important contributions to the formulation of mass renormalization in electrodynamics, Mehra does not refer to Max Dresden's careful review of this work in his sensitive and thorough biography, *H. A. Kramers: Between Tradition and Revolution* (Springer-Verlag, 1987). Had he done so, he would not have had J. Serpe, a student of Kramers, work on the problem of vacuum polarization (page 214) and he would have realized that Victor Weisskopf's account of having "a lot of conversations with Kramers" at the 1940 Ann Arbor summer school cannot be right (page 226): Kramers stayed in Holland throughout the war, and by June 1940 that country had been overrun by the Germans. Mehra has Feynman resign from the National Academy of Sciences "when Frederick Seitz followed Detlev Bronk as president [of the NAS]" (page 395) when in fact the resignation occurred much later, while Philip Handler was president.

Yet for all these shortcomings, the book does convey Feynman's remarkable accomplishments and outstanding stature as a physicist. Perhaps because the book is a pastiche—drawing from the best available secondary sources—and because Feynman's thoughts and quests are compelling, it does keep the reader's interest. Mehra did gather new information by contacting some of Feynman's friends from high school and his high-school physics and chemistry teachers as well as some of Feynman's students and colleagues at Caltech. Mehra also obtained sound advice and help from leading physicists, so we do get a sense of the sweep of Feynman's accomplishments.

Over half of the book concerns Feynman's work up to 1950, with quantum electrodynamics the centerpiece of that presentation. The flavor of the book changes thereafter, taking on more of the character of review articles when dealing with Feynman's technical work. Somewhat fewer than 50 pages are devoted to Feynman's work on liquid helium; his work on polarons, $V-A$ and conserved vector interactions in beta decay, gravitation, partons and jets gets even briefer expositions. What we do not get is the relative importance to Feynman of these researches. Surely the parton work played a more crucial role—intellectually and psychologically—than did the polaron problem, yet more space is devoted to the polaron problem.

What we also do not get is a description of the genesis of Feynman's later ideas or an account of the enormous amount of work that went into whatever got published—or for that matter the enormous amount of work in diverse fields that never saw the light of day. All these materials are to be found among Feynman's papers in the Caltech archives. Also to be found there is an extensive collection of Feynman's course notes dating from the 1950s to the 1980s. They include the notes for the high-energy physics courses he taught from 1968 to 1975, the notes on the gauge theory and quantum chromodynamics course he taught in the early 1980s, as well as his extensive notes on QCD in 2 + 1 dimensions.

Some of the earlier course materials were published in the Addison-Wesley series Lectures in Physics, but it is precisely an analysis of the unpublished notes that would have been revealing of Feynman's later thoughts and would have made Mehra's book a much more valuable contribution. Also, one would have expected what purports to be an intellectual biography of Feynman to include a complete bibliography of Feynman's papers, books and published talks, but this is not the case.

Feynman's role as teacher and his extensive interest in computing and computers do come through in the book. Mehra's report of Feynman's reflections on science and religion and on science and society consist essentially of extensive quotations and paraphrases of Feynman's articles on the subject. Here too, Feynman's thoughts and words make you read on and ponder what you read.

In short, what Mehra has done is the easy part of writing an intellectual biography of Feynman. He has availed himself of the readily available writings and researches on and by Feynman. Feynman deserves better, in both the integrity of the presentation and the thoroughness of the scholarship.

Silvan S. Schweber
Brandeis University
Waltham, Massachusetts

Environmental Physics

Egbert Boeker and
Rienk van Grondelle
Wiley, New York, 1995. 448 pp.
$34.95 pb ISBN 0-471-95110-2

It is a pleasure to read a book on the environment that emphasizes equations of scientific process rather than descriptive words of summation. Though equations won't answer all environmental questions, they can often yield the partial answers. If I were teaching a graduate level course on the physics of the environment, *Environmental Physics* by Egbert Boeker and Rienk van Grondelle would be one of the required texts for the course. I was delighted to find, for instance, materials that I have collected from books and articles over the years now concisely gathered in one place. Since *Environmental Physics* goes further into the well of knowledge than most undergraduates would wish to travel, I would select the book only as recommended reading for them and put it on reserve in the library.

Rather than giving a thin discussion of the entire book, I will review two sections: chapter 3 on the global climate and chapter 5 on the transport of pollutants.

Since it is very likely that the carbon-dioxide content of the atmosphere will double during the 21st century, it is necessary to understand the effects of this doubling. In chapter 3, Boeker and van Grondelle nicely extend the simple energy balance to consider the temperature of both the Earth's surface and its atmosphere. This is followed by an estimate of the radiative forcing term that raises the surface temperature as a consequence of the heat trapping by carbon dioxide. The estimate of a 1.4 K rise caused by an intensity increase of 5 W/m^2 is not a proof, but it helps us physicists to understand the mechanisms for such a predicted temperature rise. With this understanding, perhaps we can interpret the new results on enhanced solar absorption by clouds. A nice calculation of lapse rates (the reduction of temperature with a rise in height) is followed by estimates of stable and unstable vertical motions of air. The chapter concludes with a mathematical discussion of some of the elements of the general circulation models, an extremely relevant topic since the calculations from such models have thus far led the experimental data in the conclusion that carbon dioxide is the problem.

The rather long (99-page) chapter on the transport of pollutants is important because the authors have gathered here considerable basic information on pollutant transport in air and in surface and underground water. It is a pleasure to follow the development of differential equations and their solutions to establish a firm foundation for more complicated issues. *Environmental Physics* does not enter into the present issue of underground burial of nuclear wastes, for instance, but the text clearly establishes the methodology that should be used. After reading this chapter we may not be able to pass professional

judgment on the safety of proposed nuclear waste depositories, but at least we will be able to ask better questions. Most recently Charles D. Bowman and Francesco Venneri have theorized that leached plutonium from spent fuel rods in Nevada might collect in localized spots and create an underground explosion of 0.3 kilotons. (C. D. Bowman and F. Venneri, "Underground Autocatalytic Criticality from Plutonium and Other Fissile Materials," report no. LA-UR 94-4022, Los Alamos Nat. Lab., 1994.) My examination of their paper shows no application of the equations on underground water flow, which predict diminished concentration from speeding gaussian distributions, given in chapter 5.

Because of the high quality of *Environmental Physics*, it will be immediately useful to the environmental movement in the United States. Many of the environmental laws are now under attack and undoubtedly will be softened. It is a pity that, in the larger debate on the environment, the environmental movement has been wounded because each environmental group has wanted to maximize the regulations in its area without concern for the broader establishment of therapeutic priorities for "patient Earth." A good study of *Environmental Physics* should help us all in our efforts to separate the larger problems from the smaller ones.

DAVID HAFEMEISTER
California Polytechnic State University
San Luis Obispo, California

Industry's Future: Changing Patterns of Industrial Research

Herbert I. Fusfeld
American Chemical Society, Washington, DC, 1994. 369 pp. $39.95 hc ISBN 0-8412-2983-X

The unique characteristic used by Herbert Fusfeld in *Industry's Future* to distinguish industrial research from related endeavors is the former's combination of performers, funders and users of research output within an industrial firm. The author (who has served as director of research for Kennecott Copper and American Machine and Foundry, as well as having been a government manager and university professor) argues that this combination endows industrial research with unique properties of efficiency and effectiveness in converting technical discoveries into products and services of economic value.

Fusfeld's stated purpose is "to