Book Reviews

Physics, Life, and the Mind

Symmetries and Reflections. Scientific Essays. EUGENE P. WIGNER. Indiana University Press, Bloomington, 1967. 288 pp., illus. $7.50.

From epistemological questions concerning quantum mechanics to disarmament; from time reversal invariance to consciousness; from existence proofs of biological systems to the economy of nuclear power: such is the range of topics discussed in this collection of papers and essays by one of today's foremost physicists. The contributions appeared originally in a variety of publications, including *Reviews of Modern Physics*, the *Proceedings of the American Philosophical Society,* and the *New York Times Magazine,* to name a few.

Thus Wigner has written about many kinds of problems and for diverse audiences. He raises questions that are stimulating, and sometimes disquieting. One need not agree with all his answers to recognize this as an important book. The author takes care, in text and in footnote, to disclaim authority whenever he believes that the reader should be so cautioned. The reading, rarely light, is strongly thought-provoking. This volume deserves an audience far wider than that of physicists only.

The book has a coherence of principal themes much greater than one would expect from a glance at the two dozen titles of the separate papers. Three of these themes which to this reviewer seem uncommonly challenging are selected here.

Are there biotonic laws? A biotonic law (a phrase coined by Elsasser) is a law of nature which cannot be contained in the laws of physics. The question arises in the discussion of the probability for the existence of self-reproducing states. Under carefully stated assumptions (notably that interaction between a "living" state and a suitable nutrient always leads to multiplication) the author gives a simple quantum mechanical argument which yields zero for this probability. This reminds one of Charcot's dictum: *La théorie c'est bon, mais ça n'empêche pas d'exister.* In any event, Wigner says that his argument is not conclusive. At the same time, he does not exclude the possibility that, in the realm of biological phenomena, biotonic laws do come into play. In fact, he does believe in the existence of biotonic laws, but on other grounds: his "firm conviction in the existence of biotonic laws stems from the overwhelming phenomenon of consciousness."

Consciousness as a subject of scientific inquiry. For most scientists this is a question at most worthy of discussion after the day's labor is done. Not so for Wigner. One finds a strong preoccupation with this problem in various parts of this book. At the core of Wigner's convictions lies his distinction between two kinds of reality or existence: "the existence of my consciousness and the reality or existence of everything else."

Epistemology and quantum mechanics. Concerning the type of information which we can acquire and possess about the external inanimate world, according to quantum mechanics, Wigner subscribes to the "orthodox" theory of measurement—with two main reservations. First, he states a formal alternative, namely "that the superposition principle will have to be abandoned." Second, he does not at all exclude the possibility of an effect of consciousness on physical phenomena. Clearly Wigner's unease about the epistemology of quantum mechanics is not of the "hidden variable" variety. Nor should parapsychologists now feel encouraged to descend on his roof. The spirit in which the author deals with these three interconnected themes is one neither of apodictic statement nor of novel prediction, but of earnest concern about the possible need to extend the scope of scientific inquiry to domains now most often considered scientifically tabu. A further study of the relevant chapters (12 and 13) is recommended to all (including this reviewer). However, better bone up on your density matrix theory first.

In deciding to review this book from the end to the beginning, as is done here, I have had more in mind the spectrum of readers of this journal than the generic lines of development of the author's ideas. For, evidently, most of the author's ventures into other fields are strongly rooted in his activities as a physicist. In fact, the very title of this volume is a physicist's delight. The papers devoted to physics are reflections of Wigner's interests and major contributions in the following fields: invariance principles; nuclear theory, as well as a great deal of nuclear practice; and solid-state theory.

Wigner is the master of symmetry. The opening paper of this volume, on invariance in physics, was first presented at Einstein's 70th birthday celebration in the Palmer Laboratory at Princeton. It is a classic. In this and subsequent papers, we are reminded of the physicist's task of finding out what is irrelevant in the initial conditions in his experiments, the minimality of relevant initial conditions being a necessary condition for maximal theoretical insight.

We read again of the relations between invariance and conservation principles; of the lack of clarity concerning the conservation law of electric charge; and of the vastly more important role of invariance in quantum as compared to classical theory. And we think of two short papers by the author, tucked away in the *Göttinger Nachrichten,* where the concept of parity was first introduced and the principle of time reversal invariance in quantum theory was first fully stated. We are led from the first laws of physics, invariance under space displacement and under time displacement, via more recondite principles such as the covariance called crossing symmetry, to the very deep, difficult, and dark question of how to put general relativity on speaking terms with quantum mechanics. Every physics student should read all of this, but preferably after a few years of graduate work.

The main nuclear physics in this book is Wigner's Richtmyer lecture on the compound nucleus. Other physics contributions include a short exposé of the four classes of lattices met in solid bodies; a discussion of effects called radiation damage (in solids); a "burner versus breeder" argument from the longer-range view of applying nuclear energy; and historical notes on the first pile and on the plutonium project.

Amidst all this beautiful physics there is one remark in this book which, it seems to me, is not true to Wigner's style. It is this one. "It is true that many of the young men are attracted by the big machines of big science and that it is difficult to resist the easy success which these machines promise." Surely, some of Wigner's brilliant younger Princeton colleagues in experimental physics would have no difficulty in conveying to the author that the success-to-heartbreak ratio in big-machine work is not so much different from what it is in other parts of physics and that no big-machine experimentalist who respects himself and his pupils will promise them easy going.

The book contains two moving biographical notes with noble passages on the struggle of von Neumann and the stoicism of Fermi in the face of death. Nor will the attentive reader fail to note Wigner's own view of the role of death in life.

"The promise of future science is to furnish a unifying goal to mankind rather than merely the means to an easy life, to provide some of what the human soul needs in addition to bread alone," the author says. With this volume he has provided.

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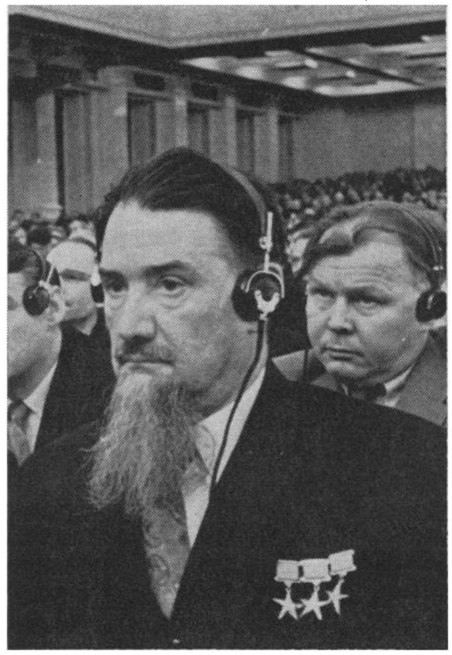
Developer of Russia's Bomb

I. V. Kurchatov. I. N. GOLOVIN. (In Russian.) Atomizdat, Moscow, 1967. 110 pp., illus. Paper, 22 kopecks.

This year, just over two decades after the Soviets achieved their first nuclear chain reaction, they have released their closest approximation to a Smyth report. It is in the form of a biography of Igor Vasilievich Kurchatov. The author, Igor Nikolaevich Golovin, is highly respected for his own researches on controlled thermonuclear reactions and worked closely with Kurchatov in the Soviet nuclear program after it was renewed in the middle of World War II. His is a warm, af-



I. V. Kurchatov at the 21st (Extraordinary) Congress of the Communist Party of the Soviet Union, February 1959. [Photograph by V. Yegorov and V. Savostyanov, Fotokhronika, TASS. Courtesy Sovfoto]

fectionate portrait of the man who accomplished for the Soviet government essentially what Vannevar Bush, Enrico Fermi, and Robert Oppenheimer did for the United States. A tall statement? Not at all, for Kurchatov directed almost every phase of the Soviet project from materials fabrication, reactor construction, and isotope separation to final detonation of the nuclear devices.

The man who was to engineer the splitting of the atom for Stalin was born in the metallurgical factory town of Simsky Zavod in the southern Urals. The year was 1903, a fateful year, for in London the Russian Social Democratic Party itself split into two groups of bitter rivals, the Mensheviks and the Bolsheviks. A few years after the revolution, Kurchatov entered Tavrichesky University in the Crimea, where his association with the greats of Soviet physics, among them Frenkel, Tamm, and Ioffe, began. Developing Kurchatov's career, Golovin effectively conveys the galvanic atmosphere of the laboratories in Leningrad and Kharkov paralleling the excitement being generated by the unfolding knowledge of the atom in Copenhagen, Paris, Cambridge, and elsewhere.

The story of the bomb begins with the letter that Georgy Flerov (co-discoverer of spontaneous fission) sent to the State Defense Committee in May 1942 urging a "uranium bomb" program. Flerov, like Kurchatov, had been engaged since the German invasion on more urgent military tasks, but the priority of nuclear research began to reassert itself. By February 1943 Kurchatov was selected as leader of the project and was back in Moscow organizing people and laboratories. The most important research establishment was Laboratory No. 2 of the Academy of Sciences, in the suburbs of Moscow. (Laboratory No. 1, in Kharkov, was directed by Kurchatov's brother-in-law, Kyrill Sinelnikov.) Today Laboratory No. 2 is the Kurchatov Institute of Atomic Energy, a major research establishment. Christmas Eve 1946 is the date given for divergence of the first Soviet reactor in the "Assembly Shop" of Laboratory No. 2. Kurchatov took it to 100 watts and in the early morning of Christmas day closed it down. The assurance the Soviet government required from their "navigator" was now theirs. Golovin traces the leadership of Kurchatov and his associates at the construction and bomb test sites. The stories are reminiscent of those concerning General Groves and Robert Oppenheimer; for the first time, apparently, in Soviet print General Boris Vannikov, Stalin's General Groves, is given a measure of recognition. So also is Colonel General Avraamy Zavenyagin, the NKVD representative, who was particularly active in the preparation of the first bomb test.

Names, but rarely places, are given in abundance—nor is the book anywhere near as technically complete as the Smyth report. Not a single party leader, past or present, is mentioned. Kurchatov's relationship with Stalin must have been particularly interesting; and Khrushchev, in the spring of 1956, took Kurchatov to Harwell with him and proudly showed him off. This brief visit was the only close glimpse Kurchatov had had of non-Soviet science, or it of him. Golovin's biography helps to correct the latter deficiency. The picture is one of continuous, intense involvement with nuclear problems to the last days of his life, which are chronicled in detail. Kurchatov died on 7 February 1960, while visiting his ailing friend Yuly Khariton, pioneer theorist on chain reactions. The vignettes Golovin presents of an eventful life are as absorbing as any to be found in the multitudinous tales of the Manhattan District.

The declassification officer appears to