

together. "Unless substantial steps are taken to resolve this problem," says Miller, "the political situation in Peru is likely to become explosive."

In the final contribution to the series, Louis Faron traces more than 400 years of agricultural production and local organization in the coastal valley of the Chancay River, located in the Department of Lima. Here the present century witnessed a shift to cotton agriculture. Absentee landlords first leased their lands to Japanese management companies, which tended to farm the holdings with Japanese sharecroppers. Sharecropping arrangements, however, were based on traditional Peruvian patterns. World War II resulted in the expulsion of the Japanese from positions of economic dominance. The hacienda owners recovered direct control of their lands, now striving to farm them with modern machinery and wage labor. Within the shadow of the haciendas exist viable Indian villages whose inhabitants work on the haciendas but also grow cotton of their own, producing more cotton on less land and at lower cost than the haciendas. There are also homestead colonies which must compete with the haciendas for available supplies of water. The Chancay valley thus demonstrates how a traditional system of relationships, embodied in the organizational form of the hacienda, can be geared to the requirements of modernization, perpetuated here "by the weight of tradition and the limitation of alternatives."

An End in Need of Definition

These studies provide no easy common denominator. In fact, if they exhibit certain convergences, such as the widening encroachment of the market and the growing use of money and credit, they also seem to indicate that such convergence produces profound divergences, as local factors are made use of in an ever-widening specialization and hence an ever-growing worldwide division of labor. Convergence and divergence seem to go hand in hand. Moreover, it seems to me inherently unlikely that the concept of "modernization" is at all adequate to the intellectual task entrusted to it. It is an essentially quantitative concept, denoting growing magnitudes in the use of energy, of organization, of communication. It may be possible to say, with Steward (in volume 1), that increase in these magnitudes finally results in a state in which "basic structures and

patterns are qualitatively altered." The concept, however, does not in and of itself allow us to specify the "criterion complex" which marks the watershed between previously existing societies and modern ones. It merely allows us to speak of "less modern" or "more modern," without yet saying anything about the defining qualitative attributes of modernity that we could recognize as the hallmarks of an evolutionary transformation.

Finally, there remains the unpleasant ethical question of "modernization for what?" Steward explicitly states that the use of the term by his collaborators and himself entails no overtones of progress or regression: "The term is neutral." Nevertheless, these studies produced in this reviewer a profound sense of anguish about a world in which social and cultural arrangements are initiated and carried through with so little concern for attendant human costs. Modernization is not only growth along stipulated quantitative dimensions; all too often it is also a veritable slaughter of the innocent.

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Results of Collision

Introduction to the Quantum Theory of Scattering. LEONARD S. RODBERG and R. M. THALER. Academic Press, New York, 1967. 412 pp., illus. \$11.50.

Most of our knowledge of the properties of the fundamental particles that compose matter, and of their interactions, is based ultimately on the results of collision experiments. It is therefore natural that scattering theory, which connects the equations of motion with the description of such experiments, should play an ever-increasing part in the education of graduate students of physics. The appearance of half a dozen books on this general subject during the last few years is an expression of this development.

Of the presently existing books on quantum scattering theory, the one under review is the most elementary. Such a book has a very useful purpose for beginning graduate students and nonspecialists, particularly when, as this one is, it is written in a readable manner. The parts I think are especially good are the discussions of the effective-range theory of low-energy scattering, of charge-exchange scattering,

and of the distorted-wave and impulse approximations, and the chapters on Green's functions, on invariance principles and conservation laws, and on angular momentum.

On the other hand, the book contains a larger number of nontrivial errors than it should. I will mention here only a few examples. On page 161 the authors use Cauchy's theorem to evaluate a contour integral even though the integrand contains the absolute magnitude of the variable, a nonanalytic function. On page 138 one finds the statement that "the Schrodinger equation is not soluble at all if $V(r)$ is more singular than r^{-1} [at the origin]." This is of course quite untrue. On page 180 an expression is given for the Møller wave operator that is incorrect, the authors' defense of it notwithstanding. This expression is used on several subsequent occasions. The origin of the trouble here is that the authors do not distinguish between operators and their matrix representations, a failure that is evident also in other parts of the book (as on page 235) and that can be badly misleading to the student.

Finally I should mention the absence of references. In the preface the authors write, "Because the treatment is self-contained and highly personal, we have not attempted to refer to the published origins of many of the ideas." That is regrettable. On this level it may not be necessary to give references for historical reasons, but surely it would be useful to the student to have some guide nearer at hand than the two general books to which the authors refer him to tell him where to go for more detail and depth. In sum, this book can be recommended only with great reservations.

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Optical Modulators

Reticles in Electro-Optical Devices. LUCIEN M. BIBERMAN. Pergamon, New York, 1966. 187 pp., illus. \$7.

The reader will be impressed with the complexity and the number of uses to which simple reticles can be put in metrology, radiometry, error-signal detection, tracking, and a host of other applications. Most technical people would ordinarily think of reticles as simple choppers or scales, but in this work Lucien M. Biberman ex-

tends the horizon to complex reticles and their applications. The depth and detail in which he describes the design and construction of various reticles for various uses are impressive. Biberman has contributed much to a field that is not generally well known or often used in the optical community, and his competence is radiated through the book by the many references to his own articles and patents, as well as to those of other inventors and contributors to the field. The optical engineer or optical physicist could learn important techniques of the technology by reading *Reticles in Electro-Optical Devices*.

Many technical people are probably not aware of the complicated reticle systems that are being used in optical devices for space and military applications. Biberman here reveals previously unpublished work of his own, describing important electro-optical techniques. The book does not mention the specific

applications for the tracking and error-correction techniques, but the reader has the feeling that the military overtone is there. How many of these techniques are applicable to other electro-optical problem areas remains to be seen.

Early in the book, Biberman develops straightforward, simple choppers, episcotisters, and reticles for simple problems. As the book progresses to more and more complicated devices, the applicability of reticles receives more emphasis, and their use in certain areas such as information processing is treated. The book benefits from the confinement of reticle fabrication to a chapter of its own and from the relegation of highly mathematical treatments to appendices. It will no doubt become a useful reference for students and workers in the field.

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The Crust and Mantle of the Earth

The Earth beneath the Continents. A volume of geophysical studies in honor of Merle A. Tuve. JOHN S. STEINHART and T. JEFFERSON SMITH, Eds. American Geophysical Union Monograph No. 10, Washington, D.C., 1966. 683 pp., illus. \$16.50. NAS-NRC Publication 1467.

This compilation of 43 papers is dedicated to Merle A. Tuve on the occasion of his 65th birthday and his retirement as director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, after 40 years of association with that organization. At its inception, the volume was planned as a unified presentation of the results of the Lake Superior seismic experiments of 1963 and 1964. These experiments, directed toward investigation of the properties of the earth's crust and upper mantle in the anomalous Lake Superior region, entailed observations of seismic waves generated by some 130 explosions in the lake. Charge weights ranged from 250 pounds to 10 tons, the majority of the shots being at about 1 ton. Papers dealing specifically with the Lake Superior program and with geological, seismic, gravity, and magnetic studies constitute about half the volume. The other contributions are the result of the decision to dedicate the volume to Tuve, at which time the scope of the book was necessarily broadened to accommodate con-

tributions from his many friends and colleagues.

Most of these additional contributions treat geophysical topics similar to the Lake Superior seismic studies, that is, estimation of the structure and composition of the upper 50 to 100 kilometers of the earth from observations of seismic waves generated by special explosions and from analyses of gravity and magnetic data. A few articles bear little relation to the general topic. Although this will introduce problems in accessibility of these particular articles, the varied content enhances the interest of the volume.

The introductory papers present the geology of the Lake Superior area, with gravity and magnetic data and interpretations. Lake Superior lies at the northern end of the prominent Mid-continent Gravity High, a belt of positive Bouguer anomalies which form one of the largest gravity features in North America. The area is a syncline filled with some 5 kilometers of sediments over as much as 10 kilometers of lavas and intrusives of the Keweenawan sequence.

Several papers present interpretations of the data accumulated in the explosion program. The complexity of the data and their structural implications are striking. There is general agreement that the data indicate an

anomalously thick crust, more than 50 kilometers, and high crustal velocities under the lake over an area some 500 kilometers long. Such crustal thicknesses were previously found only associated with mountain roots, as with the Sierra Nevada. Thicknesses in surrounding areas of central North America are about 40 kilometers. The third section of the volume contains reports of similar crustal investigations in several other areas. In addition, there is an excellent summary article, by James and Steinhart, of the general method of explosion seismic studies, with recent advances, difficulties, sources of error, and many references. This paper is recommended to anyone seeking a critical review of the method with its worldwide application and results.

The last two sections of the volume contain varied fare for the reader. Under headings of Theory, Earthquakes, and Instruments and Synthesis and New Methods in Structural Studies, one can find reports on earthquakes in Peru or on the spatial variations in tidal gravity fluctuations or on seismograph design. Several articles warrant specific mention. Bullen presents a compact summary of ray theory formulas commonly used in seismic travel time studies. Both flat and spherical earth forms are given. Woollard presents his isostatic gravity anomaly map of the United States with an excellent summary of data-reduction methods and discussion of the results, with several cross-continent profiles illustrated. Ringwood and Green comment on the petrological nature of the stable continental crust and the implications of assumptions for water-vapor pressure. The concept of a gabbroic lower crust is dismissed and a possible explanation of the evolution of the anomalous crust in the Lake Superior area is presented.

This book contains many excellent contributions. Its acquisition will normally be prompted by a high level of interest in either the crustal explosion seismology technique in general or in the Lake Superior problem specifically. For both these interests, it is perhaps the most complete compilation available. Unfortunately, this overall specialization will tend to limit the accessibility of the many excellent but more general papers. All geophysicists should at least peruse the volume—something is there for everyone.

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