chapters, Hartmann guides his readers step by step through each epoch in the process: protostellar cloud collapse, accretion through a disk, the disk–star interaction region, and the production of winds and outflows from young stellar objects.

The book's greatest strength is the close interweaving of observations and theory. At each major stage of evolution identified in the introduction, Hartmann provides a detailed summary of the observed properties and basic physics of astronomical objects thought to represent that stage. Thus, theoretical models of protostellar cloud collapse are compared directly to observations of collapse candidates; the theoretical spectral energy distributions (SEDs) of accreting star–disk systems are compared directly to observed SEDs; and pre-main sequence stellar evolutionary tracks on the Hertzsprung–Russell diagram are compared to the positions of observed stars. This even-handed treatment is what will make the book so helpful to both students and researchers in the field.

The danger of writing a book on a topic of active research is that, soon after publication, some material will be out-of-date. Alas, this has happened to Hartmann, as demonstrated in the first chapter, where he discusses the advances promised by the launch of the Infrared Space Observatory. (ISO was launched in November 1995.) Other topics reviewed, which have seen rapid progress in recent years, include angular momentum transport processes in disks and the properties of turbulence in protostellar clouds. This book will not replace the need for researchers to consult recent review articles to keep abreast of the latest developments in the field (as Hartmann himself clearly advocates in the preface). Still, do not let this unavoidable circumstance prevent you from reading this book, which otherwise skillfully reviews 30 years of previous research in the field.

There are only a few shortcomings in the book. Some aspects of the star-formation process are explained by two competing theories. For example: Are protostellar outflows produced primarily by an accretion disk alone, or by the interaction of the disk with the central star? At times, Hartmann chooses to focus on one theory rather than both, for reasons that he clearly explains. Still, for perspective, students should consult the literature referenced in the book in order to understand both arguments. Finally, I thought the book might have been even better had some discussion been included of the formation of high-mass stars (and the effect they have on the surrounding medium), and of the formation of multiple stellar systems.

Such limitations aside, investigators and students of star formation should consider themselves lucky that Lee Hartmann has written such a useful book.

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Physics in the 20th Century

Curt Suplee
Abrams, New York, 1999. 224 pp. $49.50 hc ISBN 0-8109-4364-6

It has become mandatory for notable anniversaries to spawn large-format volumes, commonly designated "coffee-table books," and it seems that the centennial of the foundation of the American Physical Society is no exception. Accordingly, APS and the American Institute of Physics (AIP) commissioned Curt Suplee of the *Washington Post*, a highly regarded science journalist, to produce such a work.

The bulk of the space in any such volume is taken up by illustrations. In *Physics in the 20th Century*, the illustrations have been chosen with care for visual impact and historic significance and handsomely reproduced with captions that fully explain what they are about. Indeed, much of the most interesting historical content is provided by these captions.

The book is organized by subject into seven sections, each accompanied by a chronological narrative text. The writing style is breezy, journalistic, and eminently readable. It is suitable for any literate reader, whether familiar with modern physics or not. Covering a century of physics in a limited space means that the explanations of the science are necessarily superficial, but they do successfully convey an impression of the importance of what was done.

The historical treatment is heavily biased toward the latter half of the century. One would have liked to see more about the likes of Albert A. Michelson and Robert W. Wood, the wizards of optics who dominated the early decades of the century, or a more comprehensive view of the great industrial laboratories that carried much of American physics through the interwar years. The epic Compton–Millikan debate over the nature of cosmic rays certainly deserves far more ink than it gets.

The most significant defect of the book, however, is the presence of a lamentably large number of errors, both scientific and historical. No science writer can be expected to cover such a broad range of material without getting a few things wrong. But one would have expected, especially in a text prepared under the aegis of APS and AIP, a more careful review by knowledgeable consulting editors.

Were such precautions taken, we would not have been told that the electron in a pre-Bohr planetary atom slows down as it radiates away its energy or that uranium-238 cannot sustain a chain reaction because it has a stable nucleus. And somebody should have noticed that fusion reactions in a hydrogen bomb do not deliver 60 times as much energy, gram for gram, as fission; even for the deuterium-tritium reaction, the ratio is a bit less than 5. These are only the most egregious examples from among a dozen or more that I found.

On the historical side, the original objective of the Davisson–Germer experiment was not, as asserted, to study crystalline structure, but simply to determine the effects of electron backscattering on the performance of vacuum tubes. (Interestingly, the caption on the figure depicting their apparatus correctly describes the historic accident that led to the annealing of the target anode into a monocrystalline form, producing the diffraction pattern that confirmed the wave properties of their electron). Nor do the Maxwell equations in themselves imply that the velocity of light is independent of the motion of the observer; Einstein's audacious postulate was still required.

Finally, many physicists involved in the long-running dispute over the significance of quantum "entanglement" will be dismayed to learn that the violations of Bell's inequality in photon spin-correlation experiments prove the ability of photons to "communicate instantaneously" over long distances. This is decidedly a minority view.

Still, one does not expect great profundity from a work of this sort, and many readers are likely to find the splendid collection of illustrations and the readable historical overview well worth the $50 price tag.

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Reasoning with the Infinite: From the Closed World to the Mathematical Universe

Michel Blay
Translated by M. B. DeBevoise
U. Chicago P., Chicago, 1998. 216 pp. $30.00 hc ISBN 0-226-05834-4

Michel Blay's *Reasoning with the Infinite* is part of a growing body of literature on the history and philosophy of mathematics that focuses on the crucial years around the invention of calculus and the publication in 1687 of Isaac Newton's *Principia*. A few decades ago, historians of mathematics were more concerned with results, such as the integration of a given expression; now they pay greater attention to methods and conceptual foundations. Blay has published extensively in this area and is one of the leading scholars on the birth of analytical mechanics and especially on Pierre Varignon, the French mathematician who "translated" Newton's geometric language into the algebraic forms of differential equations.

Blay deals with several crucial episodes of the history of mathematical physics. His book's subtitle is clearly modeled on Alexandre Koyré's *From the Closed World to the Infinite Universe* (Johns Hopkins U. P., 1957), which puts the geometrization of space at stage center of the intellectual revolution of the 17th century. By contrast, Blay detects a dichotomy between, on the one hand, geometrization and its failure to deal with the infinite and, on the other hand, mathematization, namely a more abstract enterprise no longer concerned with the reality of things but only with methods, techniques, and auxiliaries of investigation. (Readers interested in the related problem of the foundations of mathematics in the years between Galileo and Leibniz will find Paolo Mancosu's, *Philosophy of Mathematics and Mathematical Practice in the Seventeenth Century* (Oxford U. P., 1996) extremely valuable.)

One of the virtues of Blay's book is its extensive quotations and careful exegeses of primary sources, such as Galileo, Descartes, Huygens, and Newton. At times, however, the author does not deal with the material in a strictly chronological fashion, and this may confuse some readers.

Historians and philosophers of mathematics, as well as physicists with an interest in the history of science, will find this book interesting and thought-provoking, but historians and scientists will probably prefer different portions of it: Scientists will enjoy the detailed analyses of the main figures of the Scientific Revolution; historians will appreciate the careful conceptual explanations and especially the novel investigations of a neglected source, namely the work by Bernard le Bovier de Fontenelle, the secretary of the French Royal Academy of Sciences. Fontenelle's *Élemens de la géométrie de l'infini* (1727) is a very important text in Blay's story, because of its attempt to deal geometrically with the infinite. Blay goes as far as to claim that "Fontenelle's work (despite certain mathematical weaknesses . . . resulting for the most part from the lack of a clear distinction between ordinal and cardinal numbers) incontestably prefigured that of Georg Cantor and his successors."

Although this conclusion seems to require further qualifications, Blay has provided an interesting and novel perspective on the history of mathematical physics.

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Introduction to Bioanalytical Sensors

Alice J. Cunningham
Wiley, New York, 1998. 418 pp. $64.95 hc ISBN 0-471-11861-3

As those of us in the baby boomer generation age and the consequences of the second law of thermodynamics make their unwelcome inroads on our bodies, we become introduced to the world of bioanalytical sensors of various sorts. Over 5% of us, for example, will at some point develop diabetes, a condition that arises when the pancreas fails to produce enough insulin to break down glucose in the bloodstream. Although insulin injections can control this condition, it is critical to regulate the amount of insulin in the body on a semidaily basis, since the body responds to insulin in a complex way. Biosensors of quite high sophistication can now perform automated analysis of a sample drop of blood, allowing patients to monitor and regulate their insulin levels and greatly improve their quality of life.

Biotechnology has also, lately, been the darling of Wall Street, and a great deal of interest has been aroused by such concepts as a lab-on-a-chip being engendered by an array of high-technology start-up companies. The hope is to both shrink the present bioanalytical lab down to a wafer-sized object and to take advantage of the new physics and chemistry that arise in these micron-sized worlds. The drop-of-blood glucose monitors are merely the tip of the iceberg in a burgeoning field of advanced biotechnology that has the potential to transform medicine in the coming years. As the physics community seeks to broaden its horizons and find applications of physics among some not-so-usual suspects, this area offers many possibilities.

Alice J. Cunningham's compact *Introduction to Bioanalytical Sensors* offers a welcome entrée to this field. Although it is concerned more with conventional biosensors than with the new micromachined devices, it covers the basic physics, chemistry, and molecular biology of the processes that must be understood by the researcher entering the field. Cunningham, an emeritus professor of chemistry at Agnes Scott College in Atlanta, has read an astonishing amount of literature on the subject and, in her book, offers compact summaries of the basic ways these devices work. She also provides an extensive bibliography to a very diverse body of literature on the subject—including journals and books with which your average physicist is probably unfamiliar.

I would hasten to add that this is not a book you would read while taking a nice long bath. It is definitely not written by a physicist, and many concepts are presented too glibly. You suspect that there is a better way to understand selective membrane filtration, for example, from a statistical-mechanics point of view, but the book's discussion is so compact that you just know you will have to get up from the tub and do some searching among the books on your study shelves. The book presents a very broad introduction to many technologies and points the reader toward the literature; the rest is up to you.

During the time I was reading this book, I was on several study committees whose members included presidents of bioanalytic sensor companies, and I asked their opinion of it. They were very pleased to see that such a comprehensive and useful survey book had been written on the subject. As I work in biotechnology, this will be a very useful reference work for me.

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NEW BOOKS

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