cations of the world situation, and the concerns of some millions of human beings who can be as well and truly killed by bad policy as by hydrogen bombs. Knowledge of the devastation potential of a hydrogen bomb does not automatically bring with it realization of the devastation potential of a totalitarian government on the march.

Aspects of Power

A third note may be apposite. The scientists, rightly, could think of no solution save that of reorganization of power in one form or another. None can quarrel with this; no one else has thought of any other. But it so happens that power is itself a mystery whose exploration has scarcely even been intellectually organized. Historical data indicate its external effect—what it has done to peoples in the past—and historians are still considering whether this experience affords any basis for prediction about the future. The internal effect of power—what it does to the power-holder—is still a matter of conjecture. (In our generation, the world has seen several power-holders whose power-burden seems to have reduced them to a condition of psychotic unbalance, if not to positive madness.) No scientific data yet exists with respect to optimum location of power, the most practical method of assuring that power located, accepted, and organized for beneficial purposes will long continue to be used for that purpose.

Political scientists, while they do not pretend to know the answer, do know the difficulties. Physical scientists entering politics were, of course, out of the field of their precise competence. Their views were entitled to be considered on their merits, that is, were entitled to respectful hearing, examination, and appraisal exactly as are the views of any competent citizen. It is perhaps unfair to say that in some respects these views appeared naive. It is not inaccurate to say that some of them appeared uninformed. Scientists, not unnaturally, were as unaware of the implications of some of their proposed political solutions as most laymen are unaware of the scientific implications involved in their own simplicist impressions. Everything considered, it is a tribute to the recognized character of the scientists involved, to their growing capacity to apprehend problems, and to the thinking of the informed public that their proposals got the hearings they got and made the limited progress they eventually did make.

The Future

The possibility can not be excluded that, at some future time, scientific means may be found by which atomic destruction may be prevented or aborted to the extent that peril will be reduced to acceptable proportions. Absent that fact, scientists, like the rest of us, must deal with the problems by other means, of which national and international political organization offers some possibilities. There may be other means as well. Max Born's concluding essay indicates that he too has been thinking about this. After all, destruction of the human race had been possible by chemical, biological means for two or three decades before the explosion at Alamogordo. Isidor Rabi has pointed out that killing men is so childishly simple that anyone can play that game.

It was honorable of scientists to enter the political arena. They are entitled to all support as they carry on. We really are waiting for the next generation of scientists to balance fantastic discoveries of the past two decades with discoveries (perhaps no less fantastic) capable of balancing them to a point where they are no longer to be feared. Meanwhile all of us have to seek institutions of politics, national and international, buying time for nature and knowledge to provide for her apparently inevitable balances. In that process, as Paul Weiss observes, scientists have no privileged position, no specialized knowledge, no right to expect that they alone in politics will be immune from opposition and attack. No group has qualifications which entitle them to expect that the human race will place its destinies exclusively in their hands.

The Atomic Age is a noble record of a series of noble and not unfruitful attempts. As in all such attempts, some proposals are possible, some are not; some are intelligent, some hysterical; some are absurd. As the record draws itself out, it is plain that, while the scientists have been educating the political public, the political public has been, in its turn, educating the scientists as well.

The Atomic Realm

Electron Scattering and Nuclear and Nucleon Structure. A collection of reprints with an introduction. Robert Hofstadter. Benjamin, New York, 1963. xiv + 690 pp. Illus. Paper, $6.95; cloth, $10.

I am told that quite often the blind, deprived of that most ubiquitous of the five senses, develop the remaining four —and especially the sense of touch— to such an extent as to accomplish astonishing things. They literally feel their way back into a detailed experience of the world. But for that vast fraction of the world which lies in the atomic realm, all mankind is blind. So, man has developed his sense of touch, supplementing his fingers of flesh and bone with fingers made of streams of waves—electromagnetic waves and de Brogliean waves; and man has felt his way down and down into those secret regions where nature begins.

Rutherford led the way by making fingers of alpha particles, and found the atomic nucleus lying hidden in its vast cloud of electrons. Swiftly, men made other fingers of protons and deuterons and gamma rays—and felt the shape of the nucleus and sensed its lumpy insides. Someone, stricken with vocabularian paralysis, named this marvelous process with the colorless and mechanistic term *particle scattering*. Thus, one of modern man's most thrilling experiences in exploring his world is labeled with a name that repels, a negative kind of name, a divergent thing, a truism that conceals the deeper truth.

Robert Hofstadter and the Benjamin Press have struck a telling blow at this situation with their volume of reprints. Part of the title, *Electron Scattering*, is stated in smaller lettering on the title page and is eliminated completely from the cover. The *structure* of the nucleus and of the nucleon is thus emphasized. This emphasis is carried on through the volume in the author's selection of original papers from the literature. It begins with Dirac's paper of 1928 which gives a relativistic quantum electron theory and thus provides the guide with which newer and incredibly more sensitive fingers were soon to be constructed. Mechanical instructions given by Mott in the following year are contained in the second paper, and are sharpened by Guth

in the third. Accounts of the first probings and fingerings of elementary particles, neutrons, are given in the next two papers by Havens, Rabi, and Rainwater, and by Fermi and Marshall. From this point the story proceeds apace as blind men excitedly feel and describe (in measured terms) what they find inside the "elementary" particles called nucleons. Theoreticians (fingerless men with great imaginations) quickly join the expedition into these vast infinitesimal regions. Fitch and Rainwater build new fingers from muons, while Hofstadter and his colleagues steadily make their electronic fingers more sensitive and finally in 1955, feel inside the proton.

Through some 83 papers, the story is told by the men who led the expedition and cheered it on. The last in the sequence is a paper by Frati and Rainwater written in 1962. Taken together in this unified set, these 83 papers, with comments on each by the man who led the assault on the summit where storms of pion resonances rage and electric and magnetic fields swirl about one's ears, form a fascinating story that will live in the annals of science as long as those annals are kept by men.

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Bacterial Viruses

Molecular Biology of Bacterial Viruses. Gunther S. Stent. Freeman, San Francisco, 1963. xvi + 474 pp. Illus. $9.50.

This brilliantly written book is by Gunther Stent, one of the few people who could conceivably have done the job. Stent combines the qualities of an outstanding scientist with those of an outstanding teacher, and he has put into some 470 pages a distilled essence of molecular biology as it is approached through bacterial viruses. Any undergraduate, graduate, or postdoctoral student with even a sketchy background in biochemistry and cellular biology can use this book to tremendous advantage.

To me, the term *molecular biology* denotes a branch of science that seeks to explain biological phenomena in terms of the structure and properties of molecules, particularly of the macromolecules. Not everything that Stent has to say about bacterial viruses is molecular biology, by this or any other definition, but then not everyone takes the term that seriously. What Stent does present is a series of chapters that cover the following topics: the discovery of bacterial viruses (bacteriophages) by Twort and d'Herelle; the bacterial host cell; the nature of the infective virus particle; the various stages in viral infection, replication, and maturation; viral genetics, both with respect to mutation and recombination; and the radiobiology of bacteriophage. All of these topics, with the exception of the bacterial host cell, are covered with enough detail to give the student a good idea of the experimental basis for each and every significant conclusion.

The only weak chapter is the one in which the bacterial host is described. The 14 pages alloted to this subject do not provide an adequate background; a student who, for example, enters the field of molecular biology from a background in pure physics and mathematics will simply have to go elsewhere to learn about the fundamental architecture and function of bacterial cells.

I have only one other criticism, and that has to do with the author's treatment of the complementation test. To perform this test, two mutant genomes are brought together in a common cytoplasm; if the wild phenotype is produced, the genomes have complemented each other and are inferred to be deficient in different functions; if the mutant phenotype is produced, the genomes are unable to complement each other and are inferred to be deficient in the same function. Benzer adapted the complementation test to the identification of functional units in viral DNA. He coined the term *cistron* for such a unit, since the test, if properly carried out, demands that the same phenotype be produced when two defective *cistrons* are in the *trans* position as in the *cis* position.

The foregoing account is similar to the one that Stent presents in an expanded form. Unfortunately, he does not tell the reader that recent work with *Escherichia coli* and *Neurospora* systems has greatly weakened the complementation test as a means of identifying the functional unit. Work by Giles, Fincham, Levinthal, Garen, and others shows that complementation occurs extensively at the protein level: two genomes, each producing the same polypeptide in defective form, will complement each other if the defects are suitably spaced. The defective polypeptides associate to form functional polymeric enzymes. Thus, the rigorous identification of a functional unit requires direct knowledge of the polypeptide produced. Strictly genetic data that utilize gross phenotype as a test of complementation can only provide a tentative identification, and then only if very large numbers of mutants are studied. Groups of noncomplementing mutants can safely be inferred to be affected in the same functional unit; a positive complementation test, on the other hand, does not necessarily mean that two different functional units are involved. A book that is as thorough as this one owes the reader a discussion of this important development.

These criticisms should not be allowed to detract from the overall impression of excellence which I wish to convey. As a final item of praise, I must record the fact that the book is handsomely composed and illustrated and that the bibliography is handled in a manner which every author would do well to imitate. The 700 references are grouped alphabetically by author at the end of the book, and are also numbered serially. References are made in the text by number, but any author's work can be located in the bibliography directly. Finally, after each entry there is a list of numbers that denotes the pages on which the reference is cited. This last courtesy is one of the many touches that make this book a pleasure to read.

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Cryogenics

Cryogenic Technology. Robert W. Vance, Ed. Wiley, New York, 1963. xviii + 585 pp. Illus. $19.50.

This book is a collection of lectures given in a graduate course on cryogenic engineering at the University of California. Each of the 15 chapters was prepared by a prominent engineer or scientist. The stated goal of the treatise is to provide a reference source for those engaged in the application of, or in basic, theoretical cryogenic studies. If we consider the diversity of the disciplines involved in cryogenic studies and the wide range of technological applications, the book must be considered a success.