

analytical techniques, they are too restrictive for the vast majority of real-world problems, which generally require posterior simulation using MCMC to get practical results. A student reading this book might get an exaggerated idea of the role that these analytical techniques play in practical problems and might regard MCMC techniques as an afterthought, whereas the truth is quite the opposite. It is for this reason that I no longer use it as a textbook in my Bayesian course, which I teach using simulation as the main calculational technique, introducing exact analytical results after discussing problems from a simulation point of view. My aim has been to prepare the students to tackle real-world problems in their chosen field after this one-semester graduate course. The post-course experience of my students attests to the success of this approach.

Thus, I am of two minds when recommending this book. Certainly I learned much from the first edition, so it can be useful for self-study by a mature scientist who is aware of its limitations; but I would be careful about using it as a textbook in a course, at least without balancing it with other material (e.g., the highly-regarded but more advanced book by Gelman, Carlin, Stern and Rubin) or with lectures that placed more emphasis on simulation methods.

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Facts and Mysteries in Elementary Particle Physics by Martinus Veltman. River Edge, NJ: World Scientific Publishing Co. Pte. Ltd., 2003. \$19.00 (paper). ISBN 981-238-149-X.

All *JSE* readers, from the merely curious to the expert in the field of modern particle physics, should read this book. The chapters are short, simple in their descriptions, yet fundamental. Each contains a bit of history linked to a few equations, both "pictorial" and mathematical. For the layman, the book is very readable and fascinating. For the expert, it is just plain fun.

Veltman develops his concepts naturally and intuitively. He does an extraordinary job of describing some of the more obscure as well as popular concepts in modern physics without the use of mathematics. In part, this is due to his gradual buildup of the necessary background for the reader and in part this is the result of his effortless prose. For example, from earlier developed ideas on the special theory of relativity, Veltman shows why it is impossible for a very high-energy photon to change in mid-flight into an electron-positron pair. As he states:

This can be understood by realizing that this high-energy photon appears as a photon of lower energy to another observer moving in the same direction as that photon. A photon always moves with the speed of light, and one can never catch up with it like in the case of particle with mass; instead, when an observer races in front of the photon he will still see it coming with the speed of light, but it appears red-shifted, i.e. it is perceived as a photon of lower energy. If the observer moves fast enough, the photon energy can for this observer become less than that needed to create an electron pair (whose energy is twice the rest mass of one electron).

The author's fresh style of writing clarifies such concepts as that of an unstable particle like the neutron stating simply that "an unstable particle does not age." This would be similar to the state of humans if diseases were eliminated and our only path out of immortality was the result of accidents. This is just one example of many. His descriptions remind one that modern physics never ceases to cross common sense. Yet he brings to the reader that uncommon sense needed.

Veltman's discussions of the concepts of the netherworld of virtual particles and quantum mechanical tunneling are clear and stimulating. The same can be said for his writings on many other aspects of quantum mechanics, including the most telling parts, mixing and probability. By the time the reader finishes this book, he will be familiar with much of the vocabulary of modern physics (except for the math, of course). He will come to understand, for example, the three grand families (or generations) of elementary particles (on the front cover) and how this limitation to three is one of the main unsolved problems in particle physics.

The book is mostly about theoretical aspects of modern physics; however, Veltman also describes important experiments that are often missing in most popular accounts of particle physics. He emphasizes that his book is limited to theoretical ideas that are supported by experimental facts. For this reason, he discusses neither supersymmetry nor string theory, since "they are figments of the theoretical mind. To quote Pauli, they are not even wrong."

Nicely spaced throughout the descriptive parts of the chapters are separate short professional biographies of the famous and not-so-famous names in modern physics, made all the more lively by the addition of interesting anecdotes about their personal lives. Perhaps he was able to collect so many of these fascinating facts because he is European and (being about the right age) may have interacted with many important physicists of overlapping generations.

Veltman and his student, t'Hooft, share the 1999 Nobel Prize in Physics "for elucidating the quantum structure of electroweak interactions in physics". In technical terms, they showed that the electroweak interaction is renormalizable. The theory of electroweak interactions is the successor to Maxwell's electrodynamics. In the 19th century, Maxwell developed the theory that unifies the description of electricity and magnetism and light. The consistent quantization of this theory (its renormalization) did not take place until the middle of the last century. It was another twenty-five years until Weinberg, Glashow, and Salam unified Maxwell's theory of electrodynamics with Fermi's theory of the weak interaction

(the one responsible for the radioactive decay of the neutron). In 1999, the Nobel committee recognized Veltman and t'Hooft's consistent quantization of that theory.

Individual tastes will largely determine the like or dislike of this book; however, the book suits my tastes perfectly. For this reason, I would strongly recommend it (may even require it) to theoretical physics graduate students, even though they may be familiar with much of the content. Like other points of a fine jewel not seen before, Veltman's engaging style of writing will remind students of the value of looking at physics through another's well-trained eye. His style will also pique the layman's interest in the most fundamental discoveries of physics in modern times.

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The Hype About Hydrogen: Fact and Fiction in the Race to Save the Climate by Joseph J. Romm. Island Press, 2004. 256 pp. \$25.00 (hardcover). ISBN 1-55963-703-X.

There are numerous roadblocks for hydrogen fuel cells, a major element in New Energy. The one that is stressed in this most important book is relatively greater cost. However, in reaching this conclusion the author is comparing the cost of hydrogen fuel cells with the cost of petroleum-driven internal combustion engines, a mature technology and the cause of the greenhouse effect. This kind of market analysis was not foreseen by those who first wrote papers about a Hydrogen Economy in 1971. It was thought of as a replacement for the polluting oil-based economy when the realization of the dangers of letting CO₂ in the atmosphere sank into the public's mind.

The author is not always consistent. Thus, on page 16, he states that 2010 is the turning point for the rate of supply of oil against time. But in spite of this, his plans imply that fossil fuels will be available through 2040.

Romm admits that a Hydrogen Economy is inevitable. But the transfer to it is not to be worked out on the basis of a competition with fossil fuels, which will last hardly a decade more, but rather on the basis that *we must have environmentally acceptable, i.e., zero CO₂ emitting, energy*, and whatever this energy costs is going to be something we shall have to pay for.

The book is very strong in terms of showing the consequences of allowing more CO₂ to be admitted into the atmosphere. He shows—and I found this riveting—the danger of a *sudden* change in the climate, which these emissions would eventually cause. But then he compares the cost of hydrogen with the present cost of fossil fuels. Of course, the fossil fuel way is much cheaper right now, but such comparisons omit the cost of pollution associated with the present