laboratory and field. Static pressures up to about 2×10^5 atmospheres (corresponding to about 500 kilometer depth) are still difficult but are no longer major research enterprises. Considerable temperature variation at these pressures has become accessible as well.

Bridgman's ancient prediction that polymorphism (lattice transformations) will be ubiquitous has been fully verified. For higher pressures found in the earth, up to several million atmospheres, one must be satisfied with simulation by shock-wave measurements. In recent years these, combined with relatively crude theory, have given us at least an approximate account of the state of matter throughout the earth. In formulating such an account we are helped by our knowledge that nuclear abundances vary, on the whole, exponentially, so that the number of elements that predominate in any one layer of the earth is small indeed. Although Stacey does not lead his readers directly to the border of the promised land, he brings them far enough, so they can do some exploring of their own.

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Elements of Quantum Theory

By Frank J. Bockhoff
304 pp. Addison-Wesley, Reading, Mass., 1969. $10.50

This book is intended to initiate undergraduate chemistry students with very limited physics and mathematics backgrounds into the concepts and elementary applications of quantum mechanics.

The author, professor of chemistry and chairman of the department at Cleveland State University, has gone to some pains to give a detailed development of those aspects of the subject that the beginner usually finds most difficult. The text divides roughly into two sections. The first half leads to a statement of the postulates and their application to the standard problems of particles in boxes and barrier penetration, and the second half treats the quantum description of atomic and molecular structure with emphasis on the hydrogen and helium atoms.

The book's principal merit is its detailed exposition. There is nothing in the subject matter here that is not found elsewhere, but an undergraduate encountering quantum mechanics for the first time may find it a useful adjunct to his reading.

HENRY S. VALK
Physics Chairman
University of Nebraska

Aphorism XXXI

Elementary Mechanics should now form a part of intellectual education, in order that the student may understand the Theory of Universal Gravitation: for an intellectual education should cultivate such ideas as enable the student to understand the most complete and admirable portions of the knowledge which the human race has attained to.

Aphorism XXXII

Natural History ought to form a part of intellectual education, in order to correct certain prejudices which arise from cultivating the intellect by means of mathematics alone; and in order to lead the student to see that the division of things into Kinds, and the attribution and use of Names, are processes susceptible of great precision. . . .

Whewell's suggestions for an intellectual education. From book reviewed below.

William Whewell's Theory Of Scientific Method

Robert E. Butts, *ed.*
358 pp. Univ. of Pittsburgh Press, Pittsburgh, Pa., 1969. $8.95

William Whewell (1794–1866) was a noted representative of mid-19th century British science and philosophy. Master of Trinity College, Cambridge from 1844 to his death, he held a distinguished position in scholarly and scientific circles. He was also a prolific writer with a considerable vogue in his day. Physicists pay little attention to him today, though his *History of the Inductive Sciences* (1837) was probably the first serious history of science to be published in English.

In this volume, Robert Butts, who teaches philosophy at the University of Western Ontario, has revived interest in Whewell by reprinting some of his writings on scientific method. Butts has also prefaced the anthology with an instructive commentary on Whewell's ideas, which covered a wide range of topics in both the logic of the physical sciences as well as what is now called "the psychology of scientific research."

The reader brought up on the modern views of philosophy of science initiated by Mach, Duhem and Poincaré and reinforced by the successes of relativity and quantum theory, will obviously find Whewell's ideas outmoded, not to say quaint. He lived in an age in which the rapid progress of science led many to the optimistic belief in successful scientific theories as "necessary truths." This is well brought out in his discussion of the laws of motion. It is true that Whewell laid considerable stress on the use of hypotheses in science, differing therein considerably from John Stuart Mill, whose views he criticized with some severity. Whewell also paid great attention to, and had great faith in, induction as a basis for scientific discovery. But he failed to see the advantages of the deductive–inductive method, which has proved so powerful in modern scientific theorizing.

R. BRUCE LINDSAY
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Nuclear Quadrupole Coupling Constants

***By* E. A. C. Lucken**
360 pp. Academic, New York, 1969. $14.50

Several firms have sensed a burgeoning interest in nuclear-quadrupole resonance studies, if the reports of commercial designs to market a general purpose NQR spectrometer are correct. Edward Lucken's book thus makes a timely appearance, and, in fact, is the first comprehensive review to appear since the pioneer monograph in 1958 by T. P. Das and E. L. Hahn (*Nuclear Quadrupole Resonance Spectroscopy*).

Lucken has given a somewhat broader coverage of quadrupole-coupling constants by including useful introductory material on their measurement in nuclear-magnetic resonance, electron-spin resonance, microwave, optical and Mössbauer spectroscopy, although it is quite natural to emphasize the results of solid-state NQR. In language familiar to chemists, the book provides a very readable summary of the NQR field, both from the view of theory and of accumulated experimental data. It will be an admirable introduction for graduate students as well as an updated survey for their professors.

Lucken has concentrated on giving a detailed discussion of the origin of quadrupole-coupling constants and their interpretation in terms of the nature of the chemical bond. Starting with a good chapter on coupling constants in atoms, and a clear presentation of electronpolarization effects (Sternheimer shielding), the discussion is then extended to results of molecular-orbital calculations. This establishes the background for the widely used semiempirical approximations due originally to Townes and Dailey, in which field gradients in molecules are related to the p electron density in the σ, π, and lone-pair orbitals of the atoms. Although the validity of these simplifying assumptions is considered with care, the author has not presented a formal development of this theory. It will likely occasion some confusion among the uninitiated—compounded here by some printing errors and some expressions quoted without derivation.

A particularly worthwhile account is given, however, of the importance of the radial part of the atomic wave functions in the accurate calculation of field gradients in both atoms and molecules. Lucken raises the very interesting question as to whether the σ and π electrons contribute equally in determining molecular coupling constants because they appear to differ in their radial dependence. The evidence on this point is sparse, but it is clear that the question is crucial in aiming at an improvement in the significance of the Townes and Dailey treatment.

The solid-state physicist will find that the book, although generally quite complete, makes scant mention of dynamic processes, relaxation effects, line widths and the general problems of field gradients in ionic solids and metals. A chapter on experimental methods in NQR is notably absent. Such an account might also have helped give the reader a feeling for the physics of the experiments, which is otherwise treated rather formally.

Experimental results are summarized in the second half of the volume, with extensive references up to the end of 1967. A spurt of new work on NQR in transition metals, principally cobalt, rhenium and manganese, has not been included. The author rightly does not attempt a complete compilation of known quadrupole-coupling constants, but quite enough are quoted to serve as a useful reference work.

ELLORY SCHEMPP
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Frühgeschichte Der Quantentheorie, 1899–1913

By Armin Hermann
181 pp. Physik Verlag, Mosbach in Baden, 1969. Paper, 24 DM; cloth, 27 DM

Armin Hermann's book makes it apparent that the history of the early years of quantum theory differs markedly from the sketchy, over simplified chronicle that many of us accept and recount to our students. This was brought home to me particularly by the chapter on the contributions of the Viennese theoretical physicist Arthur Haas (1884–1941).

Although I knew Haas and had worked with him on a project of mutual interest after he came to Notre Dame University in the 1930's, I had not realized his priority in applying the quantum idea to the atom. Hermann shows that in this regard, Haas anticipated the work of Niels Bohr by more than three years. For it was Haas who first connected Planck's constant with the dynamics of the atom and who first succeeded in expressing the Rydberg constant in terms of fundamental atomic quantities.

Curiously enough, the model used by Haas was not the nuclear atom but that of J. J. Thomson; Ernest Rutherford's scattering experiment had not yet been conceived. Nevertheless, the result was valid for a planetary atom because the Haas calculation referred to electrons coursing over the *surface* of the Thomson model. As a consequence, the size of the sphere of positive charge did not affect the result.

Because of a computational error, the numerical value of the Rydberg constant turned out to be wrong, but both R and the atomic radius a_1 were of the right order of magnitude. More importantly, the method used by Haas was essentially the one Bohr later adopted.

Haas first presented his ideas in a talk before the Vienna Chemical and Physical Society in February 1910. Unfortunately this was at about the time of the winter carnival and the experimenter Ernst Lecher characterized Haas's work as a carnival spoof. Later, according to an unpublished Haas autobiography, Fritz Hasenöhrl remarked to a colleague that "Haas was not to be taken seriously because he naively tried to combine quantum theory and spectroscopy—two subjects that could not possibly have anything in common." Subsequently, Hasenöhrl reversed himself, and others were at least charitable enough to characterize Haas's thesis as "harmless."

By October 1910, H. A. Lorentz had dignified the idea as "a daring hypothesis;" and it was taken up and seriously discussed by Arnold Sommerfeld at the first Solvay Congress in 1911. Finally, in a recorded interview for the *Sources for the History of Quantum Physics* Bohr remarked that "It was quite clear [in 1912] . . . that we now had the Rutherford atom . . . and that it was regulated by the quantum. Haas had written all these things the year before, but I did not know of them . . . ." Another ironical twist in the skein of history.

Frühgeschichte der Quantentheorie, 1899–1913 is an exceedingly well documented account of the first 15 years of the quantum idea. It takes the reader from Planck's presentation of his theory of blackbody radiation in a talk before the Berlin Physical Society on 14 December 1900 to Bohr's quantum description of the hydrogen atom in March 1913.

The author, formerly engaged in high-energy physics research in Hamburg, is now professor of the history of the natural sciences and technology at the Stuttgart University. He is the editor of a recently compiled collection of the Einstein–Sommerfeld correspondence.

The book is arranged according to the work of the eight greatest contributors to the theory: Planck, H. A. Lorentz, Einstein, Stark, Haas, Sommerfeld, Nernst and Bohr each get a chapter. This ordering by men rather than by ideas makes for some repetition, but it is not troublesome. The author's intention is to make possible the reading of any one chapter independent of the rest. A comprehensive list of literature references is appended to each chapter.

Hermann maintains that one can attain a true understanding of a theory only by personally following the thought process that originally led to its establishment—the path taken by the great innovators themselves. His book proves to be an effective guide in this quest.

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Understanding Thermodynamics

By H. C. VanNess
103 pp. McGraw-Hill, New York, 1969. Cloth $4.95, paper $2.95

This little collection of lectures is a laudable attempt to help students who, for the first time, are encountering thermodynamics beyond the substituting-in-formula stage. The work is frankly pedagogic, and therefore shares the vulnerability to differences in taste that is characteristic in poetic or culinary works. It is *not* a text, but is rather a supplement to any standard one.

The response to the material varies even in a single reader. The opening chapter, on the First Law, is in my view an unfortunate beginning. In the attempt to show the basic character of the First Law, H. C. VanNess, professor of chemical engineering at Rensselaer Polytechnic Institute, has unwittingly violated his own precept of trying first to help the students. The treatment, to be sure, is rewarding for those who already understand its logical nature. But a beginning student must feel that the conservation of energy principle, as met in a thermodynamics course, is