

cessity or upon the author's whim. As a practical matter, another problem for the foreign reader is the occurrence of Russian designations for materials—for example, the steels used in pressure vessels. The editor has endeavored to alleviate as much of this suffering as possible (a table in the appendix giving the composition of Russian steels allows one to determine the nearest US equivalent).

Although the book is concerned with apparatus and technique and not the results of research, the selection of apparatus is slanted in the direction of engineering and thermodynamic studies. Phase equilibria, compressibility of gases and liquids (nothing on solids), flow and surface tension receive extensive treatment. Apparatus for optical, x-ray and simple electrical measurements receive only cursory mention at the end, and there is nothing dealing directly with low-temperature-high-pressure studies or any of a great variety of other investigations in physics and chemistry that have been extended into the high-pressure realm in recent years.

Within these limitations, what remains is nonetheless a valuable book that is exceedingly thorough in treatment of its intended subject matter. The pressure-range coverage extends from equipment designed for experiments at less than a kilobar to ultra-high-pressure anvil and belt devices operating at the upper limits of present capability. There is a wealth of information on design considerations (including mathematical analysis) and lucid descriptions of actual equipment. Perhaps the most valuable feature of the book is the 320 figures, which are usually drawn to scale and reproduced in large size with important parts labeled and identified in the captions. Many of these figures occupy an entire page even though the book is printed on oversized pages. There are a few errors in the figures, but these are usually minor and obvious. All the standard paraphernalia of the high-pressure laboratory are covered: valves, seals, fittings, joints, windows, cylinders, pistons, compressors, pumps, intensifiers, manometers, electrical leads, even building construction. There are detailed instructions and tips on machining, heat treating, shrink fitting, safety precautions, and a variety of other problems. The chapters on valves and pressure measurement are exceptionally thorough.

The approach to problems may at times be accused of being old fashioned. For example, mirror arrangements are described for viewing gauges and the like placed behind walls in the high-pressure room, whereas the modern approach would more likely be to use closed-circuit television. In the same vein, the discussion of apparatus for compressibility measurements was devoid of any reference to recent electronic advances in capacitance measurement that give the capacitance technique great advantages over practically all others in many cases.

It was surprising to find only one reference to epoxies that have become very popular with American researchers for constructing electrical seals. However, except for the introduction of new materials, the high-pressure business changes slowly. Basic design concepts have been substantially the same for half a century and are likely to remain valid for the foreseeable future, and it is these with which the book is primarily concerned.

The modern, affluent researcher interested in high pressure only as a tool and willing to buy his apparatus can probably do without this book. For the man who must do it himself or who simply wants to know what has been done and the best alternative for his particular needs, I can not recommend a single book that is better suited to answer his questions, although I would recommend a few in addition.

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The Acoustical Foundations of Music

By John Backus
312 pp. Norton, New York, 1969.
\$7.95

The cultural gap between artists and scientists is bridged in many places, but especially by the interest that many scientists have in music. All scientists have been exposed to music; a good many of them have in their early years devoted long hours (perhaps unwillingly) to learning to play a musical instrument, and some have achieved a mastery quite comparable with that of the professional music student. The converse is much rarer; relatively few music students have had a similar exposure to the content

and techniques of physical science. John Backus's own interest in music has led him to work in a somewhat neglected area of physics—the acoustics of musical instruments. More than this, he has attempted to stimulate an interchange between the two cultures by teaching to music students at the University of Southern California a course designed to give them some insight into the nature of the physical mechanisms that underlie the art they pursue.

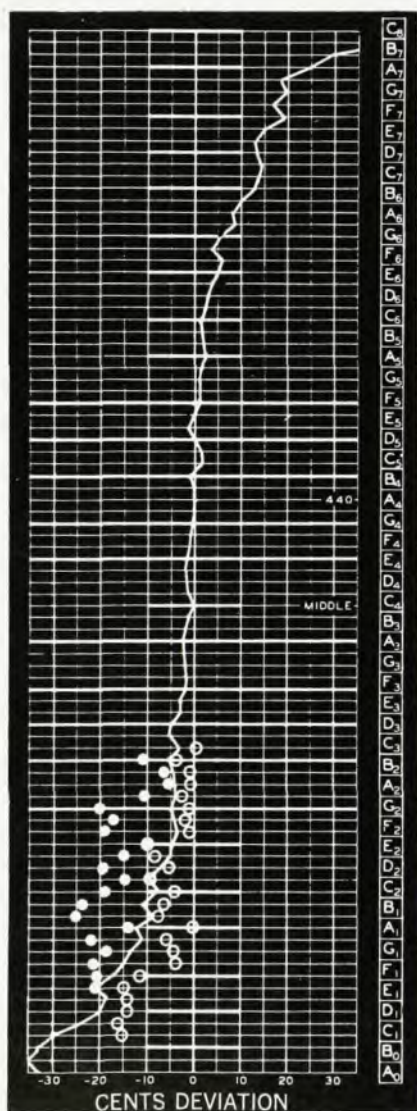
The Acoustical Foundations of Music brings together the material that Backus would, if time permitted, like to present in such a course. It is, however, much more than an exposition of physics for musicians. It is likely to attract an even wider readership among those scientists who have an interest in music and a familiarity with musical instruments, but who have never had the opportunity to relate their knowledge of physics to the behavior of these instruments and the sounds they produce. They may be surprised to find that those working in this field must admit to many areas of ignorance. Compounding the difficulty is the large amount of mythology and nonsense handed down for hundreds of years, usually by artists and instrument makers, but not infrequently by scientists who have been too hasty in jumping to conclusions and too ready to accept earlier work.

The first four chapters of the book are designed to give the music student enough background in physical acoustics to carry him through the subsequent discussions. These chapters may be safely skipped by those of us on the wrong side of the cultural fence. There follows a discussion of hearing and of tone quality that reveals how much we have yet to learn. Oscillograms and harmonic spectra of tones from adjacent notes on wind instruments vary widely, yet the ear easily identifies the instrument. The ear is relatively insensitive to changes in sound intensity, but its remarkable sensitivity to frequency (0.25%) remains the subject of much research.

Those who have a flair for numbers will enjoy the discussion of musical scales and temperament. Here mathematicians and numerologists have been most diligent, and have generated at least four well recognized ways of dividing the octave into 12 intervals. The sensible scientist will immediately vote for equal temperament, a scale of uniform logarithmic

semitone intervals. He will be pleased to note that most musicians will grudgingly admit that this is the only reasonable way to tune a piano, and then he will be shocked to learn later that the piano has abandoned the ratio of two for the octave, the whole scale being stretched so that it is flat at the lower end and sharp at the upper (see figure).

It is in the sections on musical instruments that the book is most fascinating. All of the classical musical instruments, through the process of trial and error, have undergone great refinements over the centuries. (An exception is "that fossil," the bassoon.) A scientific correlation between their physical structure and performance is,



STRETCHED OCTAVES. Data from 16 expertly tuned pianos show flattening in the bass and sharpening in the treble, compared with the tempered scale. One cent is 1/100 of a semitone. (From *The Acoustical Foundations of Music*.)

however, just beginning to take shape. It is remarkable that much of this work has been done only in the last two decades. While Backus's treatment is necessarily abbreviated, he has compiled from the most recent and pertinent research an excellent account of the acoustical principles of each of the major types of orchestral instruments and the piano.

The logical organization of the book is outstanding, the exposition is clear, and references are ample and up to date. The author's sense of humor is unobtrusive and reveals his compassion for the foibles of scientist and musician alike. Those who aspire to be something of both will be most entertained and enlightened by this volume.

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Quantum Mechanics

By Leonard I. Schiff

(3rd edition) 544 pp. McGraw-Hill, New York, 1968. \$12.50

In 1947, when I began the serious study of quantum mechanics, the most generally available books in English were the workmanlike text of Linus Pauling and E. Bright Wilson, Jr, the serious-minded and fairly weighty treatise of E. C. Kemble, and the classic of P.A.M. Dirac. Those whose German was superior to the minimum needed to squeeze through the usual language requirement were fortunate in having access to several nontrivial additions to this reading list, including V. Pauli's demanding *Handbuch* article and Arnold Sommerfeld's elegant *Wellenmechanik*. (There was then current the story of the professor, basing his lectures in large measure on Pascual Jordan's *Anschauliche Quantenmechanik*, who was reticent to mention his source out of concern for the physical well-being of the single library copy.) Admirable as these books are in many respects, none of them was ideally suited for a modern course aimed at first-year graduate students of physics.

The publication in 1949 of the first edition of Leonard Schiff's *Quantum Mechanics* must then be viewed as an event of some consequence in the pedagogical history of quantum mechanics. This volume, supplemented

by some reading in Dirac's book, gave the student for whom it was intended exactly the right mix of what quantum mechanics was and (even more) how one solved a variety of problems with it. Of the soluble examples for the motion of a single particle in a potential, there are few problems worth consideration at this level that were not included. (Among the latter I could mention the double potential—illustrative of tunneling and the periodic potential. Naturally enough, these can be found in one or more of the excellent texts of more recent vintage.)

The new edition is Schiff's response to the most important developments and changing emphasis of the last two decades. Thus, it is difficult to argue against too early an introduction of the student to the role of symmetry and its relation to group theory, to the notion of the scattering matrix and of its analytic properties, and to the use of the density matrix for the description of systems about which we have less than maximal information. All of these major topics have been added to the third edition. The presentations are in the straightforward manner characteristic of the older material, satisfying simultaneously the requirements of economy and completeness. The author has, moreover, taken advantage of the occasion to make other additions of obvious merit: a much more complete account of the matrix formulation, including transformation theory in the notation of Dirac, and an extended discussion of approximation methods for bound states and for collision problems. Again very little of consequence appropriate to the framework has been totally bypassed.

There is a well known theorem of Eugene Wigner that everyone has at least two faults, which should moreover be mentioned in a letter of recommendation. I shall assume a corresponding theorem for books and reviews of them. One may, for instance, cavil at the pedagogical soundness of some of the new material. A most glaring specific example is the concept of weight function in group space for a continuous group, first mentioned on page 196 and several times subsequently, but *never defined*. The second criticism belongs to the category of *chacun à son gout*. To one reader at least, this book, though of course well written, does not contain much beauty, charm, or elegance. Perhaps these possible outcomes were precluded by the deliberately chosen