

A third division, devoted to the theory of the ionospheric layers, discusses methods of production and dissipation of ionization, while a following section describes the regular and sporadic changes in the ionosphere and seeks to establish their causes.

The final portion of the book is concerned with the practical question of the role of the ionosphere in the propagation of radio waves. It deals at some length with the problem of prediction of ionospheric conditions.

An unusually extensive list of references to books and papers, embodying nearly three hundred items in several languages, is appended.

Dr. Rawers' book will be interesting to physicists in general for the picture it presents of the scope and importance of a subject so intimately connected with physics itself.

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Atoms, Men and God. By Paul E. Sabine. 225 pp. Philosophical Library, New York, 1953. \$3.75.

Dr. Sabine is the son of a Methodist preacher, cousin of Professor Wallace C. Sabine who founded the science of architectural acoustics. He is a onetime professor of physics at Case School of Applied Science, and retired director of the Riverbank Laboratory of Acoustics. This book, which has been fifteen years in preparation, will answer those of Dr. Sabine's friends who have wondered what he was doing in his retirement, other than defense work and the planning of the acoustics of the remodeled House and Senate chambers in our National Capitol.

He addresses himself to the problem "Can I be intellectually honest in believing what, as a Christian, I profess to believe and at the same time accept the teachings of modern science and psychology regarding the nature of man and God and the physical world?" In searching for the answer to this problem the histories of science and of religion are thoroughly reviewed, pertinent facts of chemistry and physics are surveyed, and our knowledge of psychology is explored, an attitude of rational criticism of any proposed philosophic conclusion being maintained throughout. The mechanistic view of the world, which considers all events as the operation of a machine governed by inexorable cause and effect and running down as its entropy increases, is held to be unsatisfactory because it fails to account for the evolution of higher biological species in a process of ordering which is held to run counter to a trend toward disorder. Neither does it account for the existence of *purpose* in the world, the governing of present activity in anticipation of future ends. "Biological science discloses a world in which the mechanically improbable is always taking place. Evolution in time from the elemental to the complex, from the more probable single-celled organism to the highly evolved species with their complicated functional adaptations—this is the direction in which time's arrow points in the living world. Evolution finds causa-

tion in the *pull of the future*. Mechanism finds it only in the *drive of the past*." The purposive coordination of these complex processes for the maintenance of the life of the organism defies description in mechanistic terms. Mechanism also fails to explain the origin of life. "The advent of two such substances as chlorophyll and hemoglobin, with their unique chemical and physical properties, must be regarded as a miracle from the purely physico-chemical point of view. It is quite inconceivable that they and with them the ordered relationship found throughout the living world should be the result of blind chance operating in an essentially lifeless concourse of atoms and molecules. Life becomes explicable only in terms of purpose, that is, the coordinated activities of related elements to the accomplishment of a specific end—that end being the maintenance and evolution of life itself."

The Uncertainty Principle "does not give positive evidence in favor of freedom of choice, but by replacing the bond of mathematical certainty between the present and the future, by the flexible tie of statistical probability, it makes freedom a scientifically plausible hypothesis instead of a scientific impossibility."

The chapter on psychology discusses introspection, behaviorism, conditioned reflexes, psycho-analysis and the unconscious mind. "The possibility of a collective unconscious unites the whole human family in a psychical unity that overleaps the barriers of nationality, color and race, and betokens a solidarity that is an essential reality rather than the expression of benevolent sentiment. The sense of individual isolation is not man's highest or final recognition of himself and of his own significance. Faith in the slowly dawning consciousness of the human spirit as an organic unity that, by the long and painful process of evolution, is externalizing the spiritual Will and Purpose of a living Universe—this, it seems, is not incompatible with the trend of constructive thought in modern psychology."

The busy reader will find the principal message of the book in its last chapter entitled "Christianity and Human Evolution." "We have now to tackle the other half of our job of getting a stereoscopic vision of the scientific and the religious by looking at the essentials of Christian faith with the same intellectual detachment as that with which we would scrutinize an economic theory or a philosophy of history. This is by long odds the harder part of the undertaking and the writer can promise only an honest attempt to transcend his own individual bias as one who has a *will to believe*.—The sceptic's position is also grounded in his *will to believe*; he sees religious phenomena as entirely natural phenomena that can be explained in naturalistic, that is to say humanistic, terms without the unnecessary assumption of the existence of God or of any purpose of God in human history.—We propose to follow in the present instance a procedure that has full scientific sanction and maintain that an explanation of the facts of Christian origins can be found in the operation of a process that is at the same time both natural and

supernatural. Whether this procedure will pass the test of being orthodox science or being orthodox religion may well be questioned, but progress and orthodoxy in either science or religion seldom dwell together in comfort under one ideological roof—Without discarding the traditional religious view, we may see the same set of facts and circumstances as an extension into human history of the process which for biological science accounts for the mysterious proliferation of life in the organic world. Traditional theology sees the introduction of Christian thought and ideals into the stream of human history as the supreme act in the dramatic story of man's fall and redemption, as set forth in the Hebraic-Christian scripture. We may equally well see the facts from the point of view of modern science as marking a mutation in the evolution of the spiritual side of man's nature."

"The belief that evolution is *not a chapter of accidents*, but that its operation in nature may be interpreted as an expression of purpose is an entirely rational attitude to take.—As a spiritual being, man can only be regarded as a mutation, a sharply decisive break in the course of the evolution that produced him. The *mind* of man can be regarded as the result of an act of pure creation—something new in the totality of organic life. Science has no explanation in its own terms to offer for the existence of the human mind. Christian faith ascribes it to the creative Will of God. The finite spirit of man is the developing image of the infinite Spirit of man's Creator.—At this point the critical reader will no doubt observe that the writer has failed in his attempt to maintain an entirely objective attitude toward the subject under discussion. This must be freely admitted. What has just been said is not a statement of scientifically demonstrable fact, but rather a profession of the writer's own religious faith that evolution in the human species is in the direction of the fulfillment of Jesus' vision of the Kingdom of God."

"It would seem that our almost hysterical fear of Communism within our own borders springs from a haunting anxiety that our form of democracy is not working. Racial discrimination, endless strife between labor and management, the struggle between economic groups over the distribution of material wealth, the presence of dire poverty in the midst of plenty, all conspire to create the uneasy feeling that somehow democracy has got off the track and is bumping along on the ties—that our spiritual strength falls far short of our material greatness. May it not be that this lack is our inability to bring into practical expression in the context of our individual lives and our mechanized society those ideals of human brotherhood, that sense of love and concern for our fellows which are the centre and core of the religion we profess and the only basis for a truly democratic way of life? And may not this failure arise from the fact that we have come to regard these ideals as the pious teachings of an outworn tradition, rather than the expression of truths as

deeply rooted in reality as are the truths of material science?"

Though this reviewer has a will to believe in a modified mechanistic hypothesis as an explanation of all the phenomena of both mind and matter with a minimum number of assumptions, he enthusiastically recommends this book as a most interesting and scholarly philosophical dissertation, to be classed with the writings of Sir Arthur Eddington and Sir James Jeans. On account of the broad interest in its subject matter, the sales of this book will probably be orders of magnitude greater than the sales of Dr. Sabine's textbook on Acoustics and Architecture. Many scientists give but little thought to religion, but when the scientist's child reaches the age when his friends are going to church, a day of decision has been reached. Dr. Sabine has skillfully explored the coupling between science and religion; the extent to which the reader agrees with the author's conclusions will depend on his personal coefficient of coupling.

Floyd A. Firestone

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Methods of Statistical Analysis (Second Edition). By Cyril H. Gouliden. 467 pp. John Wiley and Sons, Inc., New York, 1952. \$7.50.

A physicist can usually make a least-squares fit of six points to a linear or quadratic formula; but does he know how to test whether the quadratic term is significant? A good guess is "Yes" if he talks about variance and "No" if he talks about probable error. For the exact solution of this problem is a part of the theory of small samples, which got its start in a British brewery in 1908. That date separates modern statistics from the older variety, and the jargon of "variance" from that of "probable error". The physicist who multiplies all his standard deviations by 0.67 is announcing, in effect, that he accepts stochastic truth as it was revealed to Gauss and Laplace, and that he will not tolerate the sacrilege of a new translation.

Until lately, a physicist had some basis for such fundamentalism; for the new translation of statistics was itself written in a language foreign to him. It was contained in books about plant fertilizers and dizygotic twins, and in articles in *Biometrika* and *Annals of Eugenics*. But now statistics has been embraced by the chemists, the engineers, and the ASTM, and new books have been written in a language reasonably intelligible to physicists. These books differ widely from one another. At one extreme are the cookbooks, full of specialized recipes, without theory or discernible motivation. At the other extreme are the theoretical treatments that reduce statistics to a rigorous mathematical model, uncontaminated by any contact with experiment. Within this variety of offerings, the physicist must search for a book that promises a tangible return for his time. He needs to understand the logical structure of modern statistical theory and the principles that underlie the practical techniques; he need