Ultrasonic transducer material. Crystalline quartz in the beginning stages of preparation for use in the development of ultrasonic delay lines. Photo by Bell Laboratories.

book. Presumably these deficiencies are to some extent the result of the author's sharp focus on a specific objective.

One concludes, then, that the connection with quantum mechanics of the book *Mathematical Methods of Quantum Mechanics* is only made through a few examples, through the content of the last chapter, and through the choice of subject matter. Its style makes the book accessible to physicists, although its point of view is really that of the mathematician expounding mathematics. Supplemented by some physical examples and exercises, and by a bibliography of physics literature, applying its contents this book would be quite suitable for a short graduate course in "Mathematical Physics."

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Ultrasonic Transducer Materials

O. E. Mattiat, *ed.*
185 pp. Plenum,
New York, 1971. $12.50

Ultrasonic devices and processes have become one of the foundation stones for telephone communication, processing and underwater sound detection. For example, piezoelectric crystals are used for frequency selection and frequency control in all the long-distance telephone systems. Underwater sound systems form the background for submarine detection and guidance systems. High-amplitude systems have been used in such processing systems as ultrasonic cleaning by the production of cavitation, impact grinding or hard materials, welding of metal pieces and metals to plastics, ultrasonic accelerations of wire and plate drawing and for the study of fatigue in metals.

All of the applications require transducers for changing electrical energy into mechanical energy and vice versa. All of the ultrasonic applications cover frequency ranges from 1 KHz to the gigahertz range. The principal transducers in these ranges are magnetostrictive—1 KHz to 100 KHz—and piezoelectric crystals and piezoelectric ceramics which are used from 1 KHz to the gigahertz range. A good share of the work on magnetostrictive transducers has been done by the Japanese, who have used them for underwater sound and for fish finders. Hence it is fitting that the chapter on magnetostrictive transducers should be written by Yoshimitsui Kikuchi, who has been the principal investigator of this type of transducer. He has discussed their characteristics from theoretical and practical viewpoints and has discussed the effects of temperature, hydrostatic pressure and uniaxial stresses on the transducer properties. Both metallic materials and ferrite ceramics are discussed. A total of 125 references are cited, of which 64 are by Japanese authors, principally Kikuchi and his students.

A complete discussion of piezoelectric crystals and ceramics has been given by Don Berlincourt. He, together with Hans Jafee, has been responsible for most of the applications of piezoelectric ceramics as transducers for underwater sound systems, for ultrasonic cleaning and ultrasonic processing of materials. The piezoelectric crystals described are mostly used in filters, oscillators and very-high-frequency transducers for delay lines and other applications. However, the principal power converters are the piezoelectric ceramics. The principal ceramics are the lead-titanate–lead-zirconate combinations (usually designated PZT) and the sodium-potassium-niobate ceramics (SPN). By substituting calcium, strontium and barium for lead, and tin for zirconium, improved characteristics can be obtained. A series of eight PZT compositions have been marketed. Of these PZT 4 and PZT 8 have the highest mechanical Q's and power outputs for driving other systems. This chapter gives the most complete characterizations of these materials so far published showing the effects of temperatures, hydrostatic pressures, and directed stresses on the transducer characteristics.

The final chapter is by Allen Mertzler of the Bell Telephone Laboratories and is directed to the applications of transducer materials to very-high-frequency devices. These include ultrasonic delay lines with bit rates of 100M bits/sec, light modulators and light deflectors. These require very thin piezoelectric crystals or evaporated film transducers. A critical part of the systems is the film and electrode necessary to attach the transducer to the operating medium. Complete descriptions of the crystals, evaporators and film attachments are given in this section.

The potential audiences for this book are the ultrasonic application engineers and physicists using high-frequency ultrasonics as an investigational tool. All the authors are well known for their work in these fields. While no distinct applications are described, as this would require a much longer book, the description of the transducer materials and processes are the most complete known to me. The book can be highly recommended to application engineers and physicists.

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Introduction to Orbital Mechanics

***By* F. T. Geyling, H. R. Westerman**
349 pp. Addison-Wesley, Reading, Mass., 1971. $15.00

It is the authors' purpose to provide an introduction to orbital mechanics that would be useful to engineers and scientists "who have more than a passing interest in the subject." The field of orbital mechanics, which is really a branch of celestial mechanics devoted to "man-made" orbits, has undergone a tremendous expansion with the launching of Sputnik I in 1957. In the course of more than a decade, great advances have been achieved in artificial-satellite theory, as well as in perturbation theory, and the time has become ripe for the writing of a book. The authors are well qualified to write such a book by their broad experience in aerospace engineering with emphasis on artificial-satellite orbits. As former participants in the Summer Institute in Dynamical Astronomy, established by the late Dirk Brouwer in 1959, they were able to observe first-hand the latest trends in the teaching of celestial mechanics. These trends are well reflected in the selection and treatment of some of their material in the chapter devoted to the difficult subject of canonical transformation.

The contents of the book include the two-body problem, coordinate systems and the time, determination of orbits, perturbation theory, Lagrange planetary equations, the Lagrangian and the Hamiltonian forms of the equations of motion, canonical transformation, the von Zeipel method, and the Hansen method. A great deal of stress is laid on the artificial-satellite theory, with a detailed treatment of the drag and the radiation pressure. The Lagrange planetary equations are extensively used for the calculation of perturbations. The Hansen method, so baffling to many students, is well done, although the treatment of the integration constants is somewhat sketchy. Other interesting features of the book are: the use of the Vinti potential to illustrate the Hamilton–Jacobi separability; a discussion of the most general determining function $S(q_r, p_s, q'_u, p'_v, t)$ of a canonical transformation, on page 234, and a discussion of the orbit-element sensitivity.

The review of the book would be incomplete without the mention of some of its flaws. These flaws, mainly those of omission, are listed below: