books

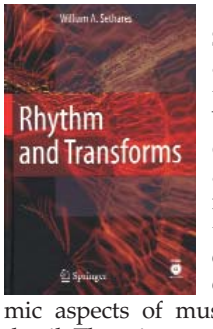
Musings on the sound of music

Rhythm and Transforms

William A. Sethares
Springer, New York, 2007. $79.95 (336 pp.). ISBN 978-1-84628-639-1, CD-ROM

Reviewed by Thomas D. Rossing

Ten years ago, electroacoustics engineer and musician William Sethares published his widely read book *Tuning, Timbre, Spectrum, Scale* (Springer, 1998; 2nd edition, 2005). His latest work, *Rhythm and Transforms*, is a fitting sequel.



In his new book, Sethares asks and answers the question: "How can we build a device that can 'tap its foot' along with the music?" To answer that question, he explores rhythm, especially the rhythmic aspects of music, in considerable detail. Three important characteristics of rhythmic phenomena are its nonverbal nature, its relationship with motor activity, and its relationship with time. *Rhythm and Transforms* focuses on a few of the simplest features of musical rhythm, such as the beat, pulse, and short phrase, and Sethares attempts to create algorithms that can emulate the ability of listeners to identify those features.

The book comes with a CD-ROM that has many sound examples, and the author urges his readers to "listen along" as they peruse the text. A primary example he uses for sound demonstrations is Scott Joplin's popular "Maple Leaf Rag." Sethares writes, "Because there are no legal complications, it is possible to freely augment, manipulate, expand, and mutilate the music." (See the author's website, http://eceserv0.ece.wisc.edu/~sethares, for examples.)

An introductory chapter titled "What is Rhythm?" is followed, appropriately enough, by the chapter "Visualizing and Conceptualizing Rhythm." The author begins by describing symbolic notations that have been used to represent time and duration in music: lyrical notation, musical notation, "necklace" notation, numerical notation, functional notation, drum/percussion tablature, Schillinger's notation, MIDI (musical instrument digital interface) notation, harmonic rhythm, dance notation, and juggling notation. He compares these symbolic notations with literal notations, which allow full reproduction of a performance.

The chapter "Auditory Perception" is followed by tutorial chapters: "Transforms," "Adaptive Oscillators," and "Statistical Models." Those chapters may discourage some readers who are not well acquainted with modern signal processing; however, readers are well advised to plow through the chapters, because each is well presented and clearly written.

The stated goal of the book is outlined in the chapter "Automated Rhythm Analysis." According to Sethares, "Just as there are two kinds of notations for rhythmic phenomenon (the symbolic and the literal), there are two ways to approach the detection of rhythms; from a high level symbolic representation (such as an event list, musical score, or standard MIDI file) or from a literal representation (such as direct encoding in a .wav file)." The chapter applies each of three technologies for locating patterns—transforms, adaptive oscillators, and statistical methods—to three levels of processing: symbolic patterns where the underlying pulse is fixed, symbolic patterns where the underlying pulse may vary, and time series data.

The final chapter fittingly includes "Speculations, Interpretations, and Conclusions." The first question raised, which is a sort of chicken-and-egg question, is whether we perceive a collection of individual notes and then observe that they happen to form a regular succession or whether we perceive a regular succession of auditory boundaries that is then resolved by the auditory system into a collection of aligned note events. Another question is, what is time? For Aristotle, time does not exist without change. For Immanuel Kant, the changes are in the mind, not in the world.

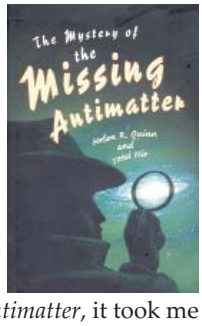
There is no doubt that Sethares is a good writer with the ability to explain sophisticated ideas and mathematics in simplified terms. Readers will certainly differ in opinion on whether he has simplified those concepts enough. His extensive glossary will be a great help to those who are encountering some of the ideas for the first time, and the sound examples on the CD-ROM will also provide great benefit. Overall, *Rhythm and Transforms* is a worthwhile addition to the literature. I'm sure it will find a place alongside *Tuning, Timbre, Spectrum, Scale* in many personal libraries, as it will in mine.

Thomas Rossing is a retired physics professor who teaches musical acoustics at Stanford University in California as a visiting professor of music in the Center for Computer Research in Music and Acoustics.

The Mystery of the Missing Antimatter

Helen R. Quinn and Yossi Nir
Princeton U. Press, Princeton, NJ, 2008. $29.95 (278 pp.). ISBN 978-0-691-13309-6

In the February 2003 issue of PHYSICS TODAY, Helen Quinn published a fascinating article, "The Asymmetry Between Matter and Antimatter" (page 30), which discussed the unexplained prevalence of matter over antimatter in the cosmos. I remember reading and rereading that article several times, making sure I was citing her insights correctly for an astrophysics text I was updating at the time. So, when I was asked to review Quinn and Yossi Nir's *The Mystery of the Missing Antimatter*, it took me only about 10 seconds to send back my e-mail response: "Helen Quinn is always knowledgeable and interesting. I'll be very pleased to review the book."



Why is the cosmic matter–antimatter asymmetry so intriguing? It is because we now know that the universe once

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 sidelined 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.

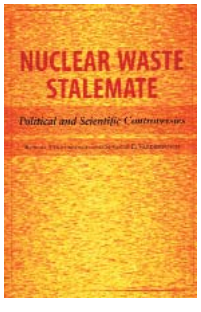
Martin Harwit
Washington, DC

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