tant contributions to all these topics are reflected in the papers cited in the various articles. Looking through the bibliography of Bethe's own publications one gets the impression of a gigantic but very delicate and perceptive tree-dozer moving through a forest of natural phenomena selecting the most interesting obstacles in its path and leveling them to the ground. Young physicists would be well advised not to look for choice problems overlooked by Bethe.

It is surely unfair, but perhaps useful, to single out a few of the papers in this volume. At the risk of offending some of my friends, I shall do so. In the opening paper, R. F. Bacher and V. F. Weisskopf review Bethe's career in a charming way, with many footnotes recounting personal anecdotes. Gregory Breit, another scientific contemporary, gives a thoughtful review of the nucleon-nucleon interaction, a subject close to Bethe's heart. Robert R. Wilson, now director of the National Accelerator Laboratory, recalls the development of accelerators at Cornell, revealing Bethe's not very widely known contributions to accelerator theory. Quantum electrodynamics is reviewed in two papers, the experimental aspects of atomic level shifts by Willis Lamb and the limits of current theory by Francis Low. Various aspects of astrophysics are discussed by William Fowler, R. E. Marshak, George Gamow, Edward Teller, E. E. Salpeter, and others. These contributions are particularly appropriate in view of Bethe's 1967 Nobel Prize award for his 1938 paper on the carbon cycle. There are several very interesting papers on solid state physics, one of Bethe's early interests.

A particularly fascinating paper, dramatically different from all the others, is that by Freeman J. Dyson. Dyson addresses the question of what might be accomplished by a truly advanced extraterrestrial technological society and what might be observed by us of projects carried out by that society. This is the one paper in the volume that Bethe probably could not have written himself.

Robert Marshak is to be commended for putting together this testimonial to the one whom Bacher and Weisskopf describe as "the great craftsman of our profession."

M. L. GOLDBERGER
Institute for Advanced Study, Princeton, New Jersey

Physics Taught Deductively

General Physics. Mechanics and Molecular Physics. L. D. LANDAU, A. I. AKHIEZER, and E. M. LIFSHITZ. Translated from the Russian edition (Moscow, 1965) by J. B. Sykes, A. D. Petford, and C. L. Petford. Pergamon, New York, 1967. x + 372 pp., illus. $8.

This is a book on a very elementary college level, and is not to be confused with the fabulous nine-volume Landau and Lifshitz *Course of Theoretical Physics*. The first hundred pages cover just enough classical mechanics to lay down the general principles and concepts used in the remainder of the book, which is devoted to elementary kinetic theory, thermodynamics, surface phenomena in liquids, viscosity, the theory of symmetry in crystals, and the kinetics of chemical reactions. In short, this is more of a physical chemistry text than the traditional physics course one might expect from the title *General Physics*.

The history of the book is rather unusual, since it was first written in 1937 but was not published until a few years ago. Rewritten and brought up to date by Akhiezer and Lifshitz, it retains some of the old-fashioned style and point of view of the '30's.

The presentation of the material is formal, cool, and graceful. The translators have maintained a high standard of English style not always found in technical books, and the translation is uniformly accurate. A considerable amount of authoritarianism is to be detected in the pedagogical approach of the book. Definitions are laid down, assumptions are made, Laws of Nature are invoked, and results are deduced. But nowhere is the student given a reason for believing in conservation of energy, except for the word of the authors that this is an important law of nature.

In at least one place, this deductive approach leads the authors into a type of logic that appears backward, to my way of thinking. Starting with the assumption that space is homogeneous (that is, that the properties of a closed system do not depend on its position in space), they show that the law of conservation of momentum follows. True enough *if* space is indeed homogeneous. But a psychologically more valid approach is to say that experimentally we observe momentum to be conserved and that this leads us to believe that space is homogeneous. In a similar vein, Le Chatelier's principle is invoked several times to predict the direction of a change of state, no motivation being given beyond a statement that it is a law of nature. This reliance on abstract principle is fine in an advanced course, but in an elementary course I would expect to spend more time building up from the concrete evidence to the abstract concepts.

However, the aim of the authors, as described in the preface, was simply to present the material in the most compact way, and in this they have succeeded very well. The chapter on symmetries in crystals is a small masterpiece, and the qualitative material on phase transitions is handled beautifully.

There is an index, but no problems, so this book may not be useful as a classroom text; but it can be highly recommended for supplementary reading or review purposes.

MILTON A. ROTHMAN
Plasma Physics Laboratory, Princeton University, Princeton, New Jersey

The Special Theory

Précis of Special Relativity. O COSTA DE BEAUREGARD. Translated from the French edition by Banesh Hoffmann. Academic Press, New York, 1966. xvi + 123 pp., illus. $5.75.

The Logic of Special Relativity. S. J. PROKHOVNIK. Cambridge University Press, New York, 1967. xiv + 128 pp., illus. $5.95.

Special Relativity. A. SHADOWITZ. Saunders, Philadelphia, 1968. xiv + 203 pp., illus. $6.50. Studies in Physics and Chemistry, No. 6.

Each of these three books on special relativity has been designed with a different purpose in view. Together they complement one another ideally.

The first book under review, Olivier Costa de Beauregard's *Précis of Special Relativity*, is a translation of the author's *Précis de Relativité Restreinte*, published in 1963, which in turn is an extract from his treatise *La Théorie de la Relativité Restreinte*, originally published in 1949 in Paris. John A. Wheeler, in a preface to the English edition, points out its value: "I know of no book that is at the same time more precise, more accurate, and more succinct in presenting so complete a treatment of Special Relativity." As a rule, subsequent editions of basic treatises provide their authors with opportunities to enlarge their texts, and each later edition is an amplification of its predecessors. In the present case the opposite process has been carried out. As a result the student of special relativity finds in this 123-page volume a concise but not superficial, a penetrating but not effusive exposition of all important nonspinorial aspects of the theory, treated with a clarity of insight and a lucidity of formulation in the best tradition of French scientific writing. This is achieved by introducing, after a short survey of experimental preliminaries, the formalism of tensors in Euclidean and pseudo-Euclidean spaces. The symmetry—though not identity—of the roles of space and time in the theory is fully made use of in the following chapter on kinematics and optics, which includes material, such as relativistic photography (J. Terrell, M. L. Boas), that was not yet known at the time the original French edition was published. The third chapter, on relativistic electromagnetism, although condensed into only 12 pages, leads the reader through the theory of the Maxwell tensor to the treatment of electromagnetic polarization and to certain asymmetric tensors which have important applications in current quantum field theory. The last two chapters, on relativistic dynamics and relativistic analytical dynamics, respectively, include Fokker's principle of stationary action and the ingenious Wheeler-Feynman emitter-absorber theory concerning radiative irreversibility—a topic on whose relations with the perfect symmetry between past and future in the fundamental physical equations the author has made important original contributions.

All this material is expounded without a break in logical continuity. It is really astounding how much physics can be dealt with within such narrow confines. Naturally the computative details of the proofs are given only in outline, but the explanations, as a rule, are given in full. The book clearly is not intended to be a primer of relativity, but every student who is no novice to the subject will draw great profit from it. Recalling the particular prehistory of this edition of Costa de Beauregard's *Précis* we may certainly say that his book will not fall into the category of books about which Franklin Pierce Adams once quipped, "A first edition of his work is a rarity but a second is rarer still."

If Beauregard's book deals with special relativity primarily as a formal theory in physics—or rather about physics—and touches upon issues of philosophical importance only at the highest summits of its exposition, Prokhovnik's study, on the whole, concentrates on the logical and methodological difficulties underlying the very foundations of the theory. In fact, the major part of its elaborations centers on the physical significance of the Lorentz transformation equations and their consequences. Prokhovnik is the spiritual heir of the late Geoffrey Builder (the book is dedicated to his memory), who established in Sydney, Australia, during the past decade or so an independent school for the study of the interpretation of special relativity. Prokhovnik today is the foremost leader of this school. His study, based on a number of previous publications of his in British and Australian journals, discusses some of the most controversial issues of the theory, such as the "clock paradox." This problem, implicitly referred to already in Einstein's fundamental paper of 1905 and first marked as a "paradox" by Langevin in 1911, gained, as is well known, wide publicity—or even notoriety—after the famous controversy in 1956 between H. Dingle and W. H. McCrea and still engages the attention of physicists and philosophers of science alike. It is salutary to find in Prokhovnik's study a comprehensive investigation of the issues involved.

After dealing with the experimental background and the development of the theory of special relativity as presented by Einstein, the author introduces the reader to the basic controversy about the meaning of time-dilatation: is it an absolute phenomenon, as Einstein assumed, or is it merely observational, like the diminution of size perceived by two mutually receding observers? Prokhovnik presents an up-to-date survey of the experimental evidence on this question, in addition to a penetrating analysis of the logical aspects of the issue. As to the reversal problem of out-and-return journeys, Einstein's recourse to general relativity and its elaborations by Tolman, Møller, Taylor, and Hurst are fully analyzed.

The most thought-provoking part of the book is probably the fifth chapter, which is entitled "The logic of absolute motion." It tries to show how far the ether hypothesis, underlying the early attempts of Lorentz and Poincaré, and —in spite of Einstein's brilliant achievements on the basis of its rejection—later espoused again by Ives, Janossy, Whittaker, Bastin, Surdin, and Builder, can be reconciled with the Lorentz equations and used as a basis for an unambiguous explication of the reciprocity phenomena. In the final chapter this neo-Lorentzian approach is related to modern views in cosmology: a physical model of the universe is constructed which shows that the different interpretations of special relativity have each an "exact and credible validity at different levels of description." The mathematical proofs of the theorems used in the main arguments are supplied in six appendices, so that the reading of the text is coherent and smooth.

Whether right or wrong in the position it adopts, Prokhovnik's book makes, by explaining the logic of the opposing viewpoints and the nature of these conflicts, a valuable contribution to the understanding of a scientific controversy which has led to heated debates and is by no means yet resolved. Even if the present study does not resolve all these problems, it provides new insights and much knowledge. It is certainly *not* one of those books H. L. Mencken had in mind when he wrote: "The chief knowledge that a man gets from reading books is the knowledge that very few of them are worth reading."

Albert Shadowitz's text intends to be neither a comprehensive summary nor a foundational investigation of special relativity; it has, rather, a didactic aim: to present for the freshman and the undergraduate in general a textbook which by pruning the shrubbery of the surrounding mathematics allows "a quick approach to the trunk of the theory and more easy access to the distant branches," as Richard Stevenson remarks in his foreword. If this was the purpose of writing the book, the author has scored a brilliant success. He has done so by choosing a geometric approach based on the Loedel diagram.

This graphical representation of the Lorentz transformation was proposed for the first time some 20 years ago by Enrique Palumbo Loedel of the Universidad Nacional de La Plata in a paper published in volume 145 of the *Anales de la Sociedad Científica Argentina*. It avoids certain didactic defects which deprive the conventional Minkowski and complex rotation diagram methods of their illustrative strength, such as the need for imaginary time coordinates, imaginary angles of rotation, different units of length for the various axes determined by their intersection with families of hyperbolae, and the like. By using only real coordinates and real angles without the need of any scale change for length and time in the different systems of coordinates involved, the Loedel diagram, still more than the Robert W. Brehme diagram, leads to an important simplification for the understanding of the physics of special relativity.

Yet in spite of its unquestionable superiority over its competitors, the Loedel diagram was not given any attention (probably owing to the fact that the Spanish-American scientific literature is to a great extent unknown in the North) until it was independently discovered by Henri Amar of Lafayette College, Easton, Pennsylvania, in November 1955. Shadowitz's is the first book to make systematic use of the Loedel method in expounding special relativity.

Despite the fact that only elementary mathematics is employed—only the chapter on form invariance (contravariant and covariant tensors, pseudotensors, and the like) makes use of the calculus—the author succeeds in treating virtually all the topics taught even in graduate-level courses in special relativity. The first five chapters deal with the kinematics and optics of relativity and include a discussion of whether the so-called Lorentz contraction is real and a treatment of the shape of moving objects. This section is followed by chapters on relativistic dynamics and on electricity and magnetism which excel in lucidity of explanation.

Since owing to his choice of approach the author did not share Blaise Pascal's difficulty ("The last thing we decide in writing a book is what to put first") but had to start with explaining the Loedel diagram, he was forced to postpone the discussion of the details of the experimental evidence (up to 1964) in support of the theory to the concluding chapter. Each chapter has a biographical section of well-chosen references and a collection of problems commensurate in difficulty with the level of the prospective reader. The book is highly recommended as an introduction to the subject and may be supplemented in breadth by the first book and in depth by the second book under review. Shadowitz's book will certainly also facilitate the work of the instructor who, in this respect, will probably object to the first part, and accept the second part, of the Logan Pearsall Smith apothegm: "I hate having new books forced upon me, but how I love cramthroating other people with them."

MAX JAMMER
Bar-Ilan University, Ramat-Gan, Israel

Early Rocketry

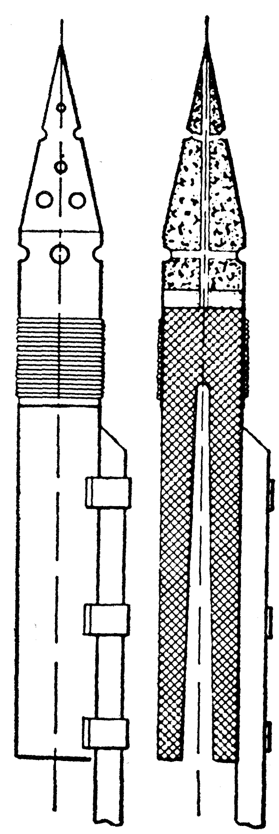
Russian Solid-Fuel Rockets. V. N. SOKOL'SKII. S. G. Kozlov, Ed. Translated from the Russian edition (Moscow, 1963) for the Israel Program for Scientific Translations. H. Needler, Transl. and Ed. National Aeronautics and Space Administration and National Science Foundation, Washington, D.C. (available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va.). iv + 236 pp., illus. Paper, $3.

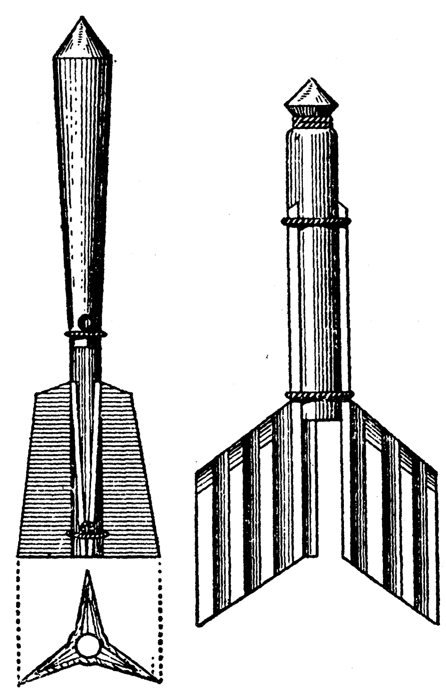
This work fills an almost total gap in one segment of the history of technology—Russian military rocketry. Rocket ordnance and pyrotechnics progressed in occasional spurts for nearly 600 years before Robert H. Goddard and other 20th-century experimenters springboarded from the heritage of 19th-century rocket motor design and ballistics. Yet general histories of the course of early rocket development are rare. There are only two good histories of rocketry in print, the classic work of Willy Ley and the more recent book by von Braun and Ordway.

Only the most scanty references to Russian rocketry have been available until this carefully documented book by historian Viktor N. Sokol'skii. That a translation has been made into English is a measure of the broad historical research activity of the National Aeronautics and Space Administration under the direction of NASA historian E. M. Emme. Translation must have been difficult for lack of suitable reference works to consult, and credit is due translator and editor H. Needler for a painstaking effort.

Sokol'skii has obviously performed an immense amount of research in Soviet archives. Each chapter has dozens of detailed references. The author carefully documents the introduction of pyrotechnic rockets into Russia late in the 17th century. By the early 1700's the writings of Simienowicz and others became available to the court and artillery laboratories. Formulas for block powder variations are given, and their use in fireworks displays is treated.

By 1814 the success of William Congreve's side-stick mount rockets had spread eastward across Europe, and corresponding models were being produced and tested in Russia. Performance results of those built by Kartmazov (up to 1¾ miles for 3.5-inch caliber) were quite respectable. Within a few years, A. D. Zasyadko performed numerous design analyses on rocket shell thickness, ratios of diameter to length, and so on. By 1823 the 1815 center-stick design of Congreve was introduced





Russian rockets of the 19th century. (Left) Military rocket of 1817, designed by A. D. Zasyadko. As in the 1805 British design of Sir William Congreve, the forward end contains incendiary material similar to Greek fire. (Above) Two varieties of fin-stabilized stickless war rockets attributed to Chichinadze and Staff Captain Skripchinskii in the 1860's. [From *Russian Solid-Fuel Rockets*]