Hamiltonian, of which the excited nuclear states are eigenstates. The theories postulate a reasonable probability distribution of an N–dimensional Hermitian matrix consistent with the available relevant information, and seek to infer the resulting distribution of eigenvalue spacings by mathematical analysis, especially in the limit of large N. The connection with the experimental data on nuclear levels is based on the hypothesis that the local statistical behavior of the energy levels is identical with the statistical properties of the eigenvalues of a large matrix. Around 1950 the study of matrices with randomly distributed elements became an active, if rather specialized, field of theoretical physics, although the statistician J. Wishart had already considered certain random matrices in 1928. Many of the important papers were collected in a reprint volume (*Statistical Theories of Spectra: Fluctuations*, Academic Press, New York, 1965) together with an introductory review by the late Charles E. Porter.

Although Porter emphasized the physical aspects from which the mathematical problems arose, most of the literature is concerned with the intriguing mathematics of random matrices. A set of fundamental papers by Freeman J. Dyson and by Dyson and M. L. Mehta, in 1962 and 1963, acquainted many theoretical physicists with the status of the statistical theory of energy levels of complex systems. Mehta, who has made significant contributions to the subject, has now written a systematic technical monograph on the mathematical theory of random matrices. This book is an excellent guide to the problems that have been solved and to those that, while formulated easily, remain unsolved. The book poses the mathematical problems clearly and contains complete proofs of most results. The "threefold way" of Dyson, corresponding to ensembles of Hermitian matrices that are invariant under orthogonal, symplectic or unitary transformations, is emphasized, but other ensembles are also discussed. The uninitiated may be surprised to discover how sophisticated mathematical techniques are required to calculate the distribution of level spacings even after the joint probability distribution of the eigenvalues has been found for any particular ensemble of random matrices.

On the other hand, the reader should not expect to find here any extended discussion of the physical basis for the choice of the commonly used matrix ensembles, other than the general symmetry requirements; nor should he be encouraged by the subtitle, "The Statistical Theory of Energy Levels," to expect to learn of the physical relevance of the many specific results. It remains unclear if, and under what conditions, statistical information about nuclear spectra (or about the spectra of the elementary particles) can be utilized profitably in gaining new understanding of the general properties of the interactions. However, in spite of numerous nontrivial misprints, some uninformative chapter headings and a misleading description on the dust jacket, Mehta's book satisfies the aim of providing an authoritative introduction to the mathematical theory of random matrices and their eigenvalues.

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Eugen Merzbacher, Visiting Professor of Physics at the University of Washington, 1967–68, has been interested in the interpretation of the spacing between neutron resonances. A professor of physics at the University of North Carolina, the reviewer wrote a text on quantum mechanics.

For the social metaphysicians

DIALOGUES ON FUNDAMENTAL QUESTIONS OF SCIENCE AND PHILOSOPHY. By A. Pfeiffer. Trans. from German. 128 pp. Pergamon Press, Oxford, 1967. 25s

BY RICHARD SCHLEGEL

One of the therapies for the alienation of science from contemporary student thinking would be a searching criticism and discussion of philosophical aspects of science. I say "philosophical aspects" but what is wanted, I think, is not so much what professional philosophers of science do (even though their contributions would give essential background understanding), but rather, a consideration of the interplay today between the content of science and its effects in our general culture.

A. Pfeiffer (we are told in the preface, written by Kurt Mendelssohn of Oxford) was a physics student in Berlin in the late 1920's, is now a professor at an East German university and has preferred not to migrate to West Germany. In his *Dialogues* he has shown us a way in which a physicist can involve his scientific outlook in some of the pressing intellectual problems of our day.

The style of the dialogs is scarcely lively, and something of Germanic heaviness of word and sentence comes through with the translation. Frequent reference to Immanuel Kant's philosophy and recurring concern with the existence of a "higher" transcendental realm that supports man's moral sense give the American reader a feeling of being rather far from the home base of Anglo-American philosophical presuppositions. Indeed, in a broad way, the book might be described as a confrontation of 19th-century German philosophical idealism with the empiricism–naturalism of current Russian thinking.

SOCIETY VS. THE INDIVIDUAL. The participants in Pfeiffer's dialog ". . . readily agree on the ethical superiority of society over the interests of the individual, and they speak against an egoistic ethic. . ."

The opening dialogs, which are concerned with philosophical implications of quantum mechanics, are, in my judgement, the weakest part of the book. The author asserts (although, nondogmatically) that uncertainty in nature is nothing more than a result of our ignorance of the details of elementary physical processes. The arguments conclude firmly in favor of objectivity of all atomic phenomena; but there is no meaningful presenta-

tion or discussion of those aspects of quantum theory that have led some physicists to find a warrant in quantum theory for at least a partial subjectivism (determination by the knower) with respect to detailed aspects of microlevel events.

The subsequent major theme of the dialogs is that of validation of ethical judgements. Relations between science and philosophy, meaning of "laws of nature," comparative roles of an alleged "spiritual element" and of biological instincts in ethical behavior, continuities between animal and human behavior, and death and the significance of an individual life are among the topics that are discussed as relevant issues. I would say that the view eventually favored by the two participants in the dialogs is, in general, one that would be agreeable to most physicists, although, of course, there would be many differences in detail.

But among Western readers there would probably be one important exception to a general agreement with Pfeiffer's views. His discussants readily agree on the ethical superiority of society over the interests of the individual, and they speak against an egoistic ethic, in which the object is above all else the development of one's own personality. There are also, it should be said, expressions of limitations on the dominance of society; thus the assertion is made that "Human progress would surely stop in its tracks if the individual were once more robbed of his freedom of choice of his general path, i.e., choice of profession, spouse and conviction." The question of how far the individual person may be encouraged to pursue his own fortune, independently of demands for wider public needs, is one that faces us in the West in the present period of disquiet. One can say much in support of the doctrine that man best serves his society by freely becoming his own best self; but how then should one bring social responsibility into the concept of "best self?"

Discussion of such questions, as well as of philosophical issues more immediately related to problems of physics, is very highly desirable today. I think we must, therefore, warmly commend Pfeiffer for his Socratic endeavor.

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Richard Schlegel is a professor of physics at Michigan State University and is interested in problems in the philosophy of physics.

The master in his metagalaxy

BEYOND THE OBSERVATORY. By Harlow Shapley. 222 pp. Scribner's, New York, 1967. $4.50

by MARTIN F. McCARTHY

Oh, what do the scientists do? Yes, what do the scientists do when they are outside their laboratories, away from lecture platforms, apart from computers, beyond the observatory? This is the question set for himself by Harlow Shapley, distinguished dean of American astronomers. His title as Professor Emeritus of Astronomy at Harvard after 30 years as director of the Harvard College Observatory means simply that Shapley, a very youthful and dynamic octogenarian, is now free to be teacher-at-large for us all. In this collection of essays Shapley shows those flashes of wit, insight and wisdom that have always marked his lectures, classes and colloquia and merited from a colleague an encomium we could all aspire to: "Shapley is incapable of giving a dull lecture."

But what does the scientist do beyond the observatory? Shapley's answer is clear. A scientist always keeps his eyes and mind open and searching as the magnificent panorama of cosmic evolution unfolds before him. He rejoices (and it is easy to see that Shapley has had a tremendous amount of fun preparing and delivering the essays in this little book) in sharing this broad and detailed view with his fellow men. A scientist knows his vocation is a fortunate and happy one: to explore a part of creation, to see how it fits into the whole pattern of things and to share the good news of all this with other people. An expert in his own branch of science, he makes himself alert to the progress and problems of other disciplines. Aware of his own limitations and his vast potentialities for error, he is not afraid of learning more and is tireless in communicating the fruits of his labors to others. He puts his knowledge and sense of research at the service of his fellow men.

Those who had the chance of hearing Shapley lecture on "Cosmography" to packed classes of Harvard and Radcliffe students will find many an echo in the topics treated here. I suggest that the reader, as a practicing scientist, may wish to look first at the index and then at the final essay, "The Scientist Outside the Laboratory." These final 20 pages illustrate the variety of subjects discussed and set forth the leitmotif of all the essays.

Harlow Shapley has never been afraid to step outside the range of his own vast expertise, "The Metagalaxy and all its parts." One notes the master's touch in all those portions of the book that deal expressly with matters astronomical, and one finds charming the original and articulate approach of the wise lover of learning to problems biological, exegetical and sociological. This is the example Shapley sets for us in this splendid set of essays: to be bright eyed, brave, inquiring and humble and always to think beyond one's self. The lesson of this book as well as Shapley's own code and the goal he sets for the

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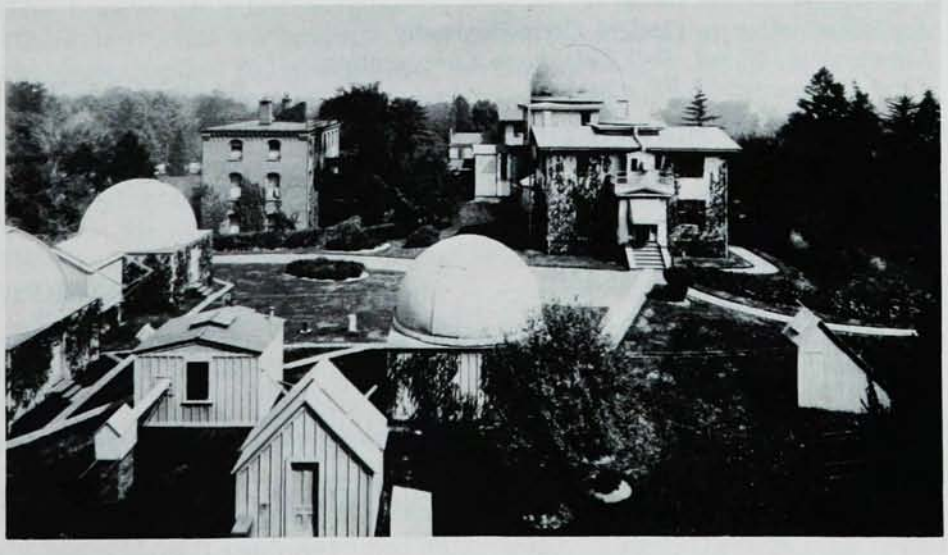

HARVARD COLLEGE OBSERVATORY as it appeared in the 1920's when Harlow Shapley became the director. Building at left housed the photographic plates.