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A Bureau of Human Heredity

IT is a remarkable fact and a no less striking example of the vicissitudes in human affairs that one branch of research, the modern study of genetics, in which the results are put to the test of practical application with the least delay, should spring from an investigation which was forgotten, and of which the record lay hidden in an obscure publication for fifty years. The resurrection of Mendel's paper on heredity, and the rapid and widespread effects which have followed the application of its principles to further experiment and to practical uses, drive home the lesson of the need for co-operation and co-ordination in scientific investigation as a condition of further advance and the avoidance of wasted effort.

The study of the principles of heredity in their application to cattle-breeding and the improvement of the food-supply, as, for example, in producing types of wheat suitable for the requirements of varying soil, climate and purpose, has tended by the immediate availability of results for the advantage of human society, to absorb the practical interest of the public. This has ensured the continued pursuit of the researches upon which such results are based.

It has at times been objected that too little is known of the facts of human inheritance for it to be at present of more than academic interest, while the time is not yet ripe to make its study of practical effect in every-day problems. This, however, if true, is true only in part; and while indeed there are vast fields of research which await exploring, there is also a mass of information, which even in the interest of purely scientific investigation, stands in need of centralisation and co-ordination, and through such centralisation might be made available for far-reaching application.

The need for some such organisation of the data bearing upon human heredity has long been felt. So long ago as 1930 it received practical recognition in the appointment by the International Federation of Eugenic Organisations of an International Human Heredity Committee, of which the main purpose was the setting up of a clearing house for human heredity. The purpose of the clearing house was then laid down to be the collection and analysis of material, the distribution of the information thus digested to institutions, to answer inquiries, and to provide assistance for research workers, as well as prepare bibliographies of current literature.

After prolonged inquiry, the International Bureau approached the British National Committee, which had been instituted in affiliation with the international body, and suggested that London was the most suitable centre for such a Bureau. In accordance with this suggestion, the British Committee in 1933 undertook to set up a Bureau of Human Heredity, which now, it is announced, has its quarters at 115 Gower Street, London, W.C.1. This Bureau will co-operate as fully as possible with other organisations working on cognate material, with the view of economising effort and avoiding overlap; but it will not be otherwise, or more closely, connected with any other organisation. Its management will be in the hands of a Council, which in the first instance will be constituted by members of the existing National Committee, to whom will be added from time to time representatives of medical and scientific bodies, whose co-operation is desired. It should thus be possible to cover as wide a field as is possible among those who are either engaged in research or in the application of its results to

practical ends. Thus among the members of the first Council are members of the Genetics Committee of the Medical Research Council and the Industrial Research Board, Prof. R. A. Fisher, director of the Galton Laboratory, Prof. Cyril Burt, representing psychology, and Prof. F. A. E. Crew, of Edinburgh. Prof. R. Ruggles Gates will act as chairman, Sir Laurence Halsey as honorary treasurer, and Mrs. C. B. S. Hodson as honorary secretary. To these are to be added representatives of the Royal Society of Medicine, the Statistical Society, the Medico-Psychological Association, the Eugenics Society, and the British Medical Association. In view of the consideration that the value of the Bureau as a place of reference for facts to medical men and other inquirers has been strongly stressed, it may be suggested that the representation of pure biology upon the Council stands in need of enlargement.

Lastly, on the important matter of finance. The Bureau at present depends entirely upon private subvention. It is estimated that now that some small sums have made it possible to set the Bureau at work, £10,000 is required to keep it going for a period of five years, and an appeal for this amount has appeared in *The Times* of May 6 over the signatures of Prof. R. Ruggles Gates, Sir F. Gowland Hopkins, Lord Moynihan, Sir Arthur Keith, Sir Grafton Elliot-Smith and others. The purpose of the appeal is one which may heartily be commended to the generosity of all who are interested in scientific studies of man.

The Key Industries Act

THE Key Industries Act may be termed appropriately the 'Fine Chemists' Charter' for, under its shelter, there has been built up in Great Britain a vigorous manufacturing industry giving employment to a number of chemists and chemical workers, which is to-day in a position to supply all the essential requirements in medicinals and fine chemicals needed by the British Empire, and is year by year adding products to its list.

It is a matter of history that the Act was first imposed as from October 1, 1921, with the object of protecting the manufacture in Great Britain of a number of substances and of scientific apparatus, which were essential for defence purposes, from unfair competition, particularly as many of the industries had arisen under war conditions and had been given no time to reorganise on a peace basis. The danger of the potential deficiencies in these industries was a serious one, and it was widely recognised that the words 'key industries' and 'safeguarding' had a very real significance.

The Key Industry Duties were extended and amended in 1926, and became due to expire in August 1936. They have now been extended in the Budget for a further period of ten years, following the report to this end of a committee set up by the Import Duties Advisory Board, which has made a searching study of the question. A useful survey of the working of the Act appears in the April issue of the *Industrial Chemist*.

There has been some suggestion that the Act should be allowed to lapse and the products transferred to the Import Duties Act, but cogent arguments were produced against the change, particularly because it involved a change in the administrative machinery which has been worked so efficiently by the Board of Trade during the fifteen years of 'safeguarding'. It will be possible in the future, however, to impose extra duties beyond the $33\frac{1}{3}$ per cent *ad valorem* on individual substances coming under 'safeguarding' if the Import Duties Advisory Committee so determines.

It is, of course, known that the Act covers optical and scientific glass, porcelain and scientific instruments, gauges and certain other materials besides chemicals. These latter are defined as "all synthetic fine chemicals", "analytical reagents, all other fine chemicals", and from time to time inquiries before a tribunal have been held to decide whether certain substances came within this definition. In December 1933 a "preparation", as distinct from a chemically identifiable compound, was added to the list against the opposition of the Board of Trade, a decision which did not find favour in medical circles.

It is unquestionable that the fine chemical industry of Great Britain, and indeed the chemical industry as a whole, has benefited greatly from the imposition of the duties. Its continuance will give a reasonable period of security in which long-term plans can be undertaken, and research and the training of the necessary staff encouraged.

Organisation of Science in the U.S.S.R.

Soviet Science
By J. G. Crowther. Pp. x+342+16 plates. (London: Kegan Paul and Co., Ltd., 1936.) 12*s*. 6*d*. net.

MR. CROWTHER is well qualified for the task he has undertaken. He has already published two books on historical aspects of science, and he has a wide knowledge of Russian scientific institutions. Further, he is very friendly disposed to the Soviet system, presenting everything in the most favourable light, yet never distorting facts or indulging in propaganda. He gives in this book the most complete account yet issued in English of the present position in the different branches of science in Russia.

The author shows at once his familiarity with his subject by starting with an account of dialectical materialism. This is the philosophy underlying modern Russian developments in politics, science and art, and without some knowledge of it one cannot properly appreciate and understand science as pursued in Russia to-day. In the first ten pages the author gives a well-written summary of this method of proceeding by thesis, antithesis and synthesis, but it would have been useful to give reference to accounts by English philosophers as well as those of Bukharin and Lenin. Those English men of science who wish to enter fully into the spirit of Russian science must first familiarise themselves with this system of philosophy, otherwise they will constantly find themselves confronted with ideas they completely fail to understand.

Next follows an account of the organisation of scientific activity in Russia. The Academy of Sciences is at the head: its original restriction to forty members has been relaxed, and it now includes 18 chemists, 13 historians, 10 philologists, 10 geologists, 8 orientalists, 8 biologists, 8 engineers, 6 economists, 4 physicists and 2 philosophers. The sciences are divided into three departments, natural science, sociology and technology; these are pursued in about twenty large institutes with great staffs and a considerable budget.

The Academy makes its five-year plan of scientific investigation which the Institutes then carry out. The individuals working at these institutes may discuss among themselves how best to perform their allotted tasks, but they cannot strike out a line of their own independent of the Academy's instructions. Until 1934 the Academy was in Leningrad, but it was felt that the intellectual atmosphere of that city was not assimilated to that of the new communist society; the Academy was therefore transferred to Moscow, in the hope that, as Mr. Crowther says, "if the intellectual centre was also at the headquarters of the Government and nearer to the spiritual sources of the new ideology, the defects in its intellectual atmosphere would be removed by the closer contact".

The work of several of the institutes is described. The organisation is completely different from anything in Great Britain. There are frequently three leaders; the director, the secretary of the trades union to which the members of the staff belong, and the secretary of the group of Communists or the 'party cell' in the laboratory. The Communists (called simply 'the Party') are not numerically strong; Mr. Crowther instances an Institute where out of 330 members of staff only 34 are members or candidates for membership of the Party. But their power is such that no director dare go against their wishes. Competition for the directorship is not so severe as in Great Britain. In the newer buildings the scientific staff live in flats at the Institute, so that they are available to each other at all times; at Kharkov, for example, each flat may have three rooms, electric light and gas for a cooker. There are some disadvantages; water is often scarce and household washing and baths may be possible only at night. As everywhere, the staff are young, mostly less than thirty, none more than forty-one years of age. Frequently the workers engaged on a particular problem are organised in a brigade which holds meetings and adopts other devices to foster the collective spirit and to carry out their allotted duties according to plan. The different brigades enter into "socialistic competitions" with each other to see which can do the best work, or the quickest work. "The personal desires of the individual members of a brigade," says Mr. Crowther, "receive little consideration." Behind all stands the 'party cell' to explain Stalin's pronouncements, to organise socialistic competitions, and generally to see that the 'plan' is carried out. Staff lectures and staff meetings are frequent, and much stress is laid on the need for political and philosophical instruction of the staff: "discussion of philosophical questions," Mr. Crowther tells us, "deepens the workers' understanding of the nature of science and its role in social affairs. It reveals, too, often unconsciously, the tendencies of the participators'

thoughts. Saboteurs may be discovered through the suggestiveness of their philosophical opinions." Mr. Crowther does not say what becomes of these saboteurs, and indeed he may not have been able to find out.

The numbers of people engaged are enormous. Mr. Crowther describes, among others, N. I. Vavilov's Plant Research Institute at Leningrad, now being transferred to Moscow. One branch alone of his work requires 1,800 assistants ; another requires 2,000. Huge staffs of this sort present no difficulty to Vavilov, who is certainly one of the most remarkable men I ever met in Russia. He began by making botanical expeditions to various parts of the world to collect the wild species of the various cultivated plants, and set up the very interesting hypothesis that a region where many wild varieties of a species occur is clearly a region of genetical instability and therefore probably a centre of origin of that species. On this basis he has constructed maps showing where the various species of cultivated crops arose. These he finds are very similar to the maps showing the origin of domesticated animals and of civilised man. He uses this enormous mass of material in making genetical experiments on a grand scale, and already he has produced some very interesting new varieties of crops.

It is almost like a different world from ours. Which will in the end prove the better method for scientific discovery ? The British system has its defects, which the dialectical materialists are not slow to point out ; Mr. Crowther quotes as one of their paradoxes : "as scientists [in Western conditions] achieve more and more extraordinary triumphs in their own branches they seem as a class to become more and more stupid". In this new system of planned scientific activity "every scientist knows his place and the degree of his dependence on others. He is unable to give harmful expression to illusory ideas of absolute freedom or behave with social irresponsibility".

We know how much the world already owes to Russian scientific genius. Will the new order help it ? How much freedom is necessary for human development ? Perhaps the most interesting and valuable part of the great Russian experiment is that it will show how far a group of men can advantageously arrange a nation's material, intellectual and spiritual life on a plan to which all must conform. E. J. RUSSELL.

Experimental Physics

Grimsehls Lehrbuch der Physik : zum Gebrauch beim Unterreicht, neben Akademischen Vorlesungen und zum Selbststudium. Neubearbeitet von Prof. Dr. R. Tomaschek. Band 1 : Mechanik, Wärmelehre, Akustik. Neunte Auflage. Pp. vii+674. (Leipzig und Berlin : B. G. Teubner, 1936.) 19.80 gold marks.

THE new edition of "Grimsehl" needs no lengthy introduction to students of physical science. The present volume (mechanics, heat and sound) preserves its strictly elementary character —insisting on the view that physics is primarily an experimental science, and confining mathematical expositions to the very simplest applications of the infinitesimal calculus. Within these limits, the exposition of the subject-matter is as clear and interesting as ever, and the editor is to be congratulated on having covered a very wide ground without the slightest tendency to scrappiness in treatment. The treatment is, generally, classical, and, so far as gross mechanics is concerned, the editor has judiciously introduced matter which has not yet come within the compass of the ideas of the ordinary compiler of text-books —the section on sound, for example, deals briefly with threshold values, and we find diagrams giving *Lautstärke in Phon*.

There are here and there slight lapses. The description of the variation of surface tension with temperature is qualitative, and it is merely a matter of a few lines to give an account of the power law connecting these quantities ; and the account of molecular surface energy is in need of revision. Surely, too, an account of the determination of the constant of gravitation can scarcely be called adequate which, after describing the Cavendish experiment, goes on to the statement, "Die neuesten und zuverlässigsten Versuche sind von Richarz und Krigar-Menzel 1896 in einer unterirdischen Kasematte in Spandau ausgeführt worden". There is no mention of the classic experiment of Boys, none of Poynting's balance method. Where one has to pick and choose, it is really important that the latest and most trustworthy values of physical constants should be listed and, in this respect, the experiments of Heyl (*Bur. Stand. J. Research*, Dec. 1930) should be quoted. Heyl used a torsion balance *in vacuo* ; the large masses were steel cylinders 66 kgm. in weight, the

smaller masses were spheres of gold, platinum, or optical glass. Heyl finds for the constant of gravitation $G = 6{\cdot}670 \times 10^{-8}$ cm.^{3} gm.$^{-1}$ sec.$^{-2}$. The value obtained by Richarz and Krigar-Menzel is $6{\cdot}685 \times 10^{-8}$, and Boys obtained $6{\cdot}658 \times 10^{-8}$. Birge lists the value $6{\cdot}664 \times 10^{-8}$ based on some *preliminary* experiments by Heyl.

The choice of experiments on the mechanical equivalent of heat is curious. Joule's primitive apparatus of 1843 is described and illustrated, as are a laboratory apparatus devised by Grimsehl and some of Hirn's impact experiments. Descriptions of such experiments have certainly considerable cultural value; but when a value of a physical constant is listed in heavy type as correct to four significant figures, it is very desirable that some account should be given of the most recent experiments on which the final value is based.

The reviewer does not wish to convey an erroneous impression of the merits of the book, and it must be emphasised that there are but few of such lapses to record. The reader will find Prof. Tomaschek's edition of "Grimsehl" a pleasant and valuable guide to the fundamental principles of physics. A. F.

Design Argument Restated

(1) The Purpose of God
By the Very Rev. W. R. Matthews. Pp. 182. (London: Nisbet and Co., Ltd., 1936.) 7*s.* 6*d.* net.

(2) The Hope of Immortality
By the Very Rev. W. R. Matthews. Pp. 87. (London: The Student Christian Movement Press, 1936.) 2*s.* 6*d.* net.

(1) PROBABLY, the argument for theism which appeals most to the average man is the argument from design. Kant's philosophical criticism, and the biological theory of natural selection, are usually supposed to have weakened its force. Dr. W. R. Matthews, in the volume before us, examines it afresh.

The revelations of modern astronomers do not seem to Dr. Matthews to have helped matters much. The progress of knowledge has, on the contrary, "increased the sense of mystery and incomprehensibleness to such a degree that it is often difficult to feel that we are in a friendly universe". The teleological argument "gains nothing". The impression grows upon us "that we are in a world which is alien to our values, indifferent to our hopes, and, if purposive at all, is directed towards ends for which we are irrelevant".

The truth is that nothing much can be done with the "design" argument so long as "we make the false abstraction of considering nature apart from the mind which knows nature". The point is that somehow Nature has produced minds which "begin to understand it, to form estimates of it, and, as we are compelled to believe, are advancing in their knowledge of it". "The process of nature begins to understand itself and to value itself in the consciousness of human thinkers. Here is the most secure foundation of the teleological argument".

Dr. Matthews's argument is that the "emergence" of mind and knowledge are unintelligible unless the course of evolution is directed, and that on any other view "it is impossible to see how there can be any reliance on the power of mind to know truth".

That any theory of evolution which does not admit that mind directs the process, must "when thought out, lead to a negation of the possibility of knowledge, and therefore of the truth of the theory of evolution itself", was argued by the late Lord Balfour. But we are not sure that there is not a way out of this *impasse*. It might be argued from the evolutionary point of view that organisms have developed minds to enable them to deal more efficiently with their material environment (Schopenhauer pointed out that as sight is to touch, so reason is to sight—sight gives the organism a wider range than touch, and reason than sight). That their minds *do* enable mind-endowed organisms like men to deal with their material environment, does seem to guarantee the knowledge supplied by mind—at least to a sufficient extent to satisfy most of us. That minds *have* been evolved for this special purpose seems to be suggested by the failure of minds to cope with certain kinds of knowledge—as was pointed out by Bergson, who brought up to date the "paradoxes" of Zeno. The point is that the mind, even if posterior and not anterior to matter (that is, on the materialistic no less than on the idealistic theory), is a trustworthy instrument *for its purpose*. Most civilised people believe in the same system of fact and theory.

In the same way Dr. Matthews argues that "there can be no way of justifying the validity of human judgments of value except on the hypothesis that the prior stages of evolution were guided by some power which had regard to values

and intended them". But is a philosophic theory of this sort necessary to account for the fact that, as Mr. Michael Roberts has pointed out, while from time to time some of the admirers of Wagner go over to Beethoven, the process is never reversed? Nor does a man pass from Donne to Rupert Brooke. Why? Is there nothing objective about æsthetic sensibility apart from some theory about the origin of values?

We have chosen to indicate some reflections which will probably occur to scientific readers of this book, of whom, it is to be hoped, there will be many. This very able essay in constructive apologetic indeed deserves the thoughtful attention of students of science.

(2) The publication of Dr. Matthews's broadcast lectures on immortality will be widely welcomed. The Dean deals with this vast subject with economy and lucidity. Many who heard these admirable talks will be glad to have them in a permanent form, since they are certainly of permanent value. J. C. H.

The League of Nations

(1) The Aims, Methods and Activity of the League of Nations

Pp. 220. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1935.) 2*s*.

(2) The League of Nations and the Rule of Law, 1918–1935

By Sir Alfred Zimmern. Pp. xi+527. (London: Macmillan and Co., Ltd., 1936.) 12*s*. 6*d*. net.

ON very different scales, both these books attempt not merely to describe or assess the achievements of the League of Nations but also to trace its development from early efforts and experiments in international organisation and co-operation.

(1) In the first and smaller volume, the greater part of the book is devoted to a well-balanced account of the activities of the League, including brief reference to the work of the Permanent Court of International Justice and of the International Labour Organisation. This description of the League's achievement is admirably done and, without being burdened by too great detail, enables the reader to appreciate how large a place the League already occupies in the relations of nations, despite the limitations on its efforts in the political field, and the evident weaknesses at the present time. Together with the concise description of the League's framework and methods, it should enable the reader to form an idea of the causes of some of the League's failures, and of the conditions under which it might function much more effectively.

(2) Sir Alfred Zimmern works on a larger canvas. Deliberately excluding the discussion of individual problems, he passes over many phases of the League's activity and, although a third of the book is occupied by a historical sketch of the League, he deals with only the main characteristics of the four phases into which he divides that history. It is, however, his approach to the subject which invites the special attention of the scientific worker.

Starting with the pre-War relations between States and the methods of co-operation which had then been developed, Sir Alfred describes the evolution of the Covenant out of the ideals and projects stimulated by the Great War and of the actual experience of international co-operation in allied shipping control and the like. He thus endeavours to set the actual form of international co-operation represented by the League of Nations against the background of experience in this field which we have already acquired, and in the light of this to estimate alike the causes of its failure and the possibilities of its further development or future success.

The outcome of this essentially scientific approach is a little disappointing. To some extent the reader is prepared for this by the warning against the difficulties besetting the scientific inquirer and the caution to be used in handling all books dealing with the League which prefaces Sir Alfred's sketch of its history. Moreover, he admits at the outset his doubt whether he is writing of an experiment which has reached its conclusion or describing the early phases of a living and developing institution.

That doubt is largely justified by the present political situation, but whatever the immediate issue may be, the material assembled in these books will leave no doubt in the mind of the scientific reader that the experiment must be continued in some form or other. If Sir Alfred has comparatively little to say, either in description or appraisement, of the technical side of the League's work in fields such as health, communications and transit, etc., where the League's committees have given a remarkable demonstration of the way in which knowledge and power can be linked, he

suggests that success in this field has to some extent made co-operation more difficult in the political field.

This aspect of co-operation, overshadowed as it may be by political questions at the moment, cannot be dismissed so cavalierly. Others besides the scientific worker may be disposed to inquire why a like approach should not be possible to all those difficult problems in the political field which threaten the peace of the world at the moment, and Sir Alfred himself has indicated some of the factors involved in such an approach. No means of promoting the quantity or technique of international co-operation can be neglected. Both alike increase the probability that the existing organisation for co-operation such as the League provides will be used. Equally the study of the technique of co-operation not merely supplies warning of the defects or dangers of existing organisation for co-operation but also assists in the modification or development of that organisation to meet changed conditions. Sir Alfred's conclusions in fact underline this necessity for a continually developing organisation for international co-operation, both to provide the machinery for settling disputes, and also to assist its members in discovering sensible ways of dealing with their own affairs.

Both books can be heartily welcomed as assisting the reader to arrive at that impartial and accurate knowledge of the functions and achievements of the League upon which alone its authority is finally based, and without which we can scarcely hope for that new spirit in the whole field of international politics which is the central problem of the League.

R. BRIGHTMAN.

Principles of Genetics

Genetics

By Prof. H. S. Jennings. Pp. 351. (London: Faber and Faber, Ltd., 1935.) 15*s*. net.

THE extraordinary growth of genetics as a science has been accompanied by the publication of innumerable volumes giving general accounts of progress or more detailed studies of particular fields. The contributions of Prof. Jennings to this subject have been notable, especially his work on the Protozoa and on the mathematical rules of segregation. His writings, moreover, bear the hall-mark of clarity and orderliness of thought. They are therefore well adapted for the introduction of these aspects of biology to the general reader. Another notable aspect of Prof. Jennings's books is that he does not confine his biological conclusions to animals and plants, but brings them home directly by their application to man himself. The present volume will sustain his reputation as a thinker who faces the biological and eugenic conclusions to be drawn from genetical research.

This volume is a presentation of the general features of genetics such as every educated person should know. It is not intended as a technical introduction, but it points out and enlarges upon those aspects of the subject which the intelligent layman will wish to understand. The first chapter deals with the hereditary material, the chromosomes, which are passed on from cell to cell and from generation to generation. In Chapter ii this "genetic system" is considered in contrast with the muscular or the nervous system. The picture of meiosis given at this stage is obviously incomplete, corresponding with knowledge about twenty-five years ago. But the author in his treatment follows the history of the development of knowledge, the more recent phenomena of linkage and crossing-over being considered in Chapter vi under the constitution of the chromosomes.

Sex-linked inheritance is explained, first from the well-known cases of hæmophilia and colour blindness in man, and afterwards from the phenomena in *Drosophila*. "The relation of genes to characteristics" considers multiple, duplicate and modifying factors in *Drosophila* and the action of genes in development, but it ends characteristically with a study of physical and mental inheritance in identical human twins, which is continued in the next chapter on the "relation of characteristics to the environment", where the facts are set forth clearly and without bias. The last two chapters, on genetic variations, refer to mutations in many organisms and the methods by which they originate.

In a work of this kind, where choice of topics is essential, there are many which might have been included, but the author wisely emphasises principles rather than facts, and the book can be recommended to every reader who wishes to have an understanding of genetics in its biological aspects and relations rather than a detailed treatise on the subject. Among slips noted is the statement (p. 169) that the garden pea and the sweet pea have eight chromosomes.

R. RUGGLES GATES.

A Fugue in Cycles and Bels

By John Mills. Pp. vii+269. (London: Chapman and Hall, Ltd., 1936.) 13*s*. 6*d*. net.

THE author points out that music in past ages has developed "without benefit of physics, except in so far as the simple rules of Pythagoras gave support to certain musical intervals against possible changes in taste, or style . . ." In this book an account is given of modern developments arising from successful efforts to improve the transmission of music and speech. The two chief factors are pitch and frequency, the latter here denoted in the title as cycles; and intensity and loudness, indicated by 'bels'. If one sound is ten times as loud as another, it is one 'bel' higher in sound level. If A is about 25 per cent louder than B, then A is one 'decibel' (db.) above B. The necessity for some such scheme arises from the fact that a full orchestra may vary in sound energy from about 70 watts down to a few microwatts, with a ratio of ten million to one, so that a logarithmic notation is required, and in this particular case the range is clearly 7 bels, or 70 decibels.

Although in most cases frequency and pitch may be deemed equivalent, yet an increase of intensity, without change of frequency, will produce an alteration of pitch. Thus it is stated (p. 117) that Stevens of Harvard has found that "if the power-level of a 150 cycle tone, as it reaches the ear, is 76 db. the frequency of the reference tone has to be reduced to 145 cycles (at a low power) to be equal in pitch". The latest determination of the threshold of audition is stated (p. 85) to be 10^{-16} watts. This extreme sensitivity of the ear and mind is combined with marvellous delicacy of analysis.

The book also deals in an interesting way with questions of transmission, distortion, overloading, noise, reverberation and auditorium acoustics. The final part presents and explains plots and graphs obtained mainly at the Bell Research Laboratories, New York.

The Book of Minerals

By Alfred C. Hawkins. Pp. xii+161. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1935.) 7*s*. 6*d*. net.

THE professed purpose of this little book is "to tell to the people the story of the minerals", and to this end the author has been careful to keep his text free from all technicalities. The opening section offers brief advice on where to look for minerals and how to collect them, "how to tell minerals apart" (by means of hardness, specific gravity, blowpipe tests, etc.), and gives some account of crystals and their classification. The main part of the book contains short descriptions of the most common minerals, well illustrated with photographs of museum specimens.

To one knowing nothing of the subject "The Book of Minerals" would provide a pleasant companion for a walk round a museum collection. The young collector, for whom in many ways the book seems to be designed, would soon reach a stage when this "Mineralogy without Tears" would no longer satisfy his growing thirst for knowledge. B. W. A.

Tabulæ Biologicæ Periodicæ

Herausgegeben von C. Oppenheimer und L. Pincussen. Band 3, Nr. 4 (=Tabulæ Biologicæ, Band 9, Nr. 4). Pp. iv+321–436. Band 3, complete, 55 gold marks. Band 4, Nr. 1 (=Tabulæ Biologicæ, Band 10, Nr. 1). Pp. 160. Band 4, complete, 55 gold marks. Band 4, Nr. 2–3. (=Tabulæ Biologicæ, Band 10, Nr. 2–3.) Pp. 161–208; 209–288. (Den Haag: W. Junk, 1934.) 55 gold marks.

THE data given in these numbers of the "Tabulæ Biologicæ" will be of interest to all biologists. The last part of vol. 3 concludes the list of polypeptides acted upon by erepsin and trypsin, and also tabulates the compounds hydrolysed by various amidases. The remainder of the number is devoted to a list of plants cultivated for their food or of commercial value, including their natural habitat, centres of cultivation, use and finally chromosome number. An index to the volume is included.

The first part of vol. 4 has sections dealing with redox-systems, respiratory pigments and the blood groups of the different nations of the world (which is concluded in No. 2 of the volume). Other sections deal with the influence of light on the germination of seeds and the physiology of the Myriapoda. No. 2 also includes data on the kidneys and a list of acids found in lichens. No. 3 has three sections only: a list of the less common elements found in the tissues of different animals; data on the skulls of prehistoric man and finally a second article on the biology and toxicology of gases, vapours and sprays used in warfare. The material of this journal does not lend itself to a more detailed review, but the data should prove extremely useful for those interested.

Probability and Random Errors

By Dr. W. N. Bond. Pp. viii+141. (London: Edward Arnold and Co., 1935.) 10*s*. 6*d*. net.

THIS is a bright and original treatment of a subject voted by many as dull, however necessary it may be for the experimentalist to discuss with care the accuracy of the end result of his measurements and calculations. The book is addressed primarily to students of physics and chemistry, but others will find it interesting and useful. It begins with questions of pure probability, leading up to the discussion of problems of random migration and kindred topics that are of interest to the modern physicist. Various types of error are listed, and a chapter is devoted to their estimation. We then have an unusually full chapter giving the probable errors of various combinations of measured quantities. The fitting to data of the straight line and parabola is described, together with examples of the fitting of other types of curves. The first part of this section might have been simplified arithmetically, since the data are in all cases equally spaced, by giving a method, such as that of Aitken, based on orthogonal polynomials. A chapter on periodogram analysis follows, and the book ends with a number of miscellaneous examples, and with two short appendixes, in one of which the formulæ of the book are conveniently summarised for reference.

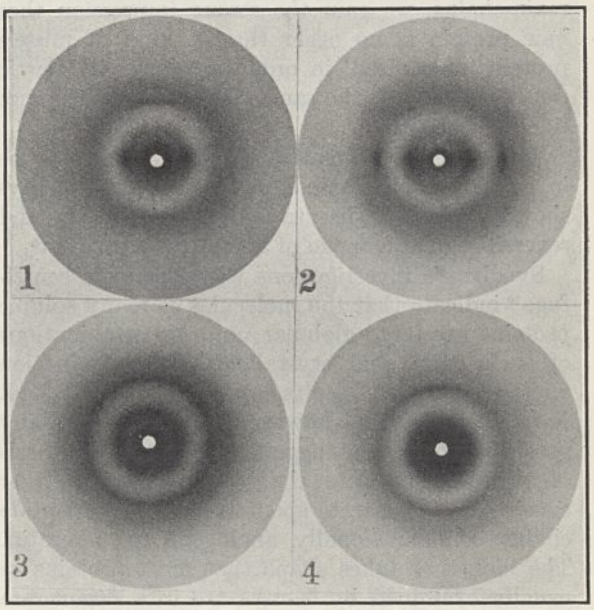
X-Ray Studies of Protein Structure*

By W. T. Astbury, Textile Physics Laboratory, University of Leeds

ACCORDING to the classical researches of Fischer and others, proteins would appear to be essentially polypeptides, giant molecules formed by the repeated condensation of α-amino-acids. This concept leads naturally to the idea of long chain-molecules like that of cellulose, the structure of which was worked out some years ago by a particularly happy combination of chemical and X-ray methods[1]. Similar methods applied to one of the simplest proteins, *fibroin*, the fibre substance of natural silk, show that, for silk at least, the hypothesis is substantially correct[1]; that, in fact, this fibre is a kind of molecular yarn or sliver built up by chain-like molecules, fully-extended polypeptides, lying roughly parallel to the fibre axis. The approximate dimensions of these chain-molecules may be predicted from atomic data already available, and they are found to fit in well with the results of X-ray analysis.

The X-ray photographs of all natural protein fibres, hair, muscle, collagen, feather, etc., show certain features in common with that of natural silk, and it seems clear that they are all built up in very much the same manner from chain-molecules lying along, or simply related to, the fibre axis. But in other respects there are well-marked differences which indicate that the straight-chain configuration found in silk cannot be true in general. Specially does this objection hold in the case of mammalian hair. On stretching hair, however, a new X-ray photograph is obtained which shows again the characteristics of fully-extended polypeptides. The chain-molecules of *keratin*, the protein of hair, must therefore be normally in some regularly folded state from which they can be pulled out straight, and to which they return when the tension is released[2].

Mammalian hairs, spines, horn, etc., are elastic over a range recalling even that of rubber, and X-rays thus indicate that the property resides in the keratin molecule itself, which can be transformed from a folded configuration (α-keratin) to the straight-chain configuration (β-keratin) and back again an indefinite number of times. The structure of β-keratin[3] (Fig. 2) appears to be that of a polypeptide 'grid' built up by interactions and combinations between the various 'side-chains' of neighbouring 'main-chains'. To accommodate these interactions the grid buckles, so to speak, in such a way that the main-chains fold in planes transverse to the side-chains. In the presence of water the folds can be pulled out by mechanical force, but they resume their normal configuration when the stretching force is removed. The basis of the 'setting' of hair when steamed in the stretched state is the hydrolytic breakdown of certain of the cross-linkages of the grid which are put under stress when the molecule is stretched. The broken cross-linkages then ultimately re-form in new (unstressed) positions, thereby eliminating the driving force of contraction. If, however, the cross-linkages are broken but not allowed to re-form, a more labile state is induced in which the (modified) keratin molecule can be made to contract to a length even shorter than that of normal α-keratin ('supercontraction').



FIGS. 1–4. X-ray photographs of (1) a protein in the α-configuration, (2) a protein in the β-configuration, (3) disoriented denatured protein, and (4) stretched denatured albumin. (Fibre axis or axis of extension vertical.)

The X-ray photograph of washed and dried muscle (Fig. 1) is remarkably like that of α-keratin[4,5]. The photograph in the main arises from the chief muscle protein, *myosin*[6], which must be presumed to exist normally in a folded, or α-, configuration. If, therefore, the elastic elements in muscle are by analogy with keratin the myosin chain-molecules, the contraction of muscle corresponds to the 'supercontraction' of keratin, and it should be possible to transform both myosin and muscle into a straight-chain, or β-, configuration[4]. These transformations have now been accomplished[5], by stretching myosin film and washed muscle

* Substance of three lectures delivered at the Royal Institution on February 20 and 27 and March 5.

respectively, and the former has also been made to show 'supercontraction' after the manner of the contraction of muscle itself[5,7]. Figs. (1) and (2) are typical α- and β-photographs, respectively, (1) being that of the foot retractor muscle (washed and dried) of *Mytilus edulis*, and (2) that of stretched horn.

Considering now these two further points : (*a*), that in spite of the close resemblance between their X-ray photographs the sulphur content of myosin is quite small compared with that of keratin, which among proteins is outstandingly rich in sulphur ; and (*b*), that the side-chain breakdown shown by X-ray analysis to precede the supercontracting state of keratin has been found by Speakman[8] to be largely concerned with the cystine –S–S– linkage between neighbouring main-chains, we gain the strong impression that hair protein is no other than a kind of muscle protein 'vulcanised' in order to reduce its elastic sensitivity and at the same time impart resistance to chemical attack.

The molecule of feather keratin appears to be in a slightly contracted β-configuration. X-rays show that it can be stretched continuously and reversibly over a range of some seven per cent[9].

Svedberg's investigations with the ultra-centrifuge[10] indicate that the molecules of many soluble proteins are large globular units or combinations of such units, and crystallographic examination and certain X-ray results support this view. Most X-ray photographs, however, taken without any special precautions, suggest almost the antithesis of this and indicate that the molecules either consist of, or generate spontaneously, polypeptide chains configurationally analogous to β-keratin. The idea thus takes shape that most proteins as usually examined by X-rays are in a degenerate state, that their original specific configuration has broken down partially or completely to form disoriented polypeptide chain-bundles[11]. The hypothesis is further strengthened by the observation[11] that when proteins are deliberately 'denatured', for example by heat, the resemblance to disoriented β-keratin becomes even more pronounced. This will be clear by comparing Figs. (2) and (3), the latter being a powder photograph of boiled egg-white—or for that matter, to all intents and purposes, any denatured protein. A crucial test, therefore, is to see whether it is possible to obtain an X-ray photograph like that of *oriented* β-keratin simply by stretching a denatured protein.

This test has now been carried out, and artificial fibres and films of denatured albumins and globulins have been shown to give, on stretching, X-ray photographs typical of oriented bundles of fully-extended polypeptides. The crystallographic orientation, though, of these photographs is not always the same : whereas stretched denatured edestin, for example, gives a photograph like Fig. (2), corresponding to chains lying *along* the axis of extension, a stretched film of 'poached' egg-white gives a photograph like Fig. (4), corresponding to chains lying *across* the axis of extension. The observed types of photograph can be explained only on the assumption that the polypeptide chains in denatured albumins are in general much shorter than those in denatured globulins[12].

It should be noted that films and fibres of denatured proteins are elastic, and often over a great range, presumably because the denaturation process usually results in a random, and maybe sometimes incomplete, liberation of chains which in part coalesce into bundles and in part remain in an irregularly coiled-up state from which they may be pulled out by tension, rather in the manner of the polyprene chains when rubber is stretched.

The immediate question of the future concerns the precise relation or relations between the 'globular' proteins and the chain-molecules to which they give rise so readily. Which is the more fundamental, the globular form or the chain form, and is one obtained from the other by a process of simple coiling or uncoiling, or is the chain form a consequence of the linear polymerisation or condensation of the globular form ? At the moment there is evidence for both possibilities[12], though it seems more likely that in general denaturation involves little more than (*a*) the dissolution of intramolecular co-valent linkages, in particular the –S–S– linkage, (*b*) the uncoiling of a chain system, and finally (*c*) the coagulation or 'crystallisation' of the liberated chains into bundles configurationally analogous to those of β-keratin[11]. It must be emphasised, however, that though denaturation appears always to lead to the formation of polypeptide chain-bundles, it does not follow that all chain-bundles are necessarily denatured. The muscle protein, myosin, for example, may be said to be 'configurationally disposed' towards denaturation—and indeed it denatures with extreme ease—but so long as it is not allowed to dry it tends to remain soluble. It is clear that if irreversibility is to be avoided, then at least the chains must be kept from too intimate relations with one another.

What then constitutes reversibility of denaturation, if there is such a thing, and Anson and Mirsky[13] maintain that there is ? At the moment, the answer given by X-rays would appear to be this, that it is determined by (*a*) the extent to which a globular protein may be uncoiled reversibly, and (*b*) the possibility of keeping the liberated chains from agglomerating into parallel bundles ; or in other words, of avoiding more intimate or widespread interaction than obtained in the original globular configuration. Much seems to

depend on the way the globular proteins are built up in the first place. If they are built up piecemeal and not by the coiling of one or more polypeptide chains, then reversible uncoiling is perhaps unlikely.

A purely formal approach to the constitution of the globular proteins may be made by combining the results of X-ray analysis with the study of protein monolayers. From the X-ray examination of the fibrous proteins we must conclude that in fully-extended polypeptide chains, in β-keratin or denatured edestin, for example, the average length of an amino-acid residue is about $3\frac{1}{2}$ A., its thickness is about $4\frac{1}{2}$ A., and its average width in the side-chain direction is about 10 A. The density of a fibrous or denatured protein, therefore, should be about $0{\cdot}0105R$, where R is the average residue-weight of the amino-acids in question. If we take R to be of the order of 120, this gives a density of 1·26 gm. per c.c.—and it is a fact that proteins do have very much this sort of density. Similarly, protein monolayers formed of parallel arrays of more or less fully-extended polypeptides with their side-chains dipping into the substrate should have a common area (not allowing for hydration) of about $95{\cdot}5/R$ sq. metres per mgm. ; that is, for $R=120$, about 0·795 sq. m. per mgm. Now Gorter and his collaborators[14], for example, find always in the region of *p*H 1 an area (extrapolated to zero pressure) of the order of 1 sq. m. per mgm., and a similar area often at the isoelectric point also, whether the molecular weight be 35,000 (Svedberg's 'unit') or a multiple of that ; for example, insulin (*p*H 5), 0·875 : pepsin (*p*H 2·7), 1·0 : zein (*p*H 5·5), 1·07 : ovalbumin (*p*H 4·7), 0·88 : casein (*p*H 4·6), 1·04 sq. m. per mgm. The natural conclusion is that protein monolayers, under certain conditions at least, are formed by the liberation of polypeptide chains from an originally globular configuration in something the same way as in the process of denaturation.

A further helpful step forward was made by Gorter[15] when he showed that the area of a protein monolayer, under the conditions defined above, corresponds to that of a set of spheres of radius about 22 A., which is the radius found by Svedberg for his spherical units of weight 35,000. (More recently Bernal and Crowfoot, in the only reasonably successful X-ray analyses of unaltered single protein crystals so far accomplished, have arrived at a similar result for the molecules of pepsin and insulin[16].) Gorter's result may also be derived from first principles by means of the X-ray data given above ; but it is difficult to proceed to the obvious inference that globular proteins are by way of being simply curved monolayers with the side-chains directed radially, because the calculated density (about 1·14) of such systems is too low.

It is a significant fact that the density of the globular proteins is roughly the same as that of the fibrous proteins. What other possibilities are there then that conform to Gorter's finding ? One is the cylinder whose height is equal to its diameter, and whose area, therefore, is again $4\pi r^2$, but the calculated density of this (about 1) is still less satisfying. Actually there is no solution along these lines *except by building a system out of pieces of monolayer separated by the characteristic 'side-chain spacing' found by X-ray analysis. We have thus to place four disks of monolayer of diameter about* 40 *A. on top of one another at a distance of about* 10 *A. apart.* Both the weight and the dimensions then correspond to those of Svedberg's units, the density is correct, and the area of the liberated monolayer would be equal to the surface area of spheres of the same diameter. Furthermore, though X-ray data on the globular proteins are still so meagre, such an arrangement fits in well with present indications[11,12] that their structure must in many cases be somehow closely related to that of the fibrous proteins.

Just recently, Wrinch has arrived at similar conclusions along quite different lines of reasoning[17]. In effect, she has succeeded in generalising the two features of the α–β keratin transformation that it was found necessary to postulate in order to explain quantitatively the experimental facts : (*a*) that the chain should fold hexagonally at regular intervals, and (*b*) that the side-chains should stand out transverse to the plane of folding. Perhaps there is some justification then after all for the suggestion[18] that in a way keratin is the grandfather of all proteins.

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The Rabbit in Australia

TO-DAY every country is shy of introducing any mammal or bird which is not already a permanent resident, recognising that it may introduce a fresh element upsetting the balance of Nature of its land. Great Britain has had experience of the black and brown rats for centuries, perhaps accidental introductions; and has lately incurred liabilities, which may be enormous, by the purposeful introduction of the American musk-rat, already the major pest of Central Europe; and the escape of the grey squirrel from the London Zoo. The rabbit also is held by Hinton to have been an introduction by the Normans; there are no mentions of warrens in Domesday Book. The English sparrow is only too well known in the United States and other countries. All pale into insignificance when compared with the rabbit in Australia, which, if control fails, will assuredly devastate a continent. The earliest arrivals, probably domesticated forms, were passengers on the first fleet of settlers 149 years ago. In Tasmania, rabbits were "running about some of the large estates in thousands" by 1827. Many of the smaller islands were also being stocked to provide food for shipwrecked mariners. On the mainland such areas where they flourished were hemmed in by forests, containing natural enemies, carnivorous mammals and birds. Then in 1859, two dozen wild rabbits were introduced to a Geelong estate, on which 20,000 were killed in the next six years, an estimated stock of 10,000 being left. To-day, three quarters of the continent is over-run.

The rabbit was originally an inhabitant of North Africa and southern Europe. The Romans carried it everywhere, sometimes (Majorca) with disastrous results. It is extraordinarily prolific, commencing to breed at four months of age and dropping up to six litters a year with an average of six young at each. The young can look after themselves when a fortnight old. If in any country there are suitable crevices in rocks or holes in the ground or protection by fallen timber, the young rabbit does not burrow, but in open country they dig holes, extending to 7–8 feet deep and often to great length; thus many living together form extensive warrens. The doe excavates a special burrow of its own, usually near the surface of the warren, where the earth is easiest to dig.

Essentially, the rabbit is an inhabitant of the plains, and at Geelong were the plains which form the greater part of Australia, with no enemies capable of keeping such a prolific animal in check. The inhabited parts were mostly laid out in sheep runs. Competition commenced, both rabbits and sheep eating the same food; the rabbit preferred the finer and more nutritious grasses and was a closer feeder and thus won in the struggle. So long as they were not too numerous, the stockmen liked them, for what did it matter if they were a few sheep less, while they had a variety in their food and especially a perquisite by the sale of rabbit skins. It was very shortsighted, for when drought came, the rabbit always won, for the sheep died first and more than sufficient rabbits were left. Then came wet seasons and the rabbit multiplied and pushed out into the semi-desert with its isolated bushes and low trees and its tussocks of grass. In turn drought came; the grass was eaten and the bush and the trees ringed and killed. What were merely 'dry lands' become desert with no plants to hold the drifting sand. Sheep cannot live on prickly pear, the only vegetation left, but rabbits can. In Australia the immediate problem is the productivity of wool and mutton reduced to about half in many pastoral districts; when the quantities of these are so reduced that the land no longer pays, it is gradually converted to desert.

The experiments in control at first made in Australia failed. The fox, who listens for the doe and her young and digs them out, was introduced, but the fox turns his attention to lambs and chicken—and, of course, kills out much of the native fauna. The efforts of Governments were mainly to prevent the spread of rabbits; thus Queensland tried to protect itself by no less than 6,303 miles of wire fencing. Ring fences were erected in places and often separate stations within these were again ringed. Western Australia ran a fence 1,139 miles without a break, and as part of this seemed ineffective two subsequent inner fences of 724 miles and 160 miles. Trapping and digging are too expensive—and poisons, while undoubtedly effective at times, never clear the whole stock; and they kill everything harmful and beneficial, fur and feather. Carbon disulphide was used as a fumigant, but even in a burrow its effect is very brief and many rabbits escaped; the same applies to carbon monoxide. Then the natural diseases of rabbits were studied and a virus was tried, but there was always left a resistant stock with which to carry on.

Mr. D. G. Stead, as Rabbit Enquiry Commissioner to the State of New South Wales, now

advocates the use of 'Cyanogas'*, and this to us seems the soundest proposal as yet formulated. Cyanogas is calcium cyanide in dust form, and this in contact with ground moisture or water vapour gives off hydrocyanic acid gas, which is the most deadly fumigant known. It is quite safe to handle in the portable foot machine, and the method is to blow a few puffs into the mouth of a warren, their number depending on its size, and then to close up and stamp down every hole with the spade, and leave the warren, into which dogs had previously driven all wanderers. The Cyanogas takes up to a day to decompose and is all this time giving off its gas, which diffuses so well that it penetrates to every part of the burrow.

Mr. Stead's figures are convincing, and his claim that this fumigant gives "the greatest kill possible" and entails "the least possible use of time and energy" seems justifiable; certainly at the estimated cost of 6*d*. per acre (or even at four times as much !) its use means "the lowest cost". In Australia it is claimed that the better sheep lands could be thus safeguarded, and their extra productiveness in wool and flesh would mean a handsome profit on the deal. Is it not also equally applicable to England, where rabbits have been selling everywhere in the country at 6*d*. a piece or less in the past winter ? The shooting of rabbits is poor sport, and the eaten-off crops that surround many fields mean often a loss of 10 per cent of the crop of a farm, and must be abolished, if farming is to pay. No doubt the Ministry of Agriculture is alive to the use of Cyanogas, but in our experience few farmers or land owners know of it, and those who do mostly regard its use as highly dangerous. It is a fumigant applicable to the brown rat and perhaps the musk-rat, but in each case it requires to be used according to the mode of life of the beast. In any event, there is some hope now that these rodent pests may be controlled.

J. S. G.

* The Rabbit in Australia: History, Life Story, Habits, Effect upon Australian Primary Production and Best Means of Extermination. By David G. Stead. Pp. 108. (Watson's Bay, N.S.W.: The Author; London: University of London Animal Welfare Society, 1935.) 2*s*. net.

Obituary

Prof. James Rice

JAMES RICE, who died on April 17 at the age of sixty-two years, was associate-professor of physics and reader in theoretical physics in the University of Liverpool. He was educated at the Royal Academical Institution, and the Queen's College, Belfast (now the Queen's University, Belfast), where he obtained the highest honours (Senior Scholarship and Dunville Studentship). In the Royal University of Ireland his career was equally distinguished (scholar, student and junior fellow), and at the examinations for the B.A. and M.A. degrees and the junior fellowship he was awarded the highest place in the first-class honours list in mathematical science. In 1902 he was appointed senior physics master at the Liverpool Institute, a post which he held until 1914, when he was appointed to a senior lectureship in physics in the University of Liverpool. In 1924 the University of Liverpool conferred on him the title and status of associate-professor, and in 1935 the additional title and status of reader in theoretical physics.

In the earlier part of his career, Rice was particularly attracted to those branches of mathematical physics which deal with thermodynamics, kinetic theory and classical statistical mechanics, and soon obtained a mastery of all these subjects. Being gifted with a keenly receptive and flexible mind as well as an outstanding ability in mathematical science, he soon became an enthusiastic and expert student of the new advances in theoretical physics—Planck's theory of the quantum of action, the Robb-Einstein-Minkowski theory of relativity, the Rutherford-Bohr theory of the atom, and the later advances in the quantum mechanical theory of atomic and molecular events due to Heisenberg, Born, Schrödinger, Bohr, Dirac and Weyl.

Rice's early mastery of the general theory of relativity was demonstrated in the clearest fashion by the publication in 1923 of his "Relativity; a Systematic Treatment of Einstein's Theory" (Longmans, Green and Co., Ltd.). Although not intended to compete with the great treatise of Eddington (from whom Rice's work received a highly favourable notice in the columns of this journal), this book dealt in a thoroughgoing fashion with the complete mathematical theory of the subject, and soon became the best text-book in the English language for serious university students of theoretical physics.

Being convinced of the fundamental importance of the new outlook on science and philosophy due to the concepts of the modern theory of relativity, Rice became a devoted advocate of these views and gave highly appreciated 'popular' lectures thereon in many parts of the country, being invited by the Parliamentary Science Group to expound the new ideas to the members. His book on relativity in Benn's well-known sixpenny series had an immense sale, and probably did more than any other work on the subject to spread the new concepts among the thinking and more intelligent sections of the British public. Throughout his whole life, Rice was an enthusiastic and expert apostle of the new and wonderful light that had come into the minds of

men. In his spirit there burned the pure and bright flame of a passion for knowing and for teaching those who would also know. Like those Irishmen of olden times who went forth to spread a new light throughout the world, he, too, felt he had a mission, and dedicated his life to it with a selfless devotion that had in it the same saintly quality.

Another example of Rice's mastery of the principles of modern theoretical physics is his "Introduction to Statistical Mechanics for Students of Physics and Physical Chemistry" (Constable and Co.), which was published in 1930. He had long contemplated a very comprehensive and advanced work on this subject, and had made many preparations for it, but the heavy calls on his time and strength made by his teaching work obliged him to confine his efforts to a smaller work. Nevertheless, Rice's "Introduction" has established itself in the affections of students of science throughout the world, and forms a very necessary and admirable preparation for a study of the advanced treatises of Fowler and of Brillouin, and the classical work of Willard Gibbs.

Prof. W. C. McC. Lewis, of the University of Liverpool, would be one of the first to acknowledge the valuable help he has received from Rice on many occasions. Students of his well-known treatise on physical chemistry will recollect the valuable contributions made by Rice to that important work.

Prof. Rice took a large part in the teaching of physics at the University of Liverpool. Besides lecturing to the advanced honours students, he gave for many years general courses on physical science, organised and supervised much of the practical laboratory work and was responsible for inspiring and guiding the work of many research students. Partly owing to his late entry into university work and largely owing to his wholehearted and unselfish devotion to the teaching of his students—and many of his friends of maturer age—he allowed himself little time for making personal advances in theoretical physics. Although he published a number of scientific papers, he will be chiefly known for his valuable books, which are gems of lucid scientific exposition of difficult branches of mathematical physics. He took an active part in the work of the Education Department of the University of Liverpool, for which his experience in teaching at the Liverpool Institute gave him special qualifications.

Rice cared much for the sorrows and troubles of his fellow-men, and took a deep and expert interest in the conditions of life and economic welfare of the workers in all classes of society. His warm heart and generous spirit could not tolerate any form of social injustice, and led him to take an active part in the work of the local branch of the Fabian Society.

Keeping himself constantly abreast of the newest advances in physical science, Rice possessed a marvellous power of assimilating this knowledge and explaining it to others. His constant aim at the University was to infuse the work of his students from the very beginning with the new concepts and principles of physics, rather than to ask students to unlearn their earlier knowledge and attack these fundamental matters as 'advanced work' in the later stages of their university life. Many generations of students both at the Liverpool Institute and at the University of Liverpool must owe him a very deep debt of gratitude for his inspired and inspiring teaching and his constant devotion to their interests. Most nobly and faithfully did he carry on the tradition of his great teacher at Queen's College, Belfast, Prof. William Blair Morton.

It may not be indiscreet to mention that an elaborate commentary on the scientific writings of J. Willard Gibbs will be published this year by the Yale University Press. In this commentary Prof. Rice was invited to participate, and contributed very important and valuable articles dealing with Gibbs's thermodynamical theory of heterogeneous equilibrium involving strained elastic solids and surfaces of discontinuity. In this work Rice returned to his earliest love, and demonstrated his complete mastery of two of the most difficult and recondite branches of thermodynamical science. It is sad to think that he will not see the publication of important work that cost him several years of intense thought—work that is surely destined to add further lustre to his reputation.

We, his many friends who live to mourn him, treasure in our hearts the memory of a sincere and affectionate friend and an eager, generous and unselfish spirit. He is survived by his devoted wife, but leaves no family. F. G. DONNAN.

DR. LUDWIG DÖDERLEIN, formerly keeper of the Zoological Museum in Strassburg, died at Munich on March 23, 1936, aged eighty-one years. He graduated as Ph.D. at Bonn in 1877, with a thesis on the skeleton of a tapir. He visited Japan, and there collected many fishes, which were described by Dr. Franz Steindachner and himself in the memoirs of the Vienna Academy of Sciences between 1883 and 1887. In 1889 he co-operated with Prof. G. Steinmann in a text-book, "Elemente der Paläontologie", and afterwards devoted himself chiefly to the study of fossil vertebrates. His latest papers on pterodactyls were published by the Bavarian Academy of Sciences in 1929.

PROF. ANTON GHON, formerly director of the Pathological-Anatomical Institute of the German University of Prague, died on April 23 at the age of seventy-one years. He had specialised in the treatment of tuberculosis, and had discovered, during his collaboration with Sachs, the so-called Ghon-Sachs bacillus. He was interred at his birthplace, Villach, in South Austria.

WE regret to announce the following deaths :

Mr. H. G. G. Payne, director of the British Archæological School in Athens, on May 8, aged thirty-four years.

Sir Alfred Watson, K.C.B., Government actuary, who was president of the Institute of Actuaries in 1920–22, on May 7, aged sixty-six years.

News and Views

Sir Norman Lockyer, 1836–1920

No centenary can be mentioned more appropriately in NATURE than that of Sir Norman Lockyer, who founded this journal in 1869. Joseph Norman Lockyer was born at Rugby on May 17, 1836, so that the centenary of his birth falls on Sunday next. Throughout his career he worked with unceasing energy for the advancement of natural knowledge, and his spectroscopic researches, as well as his imaginative insight, place him in a high position among pioneers of modern science. The records of his contributions to astrophysics, and the recollection of the stimulating influence he exerted upon the progress of science for so many years, have increased in strength and value since his death on August 16, 1920; and they will command admiration so long as the pursuit of knowledge is regarded as worthy human endeavour. In the issue of NATURE of November 6, 1919, published to celebrate the jubilee of the foundation of this journal, Sir Norman Lockyer was the subject of an article in the series of "Scientific Worthies", and Dr. Henri Deslandres then referred to him as "one of the great men of science of England and one of the greatest astronomers of all time". How well he earned this high tribute of praise may be judged from the fine volume recording his "Life and Work" published in 1928.

Helium

THE discovery of Sir Norman Lockyer's which stands out as one of the most romantic events in the history of science is that of helium. In 1866, Lockyer suggested that, with large enough dispersion, it should be possible to observe solar prominences in full daylight without waiting for the sun to be obscured in a total eclipse. Two years later, he became possessed of a spectroscope of sufficient power to make this observation, and he then noticed a strange yellow line in the spectra of solar prominences. This was at first supposed to be due to hydrogen, but experiments failed to confirm this opinion. After satisfying himself that the line could not be produced by any element then known on the earth, Sir Norman Lockyer called the unknown substance 'helium'. Not until twenty-seven years later was terrestrial helium extracted from cleveite by Sir William Ramsay, and since then it has proved to be one of the most interesting elements in both pure and applied science. For an element first discovered by an astronomer to prove in the course of time to have so many scientific and industrial contacts is a reward which few investigators can hope to obtain, and a tribute to an achievement which occupies a leading position in the archives of science.

Guthrie Lecture: Prof. F. A. Lindemann, F.R.S.

THE Guthrie Lecture for this year of the Physical Society is being delivered at the Imperial College of Science and Technology, South Kensington, at 5 p.m. on May 15 by Prof. F. A. Lindemann, professor of experimental philosophy in the University of Oxford, whose subject is "Physical Ultimates". Prof. Lindemann has carried out theoretical and experimental researches in various branches of physics. Before the Great War he was distinguished for his work on the specific heat of solids at low temperatures; the Nernst–Lindemann formula was a pioneer attempt to connect the specific heat of a substance with its characteristic frequencies. During the War he was attached to the Royal Air Force, and the apparatus which he evolved and the experiments he performed himself in actual flight on the causes and elimination of spin were recognised as of the highest importance. In 1919, at a very early age, Prof. Lindemann was appointed to the chair which he now occupies at Oxford. He has written papers on the origin and nature of magnetic storms, and his research work on meteors gave the first indication of the then unsuspected rise of temperature at heights of about 50 km. in the upper atmosphere, which has since been verified in other ways. His development of photo-electric cells and the electrometer which bears his name have been of incalculable service, not only to the solution of the astronomical problems which interested him and his father, who had his own observatory at Sidmouth, but also to physicists in general. Recently he has turned his attention to the more philosophical aspects of physics, and in his book on the "Physical Significance of the Quantum Theory", he has attempted to clear up certain difficulties connected therewith.

Bicentenary of the Duke of Bridgewater, 1736–1803

ON May 21 the bicentenary occurs of the birth of Francis Egerton, third and last Duke of Bridgewater, who has been called "the Father of British inland navigation", and to whom a monument exists at Ashridge bearing an inscription which says that "by devoting the energies of his mind to the accomplishments of the most splendid works of inland navigation, [he] opened a new field of national industry and rendered the most important services to the commercial interests of this country". A sickly, neglected boy, and an ignorant, awkward and unruly youth, the Duke was only twelve years of age when he succeeded to the title, and there was little promise in his early life that he would become one of the country's benefactors. A disagreement at the age of twenty-two with the widowed Elizabeth, Duchess of Hamilton, led to his leaving London for his home at Worsley near Manchester, and his whole life was henceforth devoted to the management of his collieries and estates. Obtaining an Act of Parliament in 1759 for a canal from Worsley to Manchester, he engaged the services of James Brindley (1716–72), and the next few years saw the construction of the

Worsley to Manchester Canal with its famous Barton Aqueduct over the River Irwell, and also the Bridgewater Canal from Longford Bridge to the Mersey at Runcorn, by which craft could proceed from Manchester to Liverpool. While he exercised the greatest possible economy in his private affairs, the Duke spent some £220,000 on his canals, which, however, ultimately yielded an annual revenue of £80,000. The Bridgewater Canal was sold in 1887 to the Manchester Ship Canal Company for £1,710,000. The Duke died in London on March 8, 1803, and was buried in the family vault at Ashridge. The monument to which reference has been made now belongs to the National Trust.

British Patents

WHILE the fifty-third Report of the Comptroller-General of the Patent Office (London: H.M. Stationery Office. 4*d*. net) is of academic interest as reminding us of the diversity of modern scientific research, its tabular appendixes reveal a gradual change in the destination of patent grants which is of over-riding industrial importance to Great Britain. Of the grants made in 1933, the last year for which final figures are available, 9,000 were made to residents within the British Empire as against 8,100 to foreigners. The figures for applications made during last year show a drop in British applications of six per cent since 1933, while those from outside the Empire have increased more than seven per cent. On this basis, grants made directly to foreigners in respect of applications made in 1935 will clearly exceed those made to British subjects. When it is realised that 1,796 of the applications made in 1935 by residents in Great Britain were made on behalf of inventors residing abroad, it becomes clear that foreign patentees are well on the way to outnumbering Britishers. If figures for purely scientific inventions were available, they would probably be even more striking, and it is disquieting to realise that patentees with no real compulsion on them to manufacture in Great Britain are increasing rapidly; German applications, for example, increased from 4,050 in 1933 to 4,481 in 1935, while in the same time applications from the United States grew from 3,194 to 3,612, these two countries being responsible for well over sixty per cent of the total foreign applications. There were no requests made in 1935 for the grant of a compulsory licence, but there were 789 for indorsement of patents "Licences of Right". The report is silent as to the results of the experimental extension of the search recently introduced, but the proportion of patents granted to applications made is apparently unaffected by it. The office surplus of receipts for 1935 over expenditure was £232,307, and must surely be a record.

Development of Rockets for High Altitude Exploration

OUR readers who are interested in the development of rocket propulsion, and may have read a review in NATURE of March 14 of a somewhat premature book on the possibilities of using rockets for interplanetary travel, will be glad to hear that an authoritative statement has been issued by the Smithsonian Institution concerning the researches carried out by Dr. Robert H. Goddard, who has been experimenting at Roswell, New Mexico. Dr. Goddard has produced a rocket weighing five pounds which is capable of developing 1,030 horse-power for a period of twenty seconds by the combustion of a mixture of gasolene and liquid oxygen. Difficulties were experienced with the steadiness of direction of the rocket, which is now controlled by gyroscopic means. So far, the rocket has not attained an altitude of more than 7,500 feet, but the altitude has been purposely limited for experimental reasons. It is hoped that it will be possible to develop rockets capable of carrying recording apparatus which will serve as scientific instruments for exploring the upper atmosphere. It is good to hear that such experiments are being carried out, and the sober objectivity of Dr. Goddard's work presents a sharp contrast to the unscientific imagination exhibited by those who seek to direct attention to the advent of interplanetary travel long before the preliminary investigations that might throw light upon its possibility or otherwise have been completed.

Archæological Investigation in the Irish Free State

UNDER a scheme of the Irish Free State for the relief of unemployment, in 1935 excavations were carried out on eleven sites, those on five being in continuation of work initiated in 1934. The results for 1935 are summarised by Dr. S. P. O'Riordan of the National Museum of Ireland in *Discovery* of April. Sites partly examined in 1934 are described first. In a cairn near Baltinglass, Co. Wicklow, additional stones carved with spiral ornament were found, with sherds of bronze age pottery and evidence of cremated burials. At Agnaskeagh, Co. Louth, the second of a group of megalithic cairns was examined and evidence again found of association with Early Iron Age. There was a considerable amount of iron and a cremation in a Hallstatt urn against the collapsed slab of a burial chamber. The most important investigation, again producing surprising results, was that of the complicated series of earthworks at Cush, Co. Limerick. Corroboration of the previous season's results, dating ring-forts with souterrains back to Late Bronze Age, was found in the discovery that the fort containing the burials was not the earliest, but had been built later than that adjoining it, and further that occupation had continued over a long period. House sites, not yet clear in all detail, show the plan of a distinctive Irish house-type. At Dunshaughlin, Co. Meath, a crannog produced evidence of a much larger area for this early Christian site (8–10th centuries) than was previously thought. Enormous quantities of bones of wild and domestic animals were found. The monastic site of Gallen Offaly continued to produce important evidence for the evolution of Irish art. Burial mounds at Lug, near Tullamore, Carrowjames, Co. Mayo, and Pollacarragune, Co. Galway, produced interesting material of bronze and iron age date, including what is probably the finest known razor as regards decoration, from the last-named.

Royal Loan to British Museum

AMONG recent additions to the collections of the British Museum (Bloomsbury), it is announced, are three ancient gold ornaments which have been placed on permanent loan by the King. Not only are these of great archæological value, but also they have the added interest that they came into the possession of the Crown during the nineteenth century under the law of Treasure Trove. The oldest of the three, dating from about 1400 B.C., is a gold beaker with handle, standing about 3¼ inches high, which was found in 1837, together with a bronze dagger and other objects, in a barrow at Rillaton Manor, Linkinhorne, Cornwall. Coming next in age is a gold torc of about the first century B.C., which is made of twisted strands of gold. It was found in Needwood Forest in 1848. The third exhibit is a pectoral cross and chain, known as the Clare reliquary, which was dug up at the site of Clare Castle, Suffolk, in 1866. It is of English workmanship of about A.D. 1400. It has a pearl in each angle, and is stippled with a representation of the crucifixion in front and a floral pattern behind. It still contains pieces of the True Cross and the Rock of Calvary.

Iranian Studies

OWING in great measure to the exhibitions of Persian and Chinese art, which have been held at the Royal Academy, interest in Asiatic art, once exclusively confined to scholars and connoisseurs, is steadily spreading to a wider circle of the public. Not merely does it take the form of purely æsthetic appreciation ; it is rather an avenue to understanding of the culture and outlook of peoples hitherto regarded as far removed in more than merely a geographical sense. In this movement, the acquisition for the nation of the Eumorfopoulos collection of Chinese and Far Eastern art, of which the exhibition at South Kensington is proving markedly successful, has been an added stimulus. While London awaits its museum of Asiatic art, any addition to the facilities for study of the cultural achievement of the East is deserving of every encouragement. On this ground at least, students and others will welcome the announcement that friends of Iran have founded a society for the study of Iranian art on the lines of the Société des Études Iraniennes of Paris. Among those who are taking an active part are Lord Lamington, Sir Denison Ross, Mr. Laurence Binyon, Mr. Leigh Ashton and Prof. D. Talbot Rice. Those who are interested in the work of the society may communicate with the secretaries, Mr. Basil Gray and Mr. S. F. Shademan, at 10 Prince's Gate, S.W.7.

Applied Physics

THE March issue of the *Review of Scientific Instruments* devotes eleven pages to a report of the meeting of the Advisory Council on Applied Physics of the American Institute of Physics held in Pittsburgh in November. The Council recommended that in the American Physical Society a Division of Applied Physics be formed under a special chairman and committee to arrange for papers on applied physics to be read and discussed and to direct the journal *Physics*. In the discussion on the training of physicists for industrial posts, it was pointed out that at most of the American universities the average graduate in physics "lacks practical sense and initiative" as compared with the chemist or engineer, and "is inclined to overemphasise theory, quantum physics and atom splitting". A demand was made that "the applied physics student should be required to study more chemistry" in order that the present belief "that it is easier to train a chemist in the physics he needs than it is to train a physicist in the chemistry he needs" may be eradicated. Like the engineer, the chemist and the metallurgist, he should have courses in the practical application of his knowledge. The Council further resolved that meetings be held to discuss the outstanding problems of each industry and that the desirability of preparing a book "Physics in Overalls" be considered.

Lancashire and Cheshire Fauna

THE twenty-first annual report of the Lancashire and Cheshire Fauna Committee deals chiefly with 1934 records, and in addition to adding 146 new records to their faunal lists and 44 to one county, there are species new to Britain and to science. Of the Micro-Lepidoptera, a species bred by F. N. Pierce and W. Mansbridge from alpaca wool and wrongly considered *Tinea merdella*, Staint, is now found to be new to science and is named *Tinea lanella*, Pierce and Metcalfe. *Scythris fallacella* is a small moth new to Britain from the north Lancashire limestone. The small pearl-bordered fritillary butterfly has reappeared in the Delamere Forest area of Cheshire after fifty years absence. Of Coleoptera, *Anthicus tobias*, Mars., previously recorded from India, Arabia, Mesopotamia and Turkey, and said to have been from rotten sacking in Kent previously, was found breeding in some numbers by Mr. H. Britten on the Manchester Corporation refuse dump. Fifteen new records of Mallophaga for the counties are added from studies of wild and domestic birds. Efforts are being made to find the Cooke collection of sawflies compiled in the area last century, in order to examine the material in the light of the committee's present knowledge of the Hymenoptera-Symphyta. Request is also made for shrews and bats for parasite study at the University of Manchester. The ornithological report for Lancashire and Cheshire includes little of wide interest compared to former years.

Mining Research at Birmingham

WE have received from the University of Birmingham the report on the work of the Mining Research Laboratory during the fifteen months to March 1935. The introduction explains how it is that the report ends with work done in March. The report especially discusses silicosis, pneumonoconiosis, etc., to which six pages out of twenty are devoted. Attention may be directed to the excellent article by Bax in Glückauf, page 1241, upon the methods used in combating silicosis in the Ruhr district. The report before us shows, like Mr. Bax's paper, that nothing definite is

yet known as to the causes of silicosis, etc. The suggestion is made that the incidence of silicosis may in large measure be due to the riding of men on 'spakes'. The essential thing is that up to the end of December 1934 there have been a great many deaths in the country from silicosis, of which more than 50 per cent have occurred in the anthracite area of South Wales. Other subjects treated in the report before us are underground illumination, utilisation of coal by converting coke oven gas into gas with high calorific value, the quantity of firedamp in coal seams as worked, the pressure not having been investigated, spontaneous combustion in coal mines, control of atmospheric conditions in hot and deep mines, whilst investigations connected with the Gresford disaster apparently have occupied a great deal of the time and energies of the Research Laboratory, of which the late Prof. J. S. Haldane was director.

Land Utilisation Survey

THE fifth annual report of the Land Utilisation Survey of Britain has recently been published. It records the number of published sheets as thirty-two, with twenty more sheets scheduled for publication in the near future. The completed survey will comprise 235 sheets. Most of the field work has now been completed, but there are still gaps, notably in East Cornwall, Herefordshire, the West Riding and parts of Wales. It is planned to issue eventually eighty-seven county reports. These will analyse the distribution of each type of utilisation and, where information is available, compare to-day's conditions with those of the past. The utilisation of the land will be correlated with soil conditions. Each county report will be published at one shilling. It may be noted that the relevant maps have been called for by the Commissioner of the Special (Depressed) Areas in order to indicate what land is still available for settlement or development. The cost of publishing a sheet is roughly £100, and various county authorities and universities have made contributions to the sheets of their areas. In other cases the ordering of large numbers of sheets for educational purposes has enabled publication to take place. The director, Dr. Dudley Stamp, appeals for more help of this kind. The headquarters of the Survey is the London School of Economics, where offers of help should be addressed.

Lasting Qualities of Printing Paper

THIRTY-THREE years ago the Carnegie Institution of Washington, after careful inquiry, decided that papers made of rags of the best grade gave the greatest promise of durability, and since then the more important books published by the Institution have been printed upon specially made all-rag paper (Carnegie Inst., Washington, Report of Editor of Division of Publications for year 1934–35, p. 371). Increasing costs of such paper, together with the fact that the supremacy of all-rag paper has been challenged, led to a new investigation, which has just been completed. The value of rag paper is confirmed, for all investigators agreed about its satisfactory behaviour over long periods, but attention is directed to factors other than quality which affect the lasting property of paper. For example, disintegration is hastened when paper is stored in atmospheres rendered acidic by the presence of sulphur dioxide. It is recommended that permanent records should be stored under controlled atmospheric conditions of 50 per cent relative humidity and 70°–75° F. temperature. It is doubtful if paper made from chemically treated wood fibres would stand as well, but the evidence is not strong enough to induce the Institute to cast aside its rags.

Tests on Wood Boxes and Crates

THE United States Forest Products Laboratory has already undertaken detailed scientific and engineering tests on wood boxes and crates. Fibreboard boxes and other shipping containers are now to be subjected to similar tests, according to Science Service, of Washington, D.C. These latter now constitute business amounting to 165,000,000 dollars in the United States. It is said that these fibre boxes and containers are on a largely empirical basis, and the unavoidable losses are as yet unknown. The investigation will take place in the pulp and paper section of the Laboratory, since fibre box paper is largely made from waste, such as newsprint, in combination with new pulp. The strength tests of the paper will be carried out with the use of highly accurate scientific instruments. These include a Tuckerman optical strain gauge which, under rigidly controlled atmospheric humidity conditions, tells the degree of stiffness in small strips of paper. A tiny mirror, rotating as the paper is stretched, throws a beam of light on a small scale which indicates the amount of stretch. Strength formulæ so derived will be correlated with others obtained from tests on the strength of finished fibre boards, as well as others calculated from tests of completed boxes. A circular rotating drum will be used for tests on completed boxes, both full and empty; the drum when revolved jolts, drops, and slides boxes round in a fashion similar to the treatment they are subjected to in transit by rail, ship or lorry.

Handbook of International Organisations

A RECORD of international organisations is kept by the Section of International Bureaux of the League of Nations, and is published as a half-yearly "Bulletin of Information on the Work of International Organisations", and collected and compressed in a "Handbook of International Organisations", of which the last Supplement is dated 1931. The information contained relates not to work organised by the League but to the voluntary international societies—"organisations internationales privées"—which exist outside the League, many of which are older than the League. They have an independent life of their own, but keep touch with the League. There appear to be certain features common to a number of these organisations and their conferences; for example, several of them feel the need of specialist international

(*Continued on p.* 821.)

Supplement to "NATURE"

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Northern Lights*

By Prof. A. S. Eve, C.B.E., F.R.S., emeritus professor of physics, McGill University, Montreal

The Upper Air

DWELLERS in cities see little of the night sky; they are dazzled by street lights and advertising signs. Those who live in the country enjoy a greater privilege. Although London is nearer to the north pole than Montreal or Quebec, yet it is the people of Canada who more frequently see the glory of the Northern Lights. It is the distance from the magnetic axis of the earth that counts, and that axis meets the surface of the earth at the north magnetic pole, which is in the island of Boothia in Canada. According to Størmer, the region in the northern half of the earth where auroras are most prevalent is a broad circular belt which has its centre near Smith's Sound in north-western Greenland. The three main forms of display are the arc or arch, the curtains and the long streamers. The colour is commonly greenish white or greenish yellow, sometimes with an admixture of red or violet.

The first appearance of the aurora is sometimes a bright quiescent arch with its peak a few degrees west of due north. This may suddenly be followed with a host of streamers, like searchlights, but changing, flickering and dancing. This is rather frivolous behaviour, for the Eskimo believe that the lights are the spirits of their ancestors. At other times the display begins with nearly vertical curtains of light the folds of which keep changing in form. It is often a fascinating and resplendent spectacle, and it is pardonable if a word picture falls short of the reality. The drapery is usually to the north, spreading from east to west, but sometimes it appears quite overhead. Even so far south as the State of New York the curtain may sometimes be seen south of the zenith.

The altitudes of these displays have been skilfully measured in Norway by Størmer, with a number of observers connected by telephone, who took photographs at the same instant from different places (Fig. 1) at a measured number of miles apart. The photographs (Fig. 2) show the northern lights in each case with a background of the stars of the Great Bear, but owing to parallax the lights are seen in different positions relative to the stars on the different photographs. A simple calculation determines the altitude of the aurora. About 60 miles is the most common result, that is, 60 miles from the surface of the earth, not from the observer. Sometimes the tops of the streamers may be 250 miles above the earth, and I believe that the lowest determination is an altitude of

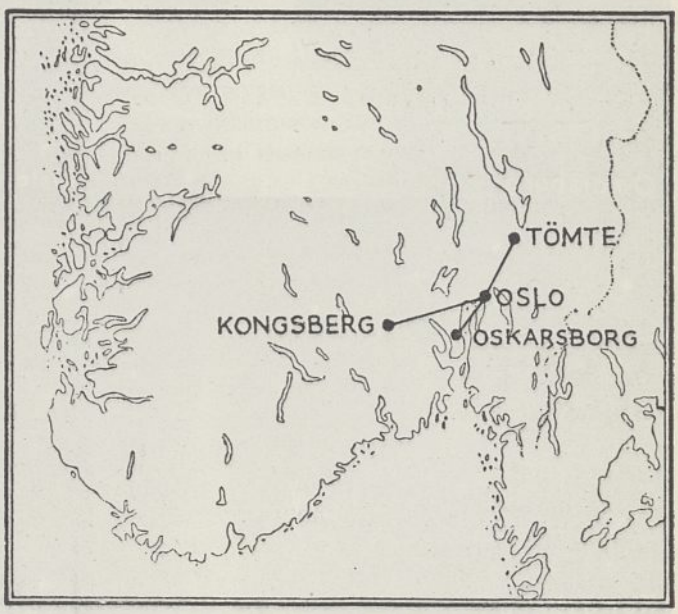

Fig. 1. Four stations in Norway selected by Dr. Carl Størmer and connected by telephone. From Oslo to Kongsberg is 63 km.

* From a Friday evening discourse at the Royal Institution on February 7.

40 miles. The record height for the top of a streamer is 1,000 kilometres, more than 600 miles. Similar measurements were made in Canada by Sir John McLennan and others, and the results there were in excellent agreement with the earlier determinations in Norway.

It is a strange fact, proved by Størmer, that those auroras which have the greatest altitudes, ranging (base to top) from 350 miles to 630 miles, occur in a *sunlit* portion of the atmosphere far above the dark region where the observer stands (*Science Review*, I, 3, 117, Feb. 1936). Those auroras which occur wholly in a dark atmosphere range from 60 miles to 200 miles. Thus the upper ionised atmosphere appears to expand by day and to shrink at night. Appleton has found similar results when measuring the altitudes of those ionised reflecting regions which echo back wireless waves of suitable wave-length.

Notwithstanding these definite facts, and the further one that Northern Lights appear behind distant mountains, there are many who declare that they have seen an aurora close to the ground. A probable, but not certain, explanation is that a patch of mist close to the ground was lit up by the vivid light of an aurora about 60 miles away*.

Sound of Auroras

Several observers, some of whom I have met personally, declare that sometimes there occurs with an auroral display a sound, distinctly audible, that resembles the swish of a silk dress, or the noise of a sword moved swiftly with the blade broadside to the air, or of wind whistling in the rigging of a ship. On the other hand, several of my scientific friends, like Frank Davies, who has been on both arctic and antarctic expeditions, have listened in vain for sounds accompanying auroras. Negative evidence, however, is never satisfactory. Others declare that the noise swells and fades at the same instants that the lights increase and diminish in intensity. It is difficult to believe that this could be true. If the aurora is 60 miles away, the sound therefrom, if any, would take, at five seconds for each mile, about

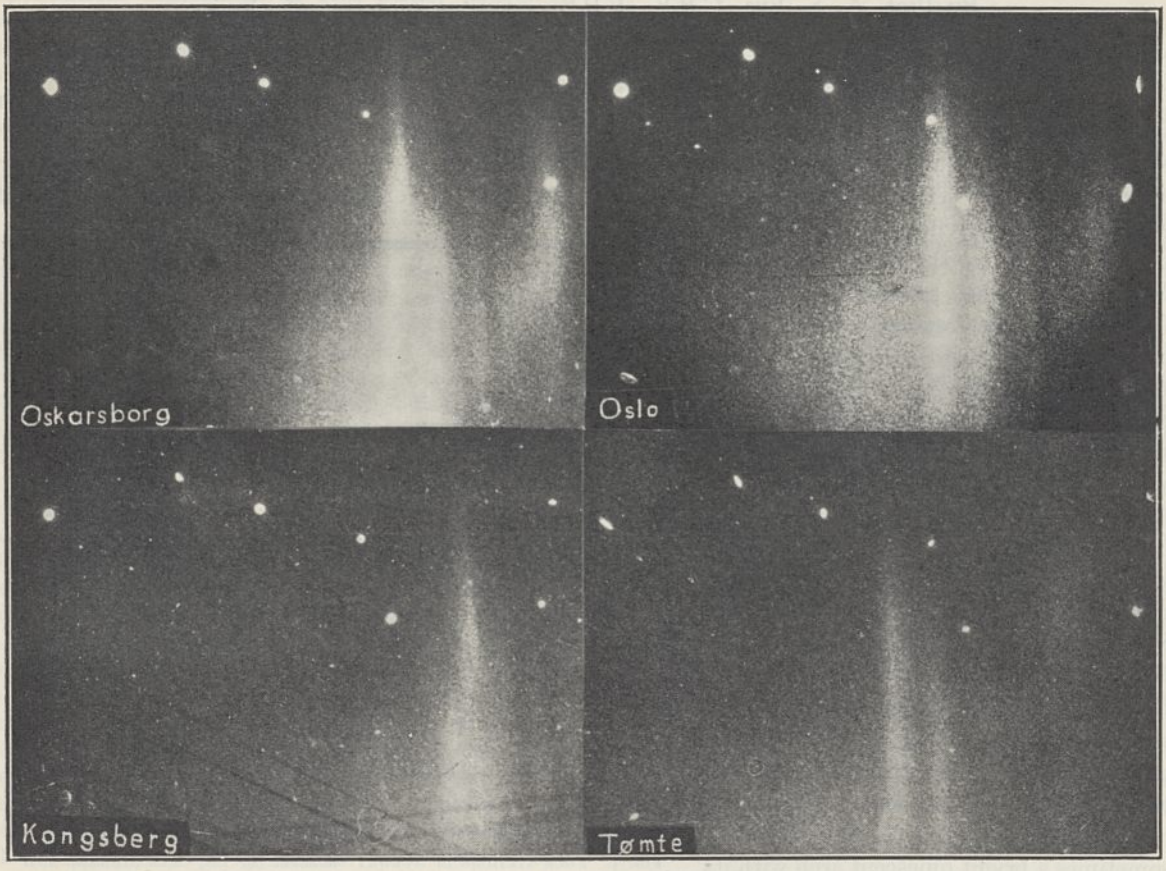

Fig. 2. Photographs of an aurora taken at the same instant from the four stations, with the stars of Ursa Major in the background. This aurora was partly in sunlight, and of unusual height. Altitudes: to base, 200 miles; to summit, 375 miles; sunlight above 190 miles, darkness below.

* See "Low Auroras", by G. C. Simpson, *Quar. J. Roy. Meteor. Soc.*, **59**, 185–190 (April 1933).

five minutes to arrive, so that coincidence would be more impossible than between lightning and thunder with a flash many miles away. Moreover, it must be remembered that sound does not emerge or travel at all well in highly rarefied air such as there is in auroral regions.

What then do these men hear? It has even been suggested that they hear the blood surging in their head, or the tinkling of the ice of their frozen breath. We may safely dismiss these suggestions as trivial. It seems more probable that they hear something real in the same sense, let us say, as we hear church bells ring. I venture to suggest that in dry, cold weather there may be a small brush discharge from snow or bushes somewhat similar to St. Elmo's Fire, seen on mountains and sometimes as an electric discharge from the masts and rigging of a ship when the earth's voltage differs considerably from that of the air. My verdict, for what it is worth, is then that men cannot possibly hear the Northern Lights, which can make little or no noise, but they may hear something else not far from them, such as a local brush discharge.

Spectroscopic Evidence

The spectrum of the aurora has been photographed, and most of the lines, or bands rather, are found to be due to nitrogen, which is the major constituent of the atmosphere (about four-fifths) here on the earth, and remains the chief constituent at great elevations. The spectrum of the aurora also includes the famous green line (Fig. 3) which Sir John McLennan investigated so ably and proved to be due to oxygen in an enhanced or unusual excited state. He and his co-workers actually produced the green line in his laboratory at Toronto by suitable stimulation of oxygen with helium, neon or argon also present. About one per cent of the air at ground-level is argon. All the other rare gases are present in much minuter quantities: neon, krypton, xenon, radon. Hydrogen is so light, and the molecular velocity in consequence so large, that the hydrogen overcomes gravity and passes out of the atmosphere.

Some of these gases, notably neon, the ingenious Claude has shown us how to collect, to place in tubes at low pressure, and to ionise with high voltage, so that every city is bespangled with artificial auroras and decorated with an extraordinary variety of coloured signs and vivid advertisements. The question is whether we most admire their scientific interest, their intrinsic beauty or the subtle skill with which they invite or induce the public to buy. It was supposed that some of the rare gases played a part in the rich colouring of auroras, and McLennan suggested that at high altitudes there is more helium than

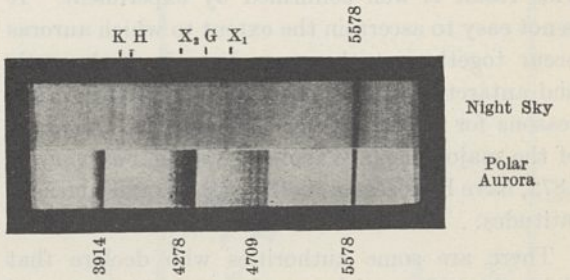

Fig. 3. A comparison of the spectra of the night-sky and of an aurora, by Lord Rayleigh. Note the green line due to oxygen in both.

oxygen. On the other hand, experiments by Kaplan indicate that enhanced nitrogen can also stimulate oxygen to emit the light of the green line. Furthermore, the extended researches of Vegard show that the spectra of auroras contain lines or bands of nitrogen and oxygen only. No traces of hydrogen or helium were found.

Aurora and Magnetism

Everyone to-day is familiar with a magnetic field, and most people also know something of the behaviour and properties of electrons. If you shoot electrons at right angles to a uniform magnetic field, the electrons will go round in circles—exact circles. The stronger the field and the slower the electrons, the smaller will be the circles; and the converse is true. The mathematical, electrical and mechanical principles are simple and certain. If, on the other hand, electrons are projected obliquely to a magnetic field, then the electrons will each one describe a helix or a path with the shape of a corkscrew.

If the electrons are shot earthwards from the sun, they will travel through space and become entrapped by the magnetic field of the earth. They will spiral round the lines of force until they meet the upper atmosphere in the regions surrounding either the north or south magnetic poles. The speed of such electrons may be sufficient by their collisions to ionise the molecules, that is, to knock other electrons from them, thus leaving positively charged molecules, or ions. The recombination of electrons with positive ions is attended with radiation, as has been amply proved in laboratory experiments. It is generally believed

that electrons spiralling round in one direction arrive near the north magnetic pole and give rise by ionisation to the *aurora borealis*; while similar electrons spiralling round the lines of magnetic force in the other sense proceed towards the south magnetic pole and occasion the *aurora australis*. This result is well confirmed by experiment. It is not easy to ascertain the extent to which auroras occur together at the same time in both arctic and antarctic regions. There are some theoretical reasons for expecting such coincidence, and some of the major displays such as that of February 4, 1872, have been seen in both northern and southern latitudes.

There are some authorities who declare that light charged particles, such as electrons, would mutually repel one another on their long journey from the sun, so that they would be scattered far afield, and in that case there should be no auroras at all! Prof. S. Chapman states that there are positive, negative and neutral particles all coming from the sun. There is also quite a wide choice of possible projectiles—electrons, positrons, protons, neutrons, deutrons, alpha particles and cosmic rays, besides photons. Therefore it is not wise to be too didactic as to the nature of the bombardment that arrives at the earth's surface, but it is right to insist that only electrically charged particles will show so marked a tendency to proceed towards the two main magnetic poles of the earth.

It may very well be asked why it is claimed that the projectiles come from the sun. The answer is that auroras, sunspots and magnetic storms all follow, over a long series of years, the same periodic variation of increase and decrease in number and intensity. This is the well-known eleven-year cycle. In recent years the variation of the effective frequency required for radio signals across the Atlantic has been found to follow the same cycle. The general result is that we have a two-fold aspect of the sun. On one hand, it must be regarded as a variable star with an eleven-year period. On the other hand, it is endowed with such marvellous constancy that the main temperature of the earth has continued between the freezing and boiling points of water ever since life first appeared upon the earth many hundreds of millions of years ago, with every prospect of its long continuance. The sun converts some of its mass into radiation at the rate of three or four million tons a second, and yet plenty remains. This delicate balance of temperature must be an unusual feat, and is a thing which if it had not happened would be deemed, like a giraffe, impossible. In my young days, Sir George Stokes would have said, Design! To-day many say, Chance! Looking on the matter as fairly as I can, and not attaching too much weight to my enormous veneration of Stokes, it still seems to me that he was probably correct. This is a difficult question which everyone must decide for himself, unless he prefers to sit on the fence.

Aurora and the Weather

There is a popular belief that a change of weather follows the Northern Lights—a change for the worse. There are many beliefs also connecting the moon and the weather; for if the moon is linked with the tides, why not with the weather? A glance at a large-scale map will show that many various types of weather, good, bad and indifferent, occur at any and the same time, at different places on the whole face of the earth, whereas the phase of the moon is the same for all. A somewhat similar statement may be made about an auroral display, which often covers a large region and has to be responsible for varied conditions. Besides, the aurora is 50 or 60 miles high, and our weather is brewed in the lowest ten miles, for the very highest cirrus clouds are rarely higher than six miles. There is, however, this point to be remembered. Northern Lights are not seen in cloudy weather, but only in clear. Hence it is much more probable that rain or cloud will follow the aurora than the reverse, but it is probably erroneous to state that the change was caused by the aurora.

Exploring the Upper Atmosphere

To-day there are ten different ways of obtaining information about the nature and properties of the higher air (Fig. 4).

Pilot balloons filled with hydrogen can carry up small, light, ingenious recording devices. If the balloon is recovered on its return to earth there are records of elevation, temperature and humidity. Such balloons may also be followed with a transit instrument, or theodolite, so that the wind velocity at different levels may be deduced. The greatest elevation attained by a balloon, without recorders, was 23½ miles, at Padua. One of Regener's balloons has ascended 17½ miles and been recovered with its recorders.

The intrepid Piccard constructed a gondola sufficiently strong not to explode outwards, and was himself carried inside it by a balloon upwards. The ascent is easy. The place and nature of

return to the earth are largely fortuitous. He reached an altitude of 10 miles and obtained valuable results on the cosmic rays, which at that height are about 150 times as intense as on the earth's surface. The Soviet gondola crashed to disaster after attaining an altitude of 12 miles. The greatest height so far attained is 13½ miles, achieved last year by Anderson and Stevens in the United States.

A new method of exploration has recently been devised by Tuve and others, members of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. A searchlight beam is directed upwards to a height of 17–40 miles, and the intensity of the light is modulated, or varied periodically at the source. A large concave mirror collects the scattered light from the upper part of the beam and brings it to a focus on a photo-cell connected to an amplifier, which is synchronised with the modulation of the searchlight. This apparatus may well give some information on the nature of the molecules in those very regions on which we are least informed, above the range of pilot balloons and below the auroral and ozone layers.

Ozone, O_3, is produced from oxygen, O_2, by radiations of a suitable frequency or by electrical discharges. Much of the ultra-violet light from the sun is absorbed or stopped in the ozonosphere about 20–40 miles above the earth. The presence of the ozone is revealed by absorption bands in the spectrum of the sun. When the sun is high it passes almost vertically through the ozone layer. When the sun is setting its rays have to pass horizontally through a much greater thickness. Measurements of the intensities of the absorption lines due to ozone lead to an estimate of the height of the ozone region—about 25 miles, and thus lower than the Northern Lights.

The barometric disturbance due to the great Krakatoa volcanic explosion travelled four times round the earth, and the actual noise of it was heard 3,000 miles away. The sound of big guns or of heavy explosions passes upwards into the cool and rarefied air and is then refracted or bent back again to the earth, so that sometimes, like short-wave radio, it cannot be heard or detected at intermediate distances. Newton stood in the gateway of Trinity College, Cambridge, and heard the guns of a naval action between Dutch and English. He foretold a British victory because the noise of battle became gradually fainter as the victors pursued the Dutch. The fact that sounds are bent back again to the earth necessitates a warmer layer above the cold. It seems that with increasing altitude the temperature may gradually decrease down to many degrees below zero Fahrenheit; but at a height of 30 miles there is an increase up

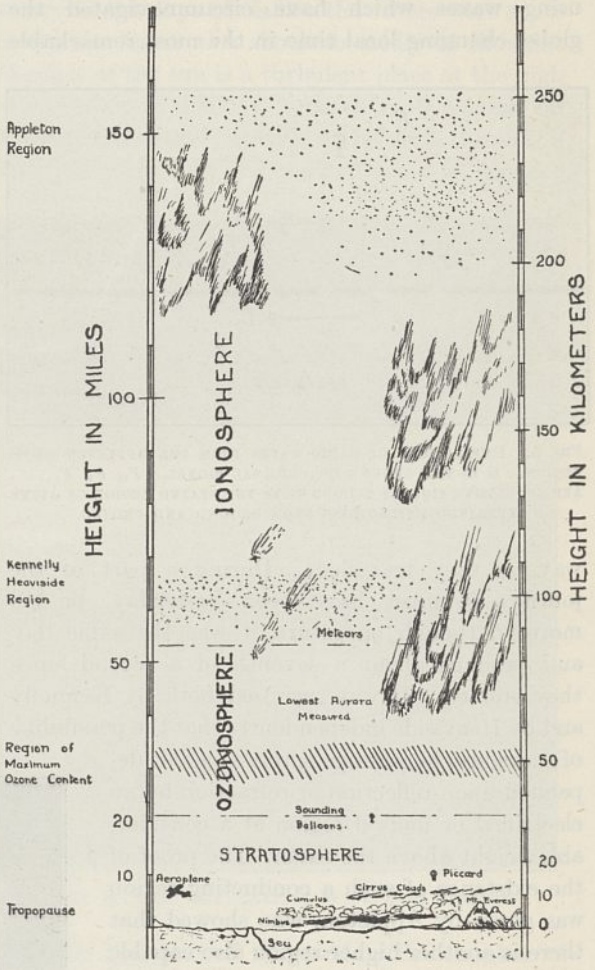

FIG. 4. THE ATMOSPHERE. DIAGRAM INDICATING THE RELATIVE HEIGHTS OF MOUNTAINS, CLOUDS, AEROPLANES, PICCARD'S GONDOLA BALLOON, SOUNDING BALLOONS, THE OZONE REGION, METEORS, NORTHERN LIGHTS AND THE TWO MAIN REGIONS (*E* AND *F*) CAPABLE OF REFLECTING RADIO WAVES.
FROM "PHYSICS" BY A. S. EVE. (LONDON: THORNTON BUTTERWORTH, LTD.)

to 80° F., and the heat to maintain this may be connected with the formation of ozone from oxygen by the sun's ultra-violet light.

RADIO WAVES

The most important method of throwing light on the nature of the upper regions of the air is by projecting radio (or wireless) waves directly upwards, for it is found that with suitable frequencies they will be reflected back to the earth again. Some will recall how puzzling it was, in the early days of wireless, to account for the fact that the electromagnetic waves, expected to move in a straight line like light, could travel from Ireland

to Newfoundland. To-day wireless waves, carrying speech, music or Morse, can be sent completely round the world, so that a man can speak to himself and hear it a fraction of a second later, using waves which have circumnavigated the globe, changing local time in the most remarkable way as they travelled. During a part of the journey it must have been yesterday, or to-morrow, though on return it was the same day and perhaps about a seventh of a second since they started. It was surmised both by Kennelly and by Heaviside independently that the possibility of successful long-range wireless signals depended upon reflection or refraction by an electrified or ionised region at a considerable height above the earth. The proof of the existence of such a conducting region was given by Appleton, who showed that there is another higher region also capable of reflecting radio waves back to the earth.

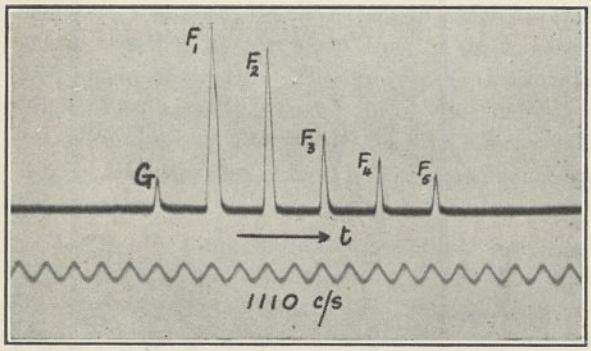

FIG. 5. REFLECTIONS OF RADIO-WAVES FROM THE APPLETON OR *F* REGION. *G* IS THE GROUND OR ORIGINAL SIGNAL. F_1, F_2, F_3 . . . ARE SUCCESSIVE SIGNALS ECHOED FROM THE STATED REGION OR AFTER REPEATED REFLECTIONS FROM GROUND AND CEILING.

The lower or *E* region is at about 100 kilometres, or 60 miles, from the earth, and it is also called the Kennelly-Heaviside region. The upper or *F* region is two or three times as high and bears the name of Appleton. It is possible to send a brief signal of suitable frequency which will be reflected back from both the *E* and *F* regions, so that both signals may be recorded on a suitable photographic plate (Figs. 5, 6) by means of the cathode ray oscillograph. It is possible to measure the very short period of time between the initial and return signals, and as the velocity of such waves is about 186,000 miles a second, it is easy to deduce the height of the reflecting region. For example, if the interval is one thousandth of a second, the reflecting layer would be about 93 miles above the earth. Experiments carried out by Henderson and others, during a total eclipse of the sun in Canada, proved that the *E* region is made conducting, or is ionised, by the ultra-violet light from the sun, but it is not yet possible to assign a cause to the *F* region.

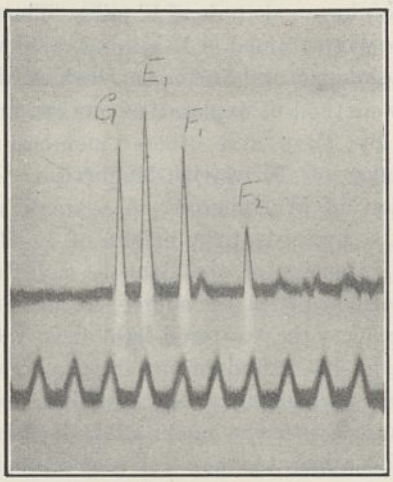

FIG. 6. THERE ARE ECHOES SHOWN FROM BOTH *E* AND *F* REGIONS. THE LOWER CURVE GIVES A TIME-SCALE OF 1,110 CYCLES A SECOND. FIGS. 5 AND 6 ARE DUE TO THE COURTESY OF PROF. E. V. APPLETON.

It should be now clear that it is necessary to determine in due course the different types of radiation responsible for (*a*) the ozone layer, (*b*) the Kennelly-Heaviside layer, (*c*) the Appleton layer, (*d*) the more occasional and local auroral displays, all of which are attributable to the sun's activity. There is a yet more difficult problem with respect to the cosmic rays and the bursts or

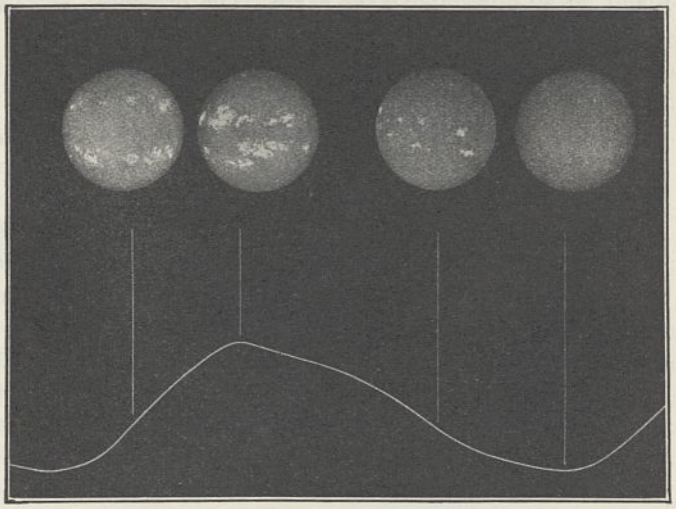

FIG. 7. FOUR STAGES OF THE SOLAR ACTIVITY, TAKEN IN CALCIUM LIGHT AT MOUNT WILSON OBSERVATORY. (ELEVEN-YEAR CYCLE, FROM LEFT TO RIGHT—FIRST QUARTER, FULL, WANING, CLEAR.)

showers of ions to which they give rise. Sometimes a hundred million ions occur at a single outburst.

In the upper atmosphere, the pressure is so low that the molecules are quite far apart, and if an electron is detached from a molecule by some type of radiation, it may have to wander a long way before it can find a partner in a positive ion; or it may find a resting place on a neutral molecule, so that the pair become a negative ion. While free, the electrons are so small and light, compared with their electric charge, that they are readily made to oscillate, or dance in rhythm, with any electromagnetic waves that are passing them. Curiously enough, the group of waves travels the *faster* in consequence, so that an electromagnetic wave entering these ionised regions obliquely has the upper part wheeling faster than the lower, until the wave front is turned round and proceeds downwards to the earth again. However, much the same sort of thing happens every time you look into an ordinary mirror or looking-glass. There also the free electrons in the mercury at the back of the glass are able by their stimulated motion to return to you a fairly faithful image of your face.

Radio signals will also bounce to and fro between the earth and the reflecting regions, proving that the earth is an admirable radio reflector. The total path for eight such reflections, which have been obtained from the *F* region, must exceed 2,000 miles.

Fig. 8. Mother-of-pearl cloud, about 15 miles high. Norway, January 29, 1932. (By courtesy of Dr. Carl Størmer.)

Sunspots

In old days the heavens were deemed to be eternal, changeless and perfect, so that the discovery in the days of Galileo that there were spots on the sun came as a shock to medieval thought. The face of the sun is a turbulent place at the high temperature of 6,000° C. Black spots appear on it, sometimes large enough to be seen through a darkened glass with the unaided eye, and broader than the diameter of the earth. The number of these spots follows the same eleven-year cycle as the frequency of the aurora. At the beginning of such a period the face of the sun may be practically without spots. In due course a few appear in middle latitudes on both sides of the sun's equator. There is a steady increase in number, the spots become nearer the equator, and they disappear when at the lowest attained latitudes (Fig. 7).

These relatively cool dark whirlwinds reveal magnetic properties discovered by Hale through the Zeeman effect, and they may perhaps be compared with the 'lows' or cyclones which often bring storm, rain and flood. The periodicity of sunspots, auroras, magnetic storms on the earth, and changing radio phenomena has been found to hold good for the fluctuations of the white polar caps on the planet Mars, and even for a cycle of ring growths in the great and ancient trees of western America.

Meteors

Most people are familiar with shooting stars or meteors and many have seen in their lives dozens or hundreds of them; yet it always comes as a surprise to learn that no less than 20 million of them every day plunge into our atmosphere with velocities ranging up to 130 miles a second. Sometimes these visitors are but the size of a pin's head, and at other times they are large enough to pierce the atmosphere and reach the earth. The famous Arizona crater may have been formed long ago by a giant meteor; the crater is 1,400 yards wide and more than 500 feet deep. In 1908, a great meteor, estimated to weigh 130 tons, fell in Siberia and devastated by its great heat hundreds of square miles of country. The elevation of most frequent meteoric displays is about 40–60 miles above the earth. It is somewhere in this region that the temperature rises according to the theory of the reflection of sound waves, to which already reference has been made. Sometimes the meteors are of iron, sometimes of stone, and it is not easy to understand how they become red or white hot when rushing through cool air, how indeed they acquire more heat from the bombardment of molecules than is carried away by them. However, the luminosity of meteors occurs in *rarefied* air at heights of 100–30 miles above the earth. An experiment in the laboratory of a similar character would be difficult to make, because our projectiles achieve a speed of a few thousand feet a second as contrasted with meteors having velocities of many miles a second.

Mother-of-Pearl and Noctilucent Clouds

There occur rarely and at great elevations iridescent clouds, as remarkable for their beauty as for their height. They are generally observed over regions of low barometric pressure and it is probable that the clouds are formed of super-cooled water vapour (S. Chapman, Nature, 129, 497, April 2, 1932). Størmer and his co-workers have measured the altitudes of many of these 'mother-of-pearl' clouds (Fig. 8) and found them to be in the stratosphere, about 15 miles above the ground.

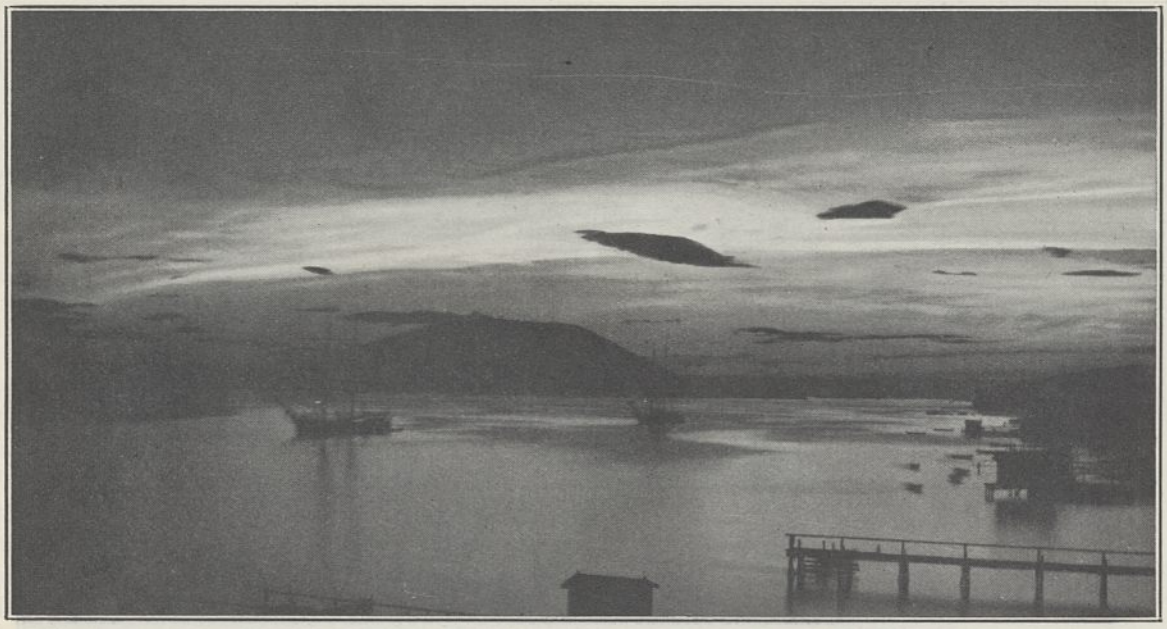

Fig. 9. Luminous night clouds. Altitude, 50 miles. Photographed at Dröbak, south of Oslo, midnight, July 27–28 1909. By courtesy of Dr. Carl Størmer.

The strangest of clouds (Fig. 9) are those observed in the middle of the night, or twilight, which occur at a measured altitude of 50 miles! The heights have been measured in Norway (Carl Størmer, *Astrophysica Norvegica*, I, 3, Feb. 1935) by the same band of observers and at many of the same stations as those used in the determination of the distance of auroras from the earth's surface. These clouds are not iridescent, and they move westwards at about a hundred miles an hour!

It will be gathered that the study of the Northern Lights is bound up with other physical phenomena in the upper regions of our atmosphere, and that progress can best be made, as in other branches of science, by advance on a broad front.

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vocabularies of their own. At many of the conferences, League of Nations representatives have been present. More and more the conferences are grouping themselves, and many conferences are being attended by representatives of other conferences. Such groups are the educational, agricultural and economic conferences. For example, the "Liaison Committee of Major International Associations" represents more than twenty-four international organisations, mostly educational. The economic conferences are not under the dictation of Governments. Between them these societies are working out a world-policy which is years ahead of the present League of Nations. The number of societies is increasing, and they are increasingly specialised. The International Council of Scientific Unions does not cover everything, although it is an authorised channel of communications. New societies of all sorts keep on appearing. All this apparatus of voluntary societies may be thought of as advisory to the official governmental League of Nations. Possibly it is more important that the politicians should listen to the scientific workers, rather than that the latter should let themselves be entangled in political machinations.

Fig Mosaic

A LEAF-MOTTLING disease of the fig has been described from California and from Australia. The malady is caused by a virus, and is known as fig mosaic. Dr. G. C. Ainsworth announces the appearance of the disease in England (*J. Roy. Hort. Soc.*, December 1935), and mentions two types of mottling, namely, irregular, yellowish-green blotches, and pale green spots or bands along the larger veins. The fruit is affected but slightly, with small spots. Now that botanists are 'virus-conscious', it has been realised that the disease was known twenty years ago, though its cause was not suspected, and it is fairly widespread in Great Britain.

England to Cape Flight

Mrs. Mollison arrived in Cape Town at 3.30 British Summer Time on May 7, having completed a flight from England in 3 days 6 hr. 25 min. This time is a little more than eleven hours better than the previous record set up by Flight Lieutenant Rose, and represents a noteworthy achievement as regards endurance of both pilot and aeroplane. Mrs. Mollison flew over the West Coast route in Africa, and her machine was a Percival Gull with a Gipsy Six (120 h.p.) engine. It is stated in *The Times* that the distance covered was about 6,200 miles, with 43 hours flying and 36 hours on the ground. At the time of writing, Mrs. Mollison is well started on the return journey, but following the East Coast route.

Institution of Electrical Engineers' Awards

THE following awards of the Institution of Electrical Engineers have recently been made for papers read during 1935–36, or accepted for publication: Institution Premium to W. L. McPherson and E. H. Ullrich; Ayrton Premium to Mr. G. H. Wilson, Lieut.-Commander E. L. Damant, and Mr. J. M. Waldram; Fahie Premium to Major L. H. Peter; John Hopkinson Premium to D. R. Davies and C. H. Flurscheim; Kelvin Premium to Dr. T. E. Allibone and F. R. Perry; Overseas Premiums to Dr. J. J. Rudra and D. J. Badkas, J. H. Sprawson and T. Varney; Extra Premiums to G. A. Whipple, A. L. Whiteley, Dr. Russell J. Reynolds, E. R. Kaan, B. G. Gates, E. T. Hippisley, A. C. Timmis, and Mr. R. Poole. *Wireless Section:* Duddell Premium to H. L. Kirke and A. B. Howe; Extra Premiums to W. J. Brown and E. B. Moullin. *Meter and Instrument Section:* Silvanus Thompson Premium to J. H. Buchanan; Extra Premiums to Prof. J. T. MacGregor-Morris and R. M. Billington, J. S. Preston and G. A. Burns and T. R. Rayner. *Transmission Section:* Sebastian de Ferranti Premium to Mr. D. Ross; Extra Premium to Mr. J. S. Forrest.

Conferences on Spectroscopy and Colour

THE Massachusetts Institute of Technology has recently announced a special summer programme on applied physics, in connexion with which a conference on spectroscopy and its applications will be held on July 20–22, and a conference on colour on July 23–25. The former conference will include discussions on spectroscopic analysis of materials, and on other applications of spectroscopy to biology, medicine, chemistry, metallurgy, mineralogy and to industrial and engineering problems; the latter will include spectrophotometry, colorimetry, and the applications of colour measurements to industrial problems. Detailed consideration will be given to the behaviour and control of the colour of dyes and pigments, and their application in such fields as the paint, ink, paper, textile and ceramics industries. These conferences come at the conclusion of the courses on spectroscopic analysis of materials which are being given at the Institute during the six weeks from June 16 until July 24. There is no charge for attendance at the meetings of the conferences, copies of the detailed programmes of which will be sent on application to Prof. G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Announcements

MR. C. H. WADDINGTON, of the Strangeways Research Laboratory, and of the sub-department of experimental zoology of the University of Cambridge, has been awarded the Albert Brachet prize of the Royal Academy of Belgium for his experiments on chicken embryos. This was the first award of the prize, which is given for the best work in embryology published in French, German, English, Italian or Dutch over a three-year period.

THE field plots and laboratories of the Rothamsted Experimental Station, Harpenden, will be opened for inspection (by invitation) on June 11, at 11.15 a.m. The Right Hon. J. Ramsay Macdonald will be present.

THE Association of Scientific Workers has arranged a public meeting on the "Utilisation of Science" to be held on Friday, May 22, at University College, London, at 8 p.m. The speakers include Prof. P. M. S. Blackett, Dr. J. Needham and Dr. J. D. Bernal.

THE forty-first Annual Congress of the South-Eastern Union of Scientific Societies will be held at Oxford on June 30–July 4. The president-elect of the Congress is Prof. G. D. Hale Carpenter, who will deliver the presidential address entitled "Charles Darwin and Entomology" on June 30. Further information can be obtained from the honorary general secretary, Mr. E. A. Martin, 14 High View Close, Norwood, S.E.19.

THE National Baby Week Council is arranging a National Baby Week to be held on July 1–7. The special subjects of propaganda this year are (1) maternal welfare, stressing the constructive aspects as distinct from maternal mortality, disease and morbidity, and (2) the question whether all is being done, nationally and locally, for the welfare of the child of 2–5 years of age. Further information can be obtained from the Secretary, National Baby Week Council, 117 Piccadilly, London, W.1.

A SHORT course in genetics, cytology and plant biochemistry will be held at the John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W.19, on July 13–25. It is expected that the following will lecture: Sir Daniel Hall, Prof. J. B. S. Haldane, Dr. C. D. Darlington, Mr. M. B. Crane, Dr. R. Scott-Moncrieff, Dr. F. G. Brieger and Dr. K. Mather. The course will be open to university and research station staffs and post-graduate students. No fee will be charged. The names of those who desire to take part should be sent in good time to the Librarian at the Institution.

THE twenty-fifth Congress of the Italian Society for the Progress of Science will be held this autumn at Tripoli, under the presidency of Marshal Balbo, Governor of Libya.

AT the suggestion of the Touring Club de France, the Paris Academy of Medicine has appointed a committee to inquire what steps can be taken to support the campaign against noise.

AN International Congress of Medical Motorists will be held in Paris on June 14–16. Further information can be obtained from the Association des médecins Automobilistes de France, Boulevard Magenta 60, Paris.

THE second Congress of the International Association for the Study of Solar, Terrestrial and Cosmic Radiations will be held at La Malou (Hérault) on July 15–17, when papers will be read on solar electrical radiations, atmospheric electricity and ionisation of the air and the radioactivity of rocks and wells. Further information can be obtained from the secretary of the Association, 24 rue Verdi, Nice.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

An assistant (Grade III) at the Chemical Research Laboratory, Teddington—The Establishment Officer, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (May 19).

A junior assistant in the Ballistics Department of the Research Department, Royal Arsenal, Woolwich, S.E.18—The Chief Superintendent (May 19).

A teacher of domestic subjects and a lecturer in mechanical engineering in the Central Technical College, Suffolk Street, Birmingham, 1—The Chief Education Officer (May 27).

A sub-assistant in the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1 (May 28).

A lecturer and two demonstrators in physiology in the University of Liverpool—The Registrar (May 29).

A teacher of mathematics in the Northern Polytechnic, Holloway, London, N.7—The Clerk (May 29).

A lecturer in physics in the Polytechnic, Regent Street, London, W.1—The Director of Education (May 29).

A demonstrator in zoology in the University of Bristol—The Registrar (May 30).

A regius professor of practice of medicine in the University of Glasgow—The Private Secretary, Scottish Office, Whitehall, London, S.W.1 (May 30).

A professor of mathematics in the Queen's University of Belfast—The Secretary (May 30).

Five assistant veterinary officers to the Essex County Council—The Clerk to the County Council, County Hall, Chelmsford (May 30).

A lecturer in the Civil and Mechanical Engineering Department and a lecturer in charge of instruction in instrument making in the Northampton Polytechnic, St. John Street, London, E.C.1 (May 31).

A lecturer in physical chemistry in University College, Bangor—The Registrar (June 6).

An assistant (Grade III) in the Admiralty Scientific and Technical Pools (chemistry and metal analysis)—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (quote C.E. 2659/36) (June 6).

An assistant lecturer in botany and an assistant lecturer in metallurgy in University College, Swansea—The Registrar (June 6).

A junior assistant physicist in the Royal Cancer Hospital (Free), Fulham Road, London, S.W.3—The Secretary (June 15).

A regius professor of astronomy in the University of Glasgow—The Private Secretary, Scottish Office, Whitehall, London, S.W.1 (June 30).

A superintending engineer and constructor of shipping in the Royal Arsenal, Woolwich—The Under-Secretary of State (C.5), The War Office, London (August 1).

Research assistants in applied mechanics or experimental physics and a research assistant of the Silk Section of the British Cotton Industry Research Association, Shirley Institute, Didsbury—The Director.

An instructor in commercial fruit growing in the Kent Farm Institute—The Agricultural Organizer, Springfield, Maidstone.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 831.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Nature of Light

OBJECTIONS to the views expressed in my communication[1] on this subject have been brought forward by Mr. C. Hurst[2] and Dr. N. S. Japolski[3].

In reply to Mr. Hurst, I would point out that the flow of energy outside the core of the quantum is in the direction of propagation of the light and is proportional to $\cos^2(pt-mz)$; thus it is always positive, and the flow will be always in one direction. Inside the core where there is a longitudinal magnetic force, there is a flow of energy at right angles to the axis, but this is proportional to $\cos(pt-mz)\sin(pt-mz)$; the average of this both with regard to time and space is zero. Thus, and this is I think the point Mr. Hurst has overlooked, at any time the energy flowing out at one place will be equal to that flowing inward at the same time at a place a quarter of a wave-length from it, and at any point the quantity flowing in will be the same as that flowing out a quarter of a period later, so that the quantum does not lose any energy by this process.

Dr. Japolski, who has made very thorough and extensive researches on the mathematical theory of cylindrical waves, raises the objection that a quantum of the kind I suggest would require a wire of infinite specific inductive capacity to guide it. I do not agree with this. I think a quantum which has its distribution of electric and magnetic forces such that the momentum is all in the direction of propagation of the light would not require any guidance after leaving its source. Whether a system of this kind could be emitted by a luminous atom or not depends upon the mechanism of that emission, a subject about which very little is known; what is known does not seem to me to make it impossible or even very improbable. Two difficulties which suggest themselves at once are first, that the wave-length of light is enormously greater than the linear dimensions of the atom which emits it, more than a thousand times greater if the dimension of the atom is taken to be 10^{-8} cm.; and secondly, why the radiation is concentrated in one direction.

With regard to the first point. We must remember that the conditions inside the atom when it is emitting light are very different from those in the ether. During the emission of the light, there is an electron returning to the place from which it or another electron has been ejected, which before it settles down will oscillate about this place with a definite period. The optical properties of an atom which contains an electron with a free period (n) have been worked out in connexion with the theory of 'anomalous dispersion', and it has been shown that if V is the velocity of light of frequency p through the atom and c that through the ether,

$$\frac{c^2}{V^2} = 1 + \frac{A.n^2}{n^2 - p^2}$$

Thus if $p=n(1-\alpha)$, where α is a small positive quantity, V must be very small compared with c, so that the wave-length of the light in the atom will be very much smaller than when it is in the ether.

Next with regard to the concentration of the radiation in a definite direction. If as seems plausible the light is due to the vibrations of an electron inside the atom, then if these vibrations were in a straight line Hertz's solution of the waves produced by a bi-pole whose moment varies harmonically shows that the radiation at a great distance from the atom would be divergent waves spreading out from the atom as centre; the flow of energy in a direction making an angle θ with the path of the electron would be proportional to $\sin^2\theta$; there would thus be continual loss of energy and no concentration. It is, however, very generally believed that there are very strong magnetic forces inside the atom; if so, the paths of the electrons in the atoms will not be straight lines, for the electrons will be twisted round the lines of magnetic force and will describe spirals whose axes are parallel to the magnetic force. If this force is nearly at right angles to a stream of electrons and is above a certain intensity, the paths of the electrons will be spirals whose turns are nearly at right angles to the force.

The stream of electrons is equivalent to an electric current and will produce much the same electric and magnetic fields as would be produced by an alternating electric current flowing through a solenoid which coincided in position with the spirals described by the electrons. These currents would produce an alternating magnetic force inside the solenoid parallel to its axis, the magnitude of which would not vary over its cross-section, and there would be no longitudinal magnetic force outside the cross-section. This agrees with the solution given in my letter, if a be taken as the radius of the solenoid. The same number of lines of magnetic force will pass through any circle outside the solenoid if its centre is on the axis and its plane at right angles to it. Thus the electromotive force round the circle due to the alteration in the magnetic force will be constant, whatever is the radius of the circle, and therefore the tangential electric force will be inversely proportioned to the radius. If the circle is inside the solenoid, the number of lines of force passing through it will be proportional to πr^2, if r be the radius, and therefore the

tangential electric force will be proportional to r; both these results are in accordance with the solution.

On this view the formation of the light quantum and its guidance is due to the magnetic force inside the atom. After it has been started on the way it should go, it will continue on that way without further guidance. A bullet has to be guided by the barrel of the rifle, but it is not necessary for the barrel to extend to the target.

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April 21.

[1] NATURE, **137**, 232, Feb. 8, 1936.
[2] NATURE, **137**, 582, April 4, 1936
[3] NATURE, **137**, 663, April 18, 1936.

Phenomenological Theory of Supra-conductivity

THE latest version[1] of F. and H. London's phenomenological theory of supra-conductivity (which on its first appearance[2] was obscured by an erroneous assumption as regards the boundary conditions[3]) can be put into a very simple form. We assume Maxwell's equations for a medium with dielectric constant ε and permeability 1 (choosing the units so as to make $c = 1$ and abolish odious 4π's):

$$\operatorname{curl} E = -\dot{H} \qquad (A) \qquad \operatorname{curl} H = \varepsilon\dot{E} + I \qquad (B)$$
$$\operatorname{div} H = 0$$

In empty space, $I = 0$. In a normally conducting metal there is a current of conduction I_c in addition to the displacement current $\varepsilon\dot{E}$:

$$I = I_c = \sigma E. \qquad (C)$$

The assumption for the supra-conductor is, that

$$I = I_c + I_s = \sigma E + I_s.$$

That is to say, there is a *third* sort of current I_s, call it the *supra-current*, which either is added to, or (if $\sigma = 0$) replaces the ordinary conduction current I_c.

I_s cannot be given in quite so simple a way as I_c, yet there is a certain *analogy* with the first two types of current. Let us introduce, just for the moment, the sign $I_d = \varepsilon\dot{E}$ for the displacement current. Then from (A)

$$\operatorname{curl} \frac{I_d}{\varepsilon} = -\ddot{H}\ , \quad \frac{\dot{I}_d}{\varepsilon} = \ddot{E}\ ; \qquad (D'')$$

and from (A) and (C)

$$\operatorname{curl} \frac{I_c}{\sigma} = -\dot{H}\ , \quad \frac{\dot{I}_c}{\sigma} = \dot{E}. \qquad (D')$$

The *new* assumption with respect to I_s is,

$$\operatorname{curl} \Lambda I_s = -H\ , \quad \Lambda\dot{I}_s = E, \qquad (D)$$

Λ being a constant of the material, like ε^{-1} and σ^{-1}. The analogy is conspicuous. Λ might be called the constant of supra-conductivity.

The equations (D) would seem rather abundant for the only purpose of introducing the third type of current. But they contain (A), which therefore can be dropped. So the *full* system of equations for the supra-conductor read

$$\operatorname{curl} H = \varepsilon\dot{E} + I \qquad \begin{matrix}\operatorname{curl} \Lambda(I - \sigma E) = -H \\ \Lambda(\dot{I} - \sigma\dot{E}) = E.\end{matrix} \qquad (1)$$

Thus there are nine equations for the nine vector components of E, H, I. As to the surfaces of discontinuity, the well-known limiting conditions of Maxwell's theory ($E_{\parallel}$, $H_{\parallel}$, $(\varepsilon\dot{E} + I)_{\perp}$, $H_{\perp}$ continuous) have, of course, to be retained. In addition, the second curl-equation of (1) requires the continuity of $\Lambda(I - \sigma E)_{\parallel}$ at the surface between two different supra-conductors. (The parallel component of supra-current will therefore have a discontinuity.)

The natural *problem of initial values* for the supra-conductor would be to give oneself E and I. Equations (1) then determine the future development uniquely. If, alternatively, E, H are to be given, one has to take care to choose H solenoidal ($\operatorname{div} H = 0$), but in addition a curl-free part of ΛI remains arbitrary.

The equations containing Λ may be taken to state that the negative of the product Λ by supra-current is a suitable vector potential to represent the E, H-field within every coherent supra-conducting region, the scalar potential being zero. From here the theory of integration is easily developed. We shall only observe, that for the density $\rho = \varepsilon \operatorname{div} E$ we get the equation

$$\ddot{\rho} + \sigma\dot{\rho} + \Lambda^{-1}\rho = 0, \qquad (2)$$

which amounts virtually to $\rho = 0$ always and everywhere in the homogeneous supra-conductor. In the *stationary* case ($\delta/\delta t = 0$), from the last equation of (1), E is zero in the supra-conductor. The E-lines therefore issue orthogonally from its surface, which, for the outside, acts as a surface of constant potential like with an ordinary conductor of vanishing resistance.

I consider this form of London's theory a rational heuristic starting point. So far as I can see, it is both self-consistent and without contradiction of other principles. The actual state of affairs is, of course, more complicated. It is well known that it presents phenomena of hysteresis, which cannot be embodied in a simple field theory.

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[1] *Physica*, **2**, 341 (1935).
[2] *Proc. Roy. Soc.*, A, **149**, 71 (1935).
[3] *Z. Phys.*, **96**, 363 (1935).

Scattering of Neutrons by Protons

IT is known that hydrogen shows a large scattering cross-section for slow neutrons. On the usual assumption that the forces between proton and neutron are of short range, this can only be explained if one also assumes[1] that the deuteron has an excited state, real or virtual, the energy of which $|W_1|$ is about 50,000 e.v. This leads to the following formula for the scattering cross-section σ of hydrogen for neutrons of energy E:

$$\sigma = \frac{h^2}{\pi M}\left\{\frac{3}{4}\frac{1}{W_0 + \frac{1}{2}E} + \frac{1}{4}\frac{1}{|W_1| + \frac{1}{2}E}\right\}.$$

Here h is Planck's constant, $\frac{1}{2}M$ is the reduced mass of the proton and neutron, and W_0 is the binding energy of the deuteron[2,3] (cf. also ref. 4) ($W_0 = 2{\cdot}2 \times 10^6$ e.v.). $|W_1|$ is defined by the value of σ for $E \to 0$ (slow neutrons).

To check this formula, I have measured the mean free path in paraffin of the photo-neutrons from radiothorium and deuterium[2]. These neutrons are fairly homogeneous in velocity and their average energy is probably[2,3] (cf. also ref. 4) about 200,000 e.v. The photo-neutron source consisted of 5 millicuries

radiothorium surrounded by 23 gm. heavy water (D_2O) and was 3·4 cm. in diameter. It was placed at a distance of 38 cm. from the face of the 'fast neutron detector'. This was an ionisation chamber filled with boron trifluoride enclosed in a cylindrical paraffin block of 12·5 cm. diameter[5]. Alternate runs were made with and without a 'thin' paraffin scatterer, a disk 6·6 cm. in diameter and 1 cm. thick (0·9 gm./cm.^{2}) placed at a distance of 25 cm. from the face of the neutron detector. (The result justifies us in regarding this scatterer as 'thin'.) More than 3,000 boron disintegrations were recorded in each case, and the effects found were $I_1 = 4{\cdot}5 \pm 0{\cdot}1$ and $I_0 = 5{\cdot}4 \pm 0{\cdot}1$ disintegrations per minute respectively.

From this we can calculate an upper limit of 5·5 cm. of paraffin for the mean free path λ of the neutrons used. This is an *upper limit* since, first, some of the neutrons scattered from the walls of the room may be counted, thus increasing the ratio I_1/I_0. It appears that an effect of this kind cannot have been large, because when 'artificial walls', made either of lead or of paraffin, were built up near the counter and source, no appreciable increase in the number of disintegrations was found. Secondly, a certain fraction of the neutrons will be scattered by the paraffin disk into the neutron detector. These scattered neutrons will have somewhat different directions and a smaller energy than the neutrons in the primary beam, and will therefore be counted with a probability which may, on the average, be larger than that of the primary neutrons. A rough estimation of this effect was made and a corrected value for the transmitted intensity of $4{\cdot}3 \pm 0{\cdot}2$ was obtained. This gives a mean free path $\lambda = 4{\cdot}5 \pm 1{\cdot}5$ cm. of paraffin, whereas the value calculated from the above formula is only 1·3 cm.

Although the accuracy of this measurement is not very high, there can be little doubt that the present theory is in definite disagreement with experiment. It can be seen from the above formula that no alteration within reasonable limits of the values of W_0, $|W_1|$ and E can bring about an agreement. It seems therefore safe to conclude that there is at present no evidence for the existence of an excited state of the deuteron, and that another model of the proton–neutron interaction is required.

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May 5.

[1] Fermi, *Phys. Rev.*, **48**, 570 (1935); Wigner, unpublished, cf. Peierls, "Reports on Progress in Physics", London, 1935, p. 27.
[2] Chadwick and Goldhaber, *Proc. Roy. Soc.*, A, **151**, 479 (1935).
[3] Feather and Bretscher, NATURE, **136**, 468 (1935).
[4] Ising and Helde, NATURE, **137**, 273 (1936); Oliphant, NATURE, **137**, 396 (1936).
[5] Chadwick and Goldhaber, *Proc. Camb. Phil. Soc.*, **31**, 612 (1935); Amaldi, d'Agostino, Fermi, Pontecorvo, Rasetti and Segrè, *Proc. Roy. Soc.*, A, **149**, 522 (1935).

A Numerical Method for Two-dimensional Fourier Synthesis

TWO-DIMENSIONAL Fourier synthesis is a most useful tool in the hands of the crystal analyst. A Patterson[1] synthesis, which uses observed intensities directly, is the only way of summarising in one picture all the information contained in a set of intensities, and at the very least it is a useful aid in the guessing of probable structures. Further, once an approximate structure has been obtained, a method of successive Fourier syntheses of the ordinary type introducing more and more F's as the signs become known will enable parameters to be found which are the best possible values obtainable from the data involved.

These uses require that a worker in crystal structure shall be able to construct a Fourier synthesis of reasonable accuracy in a very short space of time, and the method here described seems to be the most speedy of the methods which have been used. It will be described more fully elsewhere.

The problem is the summation over the area of the projection of a number (which may, for example, be eighty) of cosine 'waves' of the type shown in Fig. 1. The eighty different waves correspond to the values of F (or of some function of F in a Patterson synthesis) for all the different reflecting planes. In the case of a two-dimensional synthesis all the reflecting planes belong to one zone which we shall assume here to be the c-axis zone, so that the orientation and spacing of the planes are defined by the indexes h and k. Summation may be necessary over something like 1,800 points (supposing that one half of the total area has to be evaluated and that the projection

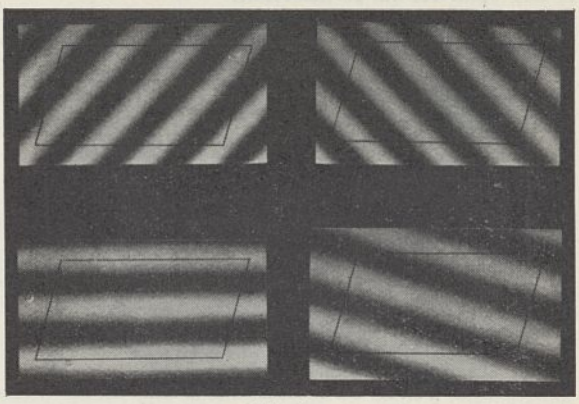

FIG. 1.

edges are divided into 60 parts) in order to retain all the information contained in the intensities. We have therefore to add up eighty terms of the type $F(hk)\cos(2\pi hx/a + 2\pi ky/b)$ for each of the 1,800 points. The mere writing down of so many numbers is exceedingly tedious and the summations are long even with the use of a machine.

The number of figures to be summed over the whole area may, however, be reduced by a factor of the order ten, by a preliminary combination of the waves. For example, all those waves of frequency 5 parallel to the y direction (that is, corresponding to $k = 5$) combine, for each value of x, into a simple wave of frequency 5 parallel to y. The amplitude and phase of this wave vary as the value of x varies; in order to avoid the difficulty of varying phase, we may alternatively represent it as the combination of a sine and a cosine wave of which the amplitudes alone vary.

The calculations are therefore immensely shortened if we consider the whole group of reflections with $k = 5$, make a preliminary summation which shows how the amplitudes vary with x, and thus for each x-level represent the whole group by one pair of cosine and sine waves of appropriate amplitude. This is repeated for each value of k, and we have only a small number of waves to add for each x-level.

In order to carry out the summations, we prepare a set of card strips for both cosine and sine waves.

Each strip represents the contribution of the waves at intervals of 1/60 of a cell edge. The strips are prepared for all amplitudes between $\overline{99}$ and 99, and all frequencies (that is, number of waves in the cell edge) up to 20. When summing a set of Fourier terms we only have to select the appropriate strips, place them one beneath the other, and sum the columns.

By using cosine and sine terms separately in preliminary and final summations, full use of the symmetries possessed by these functions can be made. It is not necessary to have the strips written out for more than one quarter of the cell edge. The cosine waves corresponding to even indexes and the sine waves corresponding to odd indexes are all symmetrical about the point $\frac{1}{4}$, while the others are anti-symmetrical about this point.

The strips are stored in boxes as shown in Fig. 2. One box contains all the cosine strips and another the sine strips, and each compartment contains the strips of one frequency. The sloping sides of the boxes ensure that when a strip is removed its place is left open for its re-insertion.

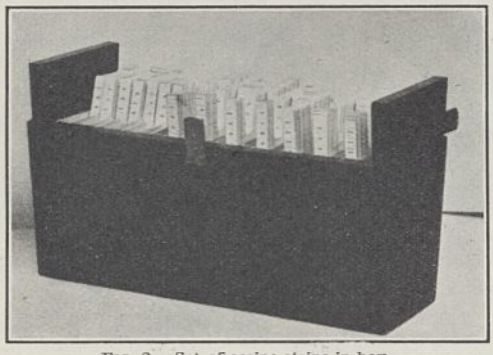

FIG. 2. Set of cosine strips in box.

The use of amplitudes from 1 to $\pm$ 99 is adequate for all work of normal accuracy. If only a few of the totals of the preliminary tables exceed 99, these totals can be made up by the use of two of the strips instead of one in the final tables. If a large number of the totals of the preliminary tables exceed 99, then all these totals should be divided by some suitable factor.

It is estimated that one worker using the strips can complete a Fourier synthesis of the size of the example used here in a total time of eight hours. (A rough estimate of the length of a Fourier synthesis can be made by giving the total number of terms involved if the complete summation were done directly. In our example, 80 F's are summed over 1,800 points, making 124,000 terms in all.) A further utility is that the selection and addition of the strips can be done by inexperienced persons, and the results checked with certainty by doing one line of the synthesis along one y-level, thus crossing all the previous x-levels.

We should be glad to know if workers in other laboratories who employ the Fourier method would find these sets of strips useful, as it may be possible to arrange for the supply of copies.

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March 7.

Z. Krist., A, **90**, 517 (1935).

Magnetic Anisotropy of Resorcinol

THE diamagnetic anisotropy of a large crystal of resorcinol, weighing 0·05550 gm., has been measured by methods similar to those described by Krishnan[1], with the following results:

$$\chi_a - \chi_c = -\ 5{\cdot}36 \times 10^{-6} \text{ C.G.S. E.M.U.;}$$
$$\chi_b - \chi_c = -\ 13{\cdot}17 \times 10^{-6} \quad \text{,,} \quad \text{,,};$$
$$\chi_b - \chi_a = -\ 7{\cdot}74 \times 10^{-6} \quad \text{,,} \quad \text{,,};$$

a, b, c being taken in accordance with Robertson's recent renaming of these axes[2], whereby $a : b : c = 10{\cdot}53 : 9{\cdot}53 : 5{\cdot}66$ A. Resorcinol is very soluble in water and in all the usual organic solvents, and Rabi's method[3] for the measurement of the absolute susceptibility in a given direction could not therefore be used. The mean susceptibility of powdered resorcinol has, however, been measured by Pascal[4] and using his value, $\chi_m = 67{\cdot}2 \times 10^{-6}$, we obtain $\chi_a = -\ 66{\cdot}4$, $\chi_b = -\ 74{\cdot}2$, $\chi_c = -\ 61{\cdot}0 \times 10^{-6}$.

Now in an orthorhombic crystal

$$\left.\begin{aligned}\chi_a &= K_1\cos^2\alpha_1 + K_2\cos^2\alpha_2 + K_3\cos^2\alpha_3\\ \chi_b &= K_1\cos^2\beta_1 + K_2\cos^2\beta_2 + K_3\cos^2\beta_3\\ \chi_c &= K_1\cos^2\gamma_1 + K_2\cos^2\gamma_2 + K_3\cos^2\gamma_3\end{aligned}\right\} \quad \ldots \quad (1)$$

where $\cos\alpha_1$, $\cos\beta_1$, $\cos\gamma_1$, are the direction cosines of K_1 relative to a, b, c, and so on; K_1, K_2, K_3 being the three principal susceptibilities of the molecule.

If $K_1 = K_2$, as is approximately true for most aromatic compounds, then

$$\left.\begin{aligned}\chi_a &= K_1 + (K_3 - K_1)\cos^2\alpha_3\\ \chi_b &= K_1 + (K_3 - K_1)\cos^2\beta_3\\ \chi_c &= K_1 + (K_3 - K_1)\cos^2\gamma_3\end{aligned}\right\} \quad \ldots \quad (2)$$

Hence if K_1 and K_3 can be estimated correctly, the direction cosines of the normal to the molecular plane can be calculated. As shown by Krishnan (*loc. cit.*), a good estimate of the molecular susceptibilities may be obtained by adding to each of the principal susceptibilities of benzene the difference between the mean susceptibility of benzene and that of resorcinol.

Thus $\left.\begin{aligned}K_1 = K_2 &= -\ 37{\cdot}3 - 11{\cdot}9 = -\ 49{\cdot}2\\ K_3 &= -\ 91{\cdot}2 - 11{\cdot}9 = -\ 103{\cdot}2\end{aligned}\right\}$

and on substituting in (2), we obtain

$$\alpha = 55{\cdot}6°,\ \beta = 47{\cdot}1°,\ \gamma = 62{\cdot}1°.$$

The same angles derived by Robertson from a single Fourier analysis[5] are

$$\alpha = 56{\cdot}1°,\ \beta = 46{\cdot}9°,\ \gamma = 61{\cdot}3°,$$

in good agreement with the above.

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[1] *Phil. Trans. Roy. Soc.*, A, **234**, 265 (1935).
[2] *Z. Krist.*, **89**, 518 (1935).
[3] *Phys. Rev.*, **29**, 174 (1927).
[4] *Ann. Chim.*, **25**, 344 (1912).
[5] NATURE, **136**, 755 (1935).

Fine Structure of the L_{23} Absorption Edge of Magnesium Metal

IN the region of ordinary X-rays, variations in the intensity of radiation transmitted through a metal foil on the short wave-length side of an absorption edge have led to interesting results in relation to the zone-structure of the unoccupied electron levels of a metal. The extension of such 'fine structure' measurements to absorption edges which lie in the region of ultra-soft X-rays (say 100–300 A.) allows the possibility of a considerable increase in the resolving power of the method, since in this region the breadth

of the underlying K, L . . . levels is known to be only of the order of 1/4 volt.

We have therefore investigated the intensity of light transmitted through a foil of magnesium on the short wave-length side of the L_{23} absorption edge, the wave-length of which has been determined by Sanner[1] as 250·25 A. A thin film of magnesium 10^{-5}–10^{-6} cm. thick was evaporated on to very thin celluloid (some 50 A. thick), and as light source a vacuum spark between molybdenum electrodes was used. The radiation was analysed with a 1-metre grazing-incidence vacuum spectrograph and, using 'oiled' plates, spectra were taken with and without the absorbing foil in position behind the slit. With the foil in place, an exposure increase of some thirty times was required. The usual methods of micro-photometry were employed to translate the observed densities, so that, at least roughly, the ratio of the intensity of the transmitted light to the incident light could be obtained for various wave-lengths.

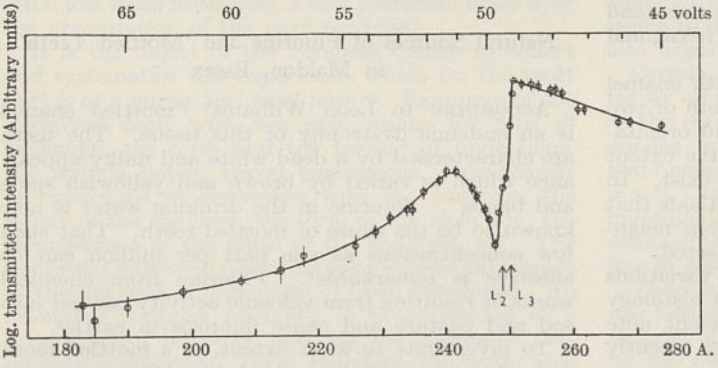

FIG. 1.

The result is shown in Fig. 1. The wave-length 250·7±0·2 A. at which absorption just starts is slightly longer than that given by Sanner. The L_2 and L_3 edges appear to be just resolved, with a separation of 1·3 A. The most striking feature of the curve is the quite sharp absorption maximum which occurs just on the short wave-length side of the edge. This should be compared with a similar peak in the emission intensity which occurs for magnesium just on the long wave-length side of the L_{23} emission band limit, as shown by O'Bryan and Skinner[2]. In fact, it is easily seen that experiments on the X-ray emission bands and on the absorption edge fine structure give complementary information regarding the electron levels in a metal, and it is satisfactory to find that in the case of magnesium, the data from the two sources fit together. In this way direct information with regard to the overlapping of the first two Brillouin zones is obtained.

We have also observed other absorption edges in the soft X-ray region, namely, the K-edge of lithium at 227±1·5 A., the M_{23} edge of cobalt at 202±1 A. and the M_{23} edge of nickel at 190·5±1·5 A. Unfortunately, the plates were not good enough for fine structure measurements, but we hope shortly to be able to make the necessary improvements in the technique.

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April 8.

[1] *Z. Phys.*, **94**, 523 (1935).
[2] *Phys. Rev.*, **45**, 370 (1934).

Intensity Anomalies in the Lyman Series of Hydrogen

IN 1930 we reported elsewhere[1] that when a condensed discharge is passed through a neon tube in which hydrogen appears as a trace of impurity, the Balmer series is seen remarkably well developed. We have been applying the same method for the extension of the Lyman series and have been able recently to get as far as the 20th member.

During this experiment, we noticed an interesting phenomenon, namely, that at times the third member of the Lyman series (L_3) is abnormally weakened, or even disappears. While we were in doubt if the phenomenon is caused by absorption by some impurity, a paper by Price and Collins[2] reporting on the absorption band of O_2^+ came out, and we noticed that there is a band (H_4) exactly coinciding with L_3. This led us to admix a slight amount of oxygen by passing it into the spectrograph through a narrow capillary, so that the partial pressure of oxygen was kept less than 0·1 mm. while the pumping was going on.

Fig. 1 shows the reproduction of one of our spectrograms thus taken, first without (a), and then with (b) the flow of oxygen. It was taken in the first order of a 1-metre grating at grazing incidence with an exposure of 2 hours.

In Fig. 1 b it will at once be noticed that not only the line L_3, but also the line L_6 is absent, and the line L_8 is abnormally weak compared with its adjacent members L_7 and L_9.

Upon referring to the data given by Price and Collins[2] (Table I, p. 717), we noticed that here again the coincidences of the frequencies are fairly close, namely, between L_6 and M_4, and L_8 and M_5.

Among the other members of the Lyman series, there is still one more instance of such a coincidence in frequency, namely, between L_{13} and M'_3. As the line L_{13} appears rather faint on most of our spectrograms, the evidence was not so clearly seen as in the above three cases.

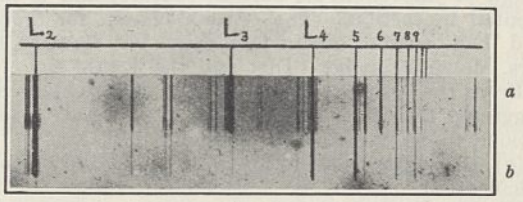

FIG. 1.

The frequencies of the lines here discussed are given in the accompanying table:

Line and Band	ν in cm.$^{-1}$	$\Delta\nu$ in cm.$^{-1}$	$\Delta\lambda$ in A.
L_3 / H_4	102823 / 102820	3	0·03
L_6 / M_4	107439 / 107460	21	0·2
L_8 / M_5	108324 / 108360	36	0·3
L_{13} / M'_3	109118 / 109130	12	0·1

The fact that the inflow of oxygen makes such a strong line as L_3 disappear completely shows that the O_3+ bands must have enormous transition probabilities, just as mentioned by Price and Collins.

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Dec. 26.

[1] T. Takamine and T. Suga, *Sci. Pap. I.P.C.R.*, **14**, 117 (1930).
[2] W. C. Price and G. Collins, *Phys. Rev.*, **48**, 714 (1935).

X-Ray Examination of Tooth Structure

THE study of the structure of teeth by X-ray diffraction methods[1] has shown that the apatite crystals of the enamel are preferentially oriented whereas those of the dentine are arranged at random. The enamel orientation is such that the crystals tend to have the [001] direction (that is, the hexagonal axis) in common.

It was found in the case of human tooth enamel that the fibre-axis could take up one or both of two positions, referred to as orientation (i) and orientation (ii) respectively. Also variations in the extent of the enamel orientation were shown to exist. In addition, it was shown by radiographic methods that differences in degree of calcification between neighbouring portions of a tooth could be detected.

An attempt is being made to link up the variations in structure revealed by X-rays with the histology and surface texture of teeth, and the present note gives a very brief summary of some results recently obtained.

Sections of human deciduous teeth have been examined by X-ray diffraction methods and by radiographic methods, and the tooth surfaces have been examined by X-ray diffraction methods. 'Good' enamel has been taken to be enamel which is smooth on the surface, is free from pigmentation in section and does not take up stain. 'Bad' enamel, on the other hand, has been taken to be enamel which is rough or uneven in its surface texture, and is pigmented in section. The criteria chosen for 'good' and 'bad' enamel are in fact those put forward by Mrs. Mellanby in her "Diet and the Teeth"[2].

From the results so far obtained, it is tentatively suggested that it is desirable for the following conditions to be satisfied by enamel:

(*a*) Radiographs should give no indication of poor calcification.

(*b*) The enamel should contain a large amount of preferentially oriented apatite, the degree of perfection of orientation being high.

(*c*) Orientation (ii) should occur (see above).

A few of the individual results may be of interest. For example, the work shows that the arrangement of crystallites is, on the average, not the same at the surface of the enamel as in the interior. This is indicated by the fact that whereas orientation (i) is almost always predominant in the enamel sections, orientation (ii) is often predominant in surface enamel.

It has also been shown that, generally speaking, a tooth is entirely enclosed by a thin layer of hypercalcified tissue. The outer enamel layer may possibly act as a protective layer and play some part in preventing caries.

A further point concerns the nature of translucent zones in the dentine. It has been generally felt that these were zones of hyper-calcification, and the X-ray evidence has confirmed this view. Moreover, similar hyper-calcified zones exist which are not translucent to light but are of normal opacity.

The work is being carried out on behalf of the Dental Disease Committee of the Medical Research Council, to which I am indebted for permission to publish this note. A full account will appear elsewhere.

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Natural Sources of Fluorine and 'Mottled Teeth' in Maldon, Essex

ACCORDING to Leon Williams[1] "mottled enamel is an endemic dystrophy of this tissue. The teeth are characterised by a dead white and milky appearance which is varied by brown and yellowish spots and bands". Fluorine in the drinking water is now known to be the cause of mottled teeth. That such low concentrations as one part per million can be effective is remarkable[2]. Fluorine from chemical works or resulting from volcanic activity can get into soil and pasture and cause fluorosis in cattle[3].

To investigate to what extent, in a mottled teeth area, fluorine is likely to be taken in by man and animals by means other than in water, a few determinations of fluorine were made in materials obtained from Maldon, Essex, and its environs, the only region in England where mottled teeth have been recognised[4].

		Fluorine
Teeth of wild rabbit from near Maldon	contained	0·0283 per cent.
,, ,, ,, ,, ,, Surrey	,,	0·0053 ,, ,,
Grass from Maldon	,,	0·0003 ,, ,,
,, ,, London	,,	0·0001 ,, ,,
Pond water from Maldon	,,	1·2 parts per mill.
,, ,, ,, London	,,	0·5 ,, ,, ,,
Well water from Maldon	,,	5·0 ,, ,, ,,
Main water in London	,,	0·5 ,, ,, ,,

That very low concentrations of fluorine in drinking water can be effective might be explained by the fact that simultaneously fluorine is being ingested in plant and animal foodstuffs. Though such sources are less important, they should be considered as possible contributory sources. The reason why acquisition through the water supply has seemed to be the all important is no doubt due to the fact that the fluorine in water occurs as sodium fluoride, whereas in foodstuffs it more likely occurs combined with calcium, in which combination it is known to be less toxic.

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Nazi-Socialism and International Science

IN an article which appeared in NATURE of December 14, 1935 (136, 927) under the above title, it is stated that the objects of the Wissenschaftliche Kongress-Zentrale (now the Deutsche Kongress-Zentrale) are to serve as a supervising influence upon German science and to introduce the ideas of the National-Socialist party into the discussions of conferences.

This statement completely misinterprets the object of the Congress Centre. The Congress Centre is a branch of the Berliner Medizinische Gesellschaft, which created it because it is part owner of the Langenbeck-Virchow-Haus in which many national and international congresses are commonly held. It has been found that everyone wishing to organise a congress has been compelled to start from the beginning each time. The experience of a previous organiser of a national or international congress is often lost since invariably a new personnel takes over the organisation of the next congress.

It is the object of the Congress Centre to collect and systematise this experience, which for the most part is of a purely technical nature. Examples of the questions dealt with are applications for bills of exchange, the form and the issuing of invitations, the agenda paper, travel concessions, arrangement of excursions in connexion with the congress, the report of the congress, the form of the reception, the arrangement of the office of the congress, etc. The Congress Centre will place this accumulated experience at the disposal of organisers of fresh congresses. An intending congress organiser is thus relieved of a great part of his work and has the assurance that nothing is forgotten. He is, therefore, the better able to devote himself to the details of the programme and the scientific aspects of the congress. For these the organising committee of the congress, which is entirely independent of the Congress Centre, is alone responsible, and usually they are entrusted to an eminent scientific authority on the subject.

The origin of the belief that the Congress Centre has an influence on the choice of scholars travelling to international congresses lies in the fact that the Congress Centre undertakes applications for bills of exchange for these persons. Owing to the very difficult exchange position in Germany, it is impossible for every German man of science to take part in a foreign congress. The number must be limited to the number of bills of exchange available on the country in question. For example, of the 90 Germans who applied, only 25 were able to attend the International Physiological Congress, because the Reichsbank issued bills of exchange for only 25 persons. As applications for bills of exchange are made by the Congress Centre, the erroneous impression can arise that the choice of participants is made by this body.

The Congress Centre is thus an arrangement, arising from purely practical requirements, for the assistance of congress organisers. We may perhaps mention that the Berliner Medizinische Gesellschaft has existed for seventy-five years, and is the largest medical association in Germany.

C. F. O. C. ADAM.
(Managing Secretary.)
Berliner Medizinische Gesellschaft,
(Langenbeck-Virchow-Haus),
Berlin.
April 14.

Scientific Workers and War

DURING recent months, several items have appeared in NATURE which were concerned at least in part with the topics of warfare, past or future. This may be taken as an expression of the realisation that science has given modern warfare its catastrophic character. While scientific investigators cannot be held directly responsible, many of them are coming to feel that they cannot remain indifferent to the indirect effects of their work.

The practical working of modern civilisation depends so largely on technical knowledge that if everyone with scientific training were to act for one common aim, that aim could be achieved. Probably the majority of scientific workers the world over prefer peace to war, and there can be no doubt that English scientific workers as a body are united in this matter. This being so, can they take action as such, apart from anything they may think worth doing in conjunction with non-scientific bodies? It seems to us that such action is not only possible but also urgently needed.

Certain objects must be, and indeed are, sought for by all scientific workers who wish for peace, such as the maintenance of the international character of science and the safeguarding of the public from scare-mongering or scientifically inaccurate statements. Apart, however, from such grounds as these, individuals are divided as to how peace is to be attained, and each point of view has its appropriate line of action.

There are first of all those who think that while war between nations is undesirable, it is still the final support of justice, and hence, in the long run, it may be the road to peace: such scientific workers will not be opposed to strong armaments, or to war research as such, but they will insist that at the same time the fullest support will be given to the principle of collective security.

Secondly, there are those who regard all war as a barbarous and destructive activity, a means which no end will justify, and who consider that aggression could be stopped by effective and whole-hearted action of a non-military character by the nations of the world. They will refuse to do research which is obviously directed towards war, and they will try to prevent such research being carried on in the universities. They will demand that if money must be spent on war research, it should be for defensive purposes only, and that the work should be published. If objection is raised to publication, then the research is probably not purely defensive in character. Again, they would organise themselves quite specifically to resist the efforts of a war-making Government in any country to coerce them into helping the war-machine when it is set going. From their point of view, it is all-important that such organisation should be in existence before any coercion is actively begun.

A third section comprises the complete pacifists, who differ as far as their practical activities are concerned in their objection to sanctions of any kind, but as scientific workers they would join in any organisation to resist the use of their services for war if war comes.

Lastly, there are many who think that in the long run war is inevitable under capitalism, and are working for the establishment of world socialism. Their immediate policy is to use any means which can stave off the outbreak of war, and they would

therefore be willing to join with those of other opinions in various practical ways.

There may be considerable overlapping between these sections of opinion, but in spite of theoretical differences, there will be occasions on which all can unite for the time being. War would be impossible if all scientific workers opposed it. Each individual scientific worker should first consider what ought to be done, and then use his influence to see that it is done.

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M. C. A. CROSS, B.A. D. M. NEEDHAM, Ph.D.
R. C. EVANS, Ph.D. J. NEEDHAM, Sc.D.
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University,
Cambridge.

[The above letter was written independently of the leading article on the same subject which appeared in NATURE of May 9.—Editor.]

Fertile Sugar Cane × Millet Hybrid

A CONSIDERABLE number of *Saccharum* × *Sorghum* hybrids have been produced at this Station during the breeding seasons of 1933–35. The accompanying photograph (Fig. 1) shows seed germinating in the

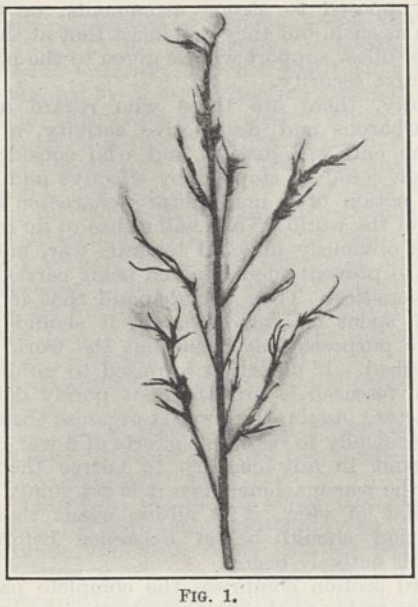

FIG. 1.

influorescence of a hybrid between the sugar cane variety P.O.J. 2725 ♀ and Guinea corn ♂ (*Sorghum vulgare*). The plant and panicle were both standing upright when the condition was observed, and the plantlets had wilted, presumably from lack of moisture and nourishment.

P.O.J. 2725 is descended from a cross between *Saccharum officinarum* and *Saccharum spontaneum*, and the latter accounts for one-eighth of its make-up.

Hybrids are frequently characterised by a high degree of sterility, and sugar cane seed germinates so rarely in Nature that for many years it was thought that the plant could only be reproduced asexually. It therefore seems of general interest to record this marked fertility in an intergeneric (*Saccharum* × *Sorghum*) hybrid.

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March 13.

Two Methods of Formation of Dictyosomes from Vesicular Golgi Bodies

OOGENESIS studies have revealed that the Golgi bodies may have a variety of shapes ranging from a granule and a vesicle to a typical dictyosome[1,2]. We have always been faced with the question whether these shapes are fixed or whether one could be derived from the other. Scattered in the literature on spermatogenesis[3] and secretory phenomena[4,5] we also find batonettes described with double chromophilic rims. If these double-rimmed batonettes have a real existence, what is their relation to the other shapes of the apparatus ? From the evidence at our disposal we feel that these types of batonettes could be derived from the vesicular Golgi bodies, the vesicles themselves being derived from granules.

Fig. 1 is a reproduction of a photomicrograph of a growing oocyte of *Clibanarius olivaceus*. At *gg* are shown the Golgi grains in which there is no differentiation into chromophilic and chromophobic regions. These enlarge and give rise to vesicles (gg_1) in which the two regions become visible. Rupture of these vesicles (gg_2) takes place at varying stages of the growth of the vesicles and gives rise to batonettes of

FIG. 1. Oocyte of *Clibanarius*. ×900.

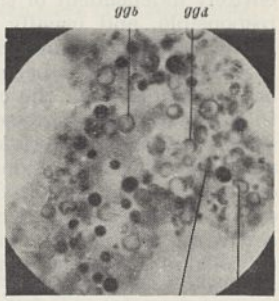

FIG. 2. *Lycastis* material. ×900.

varying sizes. A typical batonette formed by such a rupture is shown at gg_3. A glance at the photomicrograph will show how the chromophobic area which is enclosed by the chromophilic region in the vesicles comes into relation with the cytoplasm.

In *Lycastis indica* we observed double-rimmed batonettes, which differed from those described in *Clibanarius olivaceus* in having the chromophobic part between the two chromophilic rims. In some of the batonettes the chromophobic part completely disappears. In Fig. 2 are shown the various stages in the transformation of a vesicle into a double-rimmed batonette. Instead of the vesicle rupturing, the final result seems to be attained in a peculiar way. An infolding (gg_a) similar to gastrula formation takes place, and by an extension of the process (gg_b)

a double-rimmed batonette results. By still closer apposition of the two chromophilic regions the chromophobic part completely disappears. Naturally, there are also instances of multiple folding of the walls of the vesicle. The disappearance of the chromophobic part in relation with the Golgi batonette in *Lycastis indica* will be apparent if one compares Figs. 1 and 2.

The absence of the chromophobic part in the network-like Golgi apparatus of many types of mammalian somatic cells has rendered the acceptance of the theory deriving the network from the typical dictyosomes as postulated by Hirschler difficult[6]. We suggest as a provisional hypothesis that the difficulty may be removed if we conceive that the network is derived from the Golgi batonettes of the type seen in *Lycastis indica*, where the chromophobic part disappears ultimately.

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Origin of the Term 'Solute'

REGARDING the origin of the word 'solute'[1], the following may be added to the references concerning the coining of the word by Prof. Donnan and by the late Prof. N. Story-Maskelyne. In a paper presented to the American Academy on May 9, 1894 (cf. *Proc. Amer. Acad.*, **30**, 325; 1895; but perhaps published in a separate part of this volume during 1894), W. D Bancroft wrote: "There seems to me a need for a word denoting the dissolved substance. In future I shall use the word 'solute', meaning the substance dissolved in the solvent". It appears, therefore, that the use of this handy word was proposed independently and almost simultaneously by several chemists so early as 1894. Prof. Bancroft seems to have been the first to introduce the word in a scientific communication, but Prof. Donnan's suggestion was possibly the earliest to appear in print.

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[1] NATURE, **137**, 698 (April 25); 782 (May 2, 1936).

Points from Foregoing Letters

SIR J. J. THOMSON refers to several objections to his views on the nature of light, and shows how they can be overcome by suitable assumptions concerning the structure of the interior of the atom and the mechanism of light emission, about which he points out there is very little known.

The latest version of the theory of superconductivity of metals at low temperatures suggested by F. and H. London is simplified by Prof. E. Schrödinger, by assuming Maxwell's equations and the existence of a third type of current, the supracurrent, which is added to, or replaces, the ordinary conduction current.

The mean free path of the neutrons obtained from heavy hydrogen subjected to radiothorium radiation is found by Dr. M. Goldhaber to be $4{\cdot}5 \pm 1{\cdot}5$ cm. paraffin. This value cannot apparently be reconciled with that derived from a formula based upon the accepted views, and Dr. Goldhaber concludes that there is no evidence for an excited state of the heavy hydrogen alone, and that another model of the proton–neutron interaction is required.

C. A. Beevers and H. Lipson give a description of a very rapid numerical method for the summation of two-dimensional Fourier series. Sets of printed strips are used, and the method consists merely in the selection and addition of groups of these. Some advantages of this method are pointed out.

Dr. K. Lonsdale has measured the diamagnetic anisotropy of a single crystal of resorcinol. The orientation of the molecular plane relative to the crystal axes has been derived and is found to agree well with the results of a previous X-ray analysis.

The transparence of a very thin film of magnesium metal (100–1000 A. thick) for ultra-soft X-rays (extreme ultra-violet light of 100–300 A. from a molybdenum spark) has been determined by Dr. H. W. B. Skinner and J. E. Johnston. They find a sharp absorption maximum just on the short wavelength side of the absorption edge at 250 A. The fine structure of this absorption edge confirms the information obtained from X-ray emission bands regarding the electron levels in the atoms of the metal. Similar experiments with lithium, cobalt and nickel are in progress.

While investigating the Lyman series of lines in the far ultra-violet, emitted by traces of hydrogen, when a condensed discharge is passed in presence of neon, T. Takamine and T. Suga have observed that certain of the lines were considerably weakened. This, they now find, is due to the presence of a small amount of oxygen, the molecular ions O_2^+ having strong absorption bands in the neighbourhood of the hydrogen lines L_3, L_6, L_8, L_{13}.

X-ray examinations of tooth structure show, according to J. Thewlis, that good enamel—which is smooth and free from pigmentation—contains a large proportion of preferentially oriented apatite (a crystalline calcium phosphate and fluoride), and shows a sufficient degree of calcification. A special orientation of the fibre axis was also observed.

In a 'mottled teeth' area such as Maldon in Essex, where fluorine in the drinking water is the cause of the mottling, it has been found by J. H. Bowes and Miss M. M. Murray that pond water, grass and rabbits' teeth contained considerably more fluorine than similar substances from other parts. This fluorine may be a contributory cause of the abnormal condition of the teeth.

A photograph of a fertile inter-generic hybrid between a sugar cane variety and millet (Guinea corn) is submitted by C. H. B. Williams and C. Cameron.

A photomicrograph of growing ovarian cells showing the evolution of dictyosomes (particles derived from the nucleus of the spermatozoon after fertilisation of the ovum) are submitted by M. K. Subramaniam and R. Gopala Aiyar. It appears that these are formed from Golgi grains which enlarge into vesicles and rupture, giving rise to batonettes; these, the authors suggest, give rise to the network-like Golgi apparatus.

Research Items

Rumanian Folk-Dances

THE current issue of the *Journal of the English Folk Dance and Song Society* (Vol. 2) is devoted to the International (European) Folk Dance Festival, which was held in London on July 14–20, 1935 (see NATURE, July 27, 1935, p. 154). In addition to a detailed report by Mr. F. Howes of meetings, dances and excursions, it contains the papers read at the Conference which formed part of the proceedings. These papers include a study by Dr. Romus Vuia of the remarkable Rumanian dance of the Călușari, or Hobby-Horse Dance, of which the primitive evolutions attracted so much attention. At the close of a detailed description, Dr. Vuia suggests that the Călușari, who observe special customs at special places such as water, woods, hills and cross roads, have a magical origin, and that they embody two magical elements (*a*) connexion with the sun, and (*b*) connexion with the fairies, who have a special association with water. That they personify the fairies is indicated by, among other things, their knowledge of healing plants and their nature. Related forms of the dance are found throughout the Balkans, and through these a connexion is suggested with the ancient types of stick and sword dances of western Europe. The hobby-horse which appears in the dance has a double function as both the origin of and the destroyer of fertility. As the demon of fertility it takes away as well as gives. This double aspect of magic also appears in the relation of the Călușari with the fairies, who both cause and avert disease. The fool of the Călușari also appears in the Stag Dance at Christmas and the New Year. In this dance he appears with a phallus, and, instead of being killed, as is usual, he himself kills the stag. In its original form the Călușari was a dance intended to drive away the demons of ill-health.

The Oriental Migratory Locust

THE February issue of the *Bulletin of Entomological Research* (**27**, Part I, 1–194) is devoted to a series of papers describing the results of researches on locusts. It is only possible here to comment upon one of the contributions, namely, that of Dr. B. P. Uvarov, on the oriental migratory locust. The swarms of this locust, which occur over north-eastern Asia, the Malay Archipelago and the Philippine Islands are usually referred to the subspecies *migratoriodes* (R. and F.) which inhabits tropical Africa. Dr. Uvarov points out, however, that the oriental locust can be readily separated from the African subspecies since it is a smaller insect with a less constricted pronotum and a narrower head, in its gregarious phase. Its correct designation is *Locusta migratoria manilense*, Meyen, and its claim to be a separate subspecies is based upon material from specimens obtained from a number of widely separated regions. Dr. Uvarov concludes that in the Philippines, Borneo and Malaya, conditions favouring swarm development are brought about by the primitive methods of land utilisation. The grasslands, known in the Philippines as *cogonales*, are the product of shifting cultivation and of repeated burning of the grass. These lands are of a dry, impoverished type and create a habitat alien to the nature of the country but eminently suitable for the locusts. The problem of locust control under such conditions is one which demands careful field studies for its solution.

British Sawflies of the Genus *Hoplocampa*

DR. H. W. MILES has recently published a revision of the British species of the sawfly genus *Hoplocampa* (*Entom. Mon. Mag.*, March 1936). Altogether, nine species are known at present in Great Britain, and the species *H. brevis* was found for the first time only last year. *Hoplocampa flava* and *H. testudinca* infest plum and apple respectively and are known from most of the important fruit-growing areas of England. While the life-histories of these two species have been tolerably well studied, little is known of the biology of the remaining seven species. *H. alpina* appears to attack, as a larva, the blossoms of mountain ash (*Pyrus aucuparia*), while *H. brevis* lives on the fruits of the pear. The last-mentioned species has only so far been found in Cambridge, but probably has a wider range in southern Britain. The genus *Hoplocampa* is associated with *Pyrus*, *Prunus* and *Cratœgus*, and its members probably have only one generation per annum. Dr. Miles gives a key to the determination of the British species, which has been adapted from the works of Enslin and Morice, after a study of recently obtained specimens.

Ecology of a Sandy Shore

THE Skalling peninsula is a sand-dune area on the west coast of Denmark which partially cuts off a large tidal lagoon from the North Sea. The tidal range there is about 1·6 metres, and at low tide a foreshore of about five hundred metres of muddy sand is exposed on the western side of the lagoon. Thamdrup (*Medd. Komm. Denmarks Fisk. og Havundersøg.*, Ser. Fisk., **10**, No. 2, 1–125) gives a detailed account of the ecology of two traverses from high- to low-water on this shore. He describes first the chemical and physical conditions, including the salinity, hydrogen ion concentration, oxygen content, etc., of the water, and the tidal conditions, and the range of particle size in the sand. He then lists twenty-five species found, and discusses fourteen of them in detail. Notes are given on the general habits of each, and on their breeding periods so far as these are known, and his notes on growth rates, especially of *Arenicola marina*, are particularly valuable. Two molluscs, *Cardium edule* and *Macoma baltica*, are discussed in special detail on the evidence of growth obtained from annual rings on their shells, and Thamdrup shows the differences in mortality of the different year groups in successive years, as well as the wide variation in growth rate, especially in *Cardium*, at different tidal levels.

A Fungus Parasite of Cabbage

MR. J. R. THOMSON has studied a fungus which causes white spots to appear upon cabbage leaves ("*Cylindrosporium concentricum* Grev."; *Trans. Brit. Mycol. Soc.*, **20**, Pt. 2, 123–132, January 1936). The fungus was first described under the above name by

Greville in 1823, but its nomenclature has undergone many vicissitudes, and finally its first designation was restored by von Hoehnel in 1924. The paper under review substantiates and approves this latter view, and also describes the features of the organism as it occurs upon the host, and as it behaves in pure culture.

Eureka (California) Earthquake of June 6, 1932

THOUGH not of great destructive power, this earthquake forms the subject of an interesting study by Mr. N. R. Sparks (*Bull. Seis. Soc. Amer.*, **26**, 13–27; 1936). It affected chiefly the region around Humboldt Bay in Northern California, the shock being felt from Coos Bay on the north to San Jose on the south, a distance of more than four hundred miles. Nearly all the brick chimneys round Humboldt Bay were damaged or thrown down, the tops of many of those left standing being rotated in a clockwise direction. Yet a steel-reinforced concrete stack, 305 feet high, at Samoa, in the central region, was neither cracked nor shifted. The epicentre, as determined by seismographic evidence, lay in lat. 40° 45′ N., long. 124° 30′ W., and this point agrees closely with that given by the isoseismal lines. It lies a short distance off the coast, on the continuation of a fault ruptured at the time of the earthquake of 1906 and apparently parallel to the great San Andreas rift. The depth of the focus was about thirty-seven miles.

Climate of Czechoslovakia

THERE is a paper by B. Hrudicka among the Publications of the Faculty of Science of the University of Masaryk for 1935 which contains useful climatological information. It is entitled "A Climatic Map of Czechoslovakia according to Köppen's Classification". Köppen's system of classification, it may be recalled, is one of the most successful that has yet been devised. The different climates are distinguished by a number of letters, capitals corresponding with the main features defined by temperature and rainfall, while smaller letters provide for sub-divisions of these. In Czechoslovakia only three main climates are found. All three are humid (*f* according to Köppen), as there is no dry season. They are (1) the humid warm temperate (*Cf*), (2) the humid type with distinctly cold winter, the mean temperature of the coldest month being below −3° C. (*Df*), and (3) in the mountains, the tundra (*ETG*), with the warmest month averaging between 0° C. and 10° C. The climate *Df* appears in the two sub-types *Dfb* and *Dfc*; the former prevails in the low-lying regions, and is characterised by four months or more averaging over 10° C., and the latter with less than four such months, in the moderately high parts. It is interesting to note that marine influences are obviously present in this country; for example, the warmer summer required by *Dfc* compared with *ET* climates results in a rise in the boundary between these two types with distance eastwards; in the same direction there is a fall in the boundary between *C* and *D* due to the increasing severity of the winter with the more Continental conditions in the direction of Russia.

Absence of Living Bacteria in Stony Meteorites

THAT living bacteria could not exist in aerolites or stony meteorites would probably be generally accepted as a fact. Prof. Charles Lipman, however, four years ago reported the finding of living bacteria in aerolites. He claimed that stony meteorites had brought down with them from somewhere in space "a few surviving bacteria, which can in many cases be made to grow on bacteriological media in the laboratory". It might be thought that the heating of the meteorite in its descent through our atmosphere would destroy any bacteria if they were present. In reply to this objection, it is suggested that owing to poor conductivity, the interior of a meteorite remains cool even though it burns externally. The matter has been reinvestigated by S. H. Roy, using the same aerolites and methods as Prof. Lipman (*Geol. Ser. Field Mus. Nat. Hist.*, Chicago, **6**, No. 14, 179, Dec. 12, 1935). The meteorites had first to be powdered aseptically, and then cultured in various special media. Of twelve tubes of culture media inoculated with meteoritic powder, growth appeared in three only, the other tubes remaining without growth over a long period of incubation. The growths obtained were those of two common terrestrial species of bacteria, *Bacillus subtilis* and *Staphylococcus albus*. It is significant that the same organisms were obtained in control plates exposed in the container in which the crushing was carried out. The conclusion reached is therefore that no living bacteria are present in aerolites, such growths as may be obtained being due to unavoidable contamination from the air during the process of preparation for cultivation.

High Permeability in Magnetic Fields

IT has been known for several years that the magnetic properties of iron and silicon steel are altered by cooling from high temperatures in a magnetic field. This property is only shown by metals and alloys which remain plastic whilst cooling through the Curie point. In the *Bell Laboratories Record* of April, J. F. Dillinger points out that the lowest temperature at which the heat treatment is effective is identical with that at which plastic flow begins to occur. He considers that a magnetic material is composed of small regions in each of which the material is magnetised to saturation in a definite direction. In iron and permalloy it is one of the cubic axes of the crystals, but in an unmagnetised polycrystalline specimen the crystals are oriented at random. As the field is applied, the magnetisation of the various regions tends to become parallel to it. If the temperature is sufficiently high, plastic flow occurs owing to the stresses produced by the magnetisation. When the specimen is cooled, the regions still retain their new directions, and it is relatively easy to remagnetise the specimen in the direction in which the magnetic field was applied. Its permeability will consequently be greatly increased. To find the temperature range in which the application of the field is important, several specimens of permalloy cut from the same casting were heated to 1,000° C. and then cooled to room temperature. It was found that the application of the field as the specimen cools from 600° to 400° C. increases the maximum permeability from about 5,000 to 250,000. It multiplies the permeability therefore by a factor of 50. By very carefully annealing permalloy containing 65 per cent of nickel at temperatures just below its melting point in an atmosphere of hydrogen, and then heat treating it in a magnetic field, the extraordinarily high permeability of 600,000 has been attained.

High Voltage Laboratory at Queen Mary College, London

ON May 6, the High Voltage Laboratory at Queen Mary College was opened by the Earl of Athlone, Chancellor of the University of London. In this university laboratory, voltages of the order of 1,000,000 are available for the instruction of engineering students. The completion of the Laboratory has been made possible by a grant of £10,000 from the Court of the University.

The use of high voltages for the transmission of electrical energy has been a notable development in electrical engineering practice in recent years. Working voltages in use to-day include 132 kv., 250 kv. and 330 kv. Still higher voltages are projected. Apparatus which has to work at these voltages must be tested by the application of even higher voltages, and the larger companies engaged in the manufacture of electrical apparatus have high-voltage testing laboratories capable of generating 1,000 kv. and, in a few instances, 2,000 kv. In consequence of this development, it is desirable that engineering graduates should possess a knowledge of the principles of high-voltage technology, and it is also desirable that research work on high-voltage problems should be undertaken by post-graduate students. Apart from this commercial aspect, the subject of high-voltage technology is eminently suitable for inclusion in a university engineering course, since it provides scope for the application of physics and mathematics to engineering problems. In particular, transient phenomena have received great attention from engineers since high-voltage engineering became of commercial importance, and a study of the theory of transients will be an important part of any course of instruction in high-voltage technology. While the need for a university course in the principles of high-voltage engineering has long been recognised, it has been difficult for adequate instruction to be given in the subject, because of the high cost of the necessary laboratory equipment and of the buildings.

The authorities at Queen Mary College were fortunate in possessing an existing building which could be readily adapted to accommodate high-voltage equipment, and this building is now the main High Voltage Laboratory. In the rebuilding of the Electrical Engineering Department which has just been completed, two smaller high-voltage laboratories were constructed and these are known as the 150 kv. alternating current and the high-voltage direct current laboratories. Also, the flat roof of the new building provides an excellent outdoor testing area to which various high-voltage supplies can be brought.

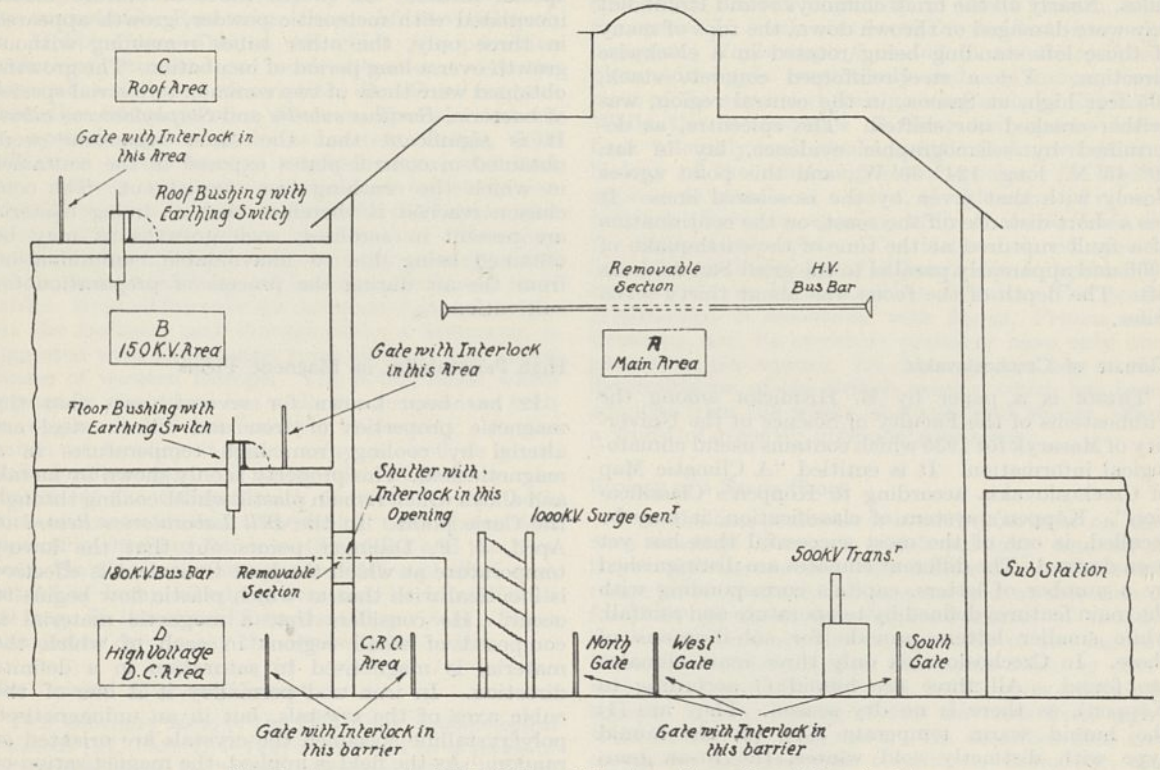

FIG. 1. Arrangement of High Voltage Laboratory, Queen Mary College, London.

The layout of the complete laboratory is shown in Fig. 1. The main items of equipment are as follows:

Main Laboratory, Area A.

(*a*) A 1,000 kv. surge-generator for the production of transient voltages.

(*b*) A high-voltage cathode ray oscillograph which enables a record to be taken of transient voltages having a magnitude of 1,000 kv. and a duration of a few microseconds.

(*c*) A 100 kv. Schering bridge for the measurement of losses in dielectrics while these are subjected to high voltages. The equipment includes a 'no loss' condenser using compressed air as dielectric.

(*d*) Two transformers connected in cascade to give 500 kv. at a frequency of 50 cycles per second. The primary supply to these transformers is given by a motor-alternator set of which the motor has a rating of 60 B.H.P. and the alternator a rating of 250 kva. Great care has been taken in the design of the alternator to ensure that its output voltage wave shall be practically free from harmonics under all conditions of operation.

(*e*) A 750 mm. sphere-gap with the spheres arranged vertically above one another, the lower sphere being moved by a motor-operated mechanism controlled from the main control desk. The sphere gap is used for measuring high voltages, both 50 cycle and impulse. It is arranged for use as a crest-voltmeter when required, the spheres then forming the high-voltage condenser of the crest-voltmeter.

150 *kv. Alternating Current Laboratory, Area B.* This area contains a 150 kv. single phase transformer and will be used to give preliminary instruction to students in high-voltage work. It will also be used for research work.

Roof, Area C. This area is on the roof of the new building, and supplies can be brought to it from areas *B* and *D*. The area will be used for making tests on outdoor-type insulators under various atmospheric conditions.

Direct Current Laboratory, Area D. Here is a 180 kv. direct current generator consisting of condensers and thermionic rectifying valves arranged as a 2-stage voltage multiplying circuit. This generator is used as the supply source for the surge-generator, but it will also be used for other purposes.

The laboratory layout has been carefully arranged so that the more expensive items of the equipment can be used in as many different areas as possible. High voltages are, of course, extremely dangerous and the greatest care has been taken to eliminate risk so far as possible. All the high-voltage testing areas are surrounded by expanded metal barriers. Entrance to the areas is obtained through doors in the barriers, and these are fitted with gate-switches which automatically switch off any high voltage in the area as soon as the door is opened.

The Laboratory is one of the best equipped of its kind in the world. It is hoped that it will serve to supply the electrical industry with engineers having an adequate knowledge of the fundamental principles of high-voltage engineering, and competent to handle the distinctive apparatus used in that branch of engineering. It is also hoped that existing knowledge of high-voltage phenomena will be extended as a result of research work done in the Laboratory.

W. J. JOHN.

Zoogeographical Divisions of the Palæarctic Region

ALTHOUGH the Palæarctic zoogeographical region, comprising the whole continent of Europe, a great part of Asia and northern Africa, is undoubtedly the best explored as regards its fauna, there has been no satisfactory modern scheme of its sub-divisions. This gap has now been filled* by the veteran Russian entomologist, A. P. Semenov-Tian-Shanskij, son of the famous explorer of Tian-Shan.

The work represents the results of fifty years' study of the distribution of recent Palæarctic Coleoptera, while the geological history of the countries involved and their fossil fauna are also taken into account. Brief characteristics are given of the four sub-regions recognised by the author, and of the provinces into which each sub-region is divided. These sub-regions are as follows :

(1) *Europæo-Siberian sub-region*, characterised by a fauna relatively poor in the number of genera represented, with a low percentage of endemic genera. This fauna is a greatly impoverished Tertiary one. Five provinces are recognised, namely, Arctic, Taiga, Forest, Steppe and the Caucasus province.

(2) *Mediterranean sub-region*, with seven provinces (Canarian, western Mediterranean, Saharan, eastern Mediterranean, Sumerian, Syrian, Hyrcanian). This is populated by a fauna regarded as an immediate development of the Pliocene fauna which has escaped here the influence of the Glacial periods. In some of the provinces, such as the Canarian and the Hyrcanian, some Miocene and even Oligocene relics still exist.

(3) *Central-Asian sub-region.* This is an innovation which is supported by strong evidence. Its fauna has some relation to that of the Mediterranean sub-region, differing from it in two respects. On one hand, many Mediterranean genera and even families have died out here, as a result of desiccation of the country. On the other hand, the desiccation resulted in a great development of numerous progressive endemics characterised by remarkable adaptations to desert life, both in structure and in habits. These evolutionary processes are still very active in several centres of the sub-region, which includes five provinces, namely, the Iranian, Turanian, Dzhungarian, Kirghizian and Mongolian.

(4) *Palæarchearctic sub-region.* This is another new conception. It occupies the south-east of Asia, extending to the Himalayas. Its fauna contains a high percentage of forms which are now mainly tropical, including eight families not represented elsewhere in the Palæarctic region. There are also many Tertiary relics which have survived on the spot since the Miocene and Oligocene. The following eight provinces are recognised : Manchurian, Corean, Japanese, inner Chinese, southern Chinese, Yunnanese, Tibetan and Himalayan.

While certain of the sub-divisions may appear too novel to some zoogeographers, the scheme proposed by the author is obviously superior to all previous ones, and deserves the close attention of anyone working on distributional problems. It is most regrettable that such an important contribution to biogeography should have appeared only in Russian, without even a summary in some other language. Explanations to the map included are, however, given in Latin as well, which will make it more widely available.

* "Les limites et les subdivisions zoogéographiques de la Région paléarctique pour les animaux terrestres basées sur la distribution géographique des insectes Coleoptères". By André Semenov-Tian-Shanskij. (Leningrad : Zoological Museum, Academy of Sciences, 1936.)

Fuel Industries Research at Leeds*

IN his Report for the session 1934–35 to the chairman and members of the Livesey Advisory Committee on the work of the Department of Coal Gas and Fuel Industries (with Metallurgy) of the University of Leeds, Prof. John W. Cobb is able to record progress in the increased number of first year students, in the recognition by industry of the value of graduation in this Department, and in the acceptance by the Institution of Civil Engineers of the degree in lieu of one or more sections of the associate membership examination. The Department carries on continuous research on problems connected with fuels and refractory materials, and for some years has been conducting an extended investigation of the influence of furnace atmosphere on the scaling of steel. This work has been encouraged and advanced by grants from the Iron and Steel Federation and, through the Iron and Steel Institute, from the Carnegie Research Fund. The recent work in this research has been directed towards the metallurgical aspects of the influence of sulphur compounds on the scaling of steel, more particularly in relation to the treatment of special steels.

Arising out of a study of carbonisation reactions in which the careful fractional distillation of cellulose, at temperatures up to 1,200°, were effected by special procedure, new light has been thrown on the course of the thermal decomposition of organic compounds. Then again, from an examination of the influence of certain surfaces on the cracking of the volatile products of coal carbonisation, the results obtained have suggested a method of modifying the character of tars which is expected to prove to be of practical value. The co-relation of the properties of cokes with their behaviour on combustion in the open grate, and the changes produced in lump coke when partially gasified, were also made the subjects of investigation and study.

An examination by Dr. A. L. Roberts of the torsional strength of refractory materials at different temperatures has been continued. On this subject a paper dealing particularly with the influence of vitreous and crystalline silica was read before the Ceramic Society in November last. In addition, he has made a study of the action of steam and other gases on refractory materials at comparatively low temperatures, and of the variation in their properties in planes at right angles.

A further activity of the Department is in co-operation with the Institution of Gas Engineers in carrying out research under the Joint Research Committee. Recent work has included the investigation of the corrosion of metals in gas appliances, and analyses of tests made on water gas plants to ascertain the influence of moderating the operating conditions, a subject on which very little direction is available as yet.

* The University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor (John W. Cobb) for the Session 1934–35. Pp. 11. (Leeds: The University, 1936.)

The Nutritive Value of Milk

A MEMORANDUM on the nutritive value of milk has been prepared by the Advisory Committee on Nutrition which was appointed last year by the Minister of Health and the Secretary of State for Scotland*. It points out that milk is the only food which contains nearly all the materials essential for growth and maintenance of life, in a form ready for utilisation by the body. Mothers' milk is the ideal food for the young of the same species, and milk of another species is the next best food for the nutrition of young mammals. The milk of any species of animal, provided it is palatable, is also an eminently suitable food for human beings, especially during growth, pregnancy and lactation.

Cows' milk contains protein, fat and carbohydrate, all the known vitamins and a variety of mineral elements necessary for normal nutrition. It is the most valuable food known for the promotion of growth and health in children. The present consumption of liquid milk is about 0·4 pint per head per day: if the average consumption could be increased to one pint, there would result an improvement in the general health of the community, especially in the case of children, in whom it would secure better bone formation and improvement in stature and physique. The incidence of disease, including rickets, would be diminished and the resistance to dental caries increased.

The few disadvantages of milk as an article of diet can be easily overcome: for infants it should be supplemented with iron and vitamins C and D. Children and nursing and expectant mothers should take about two pints a day: other adults should consume not less than half a pint a day, to ensure an adequate intake of calcium. The only significant changes effected in the composition of milk by heat are a partial loss of vitamin C and possibly of iodine: these deficiencies can be made good in the diet of babies fed exclusively on cows' milk by the addition of fruit or vegetable juice and cod liver oil, and in a mixed diet by potatoes or other vegetables or fresh fruit and some sea fish. Unless the milk comes from perfectly healthy cows, it should be boiled or pasteurised before use. Separated milk has a high nutritive value since it contains the bulk of the essential dietary constituents found in whole milk: whey, on the other hand, is a less complete food but would add considerably to the nutritional value of a diet containing cereals and cereal products.

* The Nutritive Value of Milk: Memorandum by the Advisory Committee on Nutrition. Issued by the Ministry of Health and the Department of Health for Scotland. Pp. 12. (London: H.M. Stationery Office, 1936.) 3*d*. net.

Educational Topics and Events

CAMBRIDGE.—The following grants have been authorised from the Anthony Wilkin Studentship Fund: £40 to J. R. B. Stewart, of Trinity Hall, to enable him to continue the excavations he is doing near Balikiser in Asia Minor; £40 to G. E. Daniel, of St. John's College, for the investigation of a megalith in South Wales.

In the report of the Buildings Syndicate on the completion of various building schemes undertaken in connexion with the Rockefeller benefaction for the physical and biological sciences, it is stated that the total cost amounted to £196,858.

At St. John's College the following have been elected into fellowships: E. H. F. Baldwin, H. Carmichael and J. S. Mitchell.

EDINBURGH.—Dr. A. L. Craig-Bennett, of the Department of Zoology, has been appointed by the Colonial Office to be chief fisheries officer in Palestine.

SHEFFIELD.—The following appointments have recently been made: Mr. Glyn Davies, to be lecturer in obstetrics and gynæcology; Mr. J. C. Paisley, to be junior assistant bacteriologist; Mr. A. J. Holland and Mr. N. A. Nichols, to be research assistants in the Department of Glass Technology.

IT is announced by the Lisbon correspondent of *The Times* that the honorary doctorate of the Technical University of Lisbon has been conferred on Sir Josiah Stamp, president of the British Association. Sir Josiah has presented to the University Library the original letter from a Lisbon merchant to his principal in England describing the effects on his business of the great earthquake of 1755; also a book containing some English publications of the period describing the earthquake. In return Sir Josiah was presented with a copy of the Lusiads by Camoens in a silver casket. It is stated that this is the first honorary doctorate to be conferred on an Englishman.

Two fellowships (700 dollars), eleven studentships (600 dollars) and seventeen bursaries (500 dollars) have been awarded for the year 1936–37 by the National Research Council, Ottawa, to candidates selected from Canadian universities. The policy of assisting exceptional students to pursue post-graduate work in Canadian universities has been followed since the inception of the Council, the object being to build up in Canada a supply of well-trained men of science capable of undertaking and carrying through research investigations involving a more profitable utilisation of Canadian raw materials and the expansion of markets for Canadian products.

THE education of girls in India has in recent years passed through a phase of tumultuous changes. Its backward state made such an impression on the Indian Statutory Commission that it was declared in an Interim Report (generally referred to as the Hartog Report) "priority should now be given to the claims of girls' education in every scheme of expansion". In a paper to the Indian Section of the Royal Society of Arts (*J. Roy. Soc. Arts*, March 20), Lady Hartog estimated the extent and character of the developments that have followed the publication of that Report. Whereas the Committee found that the disparity in numbers as between boys and girls at school, about 5 to 1, was increasing by more than 350,000 a year, the next few years were marked by such a rush of girl pupils alike to primary school, secondary school and college, that by 1932–33 their annual increment was exceeding that of boy pupils by more than 100,000. The gratification with which this advance has been received should not, Lady Hartog pointed out, obscure the fact that it has been accompanied by serious abuses. In the primary schools almost 40 per cent of the girl pupils are, for lack of girls' schools, accommodated in boys' schools, where they have no real place in the school life. There are, as a rule, no women teachers and no provision for teaching the girls anything outside the boys' curriculum. Of all the primary schools for girls in India, Bengal possesses nearly half, and in this province so inefficient is their instruction that the whole system of girls' primary schools is condemned as, with a few exceptions, practically useless. In the secondary schools the position is not so bad. Though overcrowded, the buildings are on the whole good, and it is beginning to be recognised that the curriculum, instead of being a replica of that of the boys, should have some relation to the home life which will be the lot of the vast majority of the girls. In the universities, the influx of girls has been justifying itself by results, especially in the medical schools; but there is said to be a crying need for more women's colleges and hostels.

Science News a Century Ago

Registration of Statistics

ON May 16, 1836, at a meeting of the Statistical Society, the Right Hon. Holt Mackenzie read a paper entitled "Observations on the means of collecting information on various points of Statistics, explanatory of a proposition for the appointment of a Committee to consider the expediency of opening books for the contemporary record of various statistical facts, and to prepare the forms in which such books shall be kept". Mr. Mackenzie said, that everyone who had attempted to prosecute statistical inquiries relating to past ages, must have been struck with the difficulty of getting fully and accurately, for any considerable series of years, information relating to things, which, at the time of their occurrence, were known to all the world, and he suggested that the Society should do for posterity what we wish our ancestors had done for us, or in other words, realise the probable wishes of the men of the year 2000. In accordance with his scheme, he therefore suggested that a set of registers should be opened to contain statistics relating to prices, wages, earnings, salaries, fees, weights and measures, coinage, interest, dividends, exchanges, insurance and income and expenditure of different classes of society, etc.

Observations of the Solar Eclipse

AMONG those who observed the annular solar eclipse of May 15, 1836, was J. D. Forbes, who on May 17 wrote from Edinburgh to Quetelet at Brussels: "On the 15th the solar eclipse was most admirably seen here. . . . I observed with a 7-feet reflector the immersion and emersion of the spots, of which there were several, but I could not observe the slightest distortion produced by refraction upon those delicate objects. My attention was chiefly directed to this

object: to examine the light from the sun's edges, at and near the annular period, in order to ascertain whether the dark lines in the spectrum were more numerous or stronger in the light which must have traversed the greatest thickness of the sun's atmosphere, and which have been supposed by Sir D. Brewster and others to be due to the absorptive action of that atmosphere. An attentive examination assures me that no material difference could exist; indeed, I did not perceive the slightest." Writing to Miss Forbes four days later, he said: "The eclipse was admirably seen here, and seemed to strike every sort of person much more than expected. I was making optical experiments in a dark room most of the time, but ran out for half a minute to see the ring, which was a wonderful sight. I sent you an account in the *Advertiser*. Dr. Chalmers preached, and I managed to hear him, too. Evening service was postponed in the churches and chapels, except Mr. Bagot's, and the smoking of glass and the burning of fingers and blacking of faces was wonderful. . . ."

Glass Balance-Springs in Chronometers

AT a meeting of the Royal Society held on May 19, 1836, Captain F. Beaufort, R.N., communicated a paper by Arnold and Dent "On the Application of Glass as a substitute for metal balance-springs in Chronometers". In their endeavour to determine and reduce the errors arising from the expansion and contraction of balance-springs in chronometers due to the variations in temperature, glass had been suggested as possessing desirable qualities. It was found that a glass balance-spring would resist the effect of cold, and by experiments made on board H.M.S. *Excellent* at Portsmouth that it would withstand the shock arising from the discharge of cannon in the vicinity. "On comparing the performance of glass balance-springs with metallic ones when the temperature was raised from 32° to 100°, it was found that while the loss in twenty-four hours in the gold springs was 8 m. 4 s., that of steel 6 m. 25 s. and that of palladium 2 m. 21 s., that of a glass spring was only 40 s." Chronometers with glass balance-springs were being tested at the Royal Observatory.

Death after Flogging

THE *Gazette des hôpitaux* of May 20, 1836, contains the following report: "A jury met at the King's Head Tavern, Woolwich, to inquire into the death of a sailor named William Saundry who died after being flogged. According to the coroner, the case required much consideration, as it had to be decided whether death was the result of a military punishment or of some disease. Death had occurred ten days after the flogging. The autopsy ordered by the coroner took place in the presence of ten doctors who decided that death was the result of fever and not of the flogging. Eight of the jury maintained that death would not have taken place without the flogging, but nine of the others agreed with the opinion of the doctors. The following verdict was given: 'William Saundry died by the visitation of God, and not by the hand of a person of any kind'. On reading a report of this case, it is difficult to say which is the most astounding: the contradictions in the report, the intense partiality of the doctors or the existence of so barbarous a punishment in a country so highly placed in the scale of civilisation as England."

Societies and Academies

LONDON

Royal Society, May 7. P. M. S. BLACKETT: Measurement of the energy of cosmic rays. (1). The electro-magnet and cloud chamber. An electro-magnet weighing about 11,000 kgm. has been constructed for the purpose of measuring the energy of cosmic rays and for studying the cosmic ray showers. The magnet gives a field of 14,000 gauss in a gap of 15 cm. between pole pieces 25 cm. in diameter for a power of 25 kw. The coils are air-cooled using a 4 h.p. fan. A special cloud chamber, 27 cm. in diameter by 3 cm. deep, is placed between the pole pieces. Two different optical systems are used, one employing a mirror and a camera at the side, and the other employing a stereo-camera photographing through a hole in one pole piece. The various arrangements of gap and optical system are compared from the point of view of measuring cosmic rays of the greatest possible energy. P. M. S. BLACKETT and R. B. BRODE: The measurement of the energy of cosmic rays. (2). The curvature measurements and the energy spectrum. The measurement of the energies depends on the measurement of very small curvatures. The method of making these measurements is described. Measurements of 180 cosmic ray tracks are given. The highest detectable energy with tracks 17 cm. long in 14,000 gauss is 2×10^{10} e.v. The energy spectrum between 10^9 and 10^{10} e.v. is shown to be approximately of the form $g(E) \propto E^{-2}$; in this range of energies about equal numbers of positive and negative particles are found. The particles over 10^{10} e.v. are mainly positive. W. EHRENBERG: The connexion between cosmic ray showers. Cosmic ray showers have so far been investigated chiefly by counting the number of triple coincidences of suitably arranged Geiger-Müller counters. The information obtained in this way is restricted to the number of these events. To obtain more complete information on showers, an ionisation chamber was put above the counters in the experiments described, and the ionisation in the chamber was recorded whenever all three counters were operated simultaneously. This ionisation is due to the shower particles traversing the chamber, and the number of ions produced is proportional to the number of particles in the shower. The number of particles in showers obtained under different conditions varies between 3 and 1,200. With lead above the chamber the rate of occurrence R of showers of N particles decreases rapidly with N, following approximately a law $R = N^{-s}$ where s lies between 2·2 and 3·1. It is concluded that all 'bursts' are nothing else than showers measured by the ionisation they produce. D. H. FOLLETT and J. D. CRAWSHAW: Cosmic ray measurements under thirty metres of clay. The zenith angle distribution of cosmic ray intensity in a north-south plane was determined at ground-level and in Holborn Underground station. At this level the vertical intensity was approximately 1/20 that at ground level. The shape of the distribution curve is the same at the two levels. This leads to the conclusion that the intensity of cosmic radiation varies as a power of the path length in an absorber, rather than exponentially; and the shape of the curve gives the value -2 for this power. Using five counters, so arranged that at least three particles arriving simultaneously are required to discharge all five at once, the presence of showers in the Underground station was proved. Rough

transition curves were taken, at that level and at ground-level; they had approximately the same shape, with a maximum at the neighbourhood of 1·6 cm. of lead. The ratio of shower frequency to vertical intensity is apparently not very different at the two levels (see also NATURE, Dec. 28, 1935, p. 1026).

PARIS

Academy of Sciences, April 6 (*C.R.*, 202, 1225–1316). EMILE JOUGUET: The waves of shock produced in a gas by a solid explosive. ARMAND DE GRAMONT and DANIEL BERETZKI: The generation of acoustic waves by means of piezo-electric quartz. Description of arrangements by means of which vibrating quartz plates can be made to give a range of 50–30,000 periods per second. LOUIS ROY: Remarks on the new Giorgi system of units. A. DEMOULIN: The curvature of congruences of spheres. PIERRE RACHEVSKY: Trimetric systems and the generalised Finsler metric. CASIMIR KURATOWSKI: A problem concerning transfinite induction. STÉFAN KEMPISTY: The Denjoy-Stieltjes integral of a function of two variables. EUGÈNE LEIMANIS: The singular points of differential equations. I. PETROWSKY: A problem of Cauchy for a linear system of partial differential equations in a real domain. BÉLA de Sz. NAGY: The invariant measurement in topological groups. LEONIDAS KANTOROVITCH: The general forms of the linear operations which transform some classic spaces into an arbitrary linear semi-ordinate space. LÉOPOLD ESCANDE and GEORGES SABATHE: Experiments on piers of weirs with aerodynamic profile and zero contractions. EDMOND BRUN, MARCEL JAMPY and ROBERT LECARDONNEL: The thermal exchanges between a heated body and the air when the body has a high velocity with respect to the fluid. BERNARD LYOT: The solar corona in 1935. Results of observations, direct and spectroscopic, made at the Pic du Midi during August and September, 1935. PIERRE SALET: The kinetic energy of the stars. G. FOURNIER: Some seasonal phenomena presented by the planet Mars during 1935. JACQUES WINTER: The polarisation of Dirac waves. RENÉ PLANIOL: The production of intense bundles of slow electrons. PIERRE JOLIBOIS and FRANÇOIS OLMER: The synthesis of ammonia by cathodic pulverisation of lead. Catalysis by cathodic projection establishes equilibrium of such a system as N_2+3H_2 at very low temperatures (38°–118° C.) compared with those required in the absence of catalysts. L. NÉEL: An attempt at the interpretation of the saturation moment of ferromagnetic metals. MAURICE DÉSIRANT and ANDRÉ MINNE: The bands of fluctuations of tellurium vapour. SALOMON ROSENBLUM, MARCEL GUILLOT and MLLE. MARGUERITE PEREY: The intensity of the groups of fine structure of the α-magnetic spectra of radioactinium and its descendants. LOUIS DOMANGE: The equilibria of some metallic fluorides with steam. Experimental data obtained with the fluorides of ten metals. C. DEGARD: Study of the structure of the molecule of nitromethane by diffraction of electronic rays in the vapour. JEAN LOUIS DELSAL: The polarimetric study of nickel malate. MLADEN PAIĆ and MLLE. VALERIE DEUTSCH: The adsorption of proteins. The influence of the hydrogen ion concentration on the adsorption of hæmoglobin by kaolin. FRANÇOIS PUCHE: Barium chlorosmate. Preparation, properties and thermal dissociation of $BaOsCl_6$. ROBERT TRUFFAULT: The condensation of benzene with unsaturated hydrocarbons and with their halogen derivatives in the presence of acid catalysts. Allyl chloride and benzene, in the presence of concentrated acid as catalyst, react to give β-chlorisopropyl benzene. PANOS GRAMMATICAKIS: The action of organo-magnesium compounds on the phenylhydrazones. Method of preparation of the symmetrical alkylphenylhydrazines. ALBERT ROBAUX: The presence of the upper Cretaceous in the Palæozoic of the Betic of Malaga (Andalusia). LOUIS LONGCHAMBON: The bituminous schists of Fécocourt. PIERRE DANGEARD: The somatic nuclear division in *Arum italicum*. LUC ALABOUVETTE, LÉONIDE FRIEDBERG and PIERRE BERGAL: Some utilisable characters for the separation of pedigree kinds of two-rowed barley, *Hordeum distichum*. JEAN GRYNFELTT: The crystalloids of the mammary gland. J. GAUTRELET, D. BROUN, H. SCHEINER and EL. CORTEGGIANI: The characterisation of sympathico and parasympathicomimetic substances in blood by dialysis *in vivo*. RAOUL LECOQ: Production of bird polyneuritis by means of diets rich in glucides, proteins and lipids, including large doses of B vitamins by simple addition of lactic acid. The addition of 10 per cent of lactic acid prevents the pigeon utilising vitamin B, even when the latter is present in high proportions. ANTOINE JULLIEN and MME. HÉLÈNE VAIREL-BLANC: The relations between the automatic activity of the heart and the structure of the organ in the snail. MME. ANDRÉE DRILHON and E. A. PORA: Ionisation and buffers of the internal medium of the crab (*Carcinus mœnas*) with parasite (*Sacculina*). MAURICE FONTAINE: The complete maturing of the genital organs of the male eel and the spontaneous emission of its sexual products. MICHEL CIUCA, MME. LYDIA MESROBEANU and GEORGES BADENSKI: Microbial variants of the Aertrycke bacillus and possible variability in the chemical constitution of the complete somatic antigen of this germ.

ROME

Royal National Academy of the Lincei (*Atti*, 22, 367–472; 1935). M. BETTI and E. LUCCHI: Anomalies in the dissociation constants of some halogenated organic acids (3). The dissociation constants of *o*-chloro- and *o*-bromocinnamic acids (*trans*) are equal ($0·39 \times 10^{-4}$). F. SACCO: Transversal tectonic lines of the Appennines (1). R. CACCIOPPOLI: (1) Elliptical partial differential equations with two independent variables, and regular problems of the calculus of variations (ii). (2) Conformable representation and quadrable surfaces. G. SCORZA DRAGONI: Concerning a theorem of Golomb on non-linear integral equations. B. SEGRE: (1) Curvilinear elements which have common origins and relative spaces meeting at a point. (2) Projective lines and an immersion invariant of a curve on a surface. E. GUGINO: Relativistic problem of motion in a stationary gravitational field. L. SONA: Translo-circulatory current which invests a bilateral lamina. Dynamic forces (4). G. BISCONCINI: On the so-called gyroscopic phenomena. L. USLENGHI: Motion of a point source in a concave angle. A. MASOTTI: (1) Centre of asymptotic motion. (2) Planar motions in presence of particular systems of vortex-sources. S. FRANCHETTI: Liquid state and interatomic forces (1). G. B. BONINO and R. MANZONI-ANSIDEI: Raman spectrum and constitution of pyrazole and of some of its derivatives. The spectrum of pyrazole contains eleven lines, similar to those of thiophen and of pyrrole, but there are no lines characteristic

of the double-bond. R. MANZONI-ANSIDEI: Raman spectrum of dimethylfurazan and of dimethyloxdiazole. G. B. BONINO, R. MANZONI-ANSIDEI and D. DINELLI: Raman spectrum of some substituted pyrrole aldehydes. These all have an intense, diffuse line at 1,620–1,650 cm.$^{-1}$ due to the strongly perturbed C=O group, and a line at 1,560–1,570 cm.$^{-1}$, which is probably due to a double bond. A. MANGINI: Condensation products of oximes with aromatic diazo compounds. A. ORRÙ: Behaviour of the electrical conductivity of hen's egg yolk at increasing and decreasing temperatures. There is no hysteresis phenomenon in the case of egg yolk. D. DINELLI: Colouring substances in the shell of cassowary eggs. M. FIORE: Presence of *Wielandiella angustifolia*, Nath., in Veronese Lias (Roverè di Velo). F. RODOLICO: Chemical composition of the eruptive rock of Cupaello (Rieti).

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, May 18

VICTORIA INSTITUTE, at 5.—Sir Ambrose Fleming, F.R.S.: "Some Philosophical Conceptions of Modern Physical Science and their Relation to Religious Thought". (Presidential Address.)

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. H. M. Traquiar: "Perimetry" (succeeding lecture on May 19).*

KING'S COLLEGE, LONDON, at 5.30.—Dr. Max Born: "Solved and Unsolved Problems of Mathematical Physics" (succeeding lectures on May 19 and 20).*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Dr. N. A. Mackintosh: "The Third Commission of R.R.S. *Discovery II*".

Tuesday, May 19

ROYAL SOCIETY OF ARTS, at 4.30.—Prof. J. W. Munro: "Insect Damage to Empire Products".

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, LONDON, at 5.—Prof. J. L. Witts: "The Paroxysmal Hæmoglobinurias".

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. Ernst Cassirer: "Leibniz and Newton: a Comparative Study of the Method of Science and Metaphysics" (succeeding lecture on May 21).*

Wednesday, May 20

CONWAY HALL, RED LION SQUARE, W.C.1, at 7.—Prof. Lancelot Hogben: "The Retreat from Reason" (Conway Memorial Lecture).*

Thursday, May 21

UNIVERSITY COLLEGE, LONDON, at 5.30.—Dr. Alfred Adler: "Some Recent Developments in Individual Psychology".*

ROYAL AERONAUTICAL SOCIETY.—(at the Science Museum, South Kensington, S.W.7).—D. R. Pye: "Slippery Surfaces" (Wilbur Wright Memorial Lecture).

Friday, May 22

ASSOCIATION OF SCIENTIFIC WORKERS, at 8.—(at University College, London, W.C.1).—Public meeting on "Utilisation of Science".*

ROYAL INSTITUTION, at 9.—Prof. E. N. da C. Andrade, F.R.S.: "Whirlpools and Vortices".

Official Publications Received

Great Britain and Ireland

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1935, prepared for the Annual General Meeting to be held on Wednesday, April 29th, 1936. Pp. 119. (London: Zoological Society of London.) [154

University College, Southampton. Avon Biological Research: Annual Report, 1934–35. Pp. 126+3 plates. (Southampton: University College.) 2*s.* 6*d.* [154

University Grants Committee. Report for the Period 1929–30 to 1934–35, including Returns from Universities and University Colleges in receipt of Treasury Grant for Academic Year 1934–35. Pp. 84. (London: H.M. Stationery Office.) 4*s.* net. [164

Sixth Report on the Heterogeneity of Steel Ingots: Discussion, Correspondence and Committee's Reply. Reported by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. (Special Report No. 9A: Supplement to Special Report No. 9.) Pp. ii+70. (London: Iron and Steel Institute.) [164

Waste-Heat Boilers in Open-Hearth Practice: Discussion, Correspondence and Committee's Reply. Second Report of the Open-Hearth Committee, being a Committee of the Iron and Steel Industrial Research Council. (Special Report No. 10A: Supplement to Special Report No. 10.) Pp. ii+63. (London: Iron and Steel Institute.) [174

Ministry of Health. International Agreement Brussels, 1924: Venereal Diseases. Centres in the Ports at Home and Abroad where Seamen can obtain Treatment. (List 7a, revised.) Pp. 25. (London: H.M. Stationery Office.) 6*d.* net. [174

Other Countries

Beiträge zur Mineralogie von Japan. Begründet von T. Wada. Neue Folge, 1. Herausgegeben von T. Ito. Pp. vii+xviii+259. (Tokyo: Imperial University.) [204

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 94: Fertility in Sheep; Artificial Production of Seminal Ejaculation and the Characters of the Spermatozoa contained Therein. By Dr. R. M. C. Gunn. Pp. 116. Bulletin No. 95 (Radio Research Board Report No. 9): 1. A Study of the Magneto-Ionic Theory of Wave Propagation by means of Conformal Representation, b Dr. V. A. Bailey; 2. Dispersion and Absorption Curves for Radio W:ve Propagation in the Ionosphere according to the Magneto-Ionic Theory, by Dr. D. F. Martyn; 3. A Temperature Compensated Dynatron Oscillator of High Frequency Stability, by J. H. Piddington; 4. The Amplification of Programme Transients in Radio Receivers, by Dr. Geoffrey Builder; 5. A Multi-Range, Push-Pull, Thermionic Voltmeter, by Dr. Geoffrey Builder; 6. The Graphical Solution of Simple Parallel-Tuned Circuits, by Dr. Geoffrey Builder; 7. An Electrical Harmonic Analyser of the Fundamental Suppression Type, by J. H. Piddington. Pp. 71. Pamphlet No. 61: A Discussion of Special Tests on the Compressive Strength of Green Karri (*Eucalyptus diversicolor*). By Ian Langlands. (Division of Forest Products, Technical Paper No. 19.) Pp. 31. (Melbourne: Government Printer.) [204

Zoologica. Vol. 21, Part 1, Nos. 1 and 2: The Reproductive Habits of the North American Sunfishes (Family Centrarchidae), by C. M. Breder, Jr.; Polychaetous Annelids from the Vicinity of Nonsuch Island, Bermuda, by A. L. Treadwell. Pp. 68+10 plates. (New York: New York Zoological Society.) [204

The Imperial College of Tropical Agriculture. The Principal's Report for the Year 1934–35 and the Accounts for the Year ended August 31, 1935. Pp. 34. (Trinidad and London: Imperial College of Tropical Agriculture.) [234

Field Museum of Natural History. Report Series, Vol. 10, No. 3: Annual Report of the Director to the Board of Trustees for the Year 1935. (Publication 354.) Pp. 281–416+plates 25–36. (Chicago: Field Museum of Natural History.) 1 dollar. [244

University of Nebraska: Conservation Department of the Conservation and Survey Division. Bulletin 12: Relative Efficiency of Roots and Tops of Plants in protecting the Soil from Erosion. By Joseph Kramer and Prof. J. E. Weaver. (Contribution from the Department of Botany, No. 99.) Pp. 94. (Lincoln, Nebr.: University of Nebraska.) [244

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. No. 68: A Monograph of the Belgian Cretaceous Echinoids. By Jerome S. Smiser. Pp. 98+9 plates. No. 71: Die Plistozaenen Baeren Belgiens. Teil 2: Die Baeren vom "Trou du Sureau" (Montaigle). Von Prof. Dr. Kurt Ehrenberg. Pp. 97+6 plates. No. 73: La faune et l'âge des quartzophyllades siegeniens de Longlier. Par Eug. Maillieux. Pp. 141+3 plates. Deuxième Série, Fasc. 1: Étude systématique du genre Lepocinclis Perty. Par Dr. W. Conrad. Pp. 85. Deuxième Série, Fasc. 2: Hydraires calyptoblastiques des Indes occidentales. Par Dr. Eugène Leloup. Pp. 73. (Bruxelles: Musée Royal d'Histoire Naturelle de Belgique.) [244

American Philosophical Society. Library: Annual Report for 1935. Pp. 18. (Philadelphia: American Philosophical Society.) [274

Rensselaer Polytechnic Institute Bulletin. Engineering and Science Series, No. 52: The Dielectric Constant of Mineral Powders. By Joseph L. Rosenholtz and Dudley T. Smith. Pp. 11. (Troy, N.Y.: Rensselaer Polytechnic Institute.) [274

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 96: Observations on *Myxomatosis Cuniculi* (Sanarelli) made with a view to the use of the Virus in the Control of Rabbit Plagues. By Sir Charles J. Martin. Pp. 28. (Melbourne: Government Printer.) [274

Sixteenth Annual Report of the Research Council of Alberta, 1935. (Report No. 33.) Pp. 44+5 plates. (Edmonton, Alba.: Research Council of Alberta.) 35 cents. [274

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 137: Boundary Interference of Partially Closed Wind Tunnels. By Kazuo Kondo. Pp. 162–190. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) 30 sen. [284