Physics at the British Association.

THE programme of Section A included papers of wide and varied interest, ranging over the subjects of pure mathematics, experimental physics, geophysics, and astronomy. A great deal of the time of the Section was absorbed in atomic problems, and it was in relation to these that much interesting discussion arose.

Dr. Aston gave a concise and comprehensive account of his work on isotopes, starting from his original discovery of the complex nature of neon and chlorine, and he spoke of his early attempts to separate the components of these gases. He described his very elegant modification of Sir J. J. Thomson's method of positive-ray analysis, by which it has now become possible to obtain mass spectra of the rare gases and many other elements with high dispersion of the component lines. He showed how the spectra of various elements could be analysed into groups of lines due to the individual isotopes, and the results interpreted by examining the spectra of different orders produced by atoms carrying multiple charges. In this way it has been possible to eliminate uncertainties arising from radiations consisting of compound molecules and to determine the number of components due to each element. Thus it was shown that chlorine consisted of three isotopic components, krypton of as many as six, and xenon of five, corresponding with atomic weights represented by whole numbers, taking oxygen of atomic weight 16 as standard. Hydrogen alone gave an atomic weight of 1·008, differing from an integral value, and this discrepancy could be explained by considering that the spectrum of hydrogen was due to a hydrogen atom from which an electron had been withdrawn, and which from theoretical considerations should have a mass differing by the observed amount from that of the hydrogen atom. The results thus show that the elements may be considered as being composed of these hydrogen nuclei, or "protons" as Sir Ernest Rutherford would have us call them, and we thus return to Prout's conception of the constitution of matter, modified only by the recent discoveries and ideas of modern physics.

Sir Ernest Rutherford followed with an account of his researches on the structure of the atom, starting from the point of view of radio-activity. When α-particles pass through matter they are scattered, and when they pass sufficiently near to the atomic nucleus they may even be turned back upon themselves. In such cases, at any rate with the lighter elements, the forces involved are so enormous that the nucleus may suffer disruption and charged hydrogen atoms, or protons," be torn from the nucleus. Hydrogen atoms travelling with high velocities thus appear, and can be detected by their scintillations produced on a fluorescent screen. These have been found when nitrogen is bombarded with α-particles, as have elementary projected particles of atomic weight 3, probably an isotopic form of helium. The inve tigation has been extended to other elements, and it would appear that the nuclei of atoms of the lighter elements can be regarded as made up of suitable combinations of hydrogen and this new isotope of helium with electrons. In the heavier elements it would seem that a condensation occurs by which is formed the ordinary helium atom of mass 4. Models were shown illustrating the possible constitution of some of the lighter nuclei, but the complete elucidation of this suggestive and ingenious line of thought must await further experiments.

The discussion of the origin of spectra directed attention to other scarcely less important aspects of atomic phenomena. Prof. Fowler opened the discussion with a masterly description of the known phenomena of spectroscopy, referring to the latest results obtained in examining and classifying the different spectral series of the elements, leaving the consideration of the theories which have been devised to explain the observations to Prof. Nicholson, who described Bohr's well-known theory of atomic radiation. This simple view is, however, insufficient to explain the complicated structure of the lines composing the series, and Prof. Nicholson outlined the extension of Bohr's theory recently developed by Sommerfeld, in which the electronic orbits are considered as elliptical instead of circular. By this extension the relations obtained by Bohr are modified so as to explain the structure of the components of the various spectral series, and the predictions of theory have been strikingly verified by the work of Paschen, whose observations also indicate that the Zeeman and Stark effects are of the magnitude to be expected by theory. Prof. W. L. Bragg directed attention to the difficulty of reconciling the above theory with X-ray observations on crystals and with the chemical evidence leading to Langmuir and Lewis's theory of atoms containing stationary electrons; and Dr. Oxley in a separate paper pointed out the bearing on the question of the magnetic properties of the atom—a subject which has hitherto not received the attention it deserves. From the magnetic evidence Dr. Oxley postulates a binding of the atoms in the hydrogen molecule by a rotating electron system—a complication which, it is to be hoped, will find some simpler substitute.

The subject of relativity was represented by two papers, one by Mr. Evershed and the other by Sir Oliver Lodge. The former paper was concerned with the observations made during the last seventeen years at the Kodaikanal Observatory on the shift of the Fraunhofer lines in the solar spectrum. The conclusion is reached that the general shift of the lines at the centre of the sun's disc and at the limb is not due to pressure, and it is suggested that the increase of shift in passing from the centre of the disc to the limb may be explained by a constant shift towards red over the disc, which is partly compensated by a shift towards violet, due to a movement of ascent radial to the sun. A comparison was drawn between solar phenomena and the results of observations in the electric arc, and the experiments of Royds were quoted as showing that the vapour density in the sun is probably less than is found at the centre of an iron arc. Mr. St. John's measurements on band lines were discussed and compared with observations made at Kodaikanal, which give values at the sun's limb nearly in agreement with the Einstein theory. There are, however, difficulties involved in fully interpreting the results on this theory, and the alternative hypothesis that motion is the sole cause was considered. This view demands an earth effect and a general recession of the iron vapour from the earth. Mr. Evershed described his ingenious experiments in which the displacements were observed by examining the light reflected from Venus. When the angle Venus-sun-earth is about 90° such observations should be crucial, for in this case we should be observing the sun at right angles to the supposed movement. The results are regarded as being favourable to the motion hypothesis, but it cannot be considered that they are as yet decisive.

Sir Oliver Lodge discussed the assumed necessary constancy of the observed velocity of light in free space as contrasted with the universally admitted constancy of its true velocity. He contended that there is no experimental evidence for the dogma that wave-fronts are concentric with a travelling observer initially situated at the source. The Michelson-Morley experiment is consistent with such concentricity, but does not necessitate it. He argued that the Einstein equations exercise no physical discrimination, and are consistent either with this mode of expression or with the FitzGerald-Lorentz conception of the contraction of matter, which was a safer mode of expressing physical results than the attempt to impose complications upon time and space. The paper gave rise to some lively discussion from the supporters of the more modern views.

Mr. F. J. M. Stratton exhibited some spectrograms of Nova Aquilæ III. recently obtained at the Lick Observatory by Mr. Moore, which show important changes taking place in the distribution of radiation from the growing disc of Nova Aquilæ. It appears that the disc given by the $H\beta$ radiation is growing at only half the rate of that given by the nebular lines N_1, N_2, while the complex bands in the spectrum corresponding with all three lines give the same multiple of the wave-lengths for the displacement of separate maxima. Moreover, the separate maxima originate in different portions of the disc, and are inclined to the normal position of spectral lines. A complex combination of expansion, rotation, and vortex motion is needed to explain the effects in terms of the Doppler principle. While the maxima remain fixed in position, the most displaced ones are growing brighter as compared with the central ones.

A further paper on astrophysics was communicated by the Rev. A. L. Cortie, who drew some remarkable comparisons between observations on solar faculæ and photographs of calcium flocculi. The occurrence of magnetic storms on the earth was attributed to the emission of electrons from low, disturbed areas of the sun, giving rise to the formation of clouds into which the earth then passed.

The programme also included an interesting paper by Prof. S. Chapman, who gave an account of some recent extensions of his work on the subject of magnetic storms. Prof. Horton described the results which he had obtained on ionisation phenomena in neon; and Prof. Whiddington showed how he had been able to detect distances of molecular magnitude by observing the variations of frequency in a thermionic-valve circuit produced by the minute changes of capacity resulting from the displacement of one plate of a condenser included in the circuit.

The reports of the Committees on Tidal Observations and on Seismology were of more than usual interest, and in the latter report Mr. J. J. Shaw referred to his recent observations on microseisms. Both communications are being published in the reports of the Association. Much interest was added to the proceedings of the Section by the opportune appearance of the new star in Cygnus. The discovery was announced by the Astronomer Royal at the first session of the Section, and reports of later observations on the new star were received during the meeting.

Chemistry at the British Association.

THE meetings of Section B at Cardiff were fairly well attended, although the programme did not contain any remarkable novelties, and the war papers, which were so conspicuous a feature of the meeting at Bournemouth, were absent. Mr. Heycock's presidential address dealt with the development of metallography, a branch of physical chemistry which owes so much to the work of Heycock and Neville, whose investigations not only opened up important new lines of research, but also set a standard of accuracy which has had a most beneficial effect on later work in metallography, especially in this country. The lesson of the intimate connection between pure science and the advance of industry was well enforced by the address. The president was able to show lantern-slides made from the original photographs of Sorby taken just half a century ago, and members were enabled to appreciate the remarkable skill of the Sheffield amateur who was a pioneer in so many branches of science.

The Section held only one joint meeting for the purpose of hearing the papers in Section A on the subject of isotopic elements. There was a very large attendance at this meeting, and the latest discoveries concerning the isotopes of the commoner elements were described with admirable clearness by Dr. Aston. It is to be regretted that no chemist took part in the discussion. The doctrine of isotopes was founded on chemical evidence, and although recent developments have come chiefly from the physical side, the subject is one of intense chemical interest, and the conclusions which have been reached, inevitable as they appear to be, call for a drastic revision of conventional ideas regarding the elements. No chemist specially associated with the work of determining atomic weights was present, or it would have been interesting to learn whether accurate atomic-weight determinations have ever been made for a single element, other than those of the radio-active group, from materials of widely different origin and geological age; whether, for example, such differences as have been observed between specimens of lead from minerals containing thorium and uranium respectively could be found between chlorides of widely differing origin so as to indicate that the isotopes of chlorine were present in a different ratio from that which has led to the accepted atomic weight of that element. The later paper of Sir E. Rutherford on the structure of the atom was also of great chemical importance, and considerations of this kind have, in the hands of Langmuir and others, been brought into direct relation with chemical facts. It is to be hoped that by the time of the next meeting of the Association chemists will be prepared to join with physicists in the discussion of these questions.

The three subjects selected for discussion on the technical side were fuel, lubrication, and non-ferrous metallurgy. Capt. Desborough's paper on industrial alcohol gave an excellent review of the prospects of production of this fuel from vegetable sources in temperate regions, and showed that, whilst the present cost of root crops grown on cultivated land is too high to allow of their profitable utilisation as sources of alcohol, the possibility of growing suitable crops on reclaimed land is by no means excluded, and figures were given to show that artichokes, sugar-beet, and a South American tuberous plant are all deserving of consideration. The use of maize in certain climates and of waste cellulose is also being studied. The experiments now in progress at the Royal Naval Cordite Factory may be expected to throw some light on the question, and the Section took occasion to pass a resolution urging on the Government Departments concerned the desirability of continuing such experi-