pioneering efforts pointing the way to new methods of solution of the intricate problems of the liquid state.

The broad objectives of a statistical mechanical theory of the liquid state are the derivation of the macroscopic transport equations of hydrodynamics from the laws of molecular dynamics, investigation of the limits of validity of the empirical laws of diffusion, heat conduction, and viscous fluid flow, and the determination of the coefficients of diffusion, thermal conductivity, and viscosity in terms of molecular variables. For liquids in thermodynamic equilibrium, the theory should provide appropriate relations between the thermodynamic functions and the potential of intermolecular force and molecular distribution functions, allowing the calculation of the equation of state and the heat capacity of the liquid in terms of molecular variables. Although rather highly developed statistical mechanical theories of the solid state and of the gaseous state of matter have been developed, the attainment of these objectives in the theory of the liquid state has been beset with formidable difficulties. The macroscopic states of a crystalline solid are under the dominant control of the ordering influence of intermolecular and interatomic forces, upon which the disordering influence of thermal motion acts as a perturbation. On the other hand, the macroscopic states of a gas are dominantly controlled by the disordering influence of thermal motion, upon which the ordering influence of intermolecular forces acts as a perturbation. The difficulties encountered in the construction of an adequate statistical theory of the liquid state arise from the circumstance that its macroscopic properties are controlled by a delicate balance between the disordering influence of thermal motion and the ordering influence of intermolecular and interatomic forces.

Born and Green have mapped a route through these difficulties, which we may hope will lead to a satisfactory solution of the problems of the liquid state. They derive the equation of continuity, the equation of motion, and the equation of energy transport of fluid mechanics from the laws of molecular dynamics. By comparing these equations with the phenomenological equations of fluid mechanics, they are able to relate the stress tensor and the heat current to the potential of intermolecular force and the distribution function in the space of molecular pairs. They derive a system of integro-differential equations for the distribution functions in the phase space of small subsets of molecules of the liquid, pairs, triplets, etc., which allow the determination of these functions from a knowledge of intermolecular forces. In the special case of thermodynamic equilibrium they obtain an integral equation for the radial distribution function of the theory of liquids, which allows the determination of the equation of state entirely in terms of molecular variables. Departures from equilibrium arising from shearing strains in viscous flow from temperature gradients are shown to produce perturbations in the radial distribution function, which lead to the viscous terms in the Newtonian stress tensor and to the Fourier law of heat conduction.

The first three articles are concerned with the development of the classical statistical mechanical theory of liquids. In the fourth article the quantum mechanical generalization of the theory is developed with the use of a density matrix. The transition to hydrodynamics leads to expressions identical with those of classical theory for the stress tensor and heat current. The distribution functions appearing in these expressions are, however, determined by the laws of quantum mechanics rather than by those of classical mechanics. The authors attempt to apply their quantum mechanical theory to the clarification of the anomalous thermodynamic and hydrodynamic behavior of helium II. Although some points of their analysis are still open to debate, it may point the way to the ultimate solution of these important problems.

It is necessary to point out that many of the results of the theory of Born and Green are not entirely new. Their equilibrium theory duplicates results previously obtained by Mayer, Yvon, and Kirkwood from the Gibbs theory of the canonical ensemble. Their theory of transport processes closely parallels the simultaneously developed theory of Kirkwood, although it differs from the latter theory in the manner in which irreversibility and thermodynamics dissipation are introduced. It is reasonable to expect that the sum of these efforts will in the course of time lead us to a satisfactory understanding of the liquid state.

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The Quaking Earth

EARTH WAVES. **By L. Don Leet. 122 pp. Harvard University Press, Cambridge, Massachusetts and John Wiley and Sons, Inc., New York, 1950. $3.00.**

The study of elastic waves plays an important role in many fields of geophysics. Waves generated by earthquakes are propagated through the interior of the earth as well as along its surface and give the best information concerning layering of the earth and the elastic properties in its interior. Waves from artificial explosions are used to give information on the structure of the uppermost layers which are of economic importance. The elastic waves produced by meteorological phenomena and other causes produce continuous unrest of the ground, which is called "microseisms". The correlation of the various types of microseisms with meteorological phenomena is still a controversial problem, but the usefulness of "hurricane microseisms" for the location of hurricanes and typhoons is beyond doubt.

The book *Earth Waves* by Leet deals with the measurement of such elastic waves. It is written for readers with training in the fundamentals of some branch of engineering, physical, or geological science, and only elementary mathematics is used. It is not intended for use as a textbook is seismology or seismic prospecting. Most parts give a compact summary of the state of our knowledge concerning certain properties of earth waves for a newcomer in the subjects covered; a few special problems are discussed in detail.

The first 38 pages deal with the recording and measurement of seismic waves in the earth. This part gives an excellent presentation of the principles of recording in-

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struments and the characteristics of the records they write. Diagrams of specific seismographs are well selected.

In the second chapter (20 pages) the author considers various types of earth waves. He discusses mainly waves recorded from artificial explosions, but also types found in seismograms of distant earthquakes and of nearby shocks. Of special interest is the record written by a field seismograph located near the atomic bomb which was exploded in New Mexico on July 16, 1945. This is the record in which the author discovered the so-called "hydrodynamic wave", a term not too well chosen, since there seems to be no physical relation to actual hydrodynamic waves. This type of motion has been found thus far only in records of nearby explosions but not in records of earthquakes.

The third chapter (52 pages) contains a summary of transmission characteristics of earth waves and the application of the theory to seismic prospecting. About 14 pages are devoted to the transmission of elastic waves through the earth, including calculation of the wave velocity through the earth's interior. It is illustrated by typical seismograms from two different epicentral distances in shallow earthquakes, by records obtained from artificial explosions for exploration geophysics, by sketches showing wave paths, and by graphs giving the relationship between observed transmission times of elastic waves from the source to the point of observation and the distance. The last 18 pages of this section are devoted to practical information about seismic prospecting.

In the last chapter the author discusses aspects of microseisms recorded continuously by sufficiently sensitive instruments. He deals mainly with the problem of locating the source of microseismic storms and the direction from which these waves approach the seismographs. He especially discusses the use of three stations located at the corners of a triangle ("tripartite stations"). He points to oversimplifications in the investigations of microseisms and discusses possible improvements for use of microseisms in locating the source of the disturbance.

The author has provided excellent illustrations. Most of the 58 figures are derived from his own work. The book can be well recommended for anyone who wants introductory information on selected topics concerning elastic waves in the earth.

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Books Received

INDUSTRIAL INSTRUMENTATION. By Donald P. Eckman. 396 pp. John Wiley and Sons, Inc., New York, 1950. $5.00.

ATOMIC PHYSICS. By Wolfgang Finkelnburg. 498 pp. McGraw-Hill Book Company, New York, 1950. $6.50.

THE PRINCIPLES OF SCIENTIFIC RESEARCH. By Paul Freedman. 222 pp. Public Affairs Press, Washington, D.C., 1950. $3.25.

THE HUMAN USE OF HUMAN BEINGS. By Norbert Wiener. 241 pp. Houghton Mifflin Company, Boston, Massachusetts, 1950. $3.00.