Toumey again rules the world of science out of bounds for analysis when he suggests that the adjudication of controversies by scientists themselves is straightforward and requires no investigation. The cold fusion controversy, for example, would have been resolved rapidly through attempts to replicate the findings of Stanley Pons and Martin Fleischmann, claims Toumey, had not the media complicated the evaluation process by transforming the story into a moral battle with heroes and villains. In fact, replication in science is often far from simple, as Harry Collins and Trevor Pinch argue in *The Golem* (Cambridge Univ. Press, 1993), one of the most important books on the public understanding of science (but one that Toumey does not cite). As Collins and Pinch note in their own discussion of cold fusion, it was no easy task for experts to decide whether particular scientists had adequately repeated Pons and Fleischmann's experimental procedures. Therefore (p. 69) "negative results could be explained away by the believers as being due to differences in the replicating instrument." The bottom line is that scientists, just like laypeople, are constantly in the business of assessing who or what is credible. To address the manipulations of science that Toumey eloquently describes, and to work toward more productive relations between scientists and laypeople, we must gain a clearer understanding of the processes by which scientific credibility is asserted, evaluated, and contested, both within the inner circles of science and in the broader society.

Steven Epstein
Department of Sociology,
University of California at San Diego,
La Jolla, CA 92093, USA

Vignettes: Yesteryear in Oxbridge

At Oxford [William Henry] Perkin . . . replaced . . . William Odling, who had retired from the Waynefleet chair in 1912 at age 83, after occupying it for forty years. A cultivated Nestor of chemistry, Odling was a connoisseur of engravings but not interested in the patient pursuit of detail via experiments done at the laboratory bench. Preferring the philosophical and speculative aspects of chemistry, Odling was not the slave of his laboratory, which he thought it a breach of etiquette for the professor to enter. . . .

Oxford was a collegiate university devoted to arts subjects, teaching, and connoisseurship; science was seen as peripheral, specialist publication suspected as narrow, and from the colleges' enclave, research seen as an ungentlemanly, boorish, and even foolish German idea.

—*Jack Morrell*, in *Research Schools: Historical Reappraisals* (Gerald L. Geison and Frederic L. Holmes, Eds.; *Osiris*, vol. 8)

We were a polite society and I expected to lead a quiet life teaching mechanics and listening to my senior colleagues gently but obliquely poking fun at one another. This dream of somnolent peace vanished very quickly when Rutherford came to Cambridge. Rutherford was the only person I have met who immediately impressed me as a great man. He was a big man and he made a big noise and he seemed to enjoy every minute of his life. I remember that when transatlantic broadcasting first came in, Rutherford told us at a dinner in Hall how he had spoken into a microphone to America and had been heard all over the continent. One of the bolder of our Fellows said "Surely you did not need to use apparatus for that."

—*Geoffrey Taylor*, 1952, as quoted by George Batchelor in *The Life and Legacy of G. I. Taylor* (Cambridge University Press)

Neutrino Questions

Stars as Laboratories for Fundamental Physics. The Astrophysics of Neutrinos, Axions, and Other Weakly Interacting Particles. GEORG G. RAFFELT. University of Chicago Press, Chicago, 1996. xxii, 664 pp., illus. $77 or £61.50. Theoretical Astrophysics. ISBN 0-226-70271-5.

The foundation of astrophysics is the belief that the same laws of physics that hold on Earth govern what goes on in the stars. Thus we can use nuclear cross-sections, atomic energy levels, and fundamental laws discovered in our terrestrial laboratories to calculate stellar processes. However, there may be relevant fundamental physics that has not yet been discovered on Earth. This leads to the possibility that new laws of physics may be discovered by studying the stars. It is this possibility that is the subject of Raffelt's book.

The physics of interest to Raffelt concerns the properties of elementary particles, primarily neutrinos and hypothetical particles called axions. In fact, more than half the book is devoted to neutrinos. The importance of neutrinos for astrophysics derives from the fact that they are the only known particles that interact only weakly. This means that if they are produced at high temperatures inside stars they can escape more easily than other particles and so can be a major agent of energy loss. In the case of a collapsing star leading to a type II supernova, nearly all of the energy of collapse (of order 10^{53} ergs) is emitted in the form of neutrinos over a period of about 10 seconds. The fact that neutrinos can escape easily from deep inside a star means that neutrino astronomy could make possible the study of stellar regions that cannot be directly explored in any other way. In particular, the detection of neutrinos from the sun has confirmed our general picture of the nuclear reactions occurring there.

The one indication of new physics from astrophysical observations is the quantitative disagreement between the measured neutrino fluxes from the sun and the results of detailed calculations. This could be explained by oscillations of electron-neutrinos from the sun into another type of neutrino if neutrinos have mass. Indeed, this is the strongest evidence available in favor of a non-zero neutrino mass. The subject of neutrino oscillations and solar neutrinos is covered very clearly in the book. Though the treatment is not as detailed as that in *Neutrino Astrophysics* by John Bahcall (Cambridge Univ. Press, 1989), it is very adequate and up to date.

The detection of neutrinos from a supernova in the Large Magellanic Cloud in 1987 (SN1987A), even though they were only 19 or 20 in number, was one of the most important astrophysical events of recent times. These were the first neutrinos observed from a source outside the solar system, and they actually came from outside our own galaxy. Raffelt develops in detail theoretical analysis, much of it his own original work, on the propagation of neutrinos in dense media such as supernova cores. A variety of conclusions have been drawn from the observation of SN1987A neutrinos, ruling out exotic sources of energy loss, limiting the Dirac mass and magnetic moments of neutrinos,

and constraining neutrino opacity. There is also a summary of recent analyses of the effect of possible neutrino oscillations on the supernova mechanism as well as on R-process nucleosynthesis.

Theoreticians like to invent theories with new types of particles. One class involves almost massless spin-zero particles, called Nambu-Goldstone bosons, which arise from the spontaneous breaking of a global symmetry. There is no compelling reason to believe in any such particles, but much analysis has centered on the particle called the axion, which could be a candidate for dark matter. Raffelt discusses various possible processes involving axions that make it possible to constrain the axion couplings from astrophysical observations. A more popular candidate for dark matter is one of the class known as supersymmetric particles, but these are only briefly mentioned.

It should be emphasized that the "fundamental physics" of the title has a very limited meaning. Stars can tell us about general relativity, nucleosynthesis, atomic physics, and much else, but these are not the subjects of this book. Also the book does not discuss the goals of proposed future neutrino astronomy projects like an expanded AMANDA at the South Pole, where the best hope is to find neutrinos from active galactic nuclei. Within the restricted range of topics covered the book is authoritative and thorough.

Lincoln Wolfenstein
Physics Department, Carnegie Mellon University, Pittsburgh, PA 15213, USA

Also Noteworthy

The Life of Stefan Banach. Through a Reporter's Eyes. ROMAN KAŁUŻA. Birkhäuser, Cambridge, MA, 1996. x, 137 pp. $24.50. Translated from the Polish edition (1992) by Ann Konstant and Wojbor Woyczyński.

Stefan Banach (1892–1945), a founder of functional analysis, was a member of the illustrious group of mathematicians who met at the so-called Scottish Cafe in Lvov, Poland, in the 1930s. A good deal has been written about the group (see for example *Science* **218**, 880 [1982]) but relatively little about Banach himself, and this book attempts to remedy the deficiency by reconstructing the basic facts of his life, which is especially poorly documented for the years of the two world wars. The journalist author frankly disavows any claim to mathematical authoritativeness but does quote some of Banach's peers and contemporaries in the field concerning his work.

On Social Structure and Science. ROBERT K. MERTON. Piotr Sztompka, Ed. University of Chicago Press, Chicago, 1996. viii, 386 pp. $55 or £43.95; paper, $19.95 or £15.95. The Heritage of Sociology.

As a sociologist Robert Merton, in the words of Sztompka's introduction to this volume reprinting 24 of his essays, "opened up fruitful areas of inquiry along lines that he and generations of others would pursue for decades." One of these areas has been the sociology of science, and eight of the essays included here are on this theme. Among their topics are the rise of modern science (1938), the reward system of science (1957), multiple discoveries in science (1961), and the "Matthew effect" (1988; see also *Science* **159**, 56 [1968]).

Sixty Years of Biology. Essays on Evolution and Development. JOHN TYLER BONNER. Princeton University Press, Princeton, NJ, 1996. x, 145 pp., illus. $24.95 or £18.95.

In the five essays (all but one new) gathered here the Princeton biologist considers a set of evolutionary themes that have particularly engaged his interest. Among these are the relation of the physical properties of living matter to natural selection, the significance of the competition and the division of labor found at all levels of biological organization, and determinism and flexibility in development. In the title essay Bonner reflects on the changes in biology and in the way science in general is done that have occurred over his professional lifetime.

In Search of Nature. EDWARD O. WILSON. Island/Shearwater, Washington, DC, 1996. x, 214 pp., illus. $19.95.

This is a collection of a dozen reprinted essays (1975–1993), the central theme of which is, as in many of the author's other writings, that "wild nature and human nature are closely interwoven." Among the subjects of his reflections here are the roots and ramifications of our awe of snakes and sharks, how ants have "managed to stay on top of things" for eons, the evolution of human behavior (altruism, aggression, and "culture as a biological product"), and the merits of the "environmentalist vision" as opposed to human "exemptionalism."

Katherine Livingston

Books Received

Ants and Plants. An Example of Coevolution. Pierre Jolivet. Backhuys, Leiden, The Netherlands, 1996. 303 pp., illus. NLG 132,00. Translated and enlarged from the French edition (Paris, 1986).

Atomic, Molecular, and Optical Physics Handbook. Gordon W. F. Drake, Ed. AIP Press, Woodbury, NY, 1996. xviii, 1095 pp., illus. $130.

Circular Dichroism and the Conformational Analysis of Biomolecules. Gerald D. Fasman, Ed. Plenum, New York, 1996. x, 738 pp., illus. $125.

Classics in Total Synthesis. Targets, Strategies, Methods. K. C. Nicolaou and E. J. Sorensen. VCH, New York, 1995. xxiv, 798 pp., illus. $80; paper, $49.95.

The Enigmatic Photon. Vol. 3, Theory and Practice of the $B^{(3)}$ Field. Myron W. Evans *et al.* Kluwer, Norwell, MA, 1996. x, 228 pp. $114 or £77 or Dfl. 170. Fundamental Theories of Physics, vol. 77.

Extremal Properties of Polynomials and Splines. N. P. Korneichuk, A. A. Ligun, and V. F. Babenko. Nova, Commack, NY, 1996. vi, 433 pp., illus. $92. Computational Mathematics and Analysis.

Guide for the Care and Use of Laboratory Animals. Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council. National Academy Press, Washington, DC, 1996. xii, 125 pp. Paper, $9.95.

Intuitive Biostatistics. Harvey Motulsky. Oxford University Press, New York, 1995. xx, 386 pp., illus. $39.95; paper, $24.95.

Marine Biology. Function, Biodiversity, Ecology. Jeffrey S. Levinton. Oxford University Press, New York, 1995. xii, 420 pp., illus. $47.95.

Neuropeptides. Basic and Clinical Advances. Jacqueline N. Crawley and Stafford McLean, Eds. New York Academy of Sciences, New York, 1996. xii, 255 pp., illus. $100. Annals, vol. 780. From a conference, Martha's Vineyard, MA, June 1995.

Nuclear Energy. Principles, Practices, and Prospects. David Bodansky. AIP Press, Woodbury, NY, 1996. xvi, 396 pp., illus. $65.

100 and More Basic NMR Experiments. A Practical Course. S. Braun, H.-O. Kalinowski, and S. Berger. VCH, New York, 1964. xii, 418 pp., illus. Paper, $49.95.

Papers on General Topology and Applications. Eva Coplakova and Klaas Pieter Hart, Eds. New York Academy of Sciences, New York, 1996. xii, 227 pp., illus. $110. Annals, vol. 788. From a conference, Amsterdam, Aug. 1994.

Quantification of Brain Function Using PET. Ralph Myers *et al.*, Eds. Academic Press, San Diego, 1996. xxx, 443 pp., illus. $99.

Retroviral Reverse Transcriptases. Simon Litvak. Chapman and Hall, New York, and Landes, Austin, TX, 1996. xii, 206 pp., illus. $69.95. Molecular Biology Intelligence Unit.

Russian Contributions to Invertebrate Behavior. Charles I. Abramson, Zhanna P. Shuranova, and Yuri M. Burmistrov, Eds. Praeger, Westport, CT, 1996. xvi, 231 pp., illus. $75.

Solar and Astrophysical Magnetohydrodynamic Flows. Kanaris C. Tsinganos, Ed. Published in cooperation with NATO Scientific Affairs Division by Kluwer, Norwell, MA, 1996. xiii, 742 pp., illus. $330 or £220 or Dfl. 495. NATO ASI Series C, vol. 481. From an institute, Heraklion, Crete, Greece, June 1995.

Techniques in Apoptosis. A User's Guide. T. G. Cotter and S. J. Martin, Eds. Portland, London, 1996 (U.S. distributor, Ashgate, Brookfield, VT). xii, 333 pp., illus. $120 or £75.

To Boldly Go. A Practical Career Guide for Scientists. Peter S. Fiske. American Geophysical Union, Washington, DC, 1996. iv, 188 pp., illus. Paper, $19; to AGU members, $13.30.

Variation in the Human Genome. Derek Chadwick and Gail Cardew, Eds. Wiley, New York, 1996. x, 329 pp., illus. $84.95. Ciba Foundation Symposium 197. From a symposium, London, June 1995.

What Is Mathematics? An Elementary Approach to Ideas and Methods. Richard Courant and Herbert Robbins. Revised by Ian Stewart. 2nd ed. Oxford University Press. New York, 1996. xxiv, 566 pp., illus. Paper, $18.95