Book Reviews

Physics and Philosophy. The revolution in modern science. Werner Heisenberg. Introduction by F. S. C. Northrop. Vol. 19 of *World Perspectives,* Ruth Nanda Anshen, Ed. Harper, New York, 1958. xv + 206 pp. $4.

This is in many ways a fascinating and stimulating work. In the main, Heisenberg's remarks comprise a presentation of his view of the historical roots of atomic science, of the current status of quantum theory and the extent to which it constitutes a radical break with antecedent physical theories, and of the "consequences" of quantum theory on society as well as on science. The book is so organized that each of its 11 chapters, while emphasizing one or the other of these topics, nevertheless manages to provide material relevant to all three. The contents were originally given as the Gifford lectures at the University of St. Andrews and are wholly nontechnical—at least nonmathematically-technical—in character. Of particular interest to physicists is likely to be Heisenberg's treatment of quantum "revisionists," and also his view of the future prospects of physical theory. In the chapter on "Criticism and counterproposals to the Copenhagen interpretation," he briefly considers, among others, such views as those of Bohm, Fenyes, Weizel, Einstein, Schrodinger, and the Soviet scientists Blochinzen and Alexandrov; on varying grounds he finds all of these relatively inadequate.

With respect to the future prospects of physical theory, Heisenberg first gives a nontechnical account of what he takes to be the incompatibility of quantum theory with the theory of special relativity. The pressing desideratum for theoretical physics is a viable unifying theory. The kind of candidate theories which seem most to intrigue him on this score are those which involve "the phenomenon of time reversal" (pages 162–65). He believes that "there must exist a third universal constant in nature. This is obvious for purely dimensional reasons. . . . One needs at least three fundamental units for a complete set. . . . A unit of length, one of time, and one of mass is sufficient to form a complete set. . . . One could also replace them . . . by units of length, velocity and energy. . . . Now, the velocity of light and Planck's constant of action provide only two of these units. There must be a third one, and only a theory which contains this third unit can possibly determine the masses and other properties of the elementary particles. Judging from our present knowledge of these particles the most appropriate way of introducing the third universal constant would be by the assumption of a universal length the value of which should be roughly 10^{-13} cm, that is, somewhat smaller than the radii of the light atomic nuclei" (pages 164–65). Just as certain anomalies (vis-à-vis the "common-sense" view of the world) have been associated with the introduction of the two accepted constants, so too Heisenberg seems to expect similar apparent anomalies to be associated with the *length-constant.* In particular, "we should be prepared for phenomena of a qualitatively new character when we in our experiments approach regions in space and time smaller than the nuclear radii. The phenomenon of time reversal, which has been discussed and which so far has only resulted from theoretical considerations as a mathematical possibility, might therefore belong to these smallest regions" (page 165). The sense of "time reversal" involved is the following: the theory would predict such phenomena as the creation of particles at some point in space but would also predict that the energy of *this* phenomenon would *later* be "provided for by some other collision process between elementary particles at some other point" (page 163).

On the whole, when Heisenberg is describing actual developments in modern physics, or even when he is engaged in what we might call speculative *physics* (as illustrated in the preceding paragraph), his account is rewarding—at least to a nonphysicist it seems lucid and perspicuous. In somewhat painful contrast, however, is his speculative metaphysics. In the first place his historical review of the philosophical antecedents of present-day physical theory, though compromising roughly one-fifth of the work, is routine, quite superficial (especially his treatment of Hume—one sentence, page 84), and contains some astonishing solecisms: he attributes to Berkeley the exact converse of Berkeley's view (page 84), he makes no mention whatever of Leibnitz, and he apparently credits Weizsäcker with the meta-language–object-language distinction and the notion of multivalued logics (pages 182 ff.).

More grave, however, than the deficiencies of his historical account is the dubiousness of his interpretations of the metaphysical "implications" of quantum. These considerations indeed constitute the bulk of the work, but I shall deal only very briefly with two of the many questions that they raise.

Heisenberg believes that the indispensable occurrence of the concept "probability" in the Copenhagen interpretation (to which he subscribes) of quantum theory entails, in at least one respect, something very much like an Aristotelian metaphysic. The fact that the concept is, unlike statistical concepts in other physical theories, not even theoretically eliminable in quantum signifies for him that it is "a quantitative version of the old concept of 'potentia' in Aristotelian philosophy" (page 41). The ineliminable use of the concept, he feels, has "introduced" an entirely new (for physics) dimension of reality—"something standing between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and reality" (page 41). But this is a gratuitous conclusion, the acceptance of which is certainly rendered implausible by many of the things which Heisenberg himself has to say in the very next chapter (Chapter III). Indeed, since the concepts "reality," "possibility," "subjectivity," "*midwayness* between possibility and reality," and so forth do not occur in quantum theory at all, it is clear that any conclusions which are drawn involving them are deducible not from that *theory* but only from some metaphysical presupposition about that theory or about "reality."

For the independent establishment of such presuppositions, *Physics and Philosophy* adduces no scintilla of evidence. The book does not establish that quantum has any metaphysical implications at all. What it does show is that familiarity with quantum can *cause* even brilliant men to articulate and espouse metaphysics. In fact it is just the confusion between the logical and the causal consequences of quantum which pervades and vitiates a good deal of what Heisenberg has to say about the social, linguistic, religious, and scientific "consequences" of the theory.

These ungracious remarks, however, will have failed in their intention should anyone be influenced by them not to read the book. I think that it is a book

which every scientist, every person interested in the history of ideas, will find profitable and enjoyable. It is exciting, even—indeed especially—in those passages which do not entirely persuade.

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Bone and Radiostrontium. Arne Engstrom, Rolf Björnerstedt, Carl-Johan Clemedson, and Arne Nelsen. Wiley, New York; Almquist and Wiksell, Stockholm, Sweden, 1957. 139 pp. Illus. $8.75.

For lack of a consistent editorial viewpoint this book is a puzzling mixture of general introductory material and highly specialized reports of research. It is aimed at no particular group or level. For all of that, the "shotgun approach" is not entirely without merit. Pieces and sections of the book will be interesting to almost anyone. For example, the casual scientific reader will find the introductory chapter a fine, annotated bibliography of the Sr^{90} fallout literature. The rest of the book he can and will ignore; it's much too specialized. The bone specialist will find the introduction boring, but later he will encounter a good summary of the important work on microstructure of bone for which the Karolinska group has earned an enviable reputation. To the radiation biologist, the discussions of bone microstructure are a bit "thick," but the calculations of radiation dosage will be new and exciting.

I came upon two minor annoyances. In the specialized sections, the referencing is chauvinistic. There are only rare references to work done outside the Karolinska "family," and this is a field which has been built by many men of many nations. The other annoyance is with the final summary. Here, the authors wrestle weakly with the problem of Maximal Permissible Concentrations. It would have been better either to give the problem "full treatment" or not to mention it at all.

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The Mushroom Hunter's Field Guide. Alexander H. Smith. University of Michigan Press, Ann Arbor, 1958. ii + 197 pp. $4.95.

A simple yet authoritative field manual for the identification of mushrooms has long been needed in this country, since most of the books available to the amateur mushroom collector are either obsolete in their nomenclature or limited in their geographical coverage. The preparation of a manual for the nonspecialist has been made difficult by recent progress in the taxonomy of higher fungi, because much of this progress has resulted from the use of microscopic characters for the identification of species, so that identification of some mushrooms in the field has become impossible even for the specialist. Fortunately, some of the species that are of particular importance to those interested in mushrooms as food can be recognized in the field on a basis of macroscopic characteristics and habitat.

Alexander H. Smith, curator of fungi in the Herbarium of the University of Michigan, has selected some 124 species of fungi that can be recognized in the field for inclusion in *The Mushroom Hunter's Field Guide.* In addition to mushrooms (Agaricales), the book includes other Basidiomycetes such as coral fungi, shelf fungi, chanterelles, and puffballs and edible Ascomycetes such as the morels and their relatives. For each species listed, there is at least one photograph, together with paragraphs on (i) when and where to find the species, (ii) the important characteristics for field identification, and (iii) a discussion of its edibility. Poisonous species are clearly indicated, but Smith advises caution in eating others, because some individuals are sensitive to mushrooms that most people find innocuous.

In addition to the main part of the book, there is an introduction, written in nontechnical language, which tells a little about the place of mushrooms in the scheme of things, the structure of mushrooms, and the variability of their characteristics. It also contains some general remarks about eating mushrooms and mushroom poisoning. There are also useful lists of the names of species found in the western United States, of edible mushrooms safe for beginners, of mushrooms associated with certain trees, and of the habitats of selected mushrooms according to season.

The book has two unusual external features. The first is its shape. It is shaped to fit the pocket—that is, if one happens to have pockets of 5¼ by 10¾ inches. A second and laudable feature in a book designed for field use is the water-repellent cover.

The two most important requisites for a useful field manual are workable keys and adequate illustrations. One disadvantage to artificial keys of the type found in this book is the fact that the user does not know whether he is "getting warm" or not, so that if he makes a mistake, he is lost. He is also lost if the key is misleading. For example, if *Helvella gigas* were found in the Sierra Nevada, it could not be identified by means of the key, because the choice leading to this species requires that it must occur in the Rocky Mountains.

Any deficiencies in the keys are more than compensated for by the illustrations, which are truly excellent—large, clear, and well-reproduced. Smith is an outstanding photographer, and many of his illustrations have esthetic qualities as well as scientific utility.

The Mushroom Hunter's Field Guide should have a wide appeal and help to fill the need for a book of its kind. Although it is written for the beginner, it should be useful to the more advanced collector because of its authoritativeness and the extent of its geographical range. Finally, it should be helpful as a reference work for physicians, but it is to be hoped that this attractive and scientifically accurate book will help to forestall unnecessary illness and needless deaths from mushroom poisoning.

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Young People's Book of Science. Glenn O. Blough, Ed. McGraw-Hill, New York, 1958. 446 pp. Illus. $4.50.

Space Book for Young People. Homer E. Newell, Jr. McGraw-Hill, New York, 1958. 114 pp. Illus. $2.95.

Frontiers of Science. Lynn Poole. McGraw-Hill, New York, 1958. 173 pp. Illus. $3.25.

These three books are intended primarily for children from grades four through nine. However, the general public would benefit from their use. This is especially true of *Frontiers of Science* by Lynn Poole.

Young People's Book of Science is a collection of selections from the writings of the Bendicks, Crouse, Grant, Hyde, Kimble, Poole, Richardson, Schnieder, Schwartz, Skilling, Stillman, Sullivan, Swezey, and Tannenbaum, ranging in nature from those of historical significance to others concerned with modern science.

Many methods of gathering evidence are discussed, from using your eyes, without optical instruments, up to and including use of the electron microscope. Also included are studies of weather, atomic energy, space travel, the ocean, and electricity, including television. Although all the topics are presented in a factual, yet stimulating, manner, the portion devoted to the ocean is most fascinating. This includes descriptions of the geology of the ocean floor as well as of marine biology. As you read this section, you can actually visualize a dive using a scuba or snorkel.

Space Book for Young People includes a very readable presentation of elemen-