new insights into the structure of black holes and the dynamics of gauge theories.

Given its scope, it is not surprising that string theory is exceedingly difficult to learn. This situation has been greatly improved by the publication of Joe Polchinski's two-volume *String Theory*.

Before Polchinski's book, aspiring students of string theory have relied on the textbook by Michael Green, John Schwarz and Edward Witten. The GSW book (*String Theory*, Cambridge U. P., 1985) did an admirable job of bringing together the main points of string theory as it was then understood. However, the central role played by two-dimensional conformal invariance was not fully understood at the time, and the revolutionary ideas of the past four years, involving strong–weak coupling duality, extended objects, and the applications to black hole physics and the dynamics of supersymmetric gauge theory, had not been dreamt of. Thus there has been a clear need for a more modern textbook.

The first volume of Polchinski's book—a necessary prelude to the second—develops the theory of the bosonic string. This theory is not thought to be physically realistic, but its development introduces many of the tools required for an understanding of the physically more interesting superstring. Following a brief overview, the bosonic string is quantized and its spectrum determined. Emphasis is placed on a geometrical point of view and the use of path integral techniques. This quickly leads to conformal field theory (CFT), which is used as an organizing principle throughout the text.

After developing the tools of string perturbation theory through the computation of tree-level and one-loop string scattering amplitudes, the first volume treats toroidal compactification of string theory. This is not meant to be realistic, but it can be treated exactly and introduces some of the modern ideas of string theory. In particular, the notion of T-duality, which relates large and small radius, is encountered, along with D-branes, which are extended objects whose central role in string theory duality was first appreciated by Polchinski. Volume 1 ends with brief summaries of some topics that presaged the development of nonperturbative techniques in string theory, such as the divergence of string perturbation theory, the high-energy behavior of string scattering amplitudes, and the structure of noncritical string theories.

Compared to the smooth, logical development of the first volume, the second volume, or superstring theory, begins rather abruptly by generalizing conformal field theory to superconformal field theory and then, only later, discusses the geometry behind this approach. Type I and II superstrings, the heterotic string, and superstring perturbation theory are all developed in the first hundred or so pages. This terse treatment makes some sense: The geometry of superstrings is much less intuitive than that of bosonic strings, and a detailed treatment of higher-order superstring perturbation theory would be overwhelming for all but the most sophisticated readers. Nonetheless, I felt a bit rushed. I could have used more reminders of how this material relates to the first volume.

The book then discusses two of the recent successful contributions of string theory: the ability to understand nonperturbative effects and the resulting control of strongly coupled string theory, and the insight into the structure of black holes that has resulted from the study of the extended objects responsible for these nonperturbative effects. The reader who has persevered this far is now richly rewarded by a discussion of D-branes and string duality, which explains the basis for these developments and summarizes the main results.

The remainder of volume 2 is devoted to attempts to make contact between the ten dimensions of string theory and the four-dimensional world of particle physics. This includes presentations of more advanced CFT techniques and compactification of string theory on orbifolds and Calabi–Yau spaces. This leads to four-dimensional theories, which resemble supersymmetric extensions of the standard model and are the basis for much of the current work on low-energy supersymmetry. As mentioned in the preface, the treatment of Calabi–Yau compactification is necessarily incomplete. The book by GSW is a useful supplement to the material presented here.

The use of CFT as a central theme brings a great deal of coherence to this book, although at a price. Primarily the language of string perturbation theory, CFT can rather miraculously be extended to deal with weakly coupled nonperturbative phenomena such as D-branes. Topics that require a spacetime point of view and don't easily fit into the CFT framework are treated rather briefly, if at all. The Green–Schwartz formalism is one example; another is the rather sketchy treatment of the low-energy supergravity Lagrangians in eleven and ten dimensions. Solitons in string theory, which cannot be described in terms of D-branes, are also discussed rather briefly.

Overall, this is an impressive book. It is notable for its consistent line of development and the clarity and insight with which topics are treated. While it was written with novices in mind, experts will find many new points of view and interesting results. It is hard to think of a better text in an advanced-graduate area, and it is rare to have one written by a master of the subject.

It is worth pointing out that the book also contains a collection of useful problems, a glossary, and an unusually complete index. Typographical errors seem to be few, and they are corrected and updates are provided at a dedicated Web site. In a fitting catch-22 of the computer age, the URL of the Web site is given incorrectly; it can be found at http://www.itp.ucsb.edu/~joep/bigbook.html.

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Accretion Processes in Star Formation

Lee Hartmann
Cambridge U. P., New York, 1998. 237 pp. $69.95 hc
ISBN 0-521-43507-2

How do stars form? Such a seemingly simple question has a surprisingly complex answer—so complex, in fact, that many of the details of the process of star formation are still poorly understood. What is certain is that it involves the gravitational contraction and fragmentation of massive, diffuse clouds of gas and dust in interstellar space. Thus, at its most fundamental level, star formation involves accretion: the inward flow of matter onto a growing protostellar core.

In *Accretion Processes in Star Formation*, Lee Hartmann has written a much-needed book that focuses on this all-important process. It offers a wonderful overview of the subject for graduate students in astronomy and physics and for star-formation researchers. Since the same physics that governs accretion flows in star-forming regions is important in other astrophysical systems (such as mass transfer in close binary stars), specialists in other fields should find this book of interest as well.

Hartmann takes a very broad view of accretion. In the introductory chapter, he outlines a plausible scenario for the evolution of the mass accretion rate in the idealized problem of single-star formation, beginning with the earliest contraction phase of an interstellar cloud and concluding with the initiation of hydrogen-fusion reactions in the newly formed star. This scenario is the organizational theme around which the rest of the book is built. In successive 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 litera-