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.

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## 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.

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## 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 impor-