anomalous, but the regularization of the annulus and Moebius-strip hexagons is not yet understood. In closed string theories one knows both their finiteness and freedom from anomalies. For the O(32) open superstring case, therefore, I find that the stringy regularizations of chapter 10 are unconvincing. The low-energy effective field theory calculation, discussed in chapter 13, is much clearer.

Chapter 11, rounding out the formalism, provides a derivation of Stanley Mandelstam's useful technique for explicit string calculations in the light-cone gauge.

The second half of the book concerns applications of superstrings and is necessarily more speculative. Curiously, one may regard the applications either as phenomenology—because they attempt to link the theory with experimental physics—or as mathematics—because differential and algebraic geometries come to the fore here.

Chapter 12 is an excellent treatment for physicists of the mathematics of differential geometry and differential forms using examples of gauge fields and spin-$\frac{1}{2}$ fermions. Chapter 13 contains a general account of the low-energy effective theory, particularly of the anomaly cancellation already mentioned. The compactification of six spatial dimensions is discussed in chapter 14, with particular stress on index theorems and the occurrence of zero modes. Chapter 15 explains the choice of Calabi–Yua manifolds for the compactified dimensions and explains how the heterotic string can lead to a supersymmetric E(6) grand unified theory with sensible quantum numbers for quarks and leptons. The final chapter explores several further phenomenological implications, for example, how in the E(6) scenario the renormalization group dictates that there be no more than three quark–lepton families—otherwise the gauge couplings would blow up at energies well below the Planck energy.

Without hesitation, I can rate the Green–Schwarz–Witten book as elegant and useful. Its timely publication could have a significant impact on the development of superstring theory. While it is obviously not the last word on the subject, I hope that the book will inspire a bright student to answer one of the basic outstanding questions, such as:

▷ Why does the cosmological constant vanish after supersymmetry breaking?

▷ How does one locate the correct vacuum state from the billions of candidates in the superstring theory?

▷ What are the axiomatics that allow superstrings to generalize general relativity and gauge field theories?

Introduction to Supersymmetry and Supergravity

Peter West

World Scientific, Singapore (Teaneck, N. J.), 1986. 289 pp. $32.00 hc ISBN 9971-50-027-2; $19.00 pb ISBN 9971-50-028-0

Through the cooperation of a number of researchers and the persistence of Peter West, its author, this long anticipated book has at last appeared and makes a very creditable effort to fill a niche in the literature on supersymmetry and supergravity. The book fits nicely in level of difficulty and detail between the more elementary *Supersymmetry and Supergravity* by Julius Wess and Jonathan Bagger (Princeton U. P., Princeton, N. J., 1983) and the more comprehensive *Superspace* by Marc Grisaru, Martin Roček, Warren Siegel and myself (Benjamin–Cummings, Menlo Park, Calif., 1983).

West, a physics professor at King's College in London and a well-known researcher in the area, gives a coherent and logical introduction to the subject with enough detail to illustrate the structure of supersymmetrical field theories. An example of the attention to detail is seen in the discussions of the difference between algebraically on-shell and off-shell component actions in chapters 5 and 12. Another such example is found in the appendix, which gives the proper definition of superspace complex conjugation. A lack of appreciation of this definition has often caused confusion and unnecessary complication in the literature on the superspace formulation of such theories. The range of topics treated is broad enough that the nonspecialist or intermediate-level graduate student will begin to understand the intricacies of the field.

The book proceeds from general discussions to representation theory and construction of supersymmetric models. Unfortunately, West's discussion of the superconformal algebra contains an error that causes a problem in a later "proof" of the finiteness of $N = 4$ Yang–Mills theory. However, he also gives several alternative proofs to support the arguments for the finiteness of both the $N = 2$ and $N = 4$ Yang–Mills theories. With effort, the reader unfamiliar with supersymmetric perturbation theory can learn the technique of Feynman supergraphs. Curiously, however, the presentation does not use the most recent (and efficient) calculational rules. West describes the implications of supersymmetry for quantum field theory clearly and concisely.

Leaving rigid supersymmetric theories, West moves on to the theory of supergravity. The treatment given more or less follows the historical development. The widely used method of tensor calculus is treated in an erudite manner. Undauntedly, West tackles the challenge of elucidating the structure of superspace supergravity. Here the discussion roughly parallels the treatment of Wess and Bagger. However, West pays much more attention to the nature and role of the constraints imposed on the theory. The only disappointment is that although there is much discussion of constraints, almost no effort is made to solve them. Similarly, West gives insufficient attention to how superspace generalizes and underlies the tensor calculus method.

With the impact of string theories, it was perhaps unavoidable that the book would include some discussion of strings. In the final two chapters, where this topic is treated, the book fails to maintain the high standards set by preceding chapters. An example is the discussion of the patently false notion of a finite set of auxiliary fields for the bosonic string. The discussion of two-dimensional supersymmetric models is truncated and not particularly systematic.

Overall this book is a valuable contribution. The principle of supersymmetry has had a major impact on theoretical particle physics over the last decade and will likely continue to do so for the foreseeable future. *Introduction to Supersymmetry and Supergravity* offers a way for a wider audience to gain access to and understanding of this principle.

S. James Gates
University of Maryland

The Second Creation: Makers of the Revolution in 20th-Century Physics

Robert P. Crease and Charles C. Mann

Macmillan, New York, 1986. 480 pp. $25.00 hc ISBN 0-02-521440-3

The last few years have seen the appearance of an impressive number of books that try to explain what is happening in modern physics to the lay audience that one always hopes is waiting out there. These are fine,

serious books written mostly by participants in the events described, each from its own point of view. *The Second Creation* is a little different. The authors are not participants—one is an experienced scientific editor and the other was a graduate student in philosophy at Columbia. They did an enormous amount of work, interviewing more than a hundred physicists, looking at the files and the correspondence of some of them and descending 2300 meters into the Kolar gold mine in India to see the proton-decay experiment there. Their book begins and ends in the salt mines under Lake Erie. There is every sign that during their five years of work the authors had a very good time.

What is their focus? It is the physics of fundamental particles and fields, both experimental and theoretical. Like some of the participants they obviously think that this is the central concern of physics and that the rest is a working out of details. (I hope someone will write an equally good piece of reportage on the high-temperature superconductivity explosion.) But the real focus is on people. They are portrayed as individuals, not just as exponents of this or that idea, and once we have met them, strolled with them through the places where they work and eaten with them in the cafeteria, the story of particle physics can be presented as an account of what they have done, the physics being given as needed. The authors explain just about all that can be explained without mathematics. They talk about theories and describe crucial experiments such as the search for neutral currents, giving attention both to experimental techniques and to the exhaustive consideration of data and of possible alternative explanations before anything is announced.

For whom are they writing? Not just that model layman, I'm sure, for they hold a mirror up to the profession and some of its leading members. There is more here for physicists to read than just physics.

What do the authors know? They do not pretend to be physicists. Their narrative is vivid and personal, and it will read very differently for someone who knows what $SU(3)\times SU(2)\times U(1)$ means and for someone who knows groups only by the authors' example of the integers, making no mention of the group operation. Perhaps some little errors, such as the use of "Bo" to represent boron, were allowed to pass by the dozens of people who seem to have read various chapters—these mistakes serve, without hurting anything, to tell us about the authors, as the authors tell us about the physicists.

How is the book written? Well, but with occasional lapses. There is a nice description of Victor Hess landing after an early cosmic ray flight: The photograph shows "Hess peering out through the ropes of the balloon, smiling against the sun, a wave of farmers lapping against the side of the basket." On the other hand it would be a relief if once, just once, a writer described the fast pace of something as other than "feverish."

This lively and entertaining book ends with an account of the reasoning by which the first seconds of the cosmological model universe are being reconstructed using insights from particle physics—the "second Creation" of the book's title.

DAVID PARK
Williams College

The Quantum Hall Effect

Edited by Richard E. Prange and Steven M. Girvin
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ISBN 0-387-96286-7

The discoveries of the quantum Hall effect in 1980 and of the fractional quantum Hall effect in 1982 initially took the physics community by surprise. By now we have reached a rather thorough, though by no means complete, understanding of the basic phenomena. It is now widely accepted that the quantization of the Hall resistance of a two-dimensional electron gas in a strong magnetic field in units of h/e^2 (or a simple rational fraction thereof) is due to general principles of gauge invariance and charge quantization. The exactness of this relationship has already made an impact on metrology, and the quantum Hall effect is well established as a resistance standard. For the fractional quantum Hall effect, Robert Laughlin's picture of an incompressible fluid due to electron correlation has also gained broad acceptance.

Now the field has reached a certain level of maturity, so a book summarizing the current status would be most welcome. This need is well fulfilled by the volume of review articles edited by Richard Prange and Steven Girvin. The book contains both experimental and theoretical reviews, written by leading contributors to the field. Marvin Cage covers both the experimental situation and the metrological application of the integer effect; Albert Chang has provided