

Kuhn on Kuhn: Looking Back; Fuller on Kuhn: Looking Askance

The Road since Structure: Philosophical Essays, 1970–1993, with an Autobiographical Interview

▶ Thomas S. Kuhn
Edited by James Conant
and John Haugeland
U. of Chicago Press, Chicago,
2000. \$35.00 (355 pp.).
ISBN 0-226-45798-2

Thomas Kuhn: A Philosophical History for Our Times

▶ Steve Fuller
U. of Chicago Press, Chicago,
2000. \$35.00 (472 pp.).
ISBN 0-226-26894-2

Reviewed by Kenneth G. Wilson

Human history is complex and messy. Humans who retell this history forget most of it and oversimplify the rest. Scientists are no exception; the historical summaries in scientific textbooks leave a lot to be desired.

Thomas Kuhn's *The Structure of Scientific Revolutions* (U. of Chicago Press, 1962) called attention to aspects of the history of science that most scientists overlook. But it was Kuhn's concept of paradigm shifts that captured people's imaginations and continues to have a very wide influence. Although Kuhn wrote explicitly about paradigm shifts in the physical sciences, such as those of Copernicus and Isaac Newton, the concept has much broader applicability inside and outside of science.

The two books under review, *The Road since Structure*, by Kuhn, edited

and with supplemental material by James Conant and John Haugeland, and *Thomas Kuhn: A Philosophical History for Our Times*, by Steve Fuller, are written for people who have read *The Structure of Scientific Revolutions*. A reader's prior experience with the history and philosophy of science makes the two books easier to read.

The Road since Structure is a collection of essays by Kuhn along with a lengthy interview with him conducted in 1995 by Aristide Baltas, Kostas Gavroglu, and Vassiliki Kindi. The essays form part of Kuhn's thirty-year effort to clarify the contrast between paradigm shifts and normal science, with a focus on philosophical issues. For example, Kuhn alarmed many scientists with his claim that, while science makes progress, this progress is not towards truth but rather involves never-ending change through paradigm shifts. But the scientists have not realized that Kuhn's claim is based on a philosopher's definition of "truth," which is not achieved (if ever) until there is exact knowledge of the ultimate constituents of matter on the quantum-gravity scale. Scientists use a less demanding definition for the word "truth," in which measured parameters can be subject to non-zero error bars.

In his book, Kuhn dissociates himself from the "social constructivist" claims of sociologists of science such as Steve Fuller. Kuhn claimed that a scientist's social and cultural background affects how the scientist reacts to a paradigm shift *while it is under way*. Kuhn's claim is easily justified, because differing backgrounds cause some scientists to demand more confirmatory evidence for a proposed paradigm shift than do others. Some sociologists of science, including Fuller, make a bolder claim. These sociologists assert that today's normal science, including Newton's laws of mechanics, is still dominated by cultural and social effects. In my view, residual social and cultural uncertainties do exist about long-established physical laws, but they have been diminishing as the accuracy of the testing of these laws

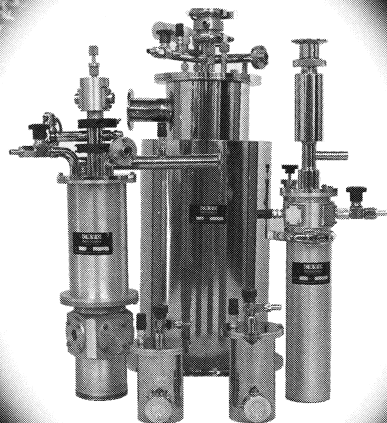
improves. However, future surprises that will challenge some aspects of these laws cannot be ruled out.

Enough has been learned about paradigm shifts in physical science to justify a reexamination of Kuhn's work, including major revisions and extensions far beyond any that Kuhn discusses in *The Road since Structure* or in other of his recent works. For example, Kuhn surely underestimated the work involved in making a new paradigm widely usable. He said little about the centuries of work on methods to solve Newton's laws by such eminent mathematicians as Pierre Simon Laplace and Joseph Louis Lagrange, instead characterizing research after a paradigm shift as a more limited "mopping up operation."

Fuller's book has at its core a 20th-century history of two research subfields: the philosophy of science and the sociology of science. This history is provided partly in the last two chapters of his book and is partly scattered throughout earlier chapters. His achievement is to provide two extensively researched examples, with many valuable references, of the pre-paradigm stage of a research field. Kuhn wrote about pre-paradigm science in chapter 2 of *The Structure of Scientific Revolutions*. A careful analysis of Fuller's history could play a key role in improving on Kuhn's description of pre-paradigm science, a messy stage that scientists are especially eager to forget once they get through it.

Fuller fails to achieve his announced intent: to reassess the achievement of *The Structure of Scientific Revolutions*. He criticizes Kuhn for proposing that scientific knowledge is socially constructed rather than objective truth and then not supporting researchers (such as Fuller himself) who followed through on this concept. But Fuller has insufficient experience with normal science to discuss the character of scientific knowledge with much depth. His view of chemistry omits any reference to quantum mechanics; his view of physics is even more fanciful. He unnecessarily denigrates Kuhn's work, and that of philosophers, sociologists,

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and historians in sympathy with Kuhn's ideas, even as he largely substantiates Kuhn's highly original concept of pre-paradigm science.

Thus one needs to read Fuller's book with caution. The reader has to have substantial experience with pre-paradigm science to accept that a book with such severe weaknesses could be worth reading.

Why should physicists care about the history of science or a reexamination of the contributions of Thomas Kuhn? Science has grown in the past (after 1760) by about 4.5% a year, as measured by the number of researchers and research articles, according to Derek De Solla Price's *Science since Babylon* (Yale U. Press, 1961). To justify similar increases in the future, scientists must understand this history, including the past societal benefits enabled by the 4.5% growth, and the benefits that ultimately ensued from research fields that went through difficult paradigm shifts or initial pre-paradigm stages first. Because of this need for understanding, all physicists should applaud individual physicists who are now full-time contributors to the history of science and can build on Kuhn's work. They should encourage individual physicists to link their historical research to questions about the future of science and the future of societal support for science.

The Physics of Foams

► Denis Weaire and Stefan Hutzler
Clarendon Press/Oxford U. Press,
New York, 1999. \$80.00 (246 pp.).
ISBN 0-19-850551-5

Foams are omnipresent. We separate mineral ores by flotation inside huge tanks of foams. We beat eggs. We drink beer and champagne. We bring pigments and other additives to cloth via foams (better than water because drying is much easier). Our cosmetics are often based on foams, not for technical reasons, but because they are more pleasing to the touch. Many fire extinguishers use foams. (If a tank of burning oil is sprayed with water, the water sinks to the bottom; when the hot front progressively goes deeper, it reaches this water layer and provokes a dramatic explosion. Foam, on the other hand, stays harmlessly on the surface.) One form of oil recovery uses foam injection, which introduces many problems of its own. In some other industrial processes, we must kill a nuisance foam, using cleverly formulated additives.

Thus foam science is very much

alive. Until recently, publications in the field were either scattered or collected in compendia with many authors. Two attempts at a real unification have appeared recently: one on the work of a Bulgarian group (*Foam and Foam Films*, by Dotchi Eksprova and Pyotr Kruglyakov; Elsevier, 1998), and one on that of an Irish group, *The Physics of Foams*, by Denis Weaire and Stefan Hutzler, discussed here.

The Physics of Foams opens with a simple presentation of key features of foam architecture, including the basic Plateau rules for the intersection of three films. The authors spend a long time on foam geometry, including some beautiful theorems (from Leonhard Euler to John von Neumann) and their own recent work in this area. This text is followed by chapters on foam fabrication and foam probing, plus an interesting part on simulation methods. Then we come to the crucial issues: coarsening, rheology, and drainage. The Irish team, to which the authors belong, has produced a beautiful set of experiments, along with a model interpretation, on forced drainage. Drainage is, at this moment, an active field of research: Some surfactant systems with rather rigid surfactant films do not follow the Irish model, and various groups are trying to understand why. The presentation continues with chapters on applications and on ordered foams—an interesting object for metallurgists.

On the whole, the book represents a major advance. It is written in a pleasant style and is accessible to a wide population of physicists. Unfortunately, the beautiful work of Karol Mysels, Kozo Shinoda, and Stan Frankel (40 years ago), on single soap films, is not described. Also, the emphasis is mostly on geometry and hydrodynamics. Physical chemistry is not very much involved, although this sector is important: Why does this surfactant foam while that other one does not? Why the difference between "soft" and "hard" surfactant films? Is foam stability controlled by the intrinsic nucleation of "buttonholes" or by such extrinsic effects as dust?

Together with the Bulgarian book (which contains a more classical view), *The Physics of Foams* is an excellent starting point. Any physicist interested in interfacial phenomena should read it. But a third book may be needed in a few years.

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