

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 50:

“Inversions of Lapse Rate of Temperature over Karachi” by A. S. Hariharan.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 51:

“A Preliminary Study of Rainfall at Quetta” by A. K. Roy and R. C. Bhattacharya.

Annual Report of the Imperial Institute of Veterinary Research.

Memoirs of the Indian Meteorological Department “On Evaporation” by S. K. Banerji.

Reviews.

THEORY OF ELECTRICITY AND MAGNETISM. By Prof. Max Planck. Translated by Henry L. Brose, M.A., D.Phil. (Oxon.), D.Sc., Macmillan & Co., Ltd., London, 1932.

This is an English translation of the third of a series of five volumes on theoretical Physics by one of the acknowledged leaders of thought in Modern Physics. The book aims at giving a unitary exposition of the Field Theory of Electricity and Magnetism and as such its arrangement and treatment of the subject are different from what are usually found in English treatises on the same subject.

English writers usually follow Maxwell as regards arrangement and method. Electrostatics, magnetism, current electricity and electrodynamics are generally treated as separate and independent branches of science with their own special laws. They usually begin with the Coulombian Laws of force based on the hypothesis of action at a distance and though the Field Theory finds a place in every book it occupies usually a very subordinate position. Emphasis is, on the other hand, mostly laid on the experimental aspects of the subject and the wealth of details given is apt to be a bit confusing to students of theoretical Physics. It is usually towards the end of the book that the classical equations of the Field Theory are deduced through which the final synthesis and fusion of the separate domains into one homogeneous whole can be achieved. This important task is, however, very often overlooked or is usually treated in a modest and neglected corner.

The author of the book under review prefers a different mode of exposition. Being one of a series of five works on theoretical Physics the book treats the subject of Electricity and Magnetism more or less in the same way as Mechanics of deformable bodies and of continuous material media are treated in the earlier volumes.

The ultimate aim of the theoretical physicist is to bring the divergent domains with their special laws under the sway of a minimum set of general principles from

which all special laws would be deduced as particular cases. Such a survey of the whole field of physics from a single unitary standpoint is as yet unrealizable, but the author here has tried to bring about the rapprochement between the distinct subjects of Electrodynamics and Mechanics, by giving the principle of the conservation of energy and the principle of contiguous action a prominent position as in the other volumes.

A plausible deduction of the Laws of Maxwell is first attempted with the help of certain assumptions about the nature of electric and magnetic energies and with the idea of the flux of energy. Once the general laws of the Field Theory are established the author deduces the special laws of Electrostatics, Magnetism, Current Electricity and of quasi stationary electrodynamical phenomena, as special consequences of the same general equations which get more or less simplified owing to the special conditions which the electric and magnetic vectors satisfy in the different cases.

The principal consequences of the laws are then worked out for each of the separate branches of the subject, and the peculiarities of conception which the Field Theory involves are discussed lucidly and in a masterly manner. This survey of the whole field from a unitary standpoint proceeds systematically through domains of increasing complexity, and ends finally with the Electro-dynamics of moving bodies where already the weakness of the Maxwellian theory begins to show, and its failures and limitations are pointed out in the last chapter where references are also given to the greater generalizations achieved in this respect in recent times.

The perusal of the book will benefit immensely the reader who has got leanings towards the theoretical side of Physics: one should, however, remain conscious of the limitations of the method and of the one-sided character of such an account.

One of the advantages of the Field Theory according to the author is that the hypothesis of this theory are of more special nature

than the rival theories based on the principle of action-at-a-distance. It is pointed out that whereas there have been different theories of action-at-a-distance in Electrodynamics there has been only one, that of Maxwell, based on the principle of contiguous action. A fewer number of undetermined constants occur in the theory than in any other. This very special nature makes the Field Theory capable of making comparatively unambiguous predictions about future events; it thus achieves more as a theory, than any other rival theories in the same field.

The method of deduction of the Field Equations which the author pursues, however, does not at all make it clear or plausible that only one unique formulation is possible of the Field Theory. Even when one accepts the principle of conservation of energy, the existence of the vector of flux and the principle of contiguous action, a large margin of possible alternative solutions still remains. The unambiguous nature of the answer expected from the Field Theory is thus not self-evident. For example, even if one accepts that the flow-vector is completely determined at every point by the electro-magnetic state it is not at all clear why this particular vector should depend on 'E' and 'H' alone and not also upon their space and time differential coefficients. There is no *a priori* objection against such a hypothesis (on the Field Theory). Exactly the same criticism might be made against the method of deduction of the fundamental equations. Maxwell's equations are not the only solution which suggest themselves of the equation (52a) of p. 21. It is easy to conceive of other solutions equally simple which, however, differ from Maxwell's equations in having additional terms in the right hand side of 27 (a) and 27 (b). Even the additional assumptions that in the statical case the general equations should break up into two independent sets which 'E' and 'H' will separately satisfy, will not remove the ambiguity. In fact the uniqueness of the Maxwellian theory does not follow from the general principles from which the author starts.

It is well known that various attempts have been made from time to time to deduce the Field Equations from some general Mechanical Principle like the principle of least action, and every such attempt has failed. The justification of the Field Equations in the special Maxwellian form is as

yet to be furnished only by the crucial experiments. The equations thus remain up to this time a convenient empirical hypothesis which furnishes the best fit to the observed facts.

The empirical nature of the Field Theory is apt to be a little overlooked in an exposition such as the author has given in the book under review. A more satisfactory and, to our mind, a more logical procedure would have been to take the Field equations as tested hypotheses and then to show as is usually done in some books that these equations are compatible with the mechanical principles of conservation of energy and momentum if certain quantities are taken as representing energies, momentum and flux vector in the electro-magnetic field.

One misses also in this book, a discussion of the Lorentz equations which preserve the advantages of the Field Theory so admirably and meets at the same time the demand for a hypothesis involving a discrete structure of electricity as revealed by experiments. Not only do the simple equations of Maxwell and Hertz prove inadequate for moving bodies as the author himself points at the end of the book, but its unsatisfactory nature is apparent as soon as a rational theory of the dielectric or conducting media is attempted. An additional chapter on this question would have been welcome.

However much we would have liked our author to have gone further in the exposition of his subject in certain directions, the book in its present form, presenting as it does an admirably simple and masterly exposition of the Field Theory of Maxwell and Hertz will prove certainly of immense benefit to all students of theoretical Physics. The translator of the book deserves our grateful thanks for thus making once more accessible to the students of Indian Universities a really good book bearing the impress of a master-mind.

S. N. BOSE.

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MODERN PHYSICS. *Lehrbuch der Theoretischen Physik*, Von. Joos. Akademische Verlagsgesellschaft m. b. H., Leipzig 1932. Price 14 Marks.

The bold and rapid advances which, since the beginning of the present century, have revolutionised Physics, have also brought with them new problems for the teacher. The wealth of material which requires to be examined at least cursorily by every serious

student of Physics is now enormous and important additions are being made every day. To understand Modern Physics, however, a knowledge of much of classical physics is absolutely imperative and it is a difficult task to determine what should be included and what can be safely omitted. A number of attempts have been made in recent years to produce text-books which solve this problem, but in many of these the emphasis has not been properly divided between the old and the new and the two methods of approach have not been sufficiently well blended into a coherent mode of presentation. In both the balance with which the classical and modern portions have been treated and the unity of method by which the transition from the one to the other has been effected, Prof. Joos' "*Lehrbuch der Theoretischen Physik*" holds a position in the front rank. It is a perfectly modern book which yet conserves with reverence the heritage of the old masterpieces and knits the newer acquisitions with the old into an organic whole. In the classical portions the methods of presentation that have stood the test of time have been followed, innovation in this domain being regarded as the reverse of improvement. However, the arrangement of these has been so contrived as to provide a natural introduction to the modern developments which have been interwoven with the classical theory in an admirable manner. The power of condensation exhibited is marvellous and yet the physical principles are explained more thoroughly than would be expected from the range of topics included.

The volume is divided into seven books; the first is devoted to a brief and yet comprehensive presentation of those necessary branches of mathematics which the student at College has not already mastered. Of these, Vector Analysis occupies the larger part and is sufficiently fully developed. Introductory sketches of Tensor Analysis, Theory of Functions of a complex variable, and the Calculus of variations have been included. The theory of vibrations and waves is dealt with in a separate chapter. The second book develops the mechanics of a particle and of rigid bodies in the usual manner and chapters have been added on the essentials of the mechanics of deformable bodies and of fluids. The scope of these can be gathered from the fact that the symmetrical top, transverse vibrations of strings and membranes and Stokes' Law of

the motion of a sphere through a viscous fluid and the theory of capillarity terminate the chapters on mechanics, elasticity and hydromechanics respectively. A final chapter deals with the special theory of relativity; the general theory is merely noticed in passing and its mathematical treatment has been omitted as being too difficult. The third book deals with electrostatics, magnetostatics, electromagnetics, and the electromagnetic theory of light. An account of high frequency alternating currents is also briefly given. The book closes with a chapter on geometrical optics. The fourth book treats of electrolytic conduction, conduction in gases, the elements of the theory of metallic conduction, atomistic theory of dielectric constants, refractive indices and magnetic permeability, and lastly the optics of moving media. The Debye-Huckel theory is described and Sommerfeld's theory of metallic conduction is also sketched without detailed mathematical treatment. The theory of the arc and glow discharge is given and Aston's Mass-spectrograph is described in connection with anode rays. The fifth and the sixth books are occupied with the theory of heat, the former from the phenomenological aspect and the latter from a statistical point of view. The theory of heat conduction, the equation of states, thermodynamics including the equilibrium of thermodynamic systems and applications of Nernst's heat theorem make up the fifth book. The sixth book is devoted to kinetic theory and classical statistics, Debye's theory of specific heats, theory of radiation and the Bose-Einstein and the Fermi statistics. The seventh and the last book touches upon the modern theories of atomic structure and quantum mechanics. The scattering of particles, Bohr's theory of the spectra of hydrogen and ionised helium, Moseley's law in X-ray spectra, the correspondence principle, the Zeeman effect, Pauli's principle and the structure of the periodic system and elements of the theory of band spectra, are all dealt with clearly and succinctly. The elements of wave-mechanics with applications to the Hydrogen spectrum, molecular spectra, dispersion and the Raman effect, and to Radioactive transformations are given. Some topics, not of sufficient importance to be included in the text, are given in the form of problems, hints for whose solution are given at the end of the book. One could have wished that

such topics as the theory of instruments of high resolving power, Saha's theory of thermal ionization, X-rays, radioactivity and nuclear structure might have been treated a little more in detail; but as the author says in the preface, the book is meant only to bring the earnest student to a vantage point from which the different peaks of physical knowledge can be surveyed and reached with greater ease by means of the guidance afforded. We can heartily say that this aim has been well achieved and an Honours student can desire no better book than that of Prof. Joos to give him an accurate and impartial orientation in the field of Physics. The printing and binding are of the same excellent quality as one is familiar with from the *Handbuch der experimental Physik* issued by the same publishers.

* * * B. V.

The Form and Properties of Crystals. By A. B. Dale. Pp x+186. (Cambridge University Press, 1932.) 6s. net.

This little book is intended by the author to serve as "an introduction to the study of minerals and the use of the petrological microscope" and help the students "to master the principles underlying the examination, measurement, and identification of minerals". Though hardly 200 pages in size, the book is a successful attempt in bringing together all the fundamental ideas bearing on the crystallographic, physical and optical study of minerals, in a form which certainly helps the student to appreciate the vital connection between these different aspects of mineralogy. The first four chapters deal with the nature, classification, internal structure and the general physical properties of crystals, while the remaining two chapters are devoted to the study of the optical properties of minerals. The fundamental principles of physical optics underlying the study of thin sections of minerals in polarised light are very clearly explained and the different methods of investigation of a mineral by means of the petrological microscope have been indicated. The numerous figures and diagrams found throughout the book go a long way in helping the student to understand clearly the subject-matter.

Though small in size, the book gives such a clear, though elementary, exposition of several important aspects of the study of crystals that there is no doubt it will be found useful not only by students of mineralogy and petrology but also by

students of chemistry and others to whom crystals are becoming matters of increasing interest and importance.

L. RAMA RAO.

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Plane Trigonometry. By B. B. Bagi. Dharwar, 1931. Price Rs. 3.

It is very gratifying to note that, of late, a number of talented persons have been writing *Swadeshi* text-books on scientific subjects in a thoroughly modern and rigorous style. Mr. Bagi must be congratulated for his successful attempt in bringing forth a book embodying many interesting and original ideas. The book has been written with commendable care as regards mathematical rigour in the proofs and in the development of the subject. Special mention may be made of the chapter on inverse functions, whose accurate treatment by Mr. Bagi stands in contrast with that to be found in many English text-books.

The book will be a very valuable asset to all teachers of the subject, as well as to such of the students who show some ability in mathematics. Many, however, will not be able to agree with the author when he talks of "the maturer intellect and the higher level of mathematical knowledge of the students of Indian Colleges"—especially at the Intermediate Standard. Unless the book is made more interesting and less terrifying to the average student—be he of any nationality whatever—by inserting a large number of easy examples in most of the chapters, and by removing the harder ones to the end, the adaptability of the book as a *text-book* becomes difficult. In particular, the absence of chapters on solutions of right-angled triangles, and easy problems on heights and distances involving only right-angled triangles may be called a defect from the point of view of the beginner. These defects—which can be easily remedied in a second edition—do not, however, diminish the unquestionable value of the book to the teacher and to a large number of students.

C. N. S.

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Metamorphism. A study of the transformations of rock-masses. By Alfred Harker. Pp. ix+360. (Methuen & Co., Ltd., London.)

The author of this treatise is well known in connection with two books which have had a far-reaching effect on geological thought. One, "The Tertiary Igneous Rocks of Skye", published in 1904, was probably one of the most fruitful investigations of its

kind ever undertaken. The other, "The Natural History of Igneous Rocks," although now a quarter of a century old, can still be read with great profit by students of petrology. The book now under consideration in no way falls below the standard of its predecessors, which is high praise indeed.

The study of metamorphism can be approached from two points of view, the descriptive, which regards metamorphic rocks simply as museum specimens to be studied for what they are; and the genetic, which pays more regard to metamorphism as a progressive process, and studies the changes through which rocks have passed during their geological history. The former, rather sterile point of view, has been the one adopted by the German school of petrologists, dominated by Grubenmann and his pupils. It has tended to divorce metamorphism from its place in geology, and, as the author aptly puts it, is a relic of the Wernerian school of geology. In the present treatise it is refreshing to find the subject treated in a more rational way, and the processes of metamorphism discussed in their relation to geological history.

Grubenmann, in his well-known treatise 'Die Kistallinen Schiefer', recognizes three grades of metamorphism, which he correlates with depths within the earth's crust. But this attitude ignores the fact that during metamorphism the earth's crust is in a disturbed state, and that the temperature gradient which prevails, and controls to a large extent the grade of metamorphism, has little relation to depth. Moreover, Grubenmann took no account of purely thermal metamorphism, which, being a special case, must be considered before a clear understanding can be gained of the more general problem. In the present treatise the author first examines the changes which all classes of rocks undergo when subjected to increasing temperature, and then discusses the more general, and more common, case in which temperature, hydrostatic pressure and shearing stress play their parts in varying degrees. It is further shown that although these three independent variables control the transformations which take place in regional metamorphism, they are so inter-related that it is possible to treat the problem much more simply, with temperature as the single variable to be considered. That this must be so to a large extent is clearly indicated in those areas of regional metamorphism in which it is

possible to lay down successive zones of metamorphism, the lines separating the zones being both isothermal lines and isodynamic lines. The pioneer in this type of work was George Barrow, who, over forty years ago, mapped successive zones of metamorphism in the South-East Highlands of Scotland, each zone being characterized by a particular index mineral, those he chose being chlorite, biotite, almandite, garnet, staurolite, kyanite and sillimanite. This work is given a prominent place in the treatise under review, in that it illustrates well the principle that metamorphism is to be regarded as a progressive change, taking place in response to a continued rise of temperature, accompanied first by a rise and later by a diminution of shearing stress. But, in addition, the author treats of every possible combination of chemical composition, temperature, hydrostatic pressure and shearing stress that could possibly arise, and concludes with a chapter on "retrograde" metamorphism.

A criticism of the book which might well be offered by some is that it gives little reference to the work of petrologists outside the British Isles. But, as the author says in his preface, "Rather has it been my design to show that this country enjoys peculiar advantages as a field for research, and that British workers have not wholly neglected the opportunities so liberally offered", and anyone who has read the book will fully concur in this opinion.

The book is well got up, and is illustrated with several hundred drawings of rock sections done with the author's usual skill, which add greatly to the value of the work. Written as it is in a style which is above reproach, and containing as it does much of the philosophy of our science, this book, together with the same author's *The Natural History of Igneous Rocks*, might well be taken by students as a model upon which to fashion their own attempts at scientific presentation. As a treatise upon metamorphism it will long remain a standard work to be consulted by geologists; and it is perhaps characteristic of it to say that it will be more appreciated by field workers than by museum specialists. It is a book which worthily maintains the best traditions of British geology, which, ever since the days of Hutton and Lyell, have always been characterized by a certain sanity of outlook in approaching problems of this nature.

W. D. W.