of N-cells are excitatory; P-cells communicate by *inhibiting* or *disinhibiting*, whereas N-cells communicate by *facilitating* or *disfacilitating*.

Though P-cells communicate only with N-cells, N-cells receive a second input from other elements outside the cerebellum, and this input is excitatory rather than inhibitory. To the engineer, the N-cell may seem analogous to an electronic gate: the inhibitory P-cell input closes the gate to an excitatory input coming to the N-cell from outside the cerebellum. When the excitatory input is present and the inhibitory input absent, there will be an output from the N-cell. Even without the excitatory input, however, N-cells are "spontaneously" active, and the existence of this activity shows that N-cells have a pacemaker mechanism which generates impulses even without extrinsic sources of driving. To continue the analogy between N-cell and electronic gate, this pacemaker activity may be said to provide a third input to the gate, a "clock" input. The existence of the "clock" input provides a carrier frequency, and the frequency of impulse output discharged along from the N-cell axon is modulated down or up by the inhibitory and excitatory inputs reaching it from the cerebellar cortex and the rest of the brain, respectively.

Methodological Scheme

The preceding formulation of some of the operational features of the cerebellum was reached by Eccles, Ito, and Szentágothai through correlation of electrophysiological and anatomical data. An anatomico-physiological approach was the key to establishing the special importance of inhibition for information processing in the cerebellar cortex. Thus, physiological studies demonstrated the existence of an inhibitory process capable of blocking the excitatory synaptic action of input fibers on granule cells, and anatomical studies allowed the origin of this inhibitory action to be assigned to a special type of cell (the Golgi cell), because only this cell had terminations situated in such a way as to mediate the observed inhibition. Combined electrophysiological and anatomical data were also essential in assigning inhibitory functions to two other intracortical cerebellar neurons, the basket cell and the stellate cell. Thus, electrophysiological observations showed the existence of inhibitory synaptic action on both the somata and dendrites of P-cells, and the topographical arrangements of the basket and stellate cells conformed exactly to the requirements for cells having these respective inhibitory actions. These examples of the juxtaposition of anatomical and physiological findings are but a few of many that could be cited, for the ingenious combination of functional and structural data to yield principles of cerebellar operation is one of the outstanding features of the monograph.

This review would be misleading if it left the reader with the impression that *The Cerebellum as a Neuronal Machine* is directed primarily to the communication engineer, and it should be emphasized that the book will not make easy reading for those without a specialized background in electrophysiology and neuroanatomy. To be sure, the authors interpret their results in general operational terms, but the actual data on which their conclusions are based are those of physiology and anatomy. The reader without knowledge of the significance of neuronal hyperpolarization or depolarization, of potential field distribution in a volume conductor, or of the Golgi, Nauta-Gygax, and other histological techniques, for example, will have difficulty following the experimental results presented and will in general be unable to understand how the authors reach their conclusions. Those without a background in neurobiology might do well to preface their study of the monograph by a reading of Eccles's recent paper "Circuits in the Cerebellar Control of Movement" [*Proc. Nat. Acad. Sci. U.S.* **58**, 336 (1967)], in which notions of cerebellar organization are presented in terms that can be grasped by the nonspecialist. Finally, this review would do the authors an injustice if it were to suggest that they believe that the problems of cerebellar organization (even in the limited sense in which they have dealt with these problems) are now solved: they readily admit that the weight of evidence in support of several of their conclusions is not yet overwhelming, and add that there remain many important aspects of cerebellar architecture for which they are unable to propose a physiological role. Eccles, Ito, and Szentágothai have assembled a body of evidence and have constructed a model. Their model has gaps, but it is without doubt the best presently available, and it surely represents a great advance over the models of only a few short years ago. Furthermore, the very gaps in the model point toward future investigations which will add new chapters to what Eccles sometimes refers to as "the cerebellar story." Indeed, it seems possible that the cerebellum may turn out to be the neurophysiologist's Rosetta stone, its new and old parts revealing new and old neural codes. Future studies may decipher these codes, and may reveal how the cerebellum serves as a communication link for parts of the brain which speak the different languages of vision, audition, and kinesthesis, allowing these different languages to be translated into the language of muscular control—and of behavior in general.

EDWARD V. EVARTS
Laboratory of Clinical Science, National Institute of Mental Health, Bethesda, Maryland

Nuclear Physics

Many-Body Description of Nuclear Structure and Reactions. Course 36, International School of Physics "Enrico Fermi." C. BLOCH, Ed. Academic Press, New York, 1966. 605 pp., illus. $26.50.

The Varenna summer school was an exceptional one, and this volume of papers presented there contains many new developments, systematically and logically developed. Thus it is worth what it costs, even though the amount is a bit staggering.

Here those who do not read Russian can become acquainted with the methods of A. B. Migdal, who applies the Landau theory of Fermi liquids to nuclei. His article, "The method of interacting quasiparticles in the theory of the nucleus," is, in fact, pedagogically an improvement on his book on the same subject in Russian. Migdal's methods are of wide use in the U.S.S.R. The new feature of his work, it seems to me, is the use of density-dependent interactions, although such interactions were used by T. H. R. Skyrme and others many years ago, in somewhat different contexts. Otherwise, much of the theory is a reformulation of familiar methods in unfamiliar language, that of Green's functions. The question of origin of the P_2 force is not adequately handled in Migdal's lectures here; the reader is referred to later work, for example, that of Krainov and Malov published in *Yadernaya Fizika* **6**, 252 (1967) for a better treatment of this question. Although I do not care personally for the formula-

tion of Migdal's work, it must be admitted that he has raised a number of interesting and provocative points.

Let me draw special attention also to the article of D. Brink, "The alpha-particle model of light nuclei," which is one of the most beautiful developments in this subject. Brink likes to sit on his work for years and, on the whole, doesn't even answer letters inquiring about it, so that one must either adopt the expedient of traveling to Oxford to talk with him, or invite him to lecture at summer schools. Both are worth while.

Systematic and conservative expositions of by now standard shell-model and "beyond" techniques are given by Gillet ("Approximate methods in nuclear-structure calculations") and J. P. Elliott ("Effective interactions in the shell model"). Both articles are carefully prepared and should become standard works in the subject. The new multipole and sum-rule methods in spectroscopy are described in detail by J. B. French. These are undoubtedly very useful, although I have not mastered them yet. It is nice to have a systematic exposition on hand. C. Bloch presents "An introduction to the many-body theory of nuclear reactions" in his characteristically elegant fashion. One should not forget to mention the excellent introduction to the Hartree-Fock formalism with which F. Villars begins the book. Finally, at the end come many seminars, some good, some bad.

In sum, this is an excellent book which should come into the shelf of every nuclear physicist who can afford it.

G. E. BROWN
Department of Physics, Princeton University, Princeton, New Jersey

Sound and Matter

Ultrasonic Absorption. An Introduction to the Theory of Sound Absorption and Dispersion in Gases, Liquids, and Solids. A. B. BHATIA. Oxford University Press, New York, 1967. 441 pp., illus. $13.60.

The scientist who measures the absorption and velocity of ultrasonic waves in bulk matter is an ultrasonic spectroscopist. His task, in addition to measuring these quantities, is to attempt to relate his data to the molecular nature of matter. In order to do this, it is usually necessary that his measurements be made over a range of values of some external parameters such as ultrasonic frequency, temperature, pressure, and magnetic field. The data so obtained provide him with such information as the strength and location of the absorption peaks and the magnitude of the velocity dispersion. From these he attempts to answer the question: Why does a gas, liquid, or solid absorb ultrasonic energy?

Ultrasonic Absorption by A. B. Bhatia is essentially a systematic collection and discussion of the various answers that can be given to this question. The processes or mechanisms responsible for the absorption are discussed, and, where one exists, the molecular theory describing the process is outlined. The book is aimed at scientists "who are interested in the study of the properties of matter and wish to acquaint themselves with the basic . . . results in this field. . . ." For the researcher who is actually carrying out ultrasonic investigations it will not be as useful as somewhat more detailed accounts such as *Absorption and Dispersion of Ultrasonic Waves,* by K. F. Herzfeld and T. A. Litovitz, or *Physical Acoustics,* edited by W. P. Mason.

After several introductory chapters the book treats systematically the theoretical ideas and experimental results in gases, liquids, and solids. The sections dealing with the fluid states of matter are essentially a condensed version of the material covered in the text by Herzfeld and Litovitz. The condensation is skillfully done, and these sections provide a coherent, well-written introduction to ultrasonic research in fluids. It is unfortunate that some of the more up-to-date developments in this field are not included, but perhaps any advantage gained by their inclusion would have been offset by a corresponding loss in the simplicity of presentation.

The chapters dealing with the attenuation of ultrasound in solids are equally good. In particular, the discussion of the interaction of ultrasonic waves with electrons and phonons deserves commendation. On the whole, though, the solid-state treatment is rather more abbreviated than one would like. And while I am sympathetic toward the author's attempt to emphasize the physical content of the subject, there are some sections where a slightly more rigorous approach would be preferable.

In evaluating any book there are two critical questions that must be answered: (i) Is there a need for a book designed to meet the specific objectives of the volume under consideration? and (ii) does this particular work fill that need? To the first question the answer here is a qualified "yes," the qualifications being those mentioned above; to the second it is an unqualified "yes."

C. J. MONTROSE
Department of Physics, Catholic University of America, Washington, D.C.

Aquatic Life

Aspects of Marine Zoology. Proceedings of a symposium, London, March 1966. N. B. MARSHALL, Ed. Academic Press, London, 1967. 280 pp., illus. $14.

The symposium reports of which this book is composed deal with a variety of topics, some broad and some specialized. Two articles present new observations on the vertical movements of pelagic animal communities which form acoustic scattering layers, and show how these movements may be controlled by natural light or influenced by artificial light. A paper dealing with the luminescence of fishes recommends an anatomical classification of light organs, presents a review of the control mechanism for integumental photophores, and discusses critically the various explanations that have been offered for the function of luminescence in this group of animals.

In two additional reports on fishes a survey of the olfactory organs of bathypelagic species is given and methods for sampling mesopelagic fishes are summarized. Various types of trawls, traps, and nets are evaluated, and the need is shown for supplementary information from high-speed samplers, fishing with lines and lights, photographs, and direct observation from deep submersibles.

The sensitivity of invertebrates to small changes in hydrostatic pressure in the shallow marine environment is discussed by another symposium participant; the mechanisms involved and behavior observed in both field and laboratory experiments are considered. Another investigator reports that the neuston of the warmer seas has predominantly blue and purple pigmentation, with similarities to crustacyanin,