

was immensely hot. In thermal equilibrium, photons, baryons, and antibaryons would have been roughly equally abundant. Today, however, photons outnumber protons by roughly a billion to one, and antiprotons are essentially absent, created almost exclusively in rare, exceptionally violent cosmic explosions. Evidently, matter and antimatter annihilated early as the cosmos cooled during expansion, leaving behind an abundance of photons and tiny amounts of matter that had exceeded the primordial antimatter by just one part in a billion. The question the authors address is how that tiny excess of matter over antimatter might be explained.

With its beguiling title and fanciful cover, the book appears designed for youngsters and other interested lay readers. No tables, no heuristic diagrams, no bibliography interrupt the text. The only equation is $E = mc^2$. A few fanciful illustrations sprinkled throughout the text show Wonderland's Alice running through an accelerator to catch an electron in a butterfly net; an elephant sitting on a chair that is breaking under its weight; and a donkey surrounded by pails of water, unable to decide from which one to drink.

But Quinn and Nir's book is definitely not a popularization. Books written for the general public require careful introduction of unfamiliar matter, which the authors largely neglect. The expression $E = mc^2$ first appears on page 22 as "the energy of [a] particle at rest." The reader has to wait until page 170 to find that c stands for the speed of light. Similarly, on page 20, the authors write about an early cosmic temperature "above 10^{32} kelvin," but the kelvin is not defined until page 24, in the following chapter. The needs of novices remain unmet. The deeper the reader delves into the text, the more apparent it becomes that this is a book that mainly scientists will appreciate.

For me, and I suspect for most physicists, the greatest attraction is observing how Quinn, a professor of physics at SLAC, and Nir, a professor of physics at the Weizmann Institute of Science in Israel, systematically tackle the matter-antimatter asymmetry problem. They reject one possibility after another until only a few alternatives appear viable. The greatest hurdle to mastering the contents of the book is the authors' deliberate choice to present their complex arguments almost entirely in prose form. That makes it difficult even for a professional physicist to fully appreciate their points. A set of carefully designed diagrams could have provided,

an overview, which is hard to cull from page after page of text.

Frequent distractions arise whenever the names of high-energy-physics Nobel laureates appear. The flow of the text is then sidetracked to provide the full name and dates of birth and death (unless still living) for each awardee, plus the year when the prize was awarded. In contrast, for unexplained reasons, other notable physicists such as J. Robert Oppenheimer, Hendrik A. Lorentz, and Robert A. Millikan are not referred to by more than surname, making it difficult for unfamiliar readers to know who they are.

Although the publisher advertises the book as "a history of ideas," much of that history is confined to a 38-page appendix. Titled "Timeline of Particle Physics and Cosmology," it is a compendium of paragraphs, each highlighting and dating a significant advance in high-energy physics or cosmology. Nobel laureates are again prominently featured, which gives the impression that, in the eyes of the authors, the histories of these fields are largely fueled by the efforts of this select group of prize winners—a thesis I don't believe stands up to scrutiny.

The Mystery of the Missing Antimatter had all the makings of greatness. Yet somewhere along the line, the authors tried to serve too many masters and failed to serve any well.

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Nuclear Waste Stalemate

Political and Scientific Controversies

**Robert Vandenbosch and
Susanne E. Vandenbosch**
U. Utah Press, Salt Lake City, 2007.
\$25.00 paper (313 pp.).
ISBN 978-0-87480-903-9

Nuclear Waste Stalemate: Political and Scientific Controversies, by Robert Vandenbosch and Susanne E. Vandenbosch, promises a great deal from its title. But it fails to deliver much that could be labeled as scientific. Its focus is almost completely on the political science of the issue rather than on the scientific side. Robert Vandenbosch is a professor emeritus of chemistry at the University of Washington and coauthored with John Huizenga the book *Nuclear Fission* (Academic Press, 1973); his wife, Susanne

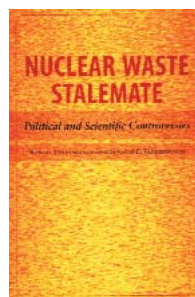
E. Vandenbosch, is a political scientist with a nuclear chemistry background.

Regardless of the book's title, the authors clearly state in the introduction that the book "focuses on the politics of the disposal of nuclear waste." But even that statement is not completely true because the main focus is on the disposal of high-level nuclear waste and used nuclear fuel. There is no discussion of low-level waste disposal, the problems of uranium mill tailings, and so forth. But they go on to state the following:

Many observers, particularly those with a technical background, believe that the nuclear waste problem is primarily a political problem. The political and scientific problems associated with developing a repository are interwoven and in this study an effort has been made to describe and analyze both facets of this effort.

I do not believe the authors have lived up to their goal of explaining the scientific aspects of nuclear waste disposal; even when they focus the discussion on a geological repository, they mention little of the challenges associated with it. The option of reprocessing high-level used nuclear fuel is briefly mentioned only in chapter 2, in about five pages; transmutation of the high-level nuclear waste receives almost twice as much discussion—though the economics of the two approaches is not mentioned.

The book's coverage on used fuel, what the authors improperly term as "spent fuel," is filled with errors. But it certainly reflects the conventional wisdom of those opposed to recycling the used fuel, even though such recycling would allow additional electricity to be generated and thus increase the return from the enormous investment already made in nuclear fuel. For example, after the fuel is used, it still has significant amounts of uranium-235 and plutonium-239. Thus it makes sense to recycle those materials into nuclear reactors to generate electricity and reduce fresh uranium consumption. Moreover, the book's comments on mixed oxide fuel, a blend of uranium and plutonium oxides, are incorrect. For instance, even though the US is moving slowly in using MOX fuel, more than 60 of the 105 nuclear reactors are capable of using that fuel without the need for any reactor modification. The text implies that reactor modifications are



a severe roadblock to the technology.

Toward the end of the book is a relatively short chapter, about 10 pages, on transportation of used fuel to Yucca Mountain in Nevada and on the work of the National Academies Committee on Transportation of Radioactive Waste, of which I was a member, that examined the issue. A lot of substance exists in the committee report, but the discussion in the chapter tends to focus on the impact of terrorism on used-fuel shipments.

The final chapter summarizes approaches to high-level waste disposal in other countries. I found the chapter to be interesting from the standpoint of what other countries—those, such as France, Sweden, and the UK, not completely hamstrung by the political maneuvering so prevalent in the US—were doing about those issues. Although the overall discussion is mostly accurate, glaring technical errors are apparent to anyone with experience in the nuclear-waste area.

Nevertheless, I found *Nuclear Waste Stalemate* an interesting read because of all the gory details of the political and legal maneuverings associated with the disposal of nuclear waste in the US. There is an old saying that government policy is like bologna: It is a lot better if you don't see how it is made. Even though a recounting of all the laws, acts, resolutions, vetoes, and such may seem uninteresting to a scientist, I found it to be extremely intriguing. A review of the political shenanigans by elected officials at all levels, and of those by a large number of advocacy groups, makes it clear why no satisfactory technical or political resolution of the issue has happened in the US.

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A Passion for Discovery

Peter Freund

World Scientific, Hackensack, NJ,
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ISBN 978-981-277-214-5 paper

Peter Freund's *A Passion for Discovery* is a collection of anecdotes involving approximately 300 20th-century physicists and mathematicians. Freund, a professor emeritus of physics at the University of Chicago, fled as a graduate student from Nicolae Ceaușescu's Romania to Austria and then came to the US via Geneva, Switzerland. His

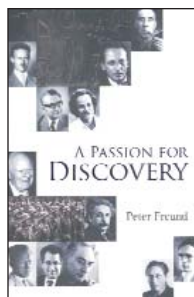
European and Soviet bloc roots allow him to vividly sketch the historical and political background for his stories. The book is largely based on his own experiences and information told to him by colleagues; thus it is quite different from an impersonal collection such as Walter Gratzer's *Eurekas and Euphorias: The Oxford Book of Scientific Anecdotes* (Oxford University Press, 2002).

Freund is a good narrator; in fact, he is a gifted writer. Here are his thoughts about the defection of the great algebraist Victor Kac from the Soviet Union (page 74):

There was no question that living in the States was much, much better than living in the Soviet Union. On the other hand, one's scientific creativity depends on many intangibles: on the relations with one's colleagues, on the meaning of the smile on a colleague's face just after he has been told of a new idea, on one's familiarity with the work environment, on one's knowledge of the location of a certain book in the library, on one's knowledge of the exact path to the library so that while on the way, one can let one's thoughts continue undisturbed on their own path. Going to another place, admittedly a better, much more pleasant place, does not mean that it will all work out for the best. It is a very big risk, and yet Kac, a man who in the rugged Soviet terrain had produced superb work—he had already started whole branches of algebra—was taking this risk. Why?

The following anecdote of Albert Einstein as a Socratic, political scientist has not been reported before, as far as I know. Freund learned of it in the 1950s from Laci Steiner, a family friend who witnessed the event (page 199):

One of the first stories about a physicist that I have ever heard has Einstein as the students' guest of honor at a University of Berlin evening discussion in the economically painful and politically ominous Twenties. First a student gave an impassioned speech about how economics determines history, to the exclusion of any meaningful role of the individual. When he was done, the speaker



turned to the great man for his expected approval, but Einstein completely disagreed with what the young student had just said and to make his point, he addressed a young student sitting in the middle of the hall. The student rose. He was a rather gaunt lad, obviously undernourished, wearing a threadbare coat, and not cleanly shaven, in fact rather slovenly. The large straight scar across his right cheek marked him as a member of one of those right-wing dueling fraternities. Einstein asked him whether he had enough money to support himself. Not surprisingly, the young man answered that he could barely subsist.

"Wouldn't a monthly stipend of," here Einstein named a sum, "go a long way towards solving your problems?"

"Sure, it would, but where in this day and age am I to get such a stipend?"

"As it happens, I have been asked by the Socialist Students' Association to nominate someone for precisely such a stipend. Give me your name and I will nominate you."

"Never! I would rather starve than accept money from the socialists," said the irate student, and he sat down.

"So much for history being determined by economics," Einstein concluded with a smile.

Freund's collection also includes a number of absurd stories, like the statement about Wolfgang Pauli: "He was a child prodigy given leave from attending high school classes so he could go to the University of Vienna to . . . teach a course" (page 20). In the endnotes to the chapter on Pauli, Freund admits that the story of the high-school kid as professor at the University of Vienna might have been apocryphal.

In another story, Finnish physicist Gunnar Nordström visits Einstein in Zurich, Switzerland, before World War I. Freund writes that "by contrast Nordström admired Einstein and made the long journey from his homeland to the shore of the Limmat to discuss matters with the master of relativity. In what may have been an intentional slight, Einstein refused to receive his Finnish visitor, who left understand-