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ELECTRICITY AND MATTER.

The Corpuscular Theory of Matter. By Prof. J. J. Thomson, F.R.S. Pp. vii+172. (London: Archibald Constable and Co., Ltd., 1907.) Price 7*s.* 6*d.* net.

THE present volume is an expansion of six lectures delivered by Prof. J. J. Thomson in his capacity of professor at the Royal Institution. It is a simple and clear account of the development of the corpuscular, or, as some prefer to call it, the electronic, theory of matter to explain the passage of electricity through metals and gases. The last two chapters are devoted to consideration of the properties of model atoms built up of corpuscles, and the evidence in favour of the view that the number of the corpuscles in an atom is about the same as its atomic weight in terms of hydrogen.

The proof of the independent existence in matter of electrons of mass small compared with the atoms has supplied a great stimulus to the attack of that most important problem of physics, the connection between electricity and matter. This attack has been conducted both on experimental and theoretical lines, and while only a beginning has been made, yet the results already obtained have been instrumental in giving a much clearer and deeper insight into the conditions of the problem, and afford considerable justification for the hope of still greater advances in the immediate future. There has been a tendency in some quarters to view with alarm, if not with distrust, the philosophic speculations of the physicist, more particularly when dealing with the question of the constitution of the chemist's atom. It is apparently considered indelicate to pry too deeply into the mysteries of atomic structure, especially if mathematical analysis is the instrument of investigation. This attitude appears somewhat unreasonable to the average physicist, and arises largely from a misunderstanding of the relative place of theory and experiment in physical science. A student of the history of physical science cannot fail to be impressed by the notable part played by mathematical physics in the development of the subject, and there is no obvious reason why the cooperation between the two branches of the subject should not be as fruitful in the future. The physicist from his training is seldom content merely to describe phenomena, but seeks for some form of theory that will serve to give a general explanation of the facts and to show their relation with other branches of the subject. In dealing with such a complicated and intangible problem as the constitution of the atom, it is essential that theory should go hand in hand with experiment, for without some kind of theory the experimenter is in most cases as helpless as a ship without a rudder.

This attitude of the physicist is very well expressed by Prof. J. J. Thomson in the opening chapter. After mentioning the postulates on which the corpuscula theory of matter is based, he proceeds:—

"From the point of view of the physicist, a theory of matter is a policy rather than a creed; its object is to connect or coordinate apparently diverse phenomena, and above all to suggest, stimulate and direct experiment. It ought to furnish a compass which, if followed, will lead the observer further and further into previously unexplored regions. Whether these regions will be barren or fertile experience alone will decide; but at any rate, one who is guided in this way will travel onward in a definite direction, and will not wander aimlessly to and fro."

The working out of the logical consequences of a simple theory and the comparison of the deductions with experiment is eminently scientific, and of great importance to the specialist who is able to form a critical estimate of the adequacy of the theory. The danger of too free a use of hypothesis is not so much for the specialist as for the general reader who, from lack of expert knowledge or of time, is unable to form a critical judgment on the matter. In such a case there is a tendency to assume that a theory which may be admittedly tentative in character represents the final, accepted views on the subject.

Two of the most interesting chapters of the book are devoted to the application of the corpuscular theory to explain the passage of electricity through metals. In one chapter the theory developed is similar in general outlines to that originally advanced by the author and the late Prof. Drude. The corpuscles which are responsible for the passage of electricity through a conductor are supposed to be free from the molecules for a time sufficiently long for them to be in temperature equilibrium with the molecules of the metal. This implies that the corpuscles behave like a gas, and that temperature equilibrium is reached when the mean kinetic energy of the corpuscle has become equal to that of a molecule of a gas at the same temperature. The passage of the current is then supposed to result from the drift of these free charged corpuscles, brought about by the action of the external electric field applied to the conductor. This theory is shown to account in a satisfactory way for the connection between thermal and electric conductivities of metal, and with minor assumptions for the Peltier and Thomson effects. Prof. Thomson points out that this form of theory suffers from one very serious defect. In order to account for the conductivities observed in metals, it is necessary to assume the presence of such a large number of free corpuscles in the metal that the specific heat of these alone, quite independently of the atoms of the metal itself, is about ten times greater than that experimentally observed. The author in the next chapter develops another form of the theory which is free from this objection, and at the same time fits in with the facts to be explained equally well as the first theory. The second method supposes that the corpuscles are not free in the metal except for the time required to pass from one atom to another. They are pulled out of the atoms of the metals by the action of the

surrounding matter, and immediately pass into adjacent atoms. This view materially reduces the number of corpuscles required for the transfer of electricity. In both these forms of theory the atoms of the metal itself are supposed immobile, and to play no direct appreciable part in the transfer of the current.

The important question of the type of radiation to be expected from a metal on the above theories is fully considered. Since the corpuscles are suddenly started and stopped, they must radiate energy in the form of thin pulses analogous to the pulses which are supposed to constitute the Röntgen rays. Lorentz has shown that if this radiation be analysed by means of Fourier's series, the amplitude of the long waves agrees closely with that deduced independently of such assumptions by means of the thermodynamical theory. Prof. Thomson, however, points out that the main radiation must consist of short waves analogous to very easily absorbed Röntgen rays. It would be of great interest and importance if the presence of such a type of radiation from metals could be experimentally detected. In another chapter the author explains the construction and properties of his well-known "model" atoms built up of rings of rotating corpuscles. No one can fail to admire the ingenuity displayed in the construction of such atoms, and in showing the remarkable way in which they imitate many of the known properties of the atom. On this hypothesis the properties of the atom are dependent on the number and arrangement of the negative corpuscles. The corresponding positive electricity, which is distributed throughout the volume of a sphere, merely serves as a cement to hold the atom together. This form of atom, while it has many advantages from the point of view of calculation, is somewhat artificial, for it implicitly assumes very peculiar properties for the positive electricity. To say that a positively charged body is one that has lost a negative corpuscle is not an explanation, but begs the question of the nature of positive electricity. The trend of modern views is to diminish in some directions the importance of the negative charge and to emphasise that of the positive. This is borne out by the author's estimates that the number of free corpuscles in an atom is about the same as its atomic weight in terms of hydrogen. Until we have a clearer idea of the nature of positive electricity we cannot hope to form a clear view of the constitution of the atom. The proof of the existence of a positive electron —the counterpart of the negative—if such exists, would be of enormous importance to theory and experiment. The problem of the nature of positive electricity is now very much to the fore, and it is to be hoped that we shall not have to wait too long for a solution.

Like all Prof. Thomson's books, the present volume is lucidly and simply written, while the mathematical analysis required for the development of the consequences of the theory is made as simple as possible. To all those interested in the latest views of the connection between electricity and matter this book will be very welcome. E. R.

CHARTING THE WORLD'S COMMERCE.

Atlas of the World's Commerce. Compiled from the Latest Official Returns at the Edinburgh Geographical Institute, and edited by J. G. Bartholomew. (London: G. Newnes, Ltd.) Twenty-two parts, each 6*d*. net.

MR. BARTHOLOMEW is a skilled hand at map-making, and in setting himself to chart the commerce of the world he has undertaken a gigantic task. With the aid of 176 large pages of coloured plates, containing more than 1000 maps and diagrams, he attempts to describe the products, imports, exports, commercial conditions and economic statistics of all the leading countries of the world, and he says quite justly that the successful accomplishment of such a work must throw much needed light on the solution of the great problem of international trade which we in British politics call "the fiscal question." His first object is to show whence we derive our food, drink, clothing, and all that we use in our daily lives. No better text could be chosen for the enlightenment of our politicians, whatever be their fiscal views, and indeed of all who would understand where England really stands in the world of commerce, and what are the essentials of her future as the central force of a great Empire.

The very immensity of Mr. Bartholomew's undertaking tends to lessen its topical value. For instance, the last three years have been momentous in their effect upon the sources of British food supply, and Mr. Bartholomew can be of little help to the man who would understand how far we are dependent upon foreign and how far upon colonial supplies, when he only carries us down to the year 1903. Canada, for instance, figures in Mr. Bartholomew's diagrams as yielding less than 86 million bushels of wheat. The produce of her western section alone was in 1906 considerably in excess of that figure. The fiscal controversy is especially associated with the food production of the newer countries, and the usefulness of Mr. Bartholomew's diagrams, so far as the fiscal controversy is concerned, goes little beyond the course of our dependence upon the older countries, such as the United States, Russia, &c. For his distribution of the chief sources of the British supply of wheat, Mr. Bartholomew brings us no further down than the 1901–3 average, from which we see that the Canadian percentage was 8·4 and the United States percentage 45·5. The limited usefulness of such figures is evident when it is noted that in 1906 the Canadian proportion was at least 12½ per cent. and the United States proportion 37 per cent. There may have been insuperable difficulties in carrying the averages down to a more recent period, but it is obvious that, in the absence of more recent figures, it is necessary to endorse with qualification Mr. Bartholomew's claim that in his new atlas "the whole fiscal question is clearly illustrated."

We may note one other respect in which the topical usefulness of Mr. Bartholomew's investigations is limited, and it is a vital one. In dealing with the import and export trade of the United Kingdom