believer from which he cannot very easily be aroused. So let him lie there.

But this religion has so damned little effect on me. . . . I cannot make head or tail of it mathematically. My brain is also too worn out by this time.

Schrödinger wrote to Einstein in 1950:

It seems to me that the concept of probability is terribly mishandled these days. . . . the quantum mechanics people sometimes act as if probabilistic statements were to be applied *just* to events whose reality is vague. . . . [The] proper basis of reality is set aside as trivial by the positivists. . . . The present quantum mechanics supplies no equivalent. It is not conscious of the problem at all; it passes by with blithe disinterest.

Einstein answered:

You are the only contemporary physicist, besides Laue, who sees that one cannot get around the assumption of reality—if only one is honest. Most of them simply do not see what sort of risky game they are playing with reality—reality as something independent of what is experimentally established. . . . Only one of the tools of our trade remains—the field concept, but God knows whether this will stand firm. I think it is worthwhile to hold on to this, i.e. the continuum, as long as one has no really sound arguments against it.

This volume of letters is a crucial fragment of a critical chapter in the history of quantum mechanics, and incidentally provides substantial insight into the personal feelings and reactions of four great minds in action.

ERWIN N. HIEBERT
Department of the History of Science, University of Wisconsin, Madison

A Closet Door Briefly Opened

The Nature of Time. Report of a meeting, Ithaca, N.Y., June 1963. T. GOLD and D. L. SCHUMACHER, Eds. Cornell University Press, Ithaca, 1967. xvi + 248 pp., illus. $8.75.

Physics is far from being a closed subject, so it is not very daring to suppose that some cherished physical concepts might be poorly understood, or even incorrect. Some such questions are popular subjects for research. Other questions people have tended to ignore, as skeletons in the closet, on the sound principle that it probably would be a waste of time to keep sorting through the skeletons until someone can come up with some more concrete starting points.

The present book contains some skeleton rattling by a group of scientists and philosophers who met to consider the merits or otherwise of time as we now think we understand it. The result is a lively discourse on some amusing and perhaps even serious questions.

One of the more prominent examples discussed in the book is the distinction between the roles of time in physics on the macroscopic level (thermodynamics) and on the microscopic level. With a minor exception, the microscopic laws of physics appear to be symmetric against time reversal, in the sense that one can derive from one physical situation another perfectly good one by reversing the direction in which time is supposed to flow. This is not true in thermodynamics, where a preferred direction of flow of time is defined by the second law, the statement that entropy increases with increasing time. The conventional resolution of this dilemma is to identify entropy as a measure of probability, so that the second law says only that systems evolve from states of lower probability to states of higher probability. This recourse to initial conditions works well enough in a closed system. It does leave open the amusing idea that there might be, somewhere else in the universe, a system set to evolve in the opposite sense in time.

In fact, it appears that the local laws of physics are not strictly invariant against time reversal, for people have observed elementary particle decays (of the K^0 meson) that should not have happened under complete symmetry. Unfortunately, this asymmetry was only discovered in 1964, a year after the conference, so we do not have a discussion of whether this small defect would be of moment to people set to live out their lives in the opposite sense of time.

There is yet the older problem of radiation. It is a common enough experience that, when a charge is accelerated, an electromagnetic wave propagates away from the charge, but no one has reported the time-reversed chain of events. Wheeler and Feynman gave in 1945 a beautiful scheme for preserving the symmetry of the local laws of physics, again assigning the time asymmetry to the initial conditions. However, the scheme works only inside a box with perfectly absorbing walls. Apparently if you are determined to preserve local time symmetry you have to make some strong statements about the global nature of the universe.

It is still not clear just how serious these problems are, or where they would lead us. It is, however, pleasant to have this new collected discussion of these and other aspects of time.

P. J. E. PEEBLES
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey

Tribute to Bethe

Perspectives in Modern Physics. Essays in honor of Hans A. Bethe on the occasion of his 60th birthday, July 1966. R. E. MARSHAK, Ed. Interscience (Wiley), New York, 1966. xii + 673 pp., illus. $19.50.

The physicist I. I. Rabi is fond of recalling the good old days when there were not experimental physicists or theoretical physicists but just plain old physicists. Nowadays there are many subdivisions among theorists and experimentalists, whose individual specialties have developed so much that these groups have trouble communicating, to say nothing of being able to work in several areas. In this reviewer's experience, there are few physicists under the age of 40 who can discuss in any depth even one of the branches of physics outside their own specialty. No one is to blame for this—it is simply what happens when a large number of aggressive, ambitious, and intelligent people make the type of assault on a field that took place in physics after World War II.

One can only envy a man like Hans Bethe, who at one time not only knew essentially all of physics but worked actively in most of the important areas. Bethe himself has slowed down now—today he is an expert only in atomic physics, nuclear physics, and high energy physics. He feels that quantum field theory and elementary particle physics are for young people.

This volume, composed of articles from Bethe's students and friends, is almost overpowering, revealing as it does the truly monumental contributions to physics he has made. There are over 40 papers by prominent physicists of all varieties—even experimentalists—covering nuclear physics, solid state physics, particle accelerators, quantum electrodynamics, particle physics, astrophysics, quantum field theory, the theory of nuclear reactors, cosmic ray physics, thermonuclear weapons, and geophysics. Bethe's well-known important contributions to all these topics are reflected in the papers cited in the various articles. Looking through the bibliography of Bethe's own publications one gets the impression of a gigantic but very delicate and perceptive tree-dozer moving through a forest of natural phenomena selecting the most interesting obstacles in its path and leveling them to the ground. Young physicists would be well advised not to look for choice problems overlooked by Bethe.

It is surely unfair, but perhaps useful, to single out a few of the papers in this volume. At the risk of offending some of my friends, I shall do so. In the opening paper, R. F. Bacher and V. F. Weisskopf review Bethe's career in a charming way, with many footnotes recounting personal anecdotes. Gregory Breit, another scientific contemporary, gives a thoughtful review of the nucleon-nucleon interaction, a subject close to Bethe's heart. Robert R. Wilson, now director of the National Accelerator Laboratory, recalls the development of accelerators at Cornell, revealing Bethe's not very widely known contributions to accelerator theory. Quantum electrodynamics is reviewed in two papers, the experimental aspects of atomic level shifts by Willis Lamb and the limits of current theory by Francis Low. Various aspects of astrophysics are discussed by William Fowler, R. E. Marshak, George Gamow, Edward Teller, E. E. Salpeter, and others. These contributions are particularly appropriate in view of Bethe's 1967 Nobel Prize award for his 1938 paper on the carbon cycle. There are several very interesting papers on solid state physics, one of Bethe's early interests.

A particularly fascinating paper, dramatically different from all the others, is that by Freeman J. Dyson. Dyson addresses the question of what might be accomplished by a truly advanced extraterrestrial technological society and what might be observed by us of projects carried out by that society. This is the one paper in the volume that Bethe probably could not have written himself.

Robert Marshak is to be commended for putting together this testimonial to the one whom Bacher and Weisskopf describe as "the great craftsman of our profession."

M. L. GOLDBERGER
Institute for Advanced Study, Princeton, New Jersey

Physics Taught Deductively

General Physics. Mechanics and Molecular Physics. L. D. LANDAU, A. I. AKHIEZER, and E. M. LIFSHITZ. Translated from the Russian edition (Moscow, 1965) by J. B. Sykes, A. D. Petford, and C. L. Petford. Pergamon, New York, 1967. x + 372 pp., illus. $8.

This is a book on a very elementary college level, and is not to be confused with the fabulous nine-volume Landau and Lifshitz *Course of Theoretical Physics*. The first hundred pages cover just enough classical mechanics to lay down the general principles and concepts used in the remainder of the book, which is devoted to elementary kinetic theory, thermodynamics, surface phenomena in liquids, viscosity, the theory of symmetry in crystals, and the kinetics of chemical reactions. In short, this is more of a physical chemistry text than the traditional physics course one might expect from the title *General Physics*.

The history of the book is rather unusual, since it was first written in 1937 but was not published until a few years ago. Rewritten and brought up to date by Akhiezer and Lifshitz, it retains some of the old-fashioned style and point of view of the '30's.

The presentation of the material is formal, cool, and graceful. The translators have maintained a high standard of English style not always found in technical books, and the translation is uniformly accurate. A considerable amount of authoritarianism is to be detected in the pedagogical approach of the book. Definitions are laid down, assumptions are made, Laws of Nature are invoked, and results are deduced. But nowhere is the student given a reason for believing in conservation of energy, except for the word of the authors that this is an important law of nature.

In at least one place, this deductive approach leads the authors into a type of logic that appears backward, to my way of thinking. Starting with the assumption that space is homogeneous (that is, that the properties of a closed system do not depend on its position in space), they show that the law of conservation of momentum follows. True enough *if* space is indeed homogeneous. But a psychologically more valid approach is to say that experimentally we observe momentum to be conserved and that this leads us to believe that space is homogeneous. In a similar vein, Le Chatelier's principle is invoked several times to predict the direction of a change of state, no motivation being given beyond a statement that it is a law of nature. This reliance on abstract principle is fine in an advanced course, but in an elementary course I would expect to spend more time building up from the concrete evidence to the abstract concepts.

However, the aim of the authors, as described in the preface, was simply to present the material in the most compact way, and in this they have succeeded very well. The chapter on symmetries in crystals is a small masterpiece, and the qualitative material on phase transitions is handled beautifully.

There is an index, but no problems, so this book may not be useful as a classroom text; but it can be highly recommended for supplementary reading or review purposes.

MILTON A. ROTHMAN
Plasma Physics Laboratory, Princeton University, Princeton, New Jersey

The Special Theory

Précis of Special Relativity. O COSTA DE BEAUREGARD. Translated from the French edition by Banesh Hoffmann. Academic Press, New York, 1966. xvi + 123 pp., illus. $5.75.

The Logic of Special Relativity. S. J. PROKHOVNIK. Cambridge University Press, New York, 1967. xiv + 128 pp., illus. $5.95.

Special Relativity. A. SHADOWITZ. Saunders, Philadelphia, 1968. xiv + 203 pp., illus. $6.50. Studies in Physics and Chemistry, No. 6.

Each of these three books on special relativity has been designed with a different purpose in view. Together they complement one another ideally.

The first book under review, Olivier Costa de Beauregard's *Précis of Special Relativity*, is a translation of the author's *Précis de Relativité Restreinte*, published in 1963, which in turn is an extract from his treatise *La Théorie de la Relativité Restreinte*, originally published in 1949 in Paris. John A. Wheeler, in a preface to the English edition, points out its value: "I know of no book that is at the same time more precise, more accurate, and more succinct in presenting so complete a treatment of Special Relativity." As a rule, subsequent editions of basic treatises provide their authors with opportunities