BOOK REVIEWS

Max Planck Festschrift 1958. Edited by W. Frank. Published by B. Kockel, W. Macke, and A. Papapetrou. 413 pp. VEB Deutscher Verlag der Wissenschaften, Berlin, 1959. DM 54.00. *Reviewed by Wolfgang Yourgrau, Smith College.*

CUSTOMARILY a Festschrift consists of panegyrics or criticisms, and rarely of original papers. The collection of essays under discussion surprisingly displays so much relevant material that my initial mistrust proved unjustified. It seems incredible to realize that Planck was born in 1858, since his name today pervades nearly all branches of physics, if not of most natural sciences, with the striking impact of an original, contemporary thinker. In appraising the present collection of articles by thirty-three scientists, I wished I could have followed the exhortation of the Duc de Saint-Simon, "savoir accorder à chacun ce qui lui est dû". The reader will sympathize with my decision to refer only to those topics which I found interesting or provocative.

Planck wrote on many facets of physical science, first as an experimenter and later as a purely theoretical physicist—or as a natural philosopher. Similarly, although this book contains a variety of papers dealing with classical, relativistic, and quantum physics, there seems to be a rational pattern of related subjects. Let us discuss the results proffered in some contributions.

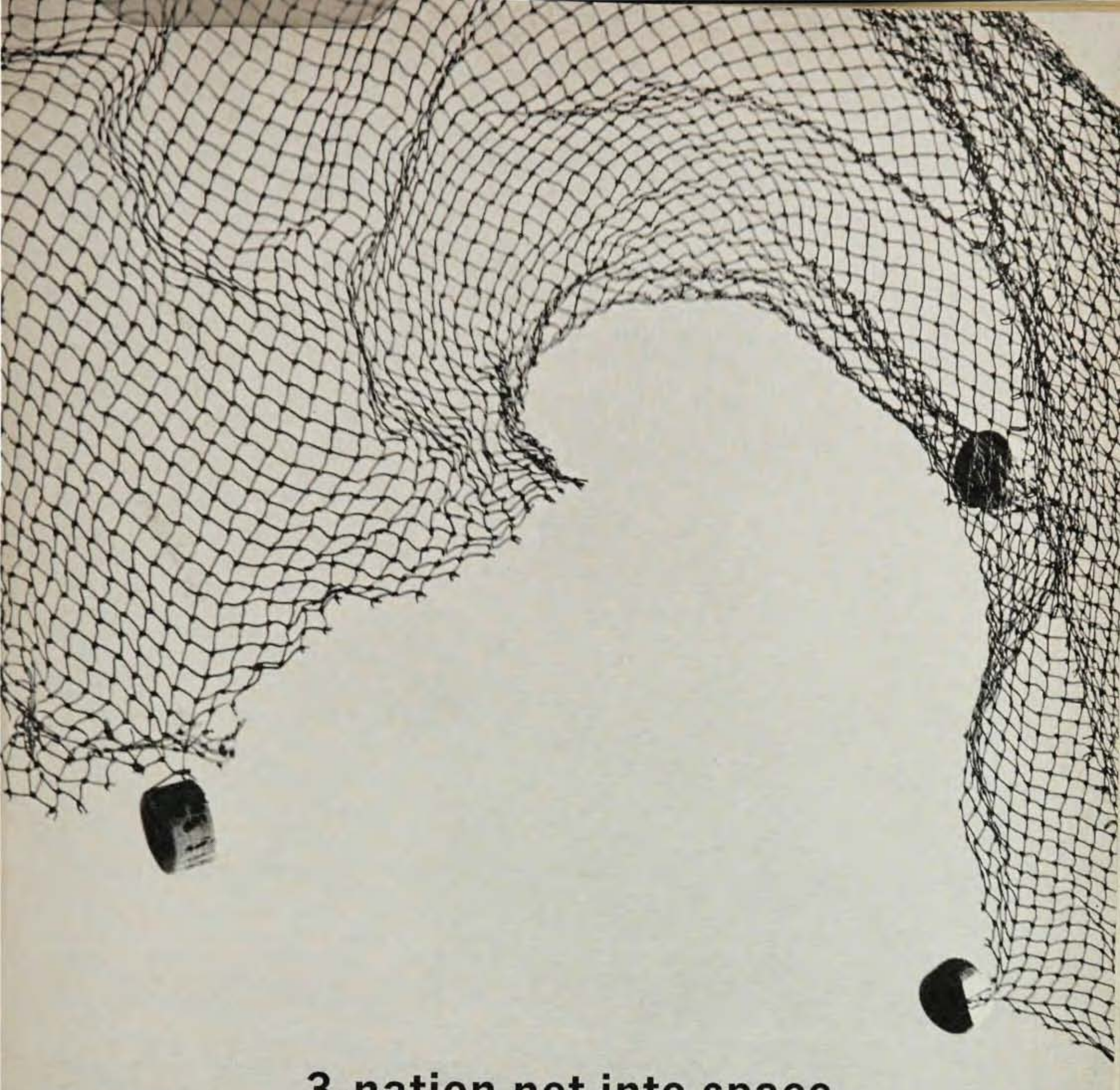
H. Alfvén examines the momentum spectrum of cosmic radiation; his findings differ from Fermi's theory. The author shows how energy of particles increases and decreases due to the change in the magnetic field. According to Fermi, cosmic radiation may infuse space uniformly, whereas Alfvén stipulates an intensity gradient causing diffusion.

I was particularly impressed by L. Infeld's inquiry into variational principles in relativistic dynamics. He relates his subject to the claim that repulsive nuclear forces occur if the particles are very near each other (J. Werle). Further, he derives the equations of motion for $v = c$ and investigates the possible interpretations of the relativistic Lagrangian. The treatment of the Lagrangian in a metric field is an æsthetic delight, especially the demonstration that for $L = 1$ we arrive at the equation of the geodetic line. Are there energy-carrying gravitational waves at all? No doubt the energy radiated by their emission has to be immeasurably minute so that a negative answer would be feasible. C. Møller is obviously persuaded that there are no such gravitational waves. In a scrutiny of the classical-relativistic treatment of spin, J. Weyssenhoff associates himself with Planck's belief in a connection between quantum and relativity theory. He warns us not to expect a better understanding of quantum theory from any new experimental discovery—his recipe: a re-examination of classical relativity theory to discover "bridges" to quantum theory.

N. Bohr's probing into the epistemology of quantum physics is an example of lucid argument. His views convey a point rather than originality, insofar as they were expressed by him on many occasions (their gist: caution in the choice of an appropriate terminology is mandatory whenever research opens a new domain of physical experience). We will assume with him that every physical description rests ultimately upon ordinary language. However, when dealing with elementary particles, Bohr wants us to avoid that manner of description which is employed for the presentation of causal relations. Does he not try the impossible?

Perhaps the most weighty of all contributions is V. Fock's interpretation of quantum mechanics. Like Bohr, he too stresses the importance of observational tools for adequate communication of a physical event. Planck's antipositivism is invoked to advocate the ultimate successes of quantum mechanics in the name of dialectical materialism. And while Heisenberg granted objectivity to a quantum state on "realistic" grounds, de Broglie, Bohm, and Vigier repudiate a positivistic interpretation by the reason of materialism, in its obsolete deterministic form. Fock rightly maintains that all these latter attempts have failed so far. His panacea: a physical interpretation of quantum mechanics which distinguishes between potentially possible (causality) and realized facts (observed states).

Unencumbered by such epistemological commitments, de Broglie suggests that the "mysterious" nature of Planck's h could be rationally comprehended, if this constant appears in the nonlinear terms (nonlinear partial derivatives) of the wave equation. I am very dubious about this contention since the mathematical technique involved is most exacting and, for many other reasons too, perhaps not the optimal method to predict traits such as mass, charge, spin, etc. In an excellent paper L. Rosenfeld analyzes Planck's definition of absolute entropy. If the author sought to appraise convincingly how Planck, Ehrenfest, Gibbs, and Boltzmann reacted to their respective conceptions of entropy, he fully achieved this aim. It is a strange experience to witness Planck's inability to penetrate into a true understanding of statistical thermodynamics, his enormous pioneering advance in this field notwithstanding. The highly informative article by F. Zwicky on collapsed matter of nuclear density and nuclear goblins concerns the role of energy with regard to the internal constitution of the stars. His results may shed light upon the way in which nuclear and gravitational changes are interrelated. He makes a



3-nation net into space

Goldstone, Calif., Woomera, Australia. Krugersdorp, South Africa.

Three different parts of the world thousands of miles from each other. Yet drawn together in a new and unique communications net: the Deep Space Instrumentation Facility.

DSIF is under the technical direction of Cal Tech's Jet Propulsion Laboratory for the National Aeronautics and Space Administration. Staffed and run by the host countries, the tracking stations will have 85-feet-in-diameter antennas, capable of transmitting and receiving. These giant, revolving steel and aluminum saucers are able to send and receive signals hundreds of millions of miles to and from space.

It was at Goldstone that JPL bounced signals off the planet Venus—35-million miles away. This two-month experiment gave us valuable data about the distance and surface of Venus and helped maintain the United States as the leader in planetary radar astronomy.

Communicating with deep space probes is just one function of the three stations of DSIF. Their primary job is tracking all the spacecraft designed by JPL to fly-by, orbit, and land on the moon and planets. Because the stations provide 360° coverage around the earth, one o the three will always be in contact with each distant spacecraft ii flight and after it arrives.

DSIF is an essential participant in the many space projects at JPL Ranger, Surveyor, Mariner. Some of these spacecraft are imminent Others are on JPL blackboards. All will bring new technologies, nev knowledge of our planets and the topless universes beyond, and a stil greater understanding of our own small world.

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strong case for supposing goblins (critical $M \approx 10^{21}$ grams; $R \approx 3$ meters) to be vital to an explanation of energy production in eruptive stars and stellar development.

The link between quantum theory and geometry is studied by M. Schönberg. His approach is rather unexpected at a moment when we try to give the mathematical formalisms of quantum mechanics and quantum field theory a physical meaning. The really exciting insight gained by workers in this displine is the proof that quantal algebras conceived as geometric algebras demand a basic unit of length!

P. A. M. Dirac shows the advantages of the relativistic wave equation of the electron in terms of Hermitian matrices. By generalization to Riemann space one can utilize the gravitational field and establish that the conservation law obtains throughout. The cogency of this paper is inexorable.

I should also like to draw the reader's attention to the following contributions: G. Heber submits a novel approach to an account of some physical and mathematical properties of a nonlocalizable field; the remarks on a uniform, nonlinear theory of matter by I. Iwanenko imaginatively transcend customary scholarly exposition; the well-written paper on quantization reveals once more the capacity of J. L. Destouches to elicit new problems from established topics; L. Pauling's ambitious subject, viz., quantum theory and chemistry, is treated in such a perfunctory manner that it scarcely supports the writer's correct claim as to the genuine difference between resonance in physics and resonance in chemistry. I might add that P. Caldirola and A. Longer argue soundly that von Neumann's and Birkhoff's approach to the ergodic theory, though adequate for classical statistical mechanics, breaks down in the case of quantum statistical mechanics (i.e., for microcanonical ensembles).

The *Festschrift* concludes with an appraisal of Planck's philosophic views concerning physics by L. Jánossy, who maintains that Planck dissociated himself from positivism and also from metaphysical ideas. (I think that Jánossy is wrong in this contention, particularly concerning the matter of metaphysics. I have tried to show, in collaboration with S. Mandelstam, that Planck was obsessed with abstruse metaphysical notions, the best illustration for this assertion being Planck's naïve interpretation of variational principles. This only proves that even a genius like Planck, a man with such deep understanding of theoretical physics, could be prone to recondite philosophic conclusions. Further, is Jánossy seriously of the opinion that Planck's physical reasoning shows an occasional affinity with dialectical materialism? Neither in his lectures nor in his writings have I detected a tittle of evidence for such an assumption.) Yet, in spite of my disagreement with some of Jánossy's imputations, I enjoyed his paper very much indeed and concur in many respects with its analysis of Planck's natural philosophy.

"The physical science of our days shows an aspect totally different from that of 1875 . . . and Max Planck is entitled to the lion's share in the credit for these changes." So spoke Max von Laue in the Albani Church in Göttingen, on October 7, 1947. Any occasion to devote one's best thoughts to a tome containing contributions to the memory of a scientist of Planck's greatness will show one's fellow workers the extent to which science has grown by reason of this very object of our dedication. I recommend this collection of articles to all those who like to ponder under a canopy of manifold and colorful attitudes and diverse doctrines. If it is true that a man is as great as the problems which irritate him, then Planck was one of the scientific giants of all times. The publishers and the editor responsible for this book have done a magnificent job—with knowledge, tact, and efficiency.

Science Since Babylon. By Derek J. de Solla Price. 149 pp. Yale University Press, New Haven, Conn., 1961. $4.50. *Reviewed by Robert L. Weber, The Pennsylvania State University.*

IN five polished and lightly footnoted essays, the author seeks to attract the attention of humanists and scientists to the "humanities of science". In an epilogue he seeks to justify the need for an autonomous university department, in fact a very large department, for the study of the history of science.

In "The Peculiarity of a Scientific Civilization" Professor Price accounts for the fact that our civilization alone has a high scientific content as being a result of the mixture, at an advanced level, of two quite different scientific techniques: one the logical, geometrical, and pictorial Greek insight, the other the quantitative and numerical skill of the Babylonians. The sequel was the early arrival in our civilization of a refined and advanced system, mathematical planetary theory, for the mathematical explanation of nature. Price believes that the origin of our exact sciences is to be found in a meeting between people who had used methods that were different but applicable to a single interest, and that it is important to make sure that this process may continue.

"Celestial Clockwork in Greece and China" adds to the Graeco-Babylonian heritage of mathematical physics with the introduction of the second leg of science: a high technology of scientific instruments, dating at least as far back as the first century B.C.

Price finds that in conventional accounts the Scientific Revolution is suspiciously well planned and too dependent upon the giants, Francis Bacon, Galileo, and Newton. In place of the eureka syndrome he prefers to emphasize the cumulative contributions of the almost anonymous practitioners, their books, and their societies. In "Renaissance Roots of Yankee Ingenuity" he suggests that even though the total state of science in the United States up to about a hundred years ago had a surprisingly small absolute value, it was a flare-up of old-fashioned Hellenistic Yankee ingenuity that set America on the path that has led to its present state.

To Price, the history of science seems to be rather