A nuclear history replete with heroes and villains

The Age of Radiance
The Epic Rise and Dramatic Fall of the Atomic Era

Craig Nelson
Scribner, 2014. $29.99 (448 pp.).
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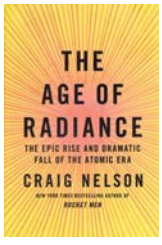
Reviewed by Alvin Saperstein

Craig Nelson's *The Age of Radiance: The Epic Rise and Dramatic Fall of the Atomic Era* covers the period from the 1895 discovery of x rays to the 2011 disaster at the Japanese nuclear power plant in Fukushima. Except for the occasional confusing sentence, the book is an interesting and well-written account of the impact of nuclear physics on society.



The Age of Radiance fulfills the Rise part of its subtitle, but it fails, I believe, in making a case for the Fall. Its later chapters give ample evidence for the continuing and pervasive role of x rays and radioactivity in medicine and daily life. Also, the author claims as a myth the statement that nuclear arms "are different from conventional weapons." But he contradicts that with illustrations showing that conventional weapons have always been used to fight wars, whereas nuclear weapons stockpiles have evolved to prevent them.

The author is not a scientist. He is a good professional storyteller who knows how to invoke aspects of the ordinary parts of the lives of his heroes and villains to capture his audience's attention and engagingly convey the development of the science and its effects on the world. I have taught physics courses, and included some historical and social aspects, for more than 50 years, and I have researched and published articles and books on nuclear physics and its implications for international security. Yet many historical and biographical facts presented in *The Age of Radiance*—certainly many aspects of the behavior of its heroes and villains—were new to me.

Among the villains is Edward Teller, whose self-centered arrogance precluded him from positively contributing to the Manhattan Project. He concentrated instead on a fruitless search for the hydrogen bomb. That technology came into fruition with the ideas of Stanislaw Ulam, whose major contributions Teller initially denied. Teller then teamed up with another villain, Lewis Strauss—a vindictive commissioner on the Atomic Energy Commission and a hydrogen-bomb proponent who felt slighted by the way J. Robert Oppenheimer defended his concentration on the atomic bomb—to publicly ostracize Oppenheimer as a Communist and a security risk. That resulted in Teller being shunned by almost the entire US physics community. Teller was also the main scientist behind Ronald Reagan's expensive drive for a high-tech defense against intercontinental ballistic missiles. That unsuccessful effort considerably delayed the start of actual nuclear disarmament by the US and the Soviet Union.

German chemist Otto Hahn is also considered a villain. He, along with physicists Lise Meitner and Fritz Strassmann, first detected the presence of barium and other intermediate-mass nuclei in a sample of uranium bombarded by neutrons. The significance of that discovery was only later recognized by Meitner (then a Jewish refugee in Sweden) and her nephew Otto Frisch. After World War II, Hahn claimed exclusive discovery of nuclear fission—with the "assistance" of Strassmann and Meitner. That claim was unfortunately accepted at face value by the Nobel Committee for Chemistry.

Meitner, Marie Curie, Enrico Fermi, and Leo Szilard are among the book's heroes. Among the other interesting people stories Nelson tells is one concerning the Hungarian quartet: Szilard, Teller, John von Neumann, and Eugene Wigner—all eminent scientists born in Budapest around the beginning of the 20th century. He also briefly discusses the Soviet equivalent of the Manhattan Project and the outstanding personalities involved. And scattered throughout the last chapters of the book are the names of many individuals, corporations, and government agencies important to the atomic era, but no "hero or villain" stories are told about them.

Many biographies of individual physicists exist, but *The Age of Radiance* is the first book I'm aware of that captures the personal aspects of several important scientists in a pleasant-to-read book. It also contains a complete index, an ample bibliography, many notes, and a number of photographs. General readers will not learn much physics, but they, and scientists too, will learn a great deal about the physicists who launched and maintained the atomic era.

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The Cosmic Cocktail
Three Parts Dark Matter

Katherine Freese
Princeton U. Press, 2014. $29.95
(272 pp.). ISBN 978-0-691-15335-3

In her first popular science book, *The Cosmic Cocktail: Three Parts Dark Matter*, theoretical astrophysicist Katherine Freese lays out the current evidence for dark matter and dark energy and the status of the relevant experiments. Along the way to the most recent developments, she introduces the reader to the concepts necessary to understand the physics and relevance of the matter composition of the universe. Freese adds some historical facts, but the history of the field is not the main theme.

The Cosmic Cocktail is a relevant update to such well-known but now somewhat out-of-date books as Evalyn Gates's *Einstein's Telescope: The Hunt for Dark Matter and Dark Energy in the Universe* (W. W. Norton, 2009) and Dan Hooper's *Dark Cosmos: In Search of Our Universe's Missing Mass and Energy* (HarperCollins, 2006). Gates's and Hooper's books are more accessible than Freese's; she demands more of the reader but also gets across more scientific facts.

Not surprisingly, her chapter on WIMPs (weakly interacting massive particles) is excellent. Freese, a specialist in astroparticle physics, explains

clearly the experimental status, and the subtleties of the data interpretation for detecting the class of particles that constitute the presently best motivated and most popular dark-matter candidates. *The Cosmic Cocktail* also treats dark energy. That discussion is informative and covers the basics, but it is nowhere near as detailed as the presentation on dark-matter detection. Throughout the book, Freese appropriately integrates her own contributions and those of others.

The topics covered in the book are timely, even though some are inadequately discussed and others do not contribute to the title's "cosmic cocktail." For example, Freese narrates the relevance and discovery of the Higgs boson and even includes construction details of the Large Hadron Collider's four detectors. But the topic of inflation gets just two sentences in the text and two more in an endnote. She covers the OPERA anomaly of faster-than-light neutrinos—including the joke about the neutrino entering a bar. But her statement that faster-than-light travel implies violations of causality will confuse readers not familiar with special relativity. Also, she does not even name the Tully–Fisher relation, and she dedicates only half a sentence to baryon acoustic oscillations.

Freese's writing style interweaves anecdotes from her personal life with the scientific explanations. Some anecdotes document academic life, others seem to serve no purpose other than to break up the text. In the first chapters, occasional abrupt changes of narrative direction take some getting used to; the later chapters are smoother. The book comes with a light dose of humor that shows mostly in the figures, such as a skull to illustrate the "Death of MACHOs" (massive compact halo objects), a penguin postcard from Antarctica, and a blurry photo of a potted plant.

Freese follows the common advice to first say what you want to tell them, then tell them, then tell them what you just told them. She regularly reminds the reader of what was explained in earlier chapters, and repeats explanations frequently throughout the book. Although that repeating material makes it easy to follow the explanations, the alert reader might find the assumed inattention somewhat annoying. The electron volt, for example, is explained at least four times. Several phrases are repeated almost verbatim in various places—for example, "eventually galaxies formed . . . these galaxies then merged to make clusters and superclusters" (page 31) reappears as "eventually this merger led to the formation of galaxies and clusters of galaxies" (page 51).

The book contains some factual errors: 3 kilometers is not 5 miles (5 kilometers is 3 miles); the radius of the Sun is not 10 000 kilometers (it's closer to 700 000); and the High Energy Spectroscopic System for measuring gamma rays is not in Europe (it's in Namibia). Some explanations and comments are vague or even misleading, such as the statement that "only with a flat geometry can the universe grow old enough to create the conditions for life to exist." One has to read carefully, including the endnotes, to find out that Freese means the *spatial* geometry has to be *almost* flat. And, although redshift at a black hole horizon is usually illustrated with somebody sending light signals while falling through the horizon, Freese instead uses sound waves; that adds confusion because sound needs a medium in which to travel. These are minor shortcomings, but they will cause readers with no knowledge of cosmology and particle physics to stumble.

We live in exciting times for cosmology and astroparticle physics—*The Cosmic Cocktail* mentions that word, "exciting," more than a dozen times. Especially on the topic of dark-matter detection, the book provides a valuable, nontechnical, and up-to-date overview.

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Principles of Musical Acoustics

William M. Hartmann
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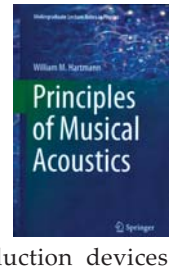

Musical acoustics is a rich, multidisciplinary subject that provides an interesting context for teaching physics concepts in an algebra-based course. Many undergraduates love music and are curious to know how instruments and sound recording and reproduction devices work. Central topics usually include vibrations and waves, analog and digital electronics, elements of musical structure, and the physiological and psychological aspects of human hearing.

Principles of Musical Acoustics by William Hartmann is part of the Springer series Undergraduate Lecture Notes in