We are reminded of aircraft nuclear propulsion (never a good idea), homogeneous reactors (always a good idea) and the often irrational reasons why some technologies survive and others don't. We are also reminded that those who go against the flow are neither always right nor always wrong and that neither rightness nor wrongness (compared to the alternatives) is uniquely correlated to the survival of an idea. Even Eugene Wigner—perish the thought—was occasionally wrong. (It may have been Paul Douglas, the former senator from Illinois, who said that no politician is either as smart or as dumb as he may appear in public. Weinberg has a lot of tolerance for most of his former antagonists, although he pulls no punches on others. I think he has too much tolerance for some of the antinuclear Luddites, who *are* in fact as dumb as they appear.)

The title of Weinberg's book expresses the underlying belief that there will be a second nuclear era, one in which the public will understand the miniscule risk of exposure to low levels of radiation. (Weinberg likes a *de minimis* standard for public exposure equal to the standard deviation of the natural background; I dislike any safety standard not based on safety.) In this new era we will leave our progeny with inexpensive, mortgage-free, long-lived nuclear power plants of such incontrovertibly safe design that no one will be concerned. (I agree that it makes little sense to decommission reactors, once built, so they should be designed with the alternative—durability—in mind. Aircraft are designed to last, with proper maintenance, as was George Washington's famous axe.) And, in Weinberg's view, the utilities will be more concentrated and more professional, divided, as the cereal industry is, into the producers and the distributors. And the waste will be stored so safely that no one will have doubts.

Perhaps and perhaps not. When the fossil fuels inevitably run out and as the world population grows, all these considerations may be seen to be minor compared to the need for electricity. Either way, all the arguments are collected here, from Weinberg's unique perspective, and anyone interested in nuclear power, past or future, or in a firsthand account of a small science that turned into a big technology, should read the book. There will be no other like it.

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The Internet for Scientists and Engineers: Online Tools and Resources

Brian J. Thomas
SPIE, Bellingham, Wash., 1995. 450 pp. $30.00 pb
ISBN 0-8194-1806-4

Many scientists are feeling somewhat uncomfortable these days: The Internet has exploded in recent years, and they find it difficult to keep up with many of its basic features. E-mail is simple, but when it comes to ftp, telnet, gopher, the World Wide Web and so on, they often need to ask a colleague or, more likely, a student for help. For such scientists, a simple, straightforward introduction to the basics of the Internet is needed.

In *The Internet for Scientists and Engineers* Brian J. Thomas aims to fill this need. His book consists of two parts. The first is a general introduction to the Internet, and the second is a thorough compendium of addresses of discussion groups, Web sites and other resources listed by discipline.

The book's first part is a straightforward, well-written description of the Internet's basic features. It explains the process of getting connected and then discusses e-mail, mail servers, discussion groups, encoding and decoding, telnet, ftp, usenet, on-line databases and the World Wide Web. The writing has a very conversational style and, unlike many similar books, is neither patronizing nor jargon-filled. Thomas covers the basics without overwhelming the reader in detail. (Recently I had to undecode a file; I used the book's instructions for undecoding and it worked the first time.) A reader should not go through the book chapter by chapter; most scientists will not need many of the sections, and a novice might get bogged down. Fortunately, *The Internet for Scientists and Engineers* has a very complete and thorough table of contents, glossary and index. (Thomas does display a "Mac" bias, but he includes examples in Windows as well.)

This general introduction is not specific to scientists and engineers. The author justifies the book's title through the second half—a massive compendium of Internet sites, primarily on the Web but including many gopher and ftp sites and many discussion groups, organized by scientific discipline.

Although this book may be one of the better introductions to the Internet yet published, it has a problem common to all books on the subject. Books are static, and the Internet is one of the most dynamic entities on the planet. By the time of this review, the book will be almost a year old and already quite outdated. For example, the author mentions that Internet access is not available through America Online or Compuserve (it has been since April). Similarly, search engines such as Lycos and Webcrawler are not mentioned, and there is only a brief reference to Netscape, the primary Web-browsing software. For a novice, however, these drawbacks are relatively unimportant, and I would expect the book's introduction to be useful for at least a few more years. The lists in the second half are also outdated; many sites are university addresses that can be found rapidly with search engines, for example, and many of the sites given are no longer functional. Nonetheless, two-year-old phone books can still be very useful, and a novice would find these lists to be valuable starting points.

For introductions to the Internet that are not outdated, one can turn to the Internet itself. One of the best is the tutorial by Patrick Crispen; it is available on the Web at http://ua1vm.ua.edu/~crispen/roadmap.html, or by sending e-mail to listserv@ua1vm.ua.edu with "get map package f=mail" in the body of the message. This set of lectures is very readable, comprehensive and current, and it will be regularly updated. It is also free. Nonetheless, many people would prefer to learn about the Internet through a medium that doesn't involve a power cord. For them, I do not know of a better introduction.

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The Beat of a Different Drum: The Life and Science of Richard Feynman

Jagdish Mehra
Oxford U. P., Clarendon, New York, 1994. 630 pp. $35.00 hc
ISBN 0-19-853948-7

Membership in the community of scholars and scientists entails a commitment to ferreting out and acknowledging the efforts of others. It is therefore somewhat difficult to comprehend how one can write about Richard Feynman without mentioning

the superb prior biography *Genius: The Life and Science of Richard Feynman* by James Gleick (Pantheon, 1992). It is also difficult to accept the reticent acknowledgment that Jagdish Mehra gives in *The Beat of a Different Drum* to Charles Weiner's extensive interview with Feynman, recorded for the American Institute of Physics' Center for the History of Physics in 1966. Weiner's interview is a remarkable piece of work—a revealing account of Feynman's life until 1966—that resulted from an amalgam of Feynman's incomparable personality and Weiner's skill as a historian. The interview formed the acknowledged basis of a good deal of Gleick's biography, and it was an invaluable source for my own account of the genesis of the Feynman diagrams, published in *Reviews of Modern Physics* in 1985. Yet whenever Mehra refers to this interview, he also cites his own later interviews with Feynman, even though Weiner covered all the ground Mehra covers in writing about Feynman up to 1966.

Mehra's narrative of Feynman's stay at Los Alamos recalls the anecdotal version that Feynman gave in "Los Alamos from Below," included in *Reminiscences of Los Alamos*, edited by Lawrence Badash and H. P. Broida (Kluwer, 1980) and Theodore A. Welton's brief account of his own work there from 1944 to 1945. Similarly, many of the later stories in Mehra's book appeared first in Feynman's own *Surely You're Joking, Mr. Feynman!* and the other collections of reminiscences that Feynman published with Ralph Leighton.

The Feynman materials in the Los Alamos archives contain, in addition to the reports that Feynman himself wrote, Lillian Hoddeson and Gordon Baym's interview with Feynman in 1980 that tries to clarify Feynman's wartime contributions. These are not referred to. Nor does Mehra refer to the papers that John Archibald Wheeler deposited at the American Philosophical Society in Philadelphia containing an important correspondence, relating to general relativity, between Feynman and Wheeler during the 1950s. Nor is reference made to the extensive comments on action-at-a-distance theories, cosmology and irreversibility that Feynman made (as Mr. X) at the 1963 conference on the nature of time organized by Hermann Bondi and Thomas Gold, the proceedings of which were published in 1967 by Cornell University Press in the book *On the Nature of Time* edited by Gold with the assistance of D. L. Schumacher.

In discussing Hendrick Kramers's

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.

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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