rule. It demonstrated that the often-recommended additive rule is valid only under certain limiting conditions (such as molecular-weight ratio >1.25 for normal polar liquids).

With regard to the general usefulness of this book, I felt that the lack of a subject index, list of tables, and list of figures is a definite shortcoming. Such aids would have greatly simplified the readers' task of finding the specific paragraph or chart appropriate for a definite need.

One other shortcoming, which should be noted, is that the author does not include liquid metals in his discussions. This class of fluids has become increasingly more important, especially in the nuclear and space fields. A number of measurements of thermal conductivities of liquid metals have been reported and should have been included in such a monograph. Moreover, a discussion of the theory of thermal conduction in a liquid metal, with the attendant electron-transfer mechanism, would have been a worthwhile addition to this book.

Aside from these two criticisms, I found this to be a worthwhile book. The translation is excellent. The text and captions are free from ambiguous or unfamiliar phrasing, which often are present in translated technical articles. In general, this monograph can be recommended for any research scientist or design engineer interested in the field of thermal conduction in liquids and gases.

J. C. Chen is an Associate Chemical Engineer in the Nuclear Engineering Department of Brookhaven National Laboratory. Currently, he is the acting group leader for heat-transfer research at BNL. His research interests have been in the area of combined radiation-conduction heat transfer, boiling liquid-metal heat transfer, and multiple scattering of electromagnetic radiation. He obtained his BChE from the Cooper Union, MS from the Carnegie Institute of Technology, and PhD from the University of Michigan.

FUN TO READ

Title The Ambidextrous Universe

Author Martin Gardner

Publisher Basic Books, 1964

Pages x + 294

Price $5.95

Reviewer Jeremy Bernstein

Martin Gardner, well known to readers of the **Scientific American** as the editor of the Mathematical Games department, is a scientific "amateur" in the oldest and best sense of the word—"amateur" in the sense of one who loves. His latest book, which is concerned with "handedness", the role of the left- and right-handed characteristics of mathematical, physical, and biological phenomena, brims over with that sense of pleasure that the love of science can induce and that is often lacking in technical books by scientists, themselves. Gardner has set himself the task of explaining to the non-physicist the background and meaning of the discovery of parity violation in the weak interactions. It is an extremely difficult thing to do. Just imagine trying. One quickly finds oneself thrown farther and farther back, to some place where one can make contact between the experience of the physicist and the experience of the typical layman. It is something like the story of the man who tried to explain the color white to someone who was blind from birth: "White is like the color of milk." "What is milk?" "Milk is something you drink from a glass." "A glass?" "Here is a glass." "Ah! now I know what white is."

Gardner begins his story with simple descriptions of experiments with a mirror—a mirror that reflects left into right. He proceeds to describe the difference between objects that are mirror symmetric (can be superimposed on their mirror images) and objects that are not. He shows by means of some fascinating examples what role this sense of symmetry plays in the visual arts and what role the lack of symmetry plays in biological systems whose molecules are arranged in helical arrays with a definite screw sense. He discusses right and left handedness in people and then proceeds to the central theme of the book—what he calls the Ozma problem: how to tell extra-terrestrials which hand we specify as our right hand and which our left, and how to make sure that *our* definition agrees, in an absolute sense, with *theirs*.

To a physicist, the solution of this problem has been known since the fall of parity, in 1957. So in a sense, a physicist reading the book is in something of the position of the reader of a mystery story who knows the solution but is interested in reading the story anyway, because the characters and the background are so fascinating. Indeed, most physicists will probably be made somewhat uneasy by those parts of the book in which the physical principles are described and simplified. It is essentially hopeless to give a rigorous understanding to the layman of, say, the intrinsic parity of a pi meson and to see how this is related to left and right handedness and how it can be determined by experiment. On these points Gardner is honest but, necessarily, vague. Eventually, one is forced to say that parity cannot be made fully clear without quantum mechanics. (In fact it is hard to imagine what role parity conservation plays in classical physics and to formulate its experimental consequences for, say, mechanics.) The physicist can fill in the gaps and imprecisions in the book for himself and will get a great deal of pleasure from the remarkably diverse examples of mirror symmetry and its lack in fields outside his specialty.

The last sections of the book deal in some speculations related to replacing parity conjugation by charge-parity symmetry (CP invariance) as the basic discrete symmetry of the world. Gardner may be feeling, alongside most professional physicists, something of the sense of dismay produced by the discovery (in the Summer of 1964) that even this invariance is no good. His book was written, or at least finished, in June of 1964, and by August the Princeton Group, headed by J. Cronin and V.

Fitch and working at Brookhaven, established CP violation (using the same miserable K mesons that provoked the theta-tau puzzle out of which parity violation emerged).

The last of the discrete symmetries associated with the Lorentz Group has now fallen, and one of the most active interests of particle physicists, these days, is putting the pieces together again. Our intellectual attitudes have evolved a great deal since Lee and Yang challenged parity conservation in 1956-57. At that time, the notion of an approximate symmetry seemed somehow tainted and obscure, and everyone turned, with relief, to CP invariance as the "real" definition of parity.

We are now quite conditioned to the idea of a hierarchy of symmetries, each playing a role on a certain time scale, and each breaking down when the time scale becomes longer or, equivalently, when the interaction becomes weaker. Are any symmetries exactly preserved for arbitrarily long-time scales? Will interactions show up that violate the conservation of even the continuous symmetries of the Lorentz Group, such as momentum and angular momentum? I certainly do not know the answers to these questions. Perhaps we shall find out enough about them so that Gardner can treat them in the next edition of his book. I am sure that he will do so with the same intellectual vitality, enthusiasm, and good humor that characterize the present version of the *Ambidextrous Universe*. His book is a great deal of fun to read, and that is saying a lot.

Jeremy Bernstein is an Associate Professor of physics at New York University and a member of the staff of the **New Yorker** *magazine. His work in physics has been largely in the weak interactions, most recently in connection with charge-parity violation. His contributions to the* **New Yorker** *have been mainly in scientific popularization. He is the author of two books—*The Analytical Engine, *about the evolution of the computer, and* Ascent, *about the evolution of the sport of mountain climbing. Both books are based on material that first appeared in the* **New Yorker**. *He graduated from Harvard in 1951 and received his PhD from the same university in 1955.*

HOW NATURE WORKS

Title Radiation Damage in Crystals

Author Lewis T. Chadderton

Publisher Methuen, London; John Wiley & Sons, Inc., N.Y., 1965

Pages xiv + 202

Price $6.75

Reviewer Paul W. Levy

For 15 or 20 years, numerous Methuen's monographs on physical subjects have been carried in this reviewer's pocket and read whenever there was an opportunity. Almost without exception they have fulfilled a need for information on a subject related to research in progress or for an introduction to a new area of interest. In other words, they provided a survey of a particular subject. Formerly, they were approximately 11 x 17 x 1 cm: a size that made them particularly convenient to carry in almost any pocket. Now, they are much larger (the book discussed here is approximately 15 x 22.5 x 2 cm), and the carrying convenience of these new issues has almost entirely disappeared. Of course, they now contain more information.

Presumably, in the Methuen monograph tradition, Chadderton's *Radiation Damage in Crystals* was designed to provide an introductory survey of the radiation-damage field. To many, radiation damage is simply determining how radiation affects the properties of a particular material; e.g., does reactor irradiation alter the creep properties, the corrosion resistance, etc., of a particular steel? To others including this reviewer, radiation damage relates to the basic physics and chemistry that describe the interaction of radiation with matter. These viewpoints are related. All engineering is the application of basic physical principles. Even if one is concerned only with practical matters, an understanding of the basic science must be helpful and intellectually stimulating.

A surprisingly large number of books on radiation damage have been published. Also surprising is that they all very nearly follow the same format: one or more chapters on principles, followed by from 3 to 20 chapters on experimental results or engineering data. Furthermore, the two main sections of these books are often very poorly correlated. Appended to sections on physical phenomena are a few sentences stating that examples are contained in a specified chapter. Then, one often finds that the indicated section does not refer to the previous discussion. Fortunately, this book is not divided in this way.

In Chadderton's book the emphasis is entirely on physical phenomenology, and it is arranged in a completely laudable manner. First discussed are the various defects that are usually found in inorganic and metallic crystals. Next considered, in logical progression, are the various processes whereby defects are produced by radiation. This begins with the collision of an energetic particle and a lattice atom—the recoil atom. It is continued in what may be described as the history of the interaction of this recoil with the atoms (and electrons) in the crystal lattice: how it and the secondary recoils lose energy and how they or the recoil chains are channeled by the periodic lattice structure. Finally, this history is terminated by a description of where the defects produced are ultimately located in the crystal. This entire process is summarized graphically in an easily read chapter called "Computer Simulation of the Radiation Damage Process". In a sense, radiation damage results from innumerable collisions between the atoms of the bombarded crystals. Thus, the crucial point is the interaction between colliding atoms. An entire chapter is devoted to this interaction. It should be particularly appealing to anyone who possesses even a slight interest in un-