double helix rather than retelling the real story himself, and the chapter called "How to Live with a Golden Helix," which contains the following charming passage: "Finally one should perhaps ask . . . am I glad that it happened as it did? I can only answer that I enjoyed every moment of it, the downs as well as the ups. . . . But to convey my own feelings, I cannot do better than quote from a brilliant and perceptive lecture I heard years ago in Cambridge by the painter John Minton in which he said of his own artistic creations, 'The important thing is to be there when the picture is painted.' "

And this: "There was in the early fifties a small, somewhat exclusive biophysics club at Cambridge, called the Hardy Club. . . . The list of those early members now has an illustrious ring . . . but in those days we were all fairly young. . . . Jim was asked to give an evening talk to this select gathering. The speaker was customarily given dinner first at Peterhouse. The food there was always good but the speaker was also plied with sherry before dinner, wine with it, and, if he was so rash as to accept them, drinks after dinner as well. I have seen more than one speaker struggling to find his way into his topic through a haze of alcohol. Jim was no exception. In spite of it all he managed to give a fairly adequate description . . . but when he came to sum up he was quite overcome and at a loss for words. He gazed at the model, slightly bleary-eyed. All he could manage to say was 'It's so beautiful, you see, so beautiful!' But then, of course, it was."

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Nuclear Fear: A History of Images

Spencer R. Weart
Harvard U. P., Cambridge, Mass., 1988. 535 pp. $29.50 hc ISBN 0-674-62835-7

Nuclear Fear is a superb account of the images that have dominated the atomic age. Spencer Weart traces such images as mushroom clouds, mysterious rays, desolate postwar worlds and "white cities" of the future from their often obscure origins in the past. Weart examines the symbols that scientists, publicists and ordinary citizens have used to describe the brave new world nuclear fission helped create. In a landmark study, he helps us understand the power of those symbols in our own lives.

Weart is admirably suited to his task. He received a doctorate in astrophysics and worked on a solar space telescope at Caltech before turning to the study of history. He is now director of the Center for History of Physics at AIP. Bridging the humanities and sciences, his prose is as easy to read on the experiments of Ernest Rutherford as it is on the dream interpretations of Carl Jung. (See Weart's article in PHYSICS TODAY, June 1988, page 28.)

Nuclear Fear is based on prodigious research. Weart has worked on his project for the past 15 years, and his efforts show. He delves into books, films, songs and other art forms. Even Spider-Man and the mighty Hulk—the Marvel Comics creations of Stan Lee—appear in Weart's account. He analyzes *On the Beach*, the gloomy novel about the end of the world by Nevil Shute; he assesses the black humor of Stanley Kubrick's extraordinary film *Dr. Strangelove*; and he touches on many more such items of popular culture. Throughout his book, Weart is able to summarize such diverse sources in a few sentences or paragraphs and to explain persuasively how they fit into the larger pattern of our response to nuclear issues.

Weart argues that "modern thinking about nuclear energy employs imagery that can be traced back to a time long before the discovery of radioactivity." Decades before the successful experiments with nuclear fission, people speculated about the concept he calls "transmutation—the passage through destruction to rebirth." He observes how the Hiroshima bomb simply defined more clearly the hopeful and frightening images that already existed. By the early 1960s, with the development of bigger and better bombs, fears came to outweigh hopes. But then, weary from war scares and anxious to ignore the ever-present threat, people turned away from bombs and focused instead on nuclear reactors. In the 1980s the real fears of weapons surfaced again as arsenals grew larger and the likelihood of a nuclear holocaust appeared greater than ever before.

As he traces these cycles, Weart shows how images from the distant past can merge and how they can become entangled with emotions. He speculates about how they help determine events. "The effects of imagery," he writes, "were strongest where they joined with the laws of physics," for myth then had the force of hardware to back it up.

Weart has broken new ground in *Nuclear Fear*. Drawing on the findings of psychology, sociology and anthropology, as well as physics and history, he has crafted a lucid and compelling account of our conscious—and unconscious—efforts to understand our nuclear world.

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The QCD Vacuum, Hadrons and the Superdense Matter

E. V. Shuryak
World Scientific, Singapore (Teaneck, N. J.), 1988. 401 pp. $78.00 hc ISBN 9971-978-32-6; $36.00 pb ISBN 9971-978-33-4

Much progress has been made in the understanding of quantum chromodynamics during the past 15 years. The discovery of asymptotic freedom has led to the development of detailed predictions about many properties of high-energy collisions. The successful comparison of these perturbative predictions with experiment underlies the near-universal acceptance of QCD as the correct theory of strong interactions.

Understanding the low-energy, or nonperturbative, dynamics of QCD has been much more difficult. However, a variety of approaches ranging from semiclassical analysis of instanton effects to numerical simulations of lattice discretizations have provided qualitative (or semiquantitative) understanding of several fundamental nonperturbative properties. Among these are the confinement of quarks into mesons and baryons, spontaneous breaking of chiral symmetry, and the transition to a quark–gluon plasma at high temperature.

Edouard Shuryak's book attempts to convey the fruit of 15 years' study of nonperturbative QCD and to serve as a guide to both past and present work. It is neither a textbook nor a research monograph; as the preface states, it is better described as "one hundred lectures on modern strong-interaction physics." The first quarter of the book is devoted to the vacuum structure of QCD. It begins with brief expositions on topics such as the meaning of color confinement and chiral symmetry breaking, topological classification of gauge fields, and numerical simulations of statistical systems. Instantons and their effects are then covered in some detail, beginning with the semiclassical treatment of a dilute gas of instantons and ending with models of interacting-instanton "liquids."

The second quarter of the book

discusses the hadronic mass spectrum. Current numerical simulation results are sketched, but the bulk of the discussion is devoted to attempts to extract masses and coupling constants of light hadrons from QCD sum rules and the operator product expansion. The equilibrium behavior of QCD at nonzero temperature or density is the topic of the next quarter. This covers the possible stability of quark matter, high-temperature dynamics of quark–gluon plasma, and the current understanding of finite-temperature phase transitions.

The last quarter of the book is largely devoted to heavy-ion collisions. The focus here is on possible collective phenomena in high-energy collisions and on the prospects for observing such phenomena in upcoming experiments. Naturally the material in this section is much more speculative than in the preceding material. Shuryak argues rather plausibly that heavy-ion collisions may actually be able to tell us something useful about the QCD vacuum structure.

The wide scope should make this book stimulating reading for almost anyone interested in nonperturbative QCD. Unfortunately, the level of detail varies tremendously from section to section. Many topics are presented in such a sketchy fashion that readers who are not already familiar with the material will likely find it hard to appreciate the significance or reliability of the quoted calculations. Surprisingly little emphasis is placed on some important subjects, such as nonperturbative renormalization-group flows, while other areas (like sum-rule-based phenomenology) receive a disproportionately large share of attention. These flaws are partially compensated by the unusually comprehensive and well-organized bibliography. (In fact, for some people the bibliography alone may justify purchasing the book.)

This book desperately needed—and failed to receive—the attention of a good technical editor. Misprints, awkward sentences and undefined symbols abound. Numerous hand-drawn graphs have inadequate captions and are difficult to interpret.

Shuryak conveys a tremendous sense of enthusiasm and optimism about the progress in understanding QCD (so much so that at times he is insufficiently critical of some of the work he quotes). He argues convincingly that QCD has not yet been reduced to a mere "calculational" problem; rather, there remains a clear need for improved insight and better physical understanding of its dynamics. Despite the book's drawbacks, I would recommend it as a good starting place for anyone interested in learning about nonperturbative QCD.

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From Clocks to Chaos: The Rhythms of Life

Leon Glass and
Michael C. Mackey
Princeton U. P., Princeton, N. J., 1988. 248 pp.
$45.00 hc ISBN 0-691-08495-5;
$13.95 pb ISBN 0-691-08496-3

During the past 15 years or so, the theory of dynamical systems in general, and of their chaotic behavior in particular, has become one of the areas at the forefront of research in mathematical physics. In theoretical research, in experiments or in both, chaotic behavior has been discovered to occur in a number of phenomena where it was more or less expected: in fluid dynamics—including the dripping of a faucet—in chemical reactions, in the propagation of laser light and in celestial dynamics. In some other areas, such as the stock market and the subject matter of this book, physiology, the applications are perhaps less obvious.

The authors are a theoretical physicist turned physiologist (Glass) and a physiologist (Mackey), both of whom have made substantial contributions to the application of the theory of dynamical systems to the analysis of physiological phenomena. Thus, as one would expect, their book is an authoritative reference. Among the mathematical concepts they explain and apply to physiological phenomena are limit cycles, attractors, various types of bifurcations (with emphasis on sub- and supercritical Hopf bifurcations and the period-doubling cascade), chaotic behavior, Hausdorff dimension, the Liaponov exponent, feedback (positive and negative), phase locking and wave propagation. The phenomena analyzed include fibrillation, mitosis, leukemia survival, migraine headaches, jet lag, neural networks, respiratory and sleep arrhythmia, orgasm and considerably more topics.

Each chapter concludes with a summary and a valuable set of notes and references allowing the reader to use the text materials as a departure for further study. There are also an extensive 30-page bibliography and a mathematical appendix, which gives some details of dynamical systems theory to help the reader in understanding the text.

However, the book is not entirely satisfactory. If it is addressed to physiologists the physical and mathematical content is too skimpy, while if it is addressed to physicists the material on physiology is presented much too schematically. As an example of the former deficiency, the authors describe a linear stability analysis of a system of differential equations without explaining the Taylor-series origin of the matrix of derivatives. Another example is the several discussions of Hopf bifurcation at different locations in the book, which make use of phase diagrams, differential equations and finite-difference equations, respectively. The authors make no attempt to explain the connections or the differences among the various concepts; for example, they write that a steady state is stable if all eigenvalues lie within the unit circle, without explaining why. In chapter 2 the period-doubling bifurcations are discussed with detailed explanations and diagrams; nonetheless I do not believe that an individual being introduced to the subject could gain any sort of working knowledge of it from this presentation. There are other examples, but these should suffice. Also, as a person not trained or knowledgeable in physiology, I was hard pressed to figure out the basic ideas from the abbreviated descriptions presented.

My conclusion is that this book would not be a useful text, but that it contains a wealth of information that would be very useful as a starting point for physicists or mathematicians interested in applying dynamical systems ideas to physiology problems. It would be less useful to physiologists, who might be better advised to begin with a more elementary, but more detailed, description of the mathematical ideas involved.

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Matched Asymptotic Expansions: Ideas and Techniques

P. A. Lagerstrom
Springer-Verlag, New York, 1988. 250 pp.
$39.95 hc ISBN 0-387-96811-3

I am critical of courses that claim to teach mathematical methods of physics but emphasize only problems that have closed-form analytical solutions. One often begins research in physics by formulating a model and then making simplifying assumptions to