first chapter contains 20 experiments aimed at high-school students; however, many of those experiments involve topics not normally taught in US high schools and thus would be more suited for an introductory-level college physics course. The author then offers 38 experiments that would be appropriate for physics majors: in mechanics, molecular physics, electricity, magnetism, optics, atomic physics, and condensed-matter physics. A chapter on Nobel Prize-winning experiments includes eight experiments that demonstrate the principles for which the award was given, but it does not attempt to replicate the methods and equipment originally used. The final chapter contains 22 relatively straightforward but open-ended student projects, with many of the details left to the ingenuity of the student.

Most of the experiments include a brief description; a list of the required equipment; a short tutorial on the relevant physics, with the essential equations and references; diagrams of the setup; and sample experimental results. The book includes historical notes, approximately 600 annotated references, photographs of historic figures, and definitions of important units. The chapter on Nobel Prize experiments has photographs of the winners and quotes from the people who introduced their Nobel lectures. The book is nicely laid out, although without color, and is well organized and nearly free of typographical errors and inaccuracies. The level of detail varies from 15 pages on thermionic emission to 2 pages for many

of the student projects. A majority of the experiments are more appropriate for the laboratory than the lecture, because they involve detailed acquisition and analysis of data and therefore do not have the pizzazz that makes for a good lecture demonstration.

I have only a few quibbles with Kraftmakher's book. He uses some non-standard terminology; for example, he denotes the voltage by U rather than by V , and he calls μ_0 the magnetic constant rather than the permeability. He rarely discusses sources and analyses of experimental errors and sometimes omits the expected values of the results. He gives no vendor sources for the non-PASCO instruments that are used and rarely mentions hazards or safety issues. Some topics, including plasmas, radioactivity, and chaos, are absent or only briefly discussed. But such concerns are relatively minor and do not diminish my admiration for his book.

Although *Experiments and Demonstrations in Physics* looks and feels like a textbook, it is aimed at anyone who wants to incorporate more and better exercises into the development or the presentation of laboratory courses or lecture demonstrations. And it is especially helpful to those who already use PASCO equipment.

Julien C. Sprott

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Chemical Sensors An Introduction for Scientists and Engineers

Peter Gründler

**Springer, New York, 2007. \$99.00
(273 pp.). ISBN 978-3-540-45742-8**

Chemical Sensors: An Introduction for Scientists and Engineers is a 273-page monograph that offers what its subtitle claims. But I would qualify the text even further as an introduction to chemical sensors for undergraduate students studying chemistry, physics, or engineering. At that level of presentation, understanding the subject requires only high-school-level physics and chemistry.

The book is well organized; its 10 chapters include an introduction to and discussion of the fundamentals of chemical sensors. Its coverage of semiconductor structures as chemical sensors and of chemical sensors as detectors and indicators provides some information for novices in the field. The discussion of specific types of sensors is divided into four main princi-

ples of chemical transduction, the conversion of a molecular reaction into a measurable output signal: heat (thermal sensors), inertial mass (mass sensors), electrochemical (potentiometric and amperometric sensors and chemiresistors), and optical (optical fibers and planar waveguides). Surprisingly, capacitive sensors are unnecessarily treated as a separate subgroup of electrochemical sensors; they should have been included under chemiresistors.

Gründler is a professor at the Leibniz Institute for Solid State and Materials Research Dresden in Germany. His book, a translation of the 2004 German edition, is well balanced, without undue emphasis on any specific area but one—the author goes into depth in the final chapter when discussing hybridization sensors, his area of interest. The chapter not only covers each type of hybridization sensor but also contains a brief but useful description of its practical applications. That chapter should create a warm and fuzzy feeling in the hearts of engineers, who otherwise could interpret the book as just another treatise on some abstract instrumentation.

The author covers a few controversial devices, such as microfabricated reference electrodes and potentiometric immunosensors. Microfabricated reference electrodes, although frequently described in the literature, are not realistic due to their small volume and short lifetime. Likewise, alluding to potentiometric immunosensors is misleading because direct potentiometric measurement of a change in charge from immunochemical reaction is not possible. Luckily, those points are not elaborated on in any detail and therefore can be disregarded.

The elementary level at which the book is written leaves the reader with a comfortable feeling that there are no problems left in the field of chemical sensors and that everything regarding sensors works just fine. Interestingly, that characteristic is precisely why the book can serve well as an introduction to chemical sensing but also why it should not be considered as a foundation for graduate research.

Gründler's approach could be a good marketing tool, and it could also lure unsuspecting novices to the field of chemical sensors. Numerous multiauthored books, such as *Sensors Update* (Wiley-VCH, 1996–2003), edited by Henry Baltes, Wolfgang Göpel, and Joachim Hesse, and the many volumes of the Springer Series on Chemical Sensors and Biosensors (2004–2007), edited by

