

BOOK REVIEWS

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Volta: Science and Culture in the Age of Enlightenment.

Giuliano Pancaldi. 381 pp. Princeton U.P., Princeton, NJ, 2003. Price: \$35.00 ISBN: 0-691-09685-6. (Myles W. Jackson, Reviewer.)

Electricity sparked the interest of a myriad of groups throughout eighteenth-century Europe. Electric machines titillated the curiosities of aristocratic courts, as courtiers strove to impress regional rulers seeking to tame nature's forces (often with a view to implementation on the battlefield). Theologians used electrical shows to demonstrate to their flock the power of an angry, vengeful God wishing to punish transgressors. Public performers were quick to incorporate electrical phenomena in order to attract curious, fee-paying audiences. And experimental natural philosophers grappled with electrical phenomena with the hope of explaining the century's most exciting branch of physics in terms of current theories of optics and gravity.

Within this context Pancaldi offers a biography of the Italian savant, Alessandro Volta. Volta's entrepreneurial acumen enabled him to negotiate the boundaries separating various communities interested in electricity: public servants, experimental natural philosophers and mechanicians. Such an accomplishment cannot be overemphasized. These groups not only had different (and at times antithetical) interests in electricity, they also possessed different forms of sociability. Pancaldi correctly argues for the differences among these cultures relevant to Volta's invention of the battery. Natural philosophers, members of the Republic of Letters, often found themselves at odds with artisans such as scientific instrument makers, whose trade secrets, patents and financial interests seemed both to taint the objectivity of scientific knowledge and threaten the openness so prized by the literati. For example, when the Göttingen natural philosopher Georg Christian Lichtenberg remarked, "Volta [is] rich in knowledge, and knows how to show it" (as quoted on p. 40), one detects a purposely ambiguous tinge of sarcasm. Public displays of "virtuosity" were often frowned upon as crass pandering to the whims of an unenlightened public. Although Pancaldi refers to Volta as a "virtuoso" (p. 9), it would be more informative to the reader if the inventor's contemporaries referred to him as such. Whereas experimental natural philosophers such as Robert Boyle and Isaac Newton enjoyed the title of virtuoso, by the late eighteenth century the epithet was no longer applicable to experimental natural philosophers. Indeed, science was seen as rendering the marvelous and spectacular rather mundane, replicable and straightforward. This desire to be disassociated from the commercial nexus of skilled artisans might offer an explanation for why Volta never sought a patent for his invention. Although Volta successfully navigated the treacherous boundaries among these communities, Pancaldi could have done more to elucidate and differentiate the various personae of the public servant, experimental natural philosopher, inventor and craftsman. Precisely because the Enlightenment opened up the practice of science to a number of communities, which had previously been excluded from experimental natural philosophy (including women and artisans), the early nineteenth

century witnessed numerous tensions among groups with differing socio-cultural backgrounds pursuing natural philosophy.

Pancaldi's work proffers a lucid and sorely needed prosopography of Enlightenment science in Italy. It also details Volta's early design of instruments, such as his electrophorous, his early views on electricity and the responses by leading French, German and British experimental natural philosophers to his views, with varying degrees of clarity.

The most informative chapters of the book discuss Volta's famous invention of the battery and the numerous ways in which it was appropriated by various savants. As Pancaldi argues, Volta gleaned his construction of the battery from a paper written by William Nicholson, who was interested in imitating the anatomy of the torpedo, an electric fish. It is in this context that one begins to appreciate Volta's renowned confrontation with Luigi Galvani, who claimed that animals (such as frogs) provided their own electric fluid, which could be measured by a simple physiological apparatus. Volta, after initially agreeing with Galvani's account, countered this view by asserting that animals played only a passive role. The contractions of the frog's legs were due to the contact of different metals and wet substances used in the experiment. Pancaldi describes Volta's challenges to Galvani's theory during 1796–1797. By using Nicholson's doubler device, Volta was able to show that it was indeed the machine that contributed the motion of "electric fluid" resulting in the twitching of the frog's legs. In late 1799 Volta built his pile composed of metals and wet cardboards as a mechanical imitation of the electric fish.

The ensuing chapter provides physicists with an important historiographic moral. As historians and philosophers of science have argued for decades, instruments never totally determine their eventual use. One needs to investigate how experimental natural philosophers appropriate an instrument, such as Volta's battery, into their own research agendas. Contra previous historical and sociological studies of science and technology, which have underscored the difficulty of replicating instruments, Pancaldi demonstrates how the battery was rather easily reproduced. Electricians, instrument makers and experimental natural philosophers constructed the battery without needing to witness Volta's skilled work. Whereas Volta saw his invention as a powerful weapon in the arsenal against animal or galvanic electricity, Johann Wilhelm Ritter used it to bolster his Romantic conception of a unified, organic nature. The discoverer of electromagnetism, Hans Christian Oersted, saw Volta's apparatus as providing evidence for two different types of electricity, one generated by friction and the other galvanic. The research objectives and conclusions of these two men were diametrically opposed to Volta's own views on electricity. And Volta reworked his own theories of electricity in general and the battery in particular by responding to the works of those and other savants, such as Jean-Baptiste Biot and Christoph Heinrich Pfaff.

Pancaldi's work is an important contribution to the history of electricity and Volta's invention of the battery. Historians of science possessing a sophisticated knowledge of historiography, however, might be somewhat disappointed with the book. On numerous occasions, Pancaldi argues that he is drawing upon both "realist" and "social constructivist" accounts in his work. Unfortunately, his use of the term "social constructivist" is rather misleading. He uses it when referring either to a straightforward socio-cultural history or when dealing with reception theory. Whenever the "internal" contributions of Volta's science are discussed, he reverts back to a "realist" account. "Social constructivists" of science have for the past 20 years claimed that what counts as the "social" and the "scientific" are at times blurred and are always historically contingent. They argue that one can indeed use their historiography to explain science's rigor. And they do not speak of "social factors" precisely because such a term assumes an internalist/externalist divide that they wish to challenge, but that Pancaldi tacitly assumes throughout his work.

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Fundamentals and Applications of Ultrasonic Waves. J. David Cheeke. 462 pp. CRC, Boca Raton, FL, 2002. Price: \$99.95 ISBN 0-8493-0130-0. (James Zagzebski, Reviewer.)

I teach a graduate medical physics course on ultrasonic imaging, and my colleagues and I continue to search for textbooks that provide both basic background on the physics of ultrasound waves and physics and instrumentation of medical acoustics. There are no books available that provide such a mix. However, the first 6 chapters of David Cheeke's book, *Review of Fundamentals and Applications of Ultrasonic Waves*, seem to provide the right level of basic acoustics for the first $\frac{1}{3}$ of such a course. I believe the book will be equally useful for other acoustics courses.

Like many specialty textbooks, *Fundamentals and Applications of Ultrasonic Waves* grew out of a course the author taught for physics and engineering majors. The book is intended for use at the advanced undergraduate level, but it would also serve as a good supplement to graduate courses, or as a reference for individuals doing research that requires a background in ultrasonics. The author's intention is to provide an overview of ultrasonics, with emphasis on applications. Although the topics covered may not be germane to every reader's specific interests, the overview provides very useful insight to many areas of ultrasonics.

The book's introduction briefly discusses an interesting cross section of applications and areas in which ultrasonics is used. These are not treated in detail, but the list emphasizes the importance of the topic and helps broaden the outlook for any reader. The introduction also outlines many interesting sources of ultrasound, both natural (animals, ocean waves) and manmade. One learns, for example, of the role of ultrasonics in the life and death struggle between a bat and a moth, complete with evasive maneuvers and jamming sonar emitted by the prey. One would like to learn more about these fascinating topics, but it's soon time to get on to aspects of ultrasonics that are important in a laboratory setting.

Other readers will naturally see the book differently, but the section of greatest interest to our medical ultrasound group is Chapters 1–7. This section provides background material on vibrations and waves, bulk waves in fluids, waves in solids, beams, diffraction, and reflection and transmission at interfaces. Medical ultrasound groups delving into elasticity imaging will find Chap. 4 ("Introduction to the Theory of Elasticity"), with its introduction to tensor notation, Lamé constants, and the thermodynamics of deformation, particularly useful.

The general approach that is followed throughout the book is to start with basic concepts and pursue them into more difficult areas, where greater complexity and mathematical formalism are required. A case in point is the chapter on reflection and transmission at interfaces. A diagram at the start of the chapter outlines the different reflecting interfaces of interest, ranging from liquid-liquid ones at perpendicular incidence, to liquid-solid interfaces, to solid-solid interfaces at oblique incidence. The treatment of simple reflectors, standing waves, and thin films is complete, filling in details that some textbooks leave as exercises for the reader. The chapter serves as a useful basis for subsequent chapters on Rayleigh waves, Lamb waves, and acoustic wave-guides. The end of each chapter contains useful didactic materials, including questions and bullet summaries.

An appendix contains useful information and ideas on experiments that might be carried out in an advanced undergraduate lab. These are not fully developed lab manuals, but simply collections of the author's ideas that could be built upon, given sufficient time and equipment; none is described in sufficient detail to enable a TA to go in and set up the experiment. They include, for example, experiments on radiation measurements using transducers, and basic transducer characterization.

If you are looking for a detailed treatment of specific applications, such as nondestructive testing, or the many facets of medical ultrasonics, you will have to look elsewhere. Considering the importance of medical ultrasonics, and the rich variety of acoustical applications that might have been included, this was a drawback for me. If, on the other hand, you are looking for a basic book along the lines of *Fundamentals of Acoustics* by Kinsler, Frey, Coppens, and Sanders, this is a very readable, logically arranged book, and has many advantages over other more classical texts.

James Zagzebski, Ph.D., is professor and chair of medical physics at the University of Wisconsin, Madison. His research interests are ultrasound parametric imaging, the use of ultrasound contrast agents, and computer models of ultrasound wave propagation.

BOOKS RECEIVED

- Catastrophe Theory** (second edition). Domenico P.L. Castriano and Sandra A. Hayes. 264 pp. Westview, Boulder, CO, 2004. Price: \$90.00 (cloth) ISBN 0-8133-4126-4; \$30.00 (paper) ISBN 0-8133-4125-6.
- Cold and Ultracold Collisions in Quantum Microscopic and Mesoscopic Systems.** John Weiner. 217 pp. Cambridge U.P., New York, 2003. Price: \$75.00 ISBN 0-521-78121-3.
- The Concepts and Practice of Mathematical Finance.** M.S. Joshi. 473 pp. Cambridge U.P., New York, 2003. Price: \$50.00 ISBN 0-521-82355-2.
- Dynamical Theory of X-Ray Diffraction** (paperback edition, revised). André Authier. 674 pp. Oxford U.P., New York, 2004. Price: \$89.50 (paper) ISBN 0-19-852892-2.
- Foundations of Classical Electrodynamics: Charge, Flux, and Metric.** Friedrich W. Hehl and Yuri N. Obukhov. 410 pp. Birkhäuser, Boston, 2003. Price: \$79.95 ISBN 0-8176-4222-6.
- Frobenius Algebras and 2D Topological Quantum Field Theories.** Joachim Kock. 240 pp. Cambridge U.P., New York, 2003. Price: \$90.00 (cloth) ISBN 0-521-83267-5; \$35.00 (paper) ISBN 0-521-54031-3.
- A Gallery of Fluid Motion.** Edited by M. Samimy *et al.* 118 pp. Cambridge U.P., New York, 2003. Price: \$95.00 (cloth) ISBN 0-521-82773-6; \$35.00 (paper) ISBN 0-521-53500-X.
- Gravity from the Ground Up.** Bernard Schutz. 488 pp. Cambridge U.P., New York, 2004. Price: \$45.00 ISBN 0-521-45506-5.
- Interatomic Forces in Condensed Matter.** Mike Finnis. 286 pp. Oxford U.P., New York, 2003. Price: \$74.50 ISBN 0-19-850977-4.
- An Introduction to Ordinary Differential Equations.** James C. Robinson. 399 pp. Cambridge U.P., New York, 2004. Price: \$100.00 (cloth) ISBN 0-521-82650-0; \$45.00 (paper) ISBN 0-521-53391-0.
- The Maunder Minimum and the Variable Sun-Earth Connection.** Willie Wei-Hock Soon and Steven H. Yaskell. 278 pp. World Scientific, River Edge, NJ, 2003. Price: \$64.00 (cloth) ISBN 981-238-274-7; \$32.00 (paper) ISBN 981-238-275-5.
- Noise Sustained Patterns: Fluctuations and Nonlinearities.** Markus Locher. 238 pp. World Scientific, River Edge, NJ, 2003. Price: \$58.00 ISBN 981-02-4676-5.
- Physics and Whitehead: Quantum, Process, and Experience.** Edited by Timothy E. Eastman and Hank Keeton. 322 pp. State University of New York Press, Albany, NY. Price: \$55.00 ISBN 0-7914-5913-6.
- Physics for Scientists and Engineers** (sixth edition). Raymond A. Serway and John W. Jewett, Jr. 1370 pp. Thomson Brooks/Cole, Belmont, CA, 2004. Price unavailable ISBN 0-534-40842-7.
- Physics for Scientists and Engineers, Vol. 1** (third edition). Paul M. Fishbane, Stephen G. Gasiorowicz, and Stephen T. Thornton. 652 pp. Prentice Hall, Upper Saddle River, NJ, 2004. Price: \$91.00 (paper) ISBN 0-13-141883-1.
- The Physics of Multiply and Highly Charged Ions, Vol. 1: Sources, Applications, and Fundamental Processes.** Edited by Fred J. Currell. 389 pp. Kluwer Academic Publishers, Norwell, MA, 2003. Price: \$167.00 ISBN 1-4020-1565-8.
- Physics: Principles with Applications, Vol. 1** (sixth edition). Douglas C. Giancoli. 483 pp. Prentice Hall, Upper Saddle River, NJ, 2004. Price unavailable (paper) ISBN 0-13-035256-X.
- Proceedings of the Dirac Centennial Symposium.** Edited by Howard Baer and Alexander Belyaev. 180 pp. World Scientific, River Edge, NJ, 2003. Price: \$77.00 ISBN 981-238-412-X.
- Quantum Theory of Fields** (reprint). Gregor Wentzel. 224 pp. Dover, Mineola, NY, 2003. Price: \$16.95 (paper) ISBN 0-486-43245-9.
- Scaling.** G.I. Barenblatt. 171 pp. Cambridge U.P., New York, 2004. Price: \$85.00 (cloth) ISBN 0-521-82657-8; \$30.00 (paper) ISBN 0-521-53394-5.
- Statistical Physics of Crystals and Liquids: A Guide to Highly Accurate Equations of State.** Duane C. Wallace. 312 pp. World Scientific, River Edge, NJ, 2002. Price: \$58.00 (cloth) ISBN 981-238-112-0; \$29.00 (paper) ISBN 981-238-113-9.
- Theoretical Mechanics of Particles and Continua** (reprint). Alexander L. Fetter and John Dirk Walecka. 570 pp. Dover, Mineola, NY, 2003. Price: \$34.95 (paper) ISBN 0-486-43261-0.
- Time's Arrow: The Origins of Thermodynamic Behavior** (reprint). Michael C. Mackey. 175 pp. Dover, Mineola, NY, 2003. Price: \$14.95 (paper) ISBN 0-486-43243-2.
- Tokamaks** (third edition). John Wesson. 749 pp. Oxford U.P., New York, 2004. Price: \$244.50 ISBN 0-19-850922-7.

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