Book Reviews

Space, Time, and Creation. Philosophical aspects of scientific cosmology. Milton K. Munitz. Free Press, Glencoe, Illinois, and Falcon's Wing Press, 1957. x + 182 pp. $3.75.

For anyone interested in modern operational thinking, the reading of Munitz' crystal-clear exposition of the aims and possibilities of our scientific methods is a real pleasure. The book offers precisely what one would expect from a philosopher—a discussion of wider perspectives than those an observational astronomer can afford to spend much time on. It reminds one of Reichenbach's *The Rise of Scientific Philosophy* in its disavowal of absolute thinking in favor of true—that is, relational—thinking. The keynote of the present book is stated immediately: "The task of logic or critical philosophy is not to understand the universe, but to understand in what such understanding consists." This theme is preserved throughout the book and gives it great unity. It is reminiscent of Reichenbach's contention that, while we cannot hope to find absolute truth, we can perhaps expect to understand why it is that we wish to know it.

The language and style of Munitz' volume is exceedingly precise, without any touch of the pedantry one usually fears to find in opening a philosophical essay. Although the author gives us remarkably clear bird's-eye views of the four or five principal cosmological models, he has us consider, not so much questions like "Is the universe finite?" or "Is there creation of matter?" but, rather, what is the legitimate meaning of these questions—what, for instance, do we really mean by the term *universe*? And what precise meaning can we attach to the term *creation of matter*?

The first four chapters outline some of the cosmogonies, from the Marduk myth to Hoyle's version of the steady-state universe. The discussion illustrates and critically examines the nature of scientific statements in general. We are gradually led to realize that any theory worthy of the name contains rules for making inferences whereby one can prescribe the general type of process by which predictions can be made from known facts to indicate probabilities of finding further facts. Whatever unifying scheme or symbolic representations may be adopted as tools, the most essential fact of any theory is always a rule of induction to predict further facts from a limited body of known facts. The value of a theory is measured by its degree of comprehensiveness, its predictive power, and its economy of conceptual means—what Einstein called its simplicity. It is particularly to be noted that one cannot talk about a part of a theory being true, the rest false. The truth of a theory is measured by the agreement of its predictions with observed facts. If this argument fails, the truth of the whole theory, not merely of a last inference from it, is questioned.

With this background we are then asked to consider the meaning of the term *universe*. In cosmology a universe is nothing but "an expression for the system of connections, facts, and usages which refined and tested thought has come to accept in one domain of experience. It means nothing apart from this funded background." To illustrate: there is the Universe of the cosmologist, the Universe of Life for the biologist, the Universe of Mind for the psychologist, the Universe of Spirit for the theologian, and the Universe of Matter for the physicist. None of these "universes" is an "object" in any other sense than that of a connected body of facts and deductions. We must give up the naive viewpoint that there is an entity called "the Universe-as-it-exists-in-itself," which would exist out of mind, independently of whether we observe its facts or not. There are only the physical and relational facts or observations and the rule of inference for obtaining more facts, partly physical, partly mental. A cognitively inaccessible *Ding-an-sich,* the layman's matter-of-fact view of the world, is a metaphysical monstrosity, wholly divorced from any meaning amenable to scientific discourse and inquiry. As de Sitter has remarked in one of his lectures, "the universe is a theory just as much as the atom." The same is the case with "the gene," or "the atom of life," or "the nature of God," or "the macroscopic atom of concretion."

While there are many spectacular popular expositions of today's specific cosmological models, only those written by philosophers begin to show to what degree the modern world pictures are mental fictions. The last six chapters of the present book constitute such an account. Rather than dwell upon dimensions and figures, the author lays bare the logic of the constructions in sufficient detail to pursue a critical examination and a well-grounded criticism of the whole scheme. It is shown that in some cases theory goes so deep as to prescribe what shall be the type of fact considered as a physical law of nature. Under the heading "Rationalism," the conventional expanding-universe theories are all shown to contain, first, observational premises; second, a physical theory verified in our immediate spatial neighborhood; and third, a rule of extrapolation to greater distances and perhaps wider classes of observational data. No presumption is made that such a theory is certain, complete, or unique. E. A. Milne's view, however, is diametrically opposite. He cares nothing for the "irrational" laws of microscopic, or even gravitational, physics. It is better, he maintains, to establish a cosmological scheme right out of our heads on a wholly deductive basis as a self-sufficient discipline and then see how much of the known physics can be fitted into the scheme. But even if nothing fits of the small-sale ordinary physics, one should not tamper with "the great intuitional simplicities" which are the basis for his world view. According to Munitz this is not scientific at all. The fallacy lies in thinking that there are available rival "deductive" and "inductive" methods in science. One cannot help recalling the same criticism voiced forcefully by F. J. M. Stratton (in 1953, in *The Observatory*), who considers Milne's methods "pre-Copernican" in their special appeal to esthetics through his "cosmological principle."

The little volume by Milne entitled *Modern Cosmology and the Christian Idea of God* also comes in for some fair criticism. The statements "the universe is unique" and "the world was created at a definite point in time on the scale of observers in relative uniform motion" are analyzed as to their precise meaning. There are only two cases to consider: "the observable universe," which is the same for all theories, and "the universe," which is defined by the rules of an adopted theory and is, therefore, as much a unique physicomental reality on the basis of any other theory as it is on that of Milne's "kinematic relativity" view. As to the sense of Milne's creation epoch, this was already latent in his introduction of the "cosmological principle": "The world views of any two equivalent observers (observers moving with the substratum in their respective neighborhoods) are identical." One must read his 1934 articles in *Zeitschrift für Astrophysik* (in English) or his book *Cosmogony and World Structure* in order fully to realize how rich can be the crop of deductions reaped in a signaling universe, such as Milne's, from this innocent-looking principle.

An excellent discussion of the curvatures of space-time manifolds is given in the chapter on world geometry. Newton's extensional, Leibniz' relational, and Einstein's physical, views of space are well described. Robertson's simple formulas to show how different "curved" spaces differ from "flat" space are quoted. It appears that the unfortunate term *curvature* has nothing whatever to do with change of direction. A much better term would have been *distance-deficit,* or *distance-excess* of perimeter, area, or volume, as the case may be. The fact is stressed that all kinds of spaces are capable of serving as world maps, with proper laws adopted for the phenomena described, but that only certain kinds of space are convenient mathematically.

A chapter on "The Age of the Universe" follows, in which it is shown that the current estimates for the expanding universe, whether on the old or the new time scale, are very far from being in any sense factual. While it is true that the Hubble constant enters into the computation of the "age," McVittie has stressed that a factor depending upon the model, a pure guess that the present radius of curvature is about 100 times the original Einstein radius, and an assumption of the average density of matter in the observed universe (an estimate which is still uncertain within a factor of 1000 according to some observational astronomers) all enter into the computation of the age. In addition to these uncertainties, we do not know that the nebulae have always moved at their present constant speeds. Accelerations and decelerations with time are at present being considered as possibilities. The result is that we know nothing certain about the age of the universe. But why should we expect to find an age for it at all, since "the universe" is really a view point, like "the atom."

The last two chapters contain a discussion of the cosmology of the steady-state universe. The "perfect cosmological principle," introduced in Bondi's version of it, may be stated as follows: "Apart from local irregularities, the universe presents the same aspect from any place at any time." With this principle at work, the steady-state universe permits the continual creation of matter in space. The author does not say this is impossible, but he maintains that there is no real evidence for it, and that it would have been far more scientific to postulate a universe of constant density in time than to assert that the cause of this constant density is creation of matter. The "perfect cosmological principle" is, he thinks, no better than an Aristotelian argument from esthetic simplicity —that is, a post-Copernican anachronism. It is not a factual statement capable of serving as a premise in an argument but a definition that functions as a criterion of what is to be regarded as a law of nature.

Finally, we are asked to consider in what sense there is creation of matter in the universe. The meaning of the term *creation* is twofold, but neither sense of the word is acceptable as a cosmological postulate. The first—namely, the shaping of objects out of already existing material—requires an agent, a primordial material, and, usually, a purpose. It is irrelevant on the large scale of cosmogony and could at best enter for the first time on the scale of nebular astronomy. But it is the second meaning, "the appearance of physical matter in time and space out of nothing," which is generally attached to the word *creation,* used by itself. Hoyle's version of the steady-state universe is carefully analyzed. It is given credit for what it is—the first complete field theory of the process of creation—but perhaps not enough credit. In the discussion of this subject it is obvious that Munitz possesses a precise knowledge both of Hoyle's technical paper of 1948 and of his popular writings. Since the appearance of the latter, in 1950, the theory of the creation *ex nihilo* of matter in three-dimensional space has caused great furor among the general reading public, due, perhaps, to a too literal acceptance of a condensed popular statement in the volume entitled *The Nature of the Universe.* The statement is: "New material appears to compensate for the background material that is constantly being condensed into galaxies. . . . I find myself forced to assume that the nature of the Universe requires continuous creation—the perpetual bringing into being of new background material." While it is hazardous to judge a man's precise meaning on an ultimate subject from his radio lectures or other popular writings, there is no doubt that Hoyle thinks of a four-dimensional vector representation of a four-dimensional flow of energy. The vector has a nonzero component in the time direction, and this appears in three dimensions as an arrival of matter (a form of energy) with zero velocity at various points in space, out of nothing observable—that is, it appears as creation out of nothing in three dimensions.

McCrea of London is given the credit for having elaborated the process to show that it is not a creation of new energy *ex nihilo* in four dimensions but the conversion of a negative four-dimensional stress into energy. But it appears to me that the germ of this idea is present also in Hoyle's 1948 paper. This appears from his two equations describing the process of creation. He also states, in his book *Frontiers of Astronomy,* that the creation of matter contemplated is due to the matter at infinity—that is, matter beyond our relativistic horizon. In other words, to Hoyle, the "creation of matter" appears *ex nihilo* only in three-dimensional space. It is but an aspect of four-dimensional conversion of energy already existing in some form in four-dimensional space-time. It is therefore, at bottom, a conversion of something existing in four dimensions only, so that it exists on paper only! This being clearly a consequence of the postulates adopted at the very beginning of Hoyle's treatment of relativity, the attentive reader would never have the occasion to doubt that when Hoyle uses the term *creation* he means "creation into our three-dimensional physical experience," not "creation out of nothing." Hence, the furor should not have been permitted to flourish long. Once this is clear, one can perhaps pardon an Englishman for not adding, over and again, "into our three-dimensional physical experience" every time the idea of creation is referred to. However, this is a serious matter to the philosopher and is severely criticized by the present author. The criticism goes deeper than the mere use of words. It touches upon the meaning of physical reality. Although not specifically stated, it appears that the author does not consider the fourth, timelike dimension of space-time a physical experimental reality—a view that certainly needs to be stressed in our own age, which permits four-dimensional universes to be talked of as if they had the physical status of basketballs. It is not the physical motion of a particle that is four-dimensional, it is the history of the motion. It is not the physical universe that is four-dimensional, it is our formal mental representation of it that is. We never measure physically "the fourth dimension" any more than we directly measure "the universe" or "the atom."

The Dutch mathematician Struik points out in his little book on four-dimensional geometry that in our experience of nature there never are more than three physical dimensions. (By "physical" is, of course, meant measurable in principle by electromagnetic or gravitational fields.) It is therefore understandable that a philosopher takes exception to Hoyle's constant use of the term *creation* by itself. For with this abbreviated use one normally associates *ex nihilo,* an unnecessary and harmful scientific concept. It dogmatically closes a subject, while the whole advantage of theory is to open up new possibilities of finding facts—physically measurable quantities—never to expostulate a supernatural entity. Infinity or finitude of a universe may be equally useful—nay, equally true—concepts as rules of extrapolation to new measurable facts. It is the set of rules, blended with physical theory, represented by mathematics (multidimensional or not), used as an extrapolation tool, and not a metaphysical "thing-in-itself," which constitutes the "universe" of cosmology.

T. S. Jacobsen
Department of Astronomy, University of Washington

Handbuch der Physik. vol. 50, *Astrophysics,* I. S. Flügge, Ed. Springer, Berlin, 1958. vii + 458 pp. Illus. DM. 98.

It was an excellent idea on the part of the editor of the new *Handbuch* to include volumes on such borderline fields as geophysics and astrophysics. Indeed, a good astrophysicist is a much more complete physicist nowadays than most of his much-too-much-specialized physicist colleagues. An astrophysicist has to know quantum mechanics and electromagnetic theory to understand stellar spectra; nuclear physics to understand the energy production in stars; diffusion theory, thermodynamics, and statistical mechanics to understand the equilibrium in stellar atmospheres; ordinary and magnetohydrodynamics to understand many of the processes in interstellar space; Hamiltonian mechanics to understand celestial mechanics; and so on. Part of this many-sidedness of modern astrophysics can be gleaned from the first astrophysics volume of the new *Handbuch.* One can also see the truly international character of the subject from the fact that, of the ten contributions from four different countries, two are in German, three are in French, and five are in English.

It is clearly impossible in the restricted confines of a review to do justice to a volume such as the present one, and one must limit oneself to a brief summary of the contents of the various contributions. The emphasis in this volume has been predominantly observational, although the longest paper deals with the theory of stellar atmospheres.

The first contribution is by Fehrenbach (Marseilles), who gives a comprehensive survey of spectral classification of stars, comparing the different possible classifications. Keenan (Delaware, Ohio) discusses briefly metallic line stars, F-, G-, and K-type high-velocity stars, and stars with carbon features, while Swings (Liège) gives a survey of molecular bands in stellar spectra. Wurm (Hamburg) contributes two papers, the first one dealing with the observational data and the second one, with the theoretical interpretation of the spectra of planetary nebulae. Greenstein (Pasadena, Calif.) discusses white dwarfs, and van de Kamp (Swarthmore, Pa.), visual binaries. Gaposchkin (Cambridge, Mass.) deals with eclipsing, and Struve and Huang (Berkeley, Calif.), with spectroscopic binaries. The last contribution includes a discussion of several peculiar systems and of the evolution and origin of binaries. Finally, Barbier (Paris) treats the theory of stellar atmospheres in ample detail.

As one has come to expect from the *Handbuch,* the standard is high throughout, and the publishers have produced a book which is a pleasure to handle. As a consequence of its subject matter, it contains a large number of half-tones, well reproduced.

D. ter Haar
Clarendon Laboratory, Oxford, England

Shell Theory of the Nucleus. Eugene Feenberg. Princeton University Press, Princeton, 1955. xi + 211 pp. $4.

The shell theory of the nucleus in its initial stages of development was rejected because of the apparent conflict with the strong, short-range character of nuclear forces. It is now a challenge to the more fundamental approaches to nuclear structure to explain the shell model's unexpected success. Feenberg, a leader in the development of shell model ideas, has written a valuable description of the model's interpretation of low-energy nuclear phenomena.

The book begins with a brief historical introduction describing the experimental information that led early workers to hypothesize the shell structure of nuclei. A quantitative presentation of the independent particle approach is then given and used in the following chapters to interpret a variety of nuclear phenomena in terms of the shell model. Magnetic dipole and electric quadrupole moments are treated. Shell model predictions of the character and location of isomeric transitions are correlated with experimental data. The classification of beta decay according to shell model states is given, along with an analysis of favored beta decay. Of particular value is the analysis of j-j coupled configurations in which the isobaric spin formalism is used. Several beta decay matrix elements and magnetic moments are calculated explicitly as examples. One chapter is devoted to collective motion and its connection with shell structure. The final chapter is an introduction to what Feenberg terms the third stage of development—namely, the attempt to relate our knowledge of the nucleon-nucleon force to the problems of nuclear structure.

In total, the book provides a remarkably fine introduction to the shell model approach and has already proved very useful to students of nuclear physics.

R. W. King
Department of Physics, Purdue University

Textile Chemicals and Auxiliaries. With special reference to surfacants and finishes. Henry C. Speel and E. W. K. Schwarz. Reinhold, New York; Chapman & Hall, London, ed. 2, 1957. vi + 545 pp. $13.50.

This second edition differs from the first edition published in 1952 in containing market data on textile chemicals and a chapter on "Felts and non-woven fabrics." It also contains information on newer developments in flameproofing and other types of finishing, new trademarked products, and new fibers, but the total amount of new material is small.

Although the type is clear, numerous obvious errors detract from the book. These include errors in chemical formulas and spelling, replacement of words with words of somewhat similar appearance but different meaning, and scrambled sentences and paragraphs.

Florence H. Forziati
Textiles Section, National Bureau of Standards

Advances in Cancer Research. vol. V. Jesse P. Greenstein and Alexander Haddow, Eds. Academic Press, New York, 1958. ix + 463 pp. Illus. $10.80.

The fifth volume of this series maintains the high standard for informative, scholarly reviews set by the preceding four volumes. The *Advances* is now a standard reference, and any cancer research laboratory or clinic is quite incomplete without it.

The first chapter, on "Tumor-host relationships," by R. W. Begg, sets the main theme of the volume. There is certainly no doubt that neoplasms produce biochemical and morphological changes in tissues distant to, and free of, the tumor, but exploitation of these effects except in a few small specific instances still remains for the future. Three additional chapters deal with aspects that may be related to this topic. "Anemia