research and exploring its applications in neutrino physics, plasma physics, astrophysics, and cosmology. They provide a very readable introduction to nuclear physics and nuclear models. Some readers will appreciate such historical anecdotes as the origin of "borromean," used to describe a class of nuclei. The chapter on nuclear reactions includes a compact but complete summary of quantum-mechanical tools needed to understand a wide class of nuclear reactions. The authors give an extensive discussion of recent neutrino-physics experiments and the role nuclear physics plays in those experiments. Discussions of nuclear astrophysics and cosmology are brief but provide a good basis for students wishing to consult more specialized texts.

The book offers a thorough treatment of cosmogenic radioactivity, which is so important in planning various low-background counting experiments, and explores at length the overlap between nuclear physics and the fields of plasma physics and nuclear engineering. The authors cover not only the basic physics underlying nuclear fission and fusion but also neutron transport in matter, different kinds of nuclear reactors, and magnetic and laser-driven inertial confinement. The brief accounts of various applications of nuclear radioactivity and of the prehistoric natural reactor in Oklo, Gabon, are nice examples of the kind of supplementary information that most other texts omit.

Most readers should be able to correct the book's few typographical errors from the context in which they appear. As in many other texts covering a rapidly evolving field, some data the authors mention—including, for example, evidence for pentaquarks—are very preliminary. The authors could have given more information on the physics of exotic nuclei and tools used to explore them, such as radioactive-beam facilities. They also could have included a discussion of relativistic heavy-ion beams and properties of quark–gluon plasmas. But inclusion of those topics would have significantly lengthened the book, making it less appropriate for a one-semester graduate course.

Overall, *Fundamentals in Nuclear Physics* is a suitable textbook for a graduate-level introductory course aimed at providing background material in nuclear physics to students who intend to specialize in particle physics, plasma physics, and astrophysics. It can also be used as a supplementary textbook in a graduate course designed for students who plan to specialize in nuclear physics.

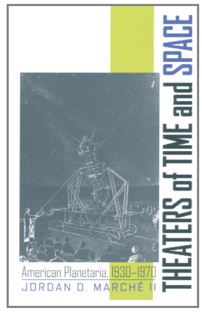
A. Baha Balantekin
University of Wisconsin–Madison

Theaters of Time and Space: American Planetaria, 1930–1970

Jordan D. Marché II
Rutgers U. Press, New Brunswick, NJ, 2005. $49.95 (266 pp.). ISBN 0-8135-3576-X

We do not usually associate James Dean with science education, but as Jordan D. Marché II reminds us in his scholarly account, *Theaters of Time and Space: American Planetaria, 1930–1970*, the opening scenes of *Rebel Without a Cause* were filmed at the Griffith Observatory in Los Angeles. In the film, the planetarium lecturer follows up a portrayal of the Big Bang with a speech about the smallness of human beings in the chilling immensity of the universe. By 1955, when the movie was released, the planetarium had become a common feature of American life, and *Theaters of Time and Space* is primarily concerned with why that was so. The book also examines the boom in planetarium building that followed on the heels of *Sputnik I* in 1957 as American lawmakers scrambled to plug what they saw as alarming gaps in the US educational system.

Marché, a lecturer in astronomy at the University of Wisconsin–Madison and a planetarium specialist, opens his book with an account of mechanical models of the universe. He moves on quickly to the story of the projection planetarium, in which Oskar von Miller played a key role. Miller was the director of the Deutsches Museum in Munich, Germany, at the turn of the 20th century and initially wanted to secure mechanical models for the museum. But during a meeting in 1914 between Miller and representatives of the Carl Zeiss Optical Co, Walther Bauersfeld and Werner Straubel hit upon the chief ideas of the projection planetarium. In 1923, the first public demonstrations were given at the Deutsches Museum.



Such was the popularity of these new devices that by 1930 engineers had constructed 15 planetaria in Europe. In that year, with the aid of a hefty donation from the vice president of Sears, Roebuck and Co, the Adler Planetarium opened in Chicago. In the following decade, Zeiss projectors were housed in Philadelphia and Pittsburgh in Pennsylvania, in Los Angeles, and in New York City. Two smaller, non-Zeiss planetaria were located in San Jose, California, and Springfield, Massachusetts.

Zeiss projectors were relatively expensive at this period. It was the dream of American entrepreneur, educator, and astronomy enthusiast Armand N. Spitz to make planetarium projectors widely available around the world. Although he was not the first to conceive of or manufacture the so-called pinhole projector, Spitz successfully brought it to a broad audience after World War II. By 1945, he had built his model-A projector at his home; it projected about 1000 stars whose brightness extended down to the fourth magnitude. Eight years later, he had sold his 100th projector worldwide.

Although Spitz projectors fueled an increase in planetarium building, it was *Sputnik I* and *Sputnik II* that greatly expanded the market for his machines. The launch of those Soviet satellites prompted lawmakers to pour money into science education in unprecedented amounts. The planetarium, as Marché argues, acquired a novel and major significance in the US, and hundreds were built for schools and colleges. Planetaria were also put to new use in the 1960s—for example, as training aids for the Apollo astronauts.

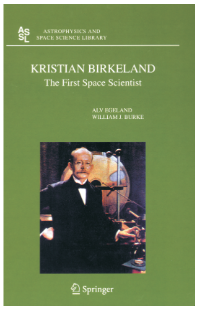
But Marché does not focus on just the hardware and its builders. He also explores in detail the kinds of presentations visitors could experience in planetaria and the reasons for the shifts in their content over the years. A particularly interesting development was the first planetarium light show. As Marché recounts, the light shows grew out of a series of sound experiments in the late 1950s by composer Henry Jacobs and filmmaker Jordan Belson in San Francisco's Morrison Planetarium. The Vortex performances, as they were termed, soon became very controversial and sparked debate about the appropriate and inappropriate uses of planetaria. Marché also traces the establishment of a community of planetarium operators, lecturers, and managers and their attempts to develop professional standards and journals. He pays attention to the composition and nature of the workforce; in so doing, he demonstrates the field's depressing extent of discrimination against women, particularly in the 1930s and 1940s.

Although the prose in *Theaters of Time and Space* occasionally reflects the book's origins as a doctoral thesis, the author's arguments are clear and flow from a great deal of careful research that includes an impressive use of archives. Marché has written an original and significant study that sets the development of planetaria in a broad context. His book deserves a wide readership beyond planetarium specialists.

Robert W. Smith
University of Alberta
Edmonton, Canada

Kristian Birkeland: The First Space Scientist

Alv Egeland and William J. Burke
Springer, New York, 2005. $109.00 (221 pp.). ISBN 1-4020-3293-5



In the media the launch of *Sputnik I* often defines the beginning of the space age and the associated exploration of space beyond Earth. However, the roots of space physics itself go farther back. In *Kristian Birkeland: The First Space Scientist*, Alv Egeland and William Burke, both well-established space physicists, present the scientific work of the Norwegian physicist.

Birkeland (1867–1917) is a major figure in Norwegian science but is less well known outside Scandinavia. Although his insight and understanding of classical electromagnetic theory were remarkable—he provided one of the first general solutions to Maxwell's equations—he chose to apply his talents to experimental physics, and his primary interest was auroral research. He obtained significant funding from the Norwegian government for an ambitious observational program. At the time Norway was part of Sweden, and Birkeland, in his grant application, appealed in part to nationalistic feelings by arguing that it was important to show that Norwegian science was at the forefront internationally.

Birkeland was also an entrepreneur. He realized that additional income from applied projects was needed to support his basic research. He formed or participated in numerous enterprises, including the building of an electromagnetic rail gun that he tried to sell to the English and French governments, but it was his method for making fertilizer that brought him financial independence. His business ventures are interesting reading, and I found myself reflecting on the similarities between Birkeland's approach and how scientists today try to fund space research at universities.