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

like a zipper that cannot be pulled up the last inch. In "Mutations of Science" he attempts to close this gap (the last century of science) by picking a vital spot for microscopic examination that will reveal the character of the period. Chosen for examination is Roentgen's discovery that "split open the world of physics"; but the curious error of N rays is also recounted. The intent or conclusion of this chapter is less clear.

Physicists who heard Professor Price's prepublication presentation at the AAPT meeting in February seemed to find a wry satisfaction in his diagnosis of the "Diseases of Science", the most quantitative, forward-looking, and disturbing of the essays. Science in its youth is shown to benefit from an exponential law of growth, only to be strangled in its maturity by a saturation limit. Science's superabundance of literature, its manpower shortages, its increasing specialization, its tendency to deteriorate in quality are presented as symptoms of a general disease. That disease might be understood better through the efforts of historians of science: "Even if we could not control the crisis that is almost upon us, there would at least be some satisfaction in understanding what was hitting us."

Laboratories in the Classroom. New Horizons in Science Education. 96 pp. Science Materials Center, Inc., New York, 1960. Paperbound $1.45. *Reviewed by Ira M. Freeman, Rutgers University.*

IN the twenty-five short essays that make up the volume under review, prominent American science educators have attempted to answer the questions: "What are the basic aims of science and mathematics education?" "What plans are being made to develop new curricula?" "What new procedures and materials are being considered?"

Names of some of the authors will be familar to many physicists who are concerned with teaching—Paul Brandwein, Fletcher Watson, Morris Meister, Alfred Bender, and others. Most of the pieces have been written expressly for this book; a few have been adapted from earlier publications.

The individual contributions touch on a wide variety of problems connected with the teaching of science in the elementary and secondary schools. Some of the topics that receive attention are creativity in science teaching, the provisions of the National Defense Education Act, TV in science teaching, club programs in the schools, teacher training, summer programs, and mathematics education.

In spite of their brevity, most of the articles are stimulating and informative. The reader who may not actually be engaged in school science education will come away with a definite impression that this field is now beginning to receive the intensive and serious kind of rethinking that it has needed for so many years. There is, for one thing, the growing realization among science teachers, administrators, and even school boards of the necessity of planning a coordinated science program extending from kindergarten through the twelfth grade. It is hoped that increasing awareness of this need will enlist the interest and talents of people who are in a position to devise much-wanted substitutes for the haphazard, dull, and repetitious mishmash that still passes for a science program in many of our schools.

In this connection, Fletcher Watson points out a real danger. Under the pressure of immediate needs, the field may come under the influence of "numerous groups, largely composed of educational amateurs, who are concerned with only a small segment of the most able students", and in place of a workable program for the long run, we may be saddled with "improvisations dominated by the personal enthusiasms of a few people for a particular subject, approach, or portion of the student population". These remarks may remind some physics teachers of one recent effort that has succeeded in creating more than a mere ripple, thanks to the great sums of money placed at its disposal and the zeal of its originators.

An Introduction to Celestial Mechanics. By Theodore E. Sterne. Vol. 9 of Tracts on Physics and Astronomy, edited by R. E. Marshak. 206 pp. Interscience Publishers, Inc., New York, 1960. Clothbound $4.50, paperbound $2.50. *Reviewed by S. F. Singer, University of Maryland.*

OF a number of recent works that I have read which deal with celestial mechanics, this appears to be one of the very few which is suitable for teaching and self-education. But it has another virtue: it presents about all that is necessary and useful, e.g., to physicists who through no fault of their own have been "propelled into space" from nuclear physics, quantum field theory, and similar "classical" endeavors.

The author is not without a sense of humor. He recommends this book to a beginning graduate student who has concentrated in physics and "is presumed to know Newton's second law, but not Kepler's". In fact, however, the student should have had a course in mathematical physics and theoretical mechanics, at least up to the level of Hamiltonians, in order to absorb the material profitably.

The first half of the book is indeed written at a fairly elementary level. Astronomical notation is used throughout, and units are carefully defined. A particular feature is the addition of a large number of worked-out problems. It is easy to see that the author has a great deal of experience with the solution of satellite orbit problems and applies this experience to the writing of the book. A good example of the careful attention given to an important subject is the referencing of the information on the value of the astronomical unit.

The discussion is very concise. Most of the orbit problems which one faces in conventional space travel problems are compressed into twelve pages of text. The eighteen worked-out examples really illustrate how to use the information. This is important both for a student