scribes would contain far more primordial helium than astronomical observations allow.

The text abounds in visual images, which come to life in lavishly detailed and aesthetically pleasing diagrams whose captions illustrate the maxim that a good picture deserves a thousand words. Concrete visual details serve to anchor abstract ideas: Matchsticks representing radii of curvature have heads, matter and spacetime grip one another with pairs of hands, the "energy hill" of a particle near a black hole is made of plaster of Paris. The diagrams are supplemented by beautifully executed full-color drawings and well-chosen photographs. The overall visual effect is stunning.

Like Wheeler's earlier books, *A Journey into Gravity and Spacetime* makes liberal use of parables, stories, imaginary conversations, dreams and visions, neologisms ("momenergy"), slogans ("law without law"), magnifying glasses, film strips, time-lapse sequences and sentence constructions that encourage participatory reading. There is also a good deal of free verse. Each chapter opens with a poem in exalted style, and there is a long prefatory ode whose final stanza summarizes the book's central message:

Help me to make this account
A radiant testimony
To the wonderful simplicity
Of the principle that the boundary
of a boundary is zero,
Heart of Einstein's great 1915,
Battle-tested, and still standard
Geometric account of your action,
oh Gravity.

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Elementary Particle Physics: Concepts and Phenomena

Otto Nachtmann
Springer-Verlag, New York, 1990 [1985]. 559 pp. $98.00 hc ISBN 0-387-50496-6

Otto Nachtmann's book is a new entry in the growing list of introductory particle physics texts for the post-"standard model" era. It looks like a good one, although I should point out that I have not given this book the ultimate test in the classroom: Most of us have had the experience of seeing diamonds lose their glitter as the semester progresses. The text is a translation from the original German edition, which has been around for about five years. One of my junior collaborators, who is German, told me he learned his trade from the German version, and he was very complimentary. This confirmed my own positive impressions—this is a text I would consider adopting.

The book's main material is contained in 460 pages and is divided into four parts. After an introduction reviewing relativity, quantized fields, the Dirac equation and definitions of cross sections, nine chapters cover quantum electrodynamics. In part 3, a discussion of strong interactions leads to quantum chromodynamics and a first exposure to nonabelian gauge theories. The fourth part covers the standard electroweak model. The book's aim is to introduce the standard model as completely as possible. Only a few pages at the end allude to grand unification, strings and some other speculative extensions. Appendixes cover over 50 pages and list a wealth of facts about spinors, traces, color factors, the Feynman rules for all pieces of the standard model and more. Each chapter ends with a list of problems, and solutions to a selection of these are given in the back.

The book emphasizes particle physics rather than field theory and concepts rather than computational techniques. The discussions are clear and very systematic, and no paragraph is redundant. The essential ingredients of every topic are enumerated in a logical and concise fashion. This characteristic style is exploited to cover a large range of topics, larger than in similar texts such as *Introduction to High Energy Physics* by Donald Perkins (Addison–Wesley, Reading, Mass., 1983), *Gauge Theories in Particle Physics* by Ian Aitchison and Tony Hey (Adam Hilger, Bristol, UK, 1982) and *Quarks and Leptons* by myself and Alan Martin (Wiley, New York, 1984), just to name a few I happen to be familiar with. These texts, designed to help the student to perform explicit computations at the earliest possible stage, introduce Feynman diagrams with little or no formal Lagrangian field theory. The approach is based on Feynman's pioneering book *Theory of Elementary Processes*, now 30 years young.

Nachtmann does not take any shortcuts but takes the traditional road via Lagrangians, second quantization and the Wick expansion. This spirit permeates the book: For example the QCD discussion is based on Lagrangians, anomalous dimensions and the like. This is to be contrasted with the very phenomenological paths travelled in the texts previously referred to: the color symmetry of the baryon wavefunction, radiation of gluons, analogy with Weiszacker–Williams and so on. This is not just a difference in taste. Unlike the older texts, which were written before the weak intermediate bosons were discovered and which are permeated with the excitement of the experimental verification of the different pieces of the standard model, this book takes the standard model as dogma and is thus able to develop its implications in a logical and concise fashion. The immediate advantage is that a more complete list of topics can be covered in a similar number of pages: To mind come good old-fashioned topics like strong interactions, the interactions of electrons with matter and *C*, *P* and *T* symmetry.

The final judgment of this book will very much depend on taste. It will probably have the edge when the teacher or student happens to be a theorist. Although Nachtmann presents the ideas in a clear and systematic way, I suspect that the student who uses this book will find performing the calculations in a systematic fashion more challenging than would the student who uses the book I coauthored with Martin. But if you have a group of talented beginning graduate students, I recommend trying this book out—if you can afford the price!

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Reversing the Arms Race: How to Achieve and Verify Deep Reductions in the Nuclear Arsenals

Edited by Frank von Hippel and Roald Z. Sagdeev

Gordon and Breach, New York, 1990. 432 pp. $40.00 hc
ISBN 2-88124-436-X

As the world grows accustomed to the *glasnost* era, shaky as it may be, cooperation between Soviet and American scientists on arms control issues no longer seems to be as newsworthy as it once was. However, the initiation of a series of joint studies in 1987 and the journal *Science and Global Security* in 1989 by the Federation of American Scientists and the Committee of Soviet Scientists for Peace, Against the Nuclear Threat (known as CSS) marked a significant development in the arms control process, and it continues to be viable today. This group of "nongovernmental" scientists is led by Frank von