

Concepts of the Universe

By Paul W. Hodge

125 pp. McGraw Hill, New York, 1969.
Paper \$3.50, cloth \$5.50

Anyone who knows little or nothing of cosmology will get much enjoyment and stimulation from an evening spent with this slim volume, more than two thirds of which consists of lively drawings and the usual magnificent photographs (mostly taken by the author) of whirling spiral galaxies, incandescent gas clouds and the like.

He will learn about the many different species of galaxies and the difficulties of determining their distances (Hodge is an expert on this kind of discussion. In 1966 he and George Wallerstein sparked a lively debate when they suggested that the accepted extragalactic distance scale was in error by 20%), the expansion of the universe and the theoretical universes that cosmologists make up in order to understand the real one, the closed and finite worlds, quasars and many other things. All this is presented in an easy and informal style, which, in the author's words, "assumes nothing on the part of the reader except the ability to read."

Here, then, are all the makings of a good book. And yet, on closer examination, it is disappointing. That one can be precise even informally and without mathematics has been shown in such splendid little books as Hermann Bondi's *The Universe at Large*, Fred Hoyle's *The Nature of the Universe* and Dennis Sciama's *The Unity of the Universe*. Hodge's book, on the other hand, makes too little effort to tell how things really are. It abounds with such woolly passages as "The second assumption is that the universe is isotropic. This means that the galaxies are distributed and are moving, whatever their velocities, in a smooth and uni-

form manner. All the velocities, for instance, are velocities of expansion. We don't have a situation where the universe around us is expanding, somewhere else it is contracting, and at other places it is perhaps vibrating or rotating or something else." This unusual definition of isotropy stands beside equally unusual definitions of homogeneity (as smoothness, apparently on the milk analogy) and of cosmic incoherence (as the complete independence of all the parts, despite the evident gravitational binding).

One error in particular should not be allowed to pass unchallenged, because it is spreading in the popular literature. On page 8 Hodge discusses the "velocity boundary" (better known as the event horizon), at which the expansion rate is such that photons from it can not reach us in a finite time, and galaxies beyond it can not be seen by us. He then concludes that "There are mathematical models of the universe that have galaxies beyond that 'disappearing' distance, going even faster than the velocity of light. Of course the laws of relativity forbid this, and such models are of only academic interest."

In actual fact, the laws of relativity not only allow this, they positively demand it in the case of many perfectly respectable models, such as the well known de Sitter model or the presently favored Lemaitre model. Of course, such things can not happen in the flat space-time of special relativity. But then no one since Milne has tried to do cosmology with special relativity. The motion of the galaxies is governed by gravity, and the modern theory of gravity is general relativity. Modern cosmology, therefore, is essentially general-relativistic cosmology. Now general relativity is, roughly, a patchwork of local special relativities (much as a curved surface is a patchwork of

Spectrogram of a galaxy is often extremely small and hard to decipher. (From *Concepts of the Universe* by Hodge.)



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1970 Volume 1 512 pages \$15.00

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By E. W. McDaniel, *Georgia Institute of Technology*; V. Cermak, *Institute of Physical Chemistry, Czechoslovak Academy of Sciences*; A. Dalgarno, *Harvard University*; E. E. Ferguson, *U.S. Department of Commerce, Environmental Science Services Administration*; and L. Friedman, *Brookhaven National Laboratory*

A Volume in the Wiley-Interscience Series in Atomic and Molecular Collisional Processes, Advisory Editor, C. F. Barnett, Assistant Editor, Donna M. Cobble

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—from the Preface

This monograph presents a critical analysis of the accuracy and reliability of all the known experimental methods for making quantitative studies of ion-molecule reactions. Considerable space is devoted to the theoretical foundations of the subject and to the various models that have been adopted in computations of reaction rates. A review is given of the measurements in the earth's atmosphere from which information on ion-molecule reactions has been deduced, followed by a discussion of ion-molecule chemistry. Experimental data on 230 ion-molecule reactions are displayed in tabular and graphical form.

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little plane elements). The set of these patches between us and our event horizon expands at such a rate that the light coming from there towards us is "like a runner on an expanding track, with the winning post forever receding from him." May this eloquent phrase of Arthur Eddington become more widely appreciated.

WOLFGANG RINDLER
University of Texas, Dallas

Structure Electronique Des Atomes et des Molecules Simples

By Michel Fayard
201 pp. Hermann, Paris, 1969. 39 F

No matter what the title may imply, this book is basically an introductory textbook on quantum mechanics with many applications to elementary problems in atomic and molecular physics. The subject, quantum mechanics, is introduced rather quickly and most physicists would be less than satisfied with this part of the book.

This approach is not surprising because the author, a professor of chemistry, was writing primarily for students in chemistry and engineering. One can almost get the feeling that the student is being handed a cookbook with some explanations between recipes. However, in the frame of reference of the chemist or engineer, that may be all that they require for understanding the language of the literature. The audience might also be the *raison d'être* for the style; that is, the treatments of the various subjects have the flavor of the quantum mechanics of the 1930's with emphasis on wave mechanics. Incidentally, this flavor may actually be a good reason to use such a text in the undergraduate-physics programs. Unfortunately for the American student, the book is in French. The skimpy index does not add greatly to the utility of the text.

HAROLD MENDLOWITZ
Howard University

Basic Quantum Mechanics

By Klaus Ziock
271 pp. Wiley, New York, 1969. \$9.95

If there is one point on which physics teachers are divided it is the question of whether an electron sees and feels an electric field or whether it is just accelerated by it. Klaus Ziock puts himself firmly in the first category with this delightfully anthropomorphic little book in which "electrons are very nimble" and in which "the neutron's disdain for electric fields is somewhat hypocritical as deep down inside it must have currents