

The need for nuclear knowledge and political control

Nuclear Weapons What You Need to Know

Jeremy Bernstein
Cambridge U. Press, New York,
2008. \$27.00 (299 pp.).
ISBN 978-0-521-88408-2

Reviewed by David Hafemeister

Jeremy Bernstein's *Nuclear Weapons: What You Need to Know* is an important addition to the scientific literature. Because nuclear weapons will continue to be a major issue, it behooves policymakers and physicists to know the basic science and diplomatic history to minimize errors in future policy decisions. Fortunately, we have some useful guideposts. The physics community has highly praised Richard Rhodes for his Pulitzer Prize-winning *The Making of the Atomic Bomb* (Simon and Schuster, 1986), and subsequently for *Dark Sun: The Making of the Hydrogen Bomb* (Simon and Schuster, 1995) and *Arsenals of Folly: The Making of the Nuclear Arms Race* (Knopf, 2007). A fourth book by Rhodes is in process, but his three thus far—at about 4000 pages total, taking into account type size—greatly exceed in scale Bernstein's 300-page effort. I was originally concerned that I was going to review "Rhodes lite." My fear, however, disappeared after reading *Nuclear Weapons*.

Bernstein has an excellent reputation as a physicist who writes eloquently about physics and its history. He has written dozens of books and articles, including biographies of Albert Einstein, Hans Bethe, and Robert Oppenheimer, and on topics such as the Farm Hall tapes, plutonium, high-energy physics, and cosmology. I crosschecked many sections of Bernstein's *Nuclear Weapons* with Rhodes's three books to compare their treatments. Rhodes covers history,

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policy, and many technical issues in more breadth and depth; however, Bernstein, a physicist writing for physicists, has an easy grasp of technical details and writes more technically on some aspects of atomic-bomb criticalities, plutonium metallurgy, polonium initiators, weapons effects, and hydrogen-bomb designs. Rhodes uses many more historical documents and covers the Soviet weapons program and nuclear spies in greater depth, as one would expect in a series with the greater number of pages. Bernstein, however, spent time at Los Alamos and knew many US weaponeers as colleagues; those connections allow him to relate fascinating, inside stories about the development of nuclear weapons. In particular, his three articles on Bethe in the *New Yorker* magazine during 1977–78 were path breaking. His friendship with physicist Robert Serber, who worked on the Manhattan Project, gave him the inside track to *The Los Alamos Primer*, which Bernstein covers in his book. The report is based on Serber's 1943 Los Alamos lecture series, which laid out the physics of nuclear weapons. Its history brings home an important lesson about the dissemination of nuclear technology.

The *Primer* was declassified in 1965. It was then publicly listed for sale by the National Technical Information Service, after which it was soon widely purchased by wannabe nuclear states. Ted Taylor, a physicist and nuclear weapons designer who had worked for the US Atomic Energy Commission and later advocated for nuclear disarmament, advised the State Department in 1978 that the *Primer* was a proliferation concern. It then became my task as a special assistant in the US State Department's Office of the Under Secretary for Arms Control to stop the sale of the *Primer*. We couldn't burn all copies of the declassified book, but at least we got the government to stop advertising the report and other documents. Nevertheless, the document was still obtainable by filing a Freedom of Information Act request.

In 1992 I was surprised when Serber

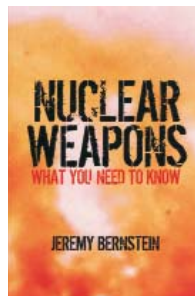
published the primer as a book, *The Los Alamos Primer: The First Lectures on How to Build an Atomic Bomb* (University of California Press), with additional commentary by Serber and an introduction by Rhodes. I quickly asked Taylor what he thought about that. He stated that the *Primer* was now no longer a serious issue because many of yesterday's secrets are today's facts, and the *Primer* contains no specific weapon dimensions. A competent nuclear engineer could today write a better version of the *Primer*. Thus, many technical barriers to building the atomic bomb were re-

duced with time, which has led nations to require a few nuclear control treaties with strong verification measures to, hopefully, maintain global stability.

Questions of history and intentions will always remain. For instance, Leo Szilard feared nuclear weapons. So why did he file his 1934 patent with the British admiralty,

which might want to make such weapons (page 65)? Of Edward Teller's ambition to make the hydrogen bomb, even when fission bombs were sufficient to end World War II, Bernstein writes, "I have never understood Teller's obsession. Why were fission bombs not enough for him?" (page 211). And exactly what information was transferred during meetings between Niels Bohr and German physicist Hans Jensen in 1943 (page 237)? After the encounters, Bohr became convinced that creating a nuclear weapon was possible. Bernstein reviews the data that Soviet spy Klaus Fuchs passed to Lavrenty Beria, data convincingly showing that relevant information on atomic bombs and possibly on hydrogen bombs was transferred.

Some issues are outside Bernstein's focus, such as the nuclear dramas of the cold war; however, his chapter on nuclear proliferation is excellent. I learned, on page 265, new facts on Abdul Qadeer Khan's nuclear Wal-Mart (see also the review on page 72). Neither Bernstein nor Rhodes suggests policies to contain future arms races, to prevent nuclear proliferation, to maintain the



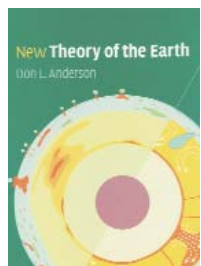
Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and to stop nuclear terrorism. One issue concerns the Comprehensive Nuclear Test Ban Treaty (CTBT) for which the US Senate declined to give its advice and consent in 1999. Since then, the UN General Assembly has elected five times to support the CTBT, with a cumulative vote of 870 to 7 (5 negative votes for the US, 1 for Palau, and 1 for North Korea). The September 2007 conference intended to encourage the CTBT into force had 106 nations in attendance, including Iraq, Iran, Pakistan, China, and Russia—but the US, India, and North Korea were absent. I believe the viability of the CTBT affects the viability of the NPT.

Bernstein's complex book is well crafted, and his descriptions are insightful; I caught only a couple of minor errors. For example, does the photo on page 22 depict Enrico Fermi joking about the fine structure constant? I was glued to *Nuclear Weapons*, even after having read Rhodes and other authors. It is sobering to realize that without the existence of a rare isotope (uranium-235) of a moderately rare element or the use of many particle accelerators, we would not be confronted by a global nuclear threat. Nuclear physics is less studied today than it was between 1930 and 1980. Today's new PhD-holders do not know about spontaneous fission of plutonium-240 and obtaining tritium from lithium deuteride. *Nuclear Weapons* should be required reading for any physics undergraduate, as it can educate the next generation on such matters. Those who want to extend their study can then move on to Rhodes's magnum opus.

New Theory of the Earth

Don L. Anderson
Cambridge U. Press, New York,
2007. \$70.00 (384 pp.).
ISBN 978-0-521-84959-3

Don L. Anderson's *New Theory of the Earth* is the much-anticipated, second edition of his monograph on the internal structure, composition, and dynamics of our home planet. The release of



the first version, *Theory of the Earth* (Blackwell, 1989) roughly coincided with the 200th anniversary of the classic, similarly titled treatise by James Hutton, the founder of modern

geology. In the new version, Anderson updates the important factual material that earned his first edition its stellar reputation, and he adds his own perspectives on the enduring controversies that make debates about Earth's interior so lively.

What sets *New Theory of the Earth* apart from other books on this subject is its broad scope, drawn from the vast storehouse of information the author assembled from every branch of solid-Earth science. Anderson, a professor emeritus of geophysics in the division of geological and planetary sciences at Caltech, asserts, quite rightly, that the traditional disciplines have fostered overly narrow views of Earth's interior. Geochemists, seismologists, petrologists, and geodynamicists often see Earth so differently that it is easy to forget we are all looking at the same planet. Anderson succeeds in counteracting this tendency by offering a genuinely interdisciplinary perspective of Earth, delivered in his engaging yet authoritative style.

The focus of the book is Earth's mantle, the mostly solid silicate and oxide shell between the crust and the core, that makes up about two-thirds of our planet's mass. The mantle largely controls Earth's internal dynamics and its long-term evolution. Anderson approaches the twin problems of interpreting mantle structure and inferring its dynamics by synthesis rather than by analysis. His skill for combining widely diverse observations into a coherent picture is on full display in the book. It must be said that not all of his interpretations reflect the community's consensus. For example, he infers that compositionally derived buoyancy forces are on a par with thermally derived buoyancy forces in the geodynamic engine; by contrast, the conventional interpretation is that thermal effects dominate the process, at least in the present-day mantle. Conventional or not, he is nevertheless careful to provide the data that underlie his interpretations; he thus empowers the readers to come to their own conclusions.

The sequencing of topics is one of the book's best qualities. Instead of describing structures in Earth in chronological order of their discovery, which is too often the approach in older monographs, Anderson begins with a brief comparison of the terrestrial planets and then offers a critique of the current ideas on mantle dynamics; that critique quickly establishes the theme for the rest of the book. The introduction is followed by the "meat and potatoes" of

the book: a review of Earth's structure and composition, from the crust to the core; an interpretation of mantle-derived isotopes and magmatic products; and a survey of the physical properties of mantle minerals and their assemblages. I found those parts to be the best in the book; they are insightfully written and replete with informative tables, diagrams, and figures. The final two parts include the author's interpretation of the mantle heterogeneity as imaged by seismic tomography, followed by a nice account of the flow of thermal energy through the mantle system in space and in time, all without recourse to a single formula.

One aspect of the new edition that readers might find problematic is the reliance on "Googlets," key words inserted into the text for directing web searches. Those entries are used in place of ordinary text citations in referring to the recent literature on a given topic. However, Anderson has retained many of the older text citations from the first edition, and that practice has given his referencing scheme a discernible bimodal quality. Interactive referencing may eventually supersede traditional citation methods as search-engine capabilities increase, although my own experiments with several of his Googlets met with mixed success.

Like its predecessor, *New Theory of the Earth* offers an insightful, insider's view of what our planet is made of and how it works. Because it is so well written and well conceived, it is suitable either as a graduate-level textbook or as supplemental reading in an advanced undergraduate course. And because it is so comprehensive, it deserves to be within arm's length of every serious student of Earth.

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Von Braun Dreamer of Space, Engineer of War

Michael J. Neufeld
Alfred A. Knopf, New York, 2007.
\$35.00 (564 pp.).
ISBN 978-0-307-26292-9

The development of spaceflight and the success of harnessing of the atom are the great stories of 20th-century technological and scientific achievement. However, both challenge historians to explain how scientists and engineers could willingly, even fervently, apply their talents to projects of great moral ambiguity. Wernher von Braun