Nature

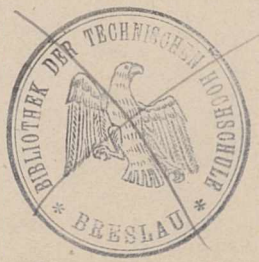
A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME CXVIII

JULY ,1926, to DECEMBER, 1926

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.



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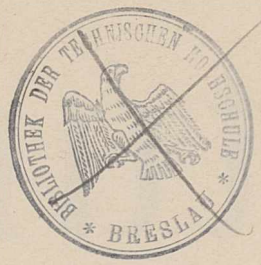
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Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

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SATURDAY, JULY 3, 1926.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Taxation of Research.

THE question of the taxation of educational and scientific institutions has very recently come prominently before the public, and indications exist that the Treasury is contemplating an important change in connexion with the policy hitherto pursued in granting exemption from income-tax to such institutions. The recent judgment of the House of Lords in the case of the Brighton College *v.* Marriott amounts to a declaration that any profits of an educational establishment which are used for educational purposes are the result of carrying on a trade and therefore taxable. The judgment in question may have far-reaching consequences, for it must be remembered that Brighton College is not only a public school, but also a " charitable institution." Following closely on the above-mentioned judgment comes the public announcement from responsible officers of the Chemical Society of the receipt by this Society of a notification that the Inland Revenue authorities are about to challenge its right, as a " charitable institution," to recover the tax deducted at the source from the interest on its invested capital (see NATURE, June 19, p. 859).

The matter was carried a stage further on June 21, when the question of exempting certain classes of educational institutions from income-tax in respect of any profits forming part of their income which was applicable to educational purposes *only*, was raised in the House of Commons in connexion with the suggested new clauses to the Finance Bill (see " Parliamentary Debates," vol. 197, No. 86). The Chancellor of the Exchequer, in dealing with the matter during the debate, indicated that he was unwilling at the present time to extend the limits of exemption of ' charities,' and admitted that, in view of the judgment in the Brighton College case, it was likely that some institutions which in the course of previous years had not been called upon to pay, might, during the course of the year, on the merits of the particular case, be brought into the ambit of taxation for the first time.

Although unable to hold out any expectations that he would make any proposal before the report stage of the Bill, Mr. Churchill stated that he could not feel that the present restrictions, though necessary, were the last word that should be said in defining what was a 'charity' deserving of exemption from income-tax and what was not; he undertook, therefore, to examine very carefully whether the frontiers of charitable exemptions could not be defined with some nearer approximation than at present.

The question of the exemption of 'charities' from income-tax is briefly reviewed in the Report of the Royal Commission on the Income Tax (1920, Cmd. 615, p. 67; H.M.S.O., 3*s*. net); *inter alia*, the Commissioners say: "The issues involved in this matter are very wide; we have taken no evidence on the general question and we think it is not covered by our Terms of Reference. We therefore content ourselves with expressing the opinion that for the purposes of Income Tax 'charities' should be specifically defined by Parliament." It is to this recommendation, then, that Mr. Churchill has undertaken, if it is possible effectively to do so, to give effect. It is perhaps significant that the Commissioners point out that "attempts made in the past, notably by Mr. Gladstone in 1863, to repeal or curtail the relief enjoyed by charities aroused strong opposition and that in the end nothing was done"; they further state that "any proposal for limiting the exemption would have a serious effect upon the available income of many institutions." It is hoped that Mr. Churchill will give due weight to the foregoing observations.

The legislature has not entirely overlooked in its taxing statutes the claims of scientific institutions, as such; indeed, in the first of the Income Tax Acts, that of 1842 (5 & 6 Vict. c. 35), provision was made for exempting from income-tax certain premises of institutions existing for the promotion of education, literature, science and the fine arts. Again, in an Act of 1843 (6 & 7 Vict. c. 36), provisions were inserted entitling such institutions, under extremely strict conditions, to exemption in respect of local rates. Later, when corporation duty was, as a compensatory measure, first imposed under the Customs and Inland Revenue Act 1885 (48 & 49 Vict. c. 5) upon the yearly value, income or profits accruing from real and personal estate permanently vested in bodies, corporate and unincorporate, which escapes liability to probate, legacy and succession duty, provision was again made for exempting such institutions from the duty in question. At the present day a scientific institution, as such, is entitled to exemption from income-tax under Schedule A (property tax) in respect of any building which is the property of such institution and is used solely for its own purposes. No payment may, however, be demanded or made for any instruction therein by lectures or otherwise, nor may the building be occupied by any officer or other person paying rent for the same (Income Tax Act, 1918, 8 & 9 Geo. V. c. 40).

A latent intention on the part of the legislature to benefit scientific institutions to some extent, great or small, is certainly present in the statutes referred to above, and at various times scientific institutions have endeavoured to avail themselves of the privileges in respect of exemption from taxation which seem to be offered to them. But how extremely difficult it is for such institutions to satisfy the Courts that their constitution and activities are of the character to qualify them to obtain the benefits which, to an ordinary layman, it seems that the legislature intended such institutions to enjoy, can be gathered from an examination of the cases in the Law Reports which relate to the claims for exemption from taxation made under the provisions of statutes particularly applying to them. It will be found that even on a particular set of facts, eminent judges have sometimes held opposing views in regard to the right to exemption.

Briefly stated, to obtain exemption from income-tax or corporation duty under the provisions of the above-mentioned statutes, a scientific institution has to satisfy the Courts that the primary object of such institution is the promotion of science in the abstract; its property and income are legally appropriated by a Royal Charter or other compelling instrument and applied in fact to that object; and further, if the object of the professional interest of its members is to be inferred, this must at least be secondary to the main and chief object. In consequence of the foregoing state of affairs, the important partial exemptions from income-tax which accrue to scientific institutions, as a rule, are granted, not by reason of the provisions of the statutes conferring privileges specifically on such institutions, but under the provisions of taxing statutes containing an exemption in favour of property dedicated to 'charitable purposes,' an expression which in a legal sense has an extremely wide meaning and is applied to all trusts known to the law of England as 'charitable uses.'

The great value of the work done by the members of the leading scientific institutions has not been contested at any time. It is fully recognised that such institutions are great clearing-houses of specialised knowledge and that they greatly stimulate scientific research. In thus promoting the advance of science and the development of industries, scientific institutions confer considerable benefits, indirectly it is true, on the whole community, and it is desirable therefore that nothing shall be done which may restrict their usefulness. A strong case can really be made for giving the widest interpretation to the exempting clauses of statutes under which scientific bodies are at present entitled to enjoy remission from taxation; further, it is certain that the national exchequer would gain more from measures taken to secure this end than from the adoption of a course which may result in seriously cutting down existing privileges.

Rust-Resisting Steels.

Stainless Iron and Steel. By J. H. G. Monypenny. Pp. ix+304+22 plates. (London: Chapman and Hall, Ltd., 1926.) 21*s.* net.

THE loss to our civilisation through the rapid attack by atmospheric and marine influences upon the iron and steel upon which it is really based has been estimated by Sir Robert Hadfield to reach the large sum of 500,000,000*l.* per annum. There is no need to criticise such an estimate, since obviously the computation is necessarily only achieved by empirical methods. The fact, however, is that there has been probably no more useful field for pure and applied science than that provided by the problem of producing rust-resisting steels.

It may be said that two decades ago the metallurgical world did not seriously contemplate the production of rustless steel as likely to be an early practical achievement; not because investigators were not giving much attention to the subject, but rather because of the curious misapprehension concerning the nature of the laboratory tests that were likely to give indication of resistance to atmospheric attack. This, of course, means that there was no accurate appreciation of the true mechanism of corrosion. For example, the literature teems with experiments upon the degree of resistance of iron and steels of diverse composition to sulphuric and hydrochloric acids of different concentrations. These acids attack the metal with the liberation of hydrogen. Such acids are not usually prevalent under natural conditions, and the rustless steels now produced which resist ordinary corrosion are not passive to the acids mentioned.

Mr. Monypenny is to be congratulated upon having produced a book of merit, in which will be found a reasonably full and accurate account of the composition and characteristics of the rustless steels which are now available. The development of these steels has been particularly rapid, and is based, fundamentally, upon the alloying of the metal chromium with the steel. If experimental samples are prepared from a range of steels of low carbon content, but with gradually increasing chromium content, and are placed in nitric acid of spec. grav. 1·20, it will be found that when a chromium content of 10 per cent. is passed, almost complete passivity is attained. The phenomenon can be, at present, satisfactorily explained by the assumption that a protective film of the desired characteristics is immediately formed on the surface of the specimen, which inhibits further action. Such explanation is completely in accord with experimental facts to date. Laboratory tests with nitric acid appear to be indicative of resistance to ordinary atmospheric effects. If, however, the range of corroding media is extended, such a simple form of test fails, and hence the practical extension of the employment of such steels to a wider range of corroding media has necessitated practical experiment under the necessarily complex actual service conditions, coupled with the gradual modification in the composition of the steel to meet those conditions. The development has taken the direction of increasingly high chromium content together with the addition of nickel. It is also claimed that other elements can be advantageously added.

If the steelmaker is to use the metal chromium in quantity, he is dependent upon his supplies of the metal, which is usually in the form of the alloy ferro-chromium. Until comparatively recently, the supplies of ferro-chromium available were very high in carbon content, but the rapid development in the metallurgy of chromium reduction has now rendered available rich alloys of chromium and iron of suitably low carbon content. These developments are made possible by the use of suitable electric furnaces and cheap power. When it is also recorded that the rustless steels are best prepared in electric steel-making furnaces, it will be realised that here, as in many other developments, the actual application of the discoveries has been dependent upon parallel progress in entirely dissimilar fields of investigation and technology.

Turning to Mr. Monypenny's book, it will be found that after a short historical account of the development of the steels, the results of a detailed study of the influence of chromium are given. The succeeding sections of the book are devoted to practical notes on the handling of the steels in various manufacturing operations, such as forging, welding, pickling; the effects of heat treatment on the mechanical and physical characteristics; and the "resistance to corrosion" as affected by composition and treatment. So far, the book, generally speaking, deals with the simple carbon chromium steels. The next section deals with the newer types of rustless steel. The principal item in this connexion is the 'austenitic' type of material obtained with the increased chromium content together with a substantial addition of nickel. The final section of the book indicates various applications in which these steels have been found successful and, incidentally, gives practical notes and hints, which should be of considerable value to intending users.

Generally speaking, the matter dealt with is clearly and logically arranged, and the reader should find little difficulty in obtaining the information he desires concerning the main characteristics of the materials, and in following the main arguments. The work is, naturally, not of the reference type where the answer to a particular problem can be readily obtained, but

rather one for the student, who, by relating the various facts represented, can find out for himself the answer to many of his problems. The book will be welcomed as covering a field which is so comparatively new that adequate treatment has not previously been given to it.

There are a few points where the author's handling of the subject is open to criticism. Much of his data for typical stainless steels is obtained on alloys containing 11 to 12 per cent. of chromium, whereas practice has established the best range as being between 12 and 14 per cent. On p. 46, in dealing with heterogeneity, the statement is made that after freezing, diffusion of carbon rapidly takes place. This is only relatively true, and, in any case, only applies to diffusion on a microscopic scale. In a mass of moderate size, diffusion of the carbon is very slow indeed.

The deduction made by the author in Chap. v., that sulphur, when present in stainless steels, "obviously is not present in the same form as in ordinary steels," will require experimental proof. On p. 103 the value of maximum stress in torsion for a sample of 55 tons tensile stainless material is apparently the value deduced on the assumption that the torque at this stage gives a distribution of a stress similar to that when the strain is entirely elastic. The real value of maximum shear stress is probably much less than this.

With regard to the author's treatment of the influence of other elements than the essential chromium and nickel on the characteristics of these steels, we have an impression that the deductions are a little hastily formed on perhaps too little experimental data. This is best instanced in the case of the influence of silicon. The author's comments concerning the influence of this element are not in accord with the fact that a very considerable tonnage of stainless steel is used with a silicon content round about 1·0 per cent., and had the author more thoroughly explored this particular field, both as regards the composition of his samples and the variation in the hardening and tempering temperatures, he would not have been led to the conclusion that silicon so readily induces brittleness.

In discussing the non-production of very high tensile stainless steel-drawn wire, the reason given by the author on p. 138 does not appear adequate. The 'hardening-up' effect should help rather than hinder the production of high tensile properties. The present writer considers the difficulties in the way of such operations are due to other causes.

More data are obviously needed on the austenitic chromium-nickel steels, and in this respect the special adaptability of such materials for many purposes might have been emphasised to a greater extent. The superiority of such materials, from the point of view of corrosion, over the stainless steels, is so pronounced as to constitute an advance in the problem of resisting corrosion only comparable with the initial introduction of the chromium steels.

Mr. Monypenny is to be congratulated upon the production of an excellent work. The book is handsomely produced, and the reproductions of the photographs and microstructures are a credit to both the author and the publishers.

Nature-Gods.

The Worship of Nature. By Sir James George Frazer. Volume 1. Pp. xxvi+672. (London: Macmillan and Co., Ltd., 1926.) 25*s.* net.

THIS volume contains the author's twenty Gifford lectures for 1924 and 1925, expanded and regrouped into sixteen chapters dealing with the worship of the sky, the earth, and the sun. It is to be followed by another which is designed "to complete the survey of the worship of the sun, and to deal with the personification and worship of other aspects of nature, both inanimate and animate," or, as the publishers' announcement has it, "the worship of the Moon, the Stars, Fire, Water, Wind, Plants, and Animals." The "Worship of Nature" is thus the counterpart of the author's last previous compilation, "The Belief in Immortality and the Worship of the Dead"; and in the present "Introduction" (p. 17) he indicates his belief that if "we survey the natural religion of primitive peoples in all parts of the world, we shall probably discover that it everywhere assumes one of two forms which, far from being incompatible with each other, are usually found to be embraced simultaneously and with equal confidence by the worshippers. One of them is the worship of nature, the other is the worship of the dead."

This survey of the "natural religion of primitive peoples in all parts of the world" Sir James Frazer has not achieved yet. In his three volumes on the "Belief in Immortality and the Worship of the Dead," he dealt only with Micronesians, Polynesians and the natives of Australia, the Torres Straits Islands, New Guinea, and Melanesia, and then stopped. In examining the "Worship of Nature" he has selected as arbitrarily; taking in turn, for the worship of the sky, the 'Aryan' and the non-Aryan peoples of antiquity (with the curious omission of Celts and Teutons), the 'civilised' peoples of the Far East (omitting among others the Japanese); then Africa (in four main sections), and nothing more. For the worship of the earth the specimen peoples are similar but not identical; Vedic Indians, ancient Greeks, Romans, Babylonians and Assyrians, Egyptians, Chinese, peoples of modern India, Africa, and America; and for the sun (in this volume), the same, with the omission of China, Africa and America,

and the inclusion of the Arabs, Japanese, and Indonesians.

Reasons for selecting these peoples are not given, except that by contrast with the procedure adopted in Pettazoni's "L' Essere celeste nelle credenze dei populi primitivi" (Rome, 1922), the "superior antiquity of the documents" about Aryan beliefs, and the "higher interest" of them, are regarded as justification for treating these beliefs first. Consequently, the separate chapters stand in no organic connexion with each other; there is no attempt made to compare their contents, or to draw any general conclusions. Even on the connexion between the sky-gods of various Aryan peoples there are only the briefest observations (p. 36), and on the significance of Ahura Mazda the compiler is "content to record the two views without attempting either to judge or to reconcile them" (p. 35). From the author of "The Golden Bough" this is disappointing.

Within the separate topics, the method is that adopted in "The Belief in Immortality": to select the most trustworthy authority, and summarise the principal statements in more or less systematic order; but what the system is, we are left to judge for ourselves. But whereas in Micronesia, for example, this method is so far justified that there is usually only one authoritative record for each people, or at most the observations of two or three observers, its application to peoples who have been so carefully and repeatedly studied as the Aryan peoples of antiquity has an appearance of economy of effort. The chapter on the worship of earth in China, for example, is almost wholly extracted from Chavannes' "Les T'ai Chan" (Paris, 1910); in Babylonia, from King's "History of Sumer and Akkad"; in Egypt, from Wiedemann and Erman; and on the worship of the sun in Japan, from Aston's "Shinto, the Way of the Gods." The result is very readable, diverting in its frequent long episodes quoted verbatim, its eloquent verbal landscape-painting, and its sardonic and sometimes broad humour at the expense of the more ingenuous "devices of the heathen"; but it does not advance learning greatly. In the work of a beginner it would run the risk of being described as the method of "scissors and paste"; in that of a veteran, we naturally look for another explanation. But Sir James Frazer does not help us. Is he insinuating that there is nothing more to say, except that this and that people may be accepted as worshippers of the sky, earth, sun, and the like; or is he speaking to us in parables, and reserving his own conclusions for yet another volume? The lame conclusion of "The Belief in Immortality" (p. 326) favours the former inference: "accordingly, we are justified in concluding that the belief in immortality and the worship of the dead were fundamental features of the ancient Micronesian religion," as if it were possible in any intelligible sense to speak of "the" ancient Micronesian religion, any more than of "the" ancient Micronesian race.

Occasionally, however, something rather more positive is foreshadowed. Summing up an account of the Shilluk and Lango chief-gods, whose name *jok* or *juok* means in the Dinka language "the spirit of a dead ancestor," Sir James Frazer is at some pains to contest the obvious inference, on the strength of "the analogy of African sky-gods or Supreme Beings in general," who, for the most part, he thinks, "are sharply distinguished from the ancestral spirits not only in name but in function"; and so, in spite of the embarrassing *jok*, he concludes that "so far as they go, these facts support the view that African sky-gods or Supreme Beings in general are not deified ancestors, but simply personifications of the great celestial phenomena, whether the sky, or the rain, or the sun"; a thesis which we should like to hear him defend before a jury of *jok*-ists.

From this and a few similar hints, it looks as if Sir James Frazer's contribution to the "natural theology" which the Gifford lectures were founded to elucidate may turn out to be a "spiritualistic hypothesis," as he calls it in his introduction (p. 10), which "has undergone a process of simplification and unification analogous to that undergone by the materialistic theory: as the materialistic hypothesis has reduced the multitudinous forms of matter to one substance, hydrogen, so the spiritualistic hypothesis has reduced the multitude of spirits to one God." But it is not quite clear how far the copious information collected in this volume is intended to take us in the verification of this hypothesis. Sky-gods, and earth-gods, and sun-gods, are about as much like the "one God" of the spiritualistic hypothesis as hydrogen is to the "one substance" of the materialist. All that emerges from this first volume of Sir James Frazer's new book is the rather cautious generalisation that some people worship some nature-gods. But perhaps the second volume may go further.

The Periodicity of Earthquakes.

Die Frage der Periodizität der Erdbeben: eine Darstellung des gegenwärtigen Standes der einschlägigen Untersuchungen. Von Prof. Dr. Ernest Tams. (Sammlung geophysikalischer Schriften, No. 5.) Pp. ix + 128. (Berlin: Gebrüder Borntraeger, 1926.) 9·60 gold marks.

OF those who have studied earthquakes, few have escaped the lure of earthquake statistics, or failed to attempt the detection of some influence, external to the earth, in determining, or at least

influencing, the time of occurrence. For some it has been an introduction to seismology, to some also the end of their activity in this field, to others merely an incident in a wider treatment of the subject, but sooner or later the call comes to all, and is always fraught with danger. Figures have a fascination which may be fatal; once involved in them the temptation is great to try them in one way after another until some definite conclusion seems to have been reached. The literature of the science contains many examples of such misdirected labour, often simply useless, sometimes misleading, much of which would have been avoided had those who knew their earthquakes been also acquainted with the principles of statistical investigation, or those who were familiar with mathematics understood the character of the data with which they dealt.

To the latter class the book under review makes small appeal; to the former it will be useful. Of the two parts into which it is divided, the first is devoted to a description of the methods which are used in computation; the regular method of harmonic analysis is described in sufficient detail, as also is the approximate method of overlapping means, elaborated by Dr. Davison, and in both cases examples of working are given. The author decides in favour of the latter, for ordinary use, as giving similar results to the former, with sufficient accuracy and with a much less laborious computation; but he does not seem to be acquainted with a simpler method of analysis than that described, which takes no longer, and uses no more paper, than the Davison method, besides having the advantage of giving a result in the form conventionally adopted, and with greater precision, though with not greater real accuracy. This last mentioned has, however, on its part, an advantage, in that the computation proves itself at every stage, and mistakes can be detected immediately, whereas in the other method the only proof possible is a repetition of the entire calculation, from beginning to end. Finally, a section of this part of the book is devoted to the consideration of variations in frequency due to causes which are not periodic in their recurrence.

As a whole, the treatment is satisfactory and adequate, but there are two points which do not seem to be sufficiently emphasised. The first, and it is one which it is important to impress on those to whom the work is addressed, is that while a given periodicity may be expressed as the sum of a series of harmonic periods, harmonic analysis does not assert that it must be interpreted as the result of such combination; in other words, the method can only be properly applied where the cause of the effect looked for is one that acts in a manner which makes the method applicable. The other point not dealt with, though even more important, is that where the record is so imperfect, and the data so unprecise, as in any non-instrumental record of earthquakes, it is essential to deal with averages of a large number of shocks. A somewhat extensive experience has shown the reviewer that the lower limit of this number must be put at about 400 times the number of separate groups into which the series has to be divided for the purpose of discussion. If the effect to be investigated needs a division into only two groups, then a record covering 800 shocks may suffice, but for anything analogous to a harmonic analysis, at least four times this number are required; needless to say, the more the number exceeds these limits the better, so long as the record is homogeneous for the purpose in view, but smaller numbers will give irregular and contradictory results.

The second part of the book is devoted to a consideration of the different periods, correlated with the solar or lunar day, month, year, or longer periods, and the non-periodic variations which have been correlated with variations in barometric pressure, rainfall, shifting of the poles, and so on. The treatment is rational and sufficient, and the conclusion come to by the author may be fully accepted, that though, in several cases, it has been shown that the cause investigated may possibly have some small effect in determining the time of occurrence of an earthquake, the connexion has not been established in any single instance.

The conclusion might have been strengthened had some recently published papers reached the author, by which doubt is cast on the reality of some periods which might naturally be expected to exist. Prof. H. H. Turner has suggested that the so-called annual period is not really annual, but differs from the exact year by about ten hours, so that the epoch of maximum frequency works round the calendar in about 850 years; and the Italian record, by far the most accurate and complete of any that is available, indicates that the maximum frequency, of the well-marked diurnal period, has advanced steadily through the thirty years which have been tabulated, at the rate of about five minutes a year. If these small differences are real, what is the meaning of the periods of about ten hours less than twelve complete months, or about three-quarters of a second more than twenty-four hours, respectively? They cannot be correlated directly with the revolution of the earth on its own axis, or round the sun, and they throw doubt on the exactitude of other periods which are supposed to have been detected. Everything is in doubt; we have no proof, or even reasonable probability, of the existence of any periodicity, and those who think that they have time to spare for the pursuit may find justification for an attempt to succeed where others have failed.

Among the variations in frequency which might be attributed to influences external to the earth, the one which shows the nearest approach to probability is the slightly greater frequency of shocks during the day, and the correspondingly lesser frequency at night, in summer as compared with winter. As this has been found to hold good for every suitable record which has been tested, and as it also holds good, with the necessary change in nomenclature, for lunar times and seasons, it may be accepted as a fairly well established fact. Seeing that it is also just such a variation as might be expected, if the gravitational stresses, set up by the sun and moon, had some effect in determining the time of occurrence of an earthquake, the two may reasonably be correlated as cause and effect. But if—and the reservation is an important one—this conclusion is correct, then the smallness of the effect shows how trivial is the influence of the cause, and how predominatingly the earthquake is a phenomenon of the earth, earthly.

Sir Walter Raleigh.

The Letters of Sir Walter Raleigh (1879–1922). Edited by Lady Raleigh. Vol. 1. Pp. xxix + 272 + 4 plates. Vol. 2. Pp. xv + 273-579 + 5 plates. (London: Methuen and Co., Ltd., 1926.) 30*s*. net.

IN this selection from his private letters we have a portrait drawn by his own hand of the late Sir Walter Raleigh, well known in academic circles as a distinguished critic and man of letters, and among his intimate friends as one of the most engaging and delightful companions. To have read Raleigh's books was not enough. He had a side not to be found there, in some ways still more interesting and attractive. Admirable as his writings were, many of his acquaintances prized them less highly than his conversations, when he was wholly himself, less weighted with a sense of responsibility, and accustomed to give a free and joyous vein to his whimsical humour. For Raleigh's social gifts were such that, though he preferred light to serious subjects, his hearers were too content with the fare he provided to ask for any other. So delicate was its flavour that his brand of nonsense was, for so long as he cared to distribute it, better than any sense. Nor was this surprising, for it was a nonsense sparkling with intelligence, and far removed from that 'silliness' which he disliked in man and books. It was his way to approach truth by way of humour, and to judge even of his own writings by the standard of good sense, the standard of things able to survive all humorous assaults upon them, as when he said of his "Shakespeare," "I don't want to write anything that William himself would have thought rot."

These volumes are, in Raleigh's case, a supplement, and an important supplement, to his public utterances. If they are less carefully considered, they are, because more spontaneous and instructive, a better index to his mind and character. His letters cannot replace, indeed, the charm of his conversation, but they recall it, and preserve some quality or relish of it for those who had never the fortune to hear his living voice. He enjoyed talking on paper to his friends, as he enjoyed talking to them in person, and in these letters he is speaking rather than writing. There are wines that will not bear bottling or exportation, and often the qualities in a man adjudged the most attractive by his contemporaries are either wholly hidden from succeeding generations, or but dimly guessed at. Certainly the future, which can only judge of Raleigh by his books, will miss something of the singular pleasantness that informed his daily speech. The letters cover a wide range of topics, from his early experiences as a professor in Aligarh to the late War; too wide to be illustrated by quotation, but certainly not the least interesting, are those written soon after he left Cambridge, "the place of my early friendships, dreams and idleness," which reflect the impressions of the scenery and society of the East upon a mind quick to receive and eager to record them.

Raleigh's interests, it may with truth be said, were human rather than bookish; for a professor and writer, indeed, unusually remote from the study. He would rather, he said, "have missed Cambridge than India"; and was never quite convinced of the value either of lectures or examinations. Academic machinery creaked rather dismally in his ears. The play of life as it passed before his observant eye had a fascination for him beyond anything that the poets or historians had to say of it, a fascination that into words no virtue could digest Life, he felt, needed no assistance from the artist to give it either interest or significance.

Raleigh emphatically placed living above art or science, and had more sympathy with men and their doings than with the makers of books about either. For this reason his most passionate admiration went out to adventurers, and more especially to young adventurers, the high-spirited soldiers, or voyagers or airmen, rather than to those who recorded or sang of their exploits. That his life should have in the end been sacrificed to his enthusiasm for, and determination to do justice to, the pioneers of flying is a sufficiently convincing proof of his preferences, and it was characteristic of him that as an Oxford professor, past middle life, he drilled and marched and did what he could to make himself a soldier. "The last three days I've been marching and lying out on the Downs in torrents of rain, and housed in billets. Billets is 60

beds for every 100 soldiers. . . . Weather disregarded. You have to get through barbed wire like a knife, and tear your clothes much or little."

Sir Walter's friends owe a debt of gratitude to Lady Raleigh for these volumes, and to Mr. Nichol Smith for his brief but admirable memoir of their author, for they will recall many delightful hours in his company. In all their readers they cannot but arouse regret that so rare a spirit has passed beyond the term of human acquaintanceship.

Our Bookshelf.

The Petrology of the Igneous Rocks. By Dr. F. H. Hatch. Eighth edition, revised with the assistance of Dr. A. K. Wells. Pp. xxiv+566. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1926.) 15*s.* net.

WITH the collaboration of Dr. A. K. Wells, this well-known text-book has been revised and extended until now it is virtually a new book. Among the new features are chapters dealing with the consolidation of magmas; the classification of igneous rocks; changes in composition subsequent to consolidation (including pneumatolytic, hydrothermal and other phases of metamorphism as well as weathering); petrographic provinces; and cycles of igneous activity in the British Isles.

Dr. Hatch was a member of the Committee on British Petrographic Nomenclature (1920), and he has naturally adhered to most of the decisions then reached. A welcome simplification of the unwieldy nomenclature of the subject has been achieved, but unnecessary confusion has been introduced by adopting first a classification of types into *acid*, *intermediate* and *basic* divisions, and then a subdivision of some of the groups, such as the syenite group, into *oversaturated*, *saturated* and *undersaturated* divisions. The term 'acid' is sometimes used to mean that a rock is oversaturated, and sometimes to imply a silica percentage not less than 66. It is a pity that the older terms were not altogether dropped. On p. 186 the terms *salic* and *femic* are wrongly used for *felsic* and *mafic* respectively. A useful suggestion due to Prof. Watts has been adopted: the naming of a rock according to its texture with the qualifiers 'intrusive' or 'extrusive' added where necessary. Thus one may have an *intrusive basalt* or an *extrusive dolerite*, and a common source of futile indecision among students is thereby removed, in the only logical way.

The book is now thoroughly up-to-date. It contains abundant references to the splendid work carried out at the Geophysical Laboratory at Washington. Heteromorphous rocks are discussed, eclogite being recognised as a heteromorphous phase of gabbro. The work of Dr. Brammall and Dr. Harwood on the minerals of the Dartmoor granite is included, and the book may be said to present a very complete and well-balanced survey of the subject up to the end of 1925. Controversial and speculative matters are wisely given little space, and students using the book may rely upon it as a sound and authoritative exposition of a delightful subject.

Applied Chemistry: a Practical Handbook for Students of Household Science and Public Health. By Prof. C. Kenneth Tinkler and Helen Masters. Vol. 2: *Foods.* Pp. xi+276+3 plates. (London: Crosby Lockwood and Son, 1925.) 15*s.* net.

THIS book deals with certain branches of the chemistry of foods which have particular interest to students working for the B.Sc. (Household and Social Science) degree of the University of London. It forms a companion volume to that produced by the same authors in 1920 on water, detergents, textiles, fuels, etc. The general treatment is elementary, but the authors have adopted the policy of giving references to standard works wherever possible. In addition to such subjects as milk, edible oils, foods their analysis and calorific value, raising agents, vinegar and preservatives (subjects which are found generally in food analysis books), a separate chapter on the cooking of foods is included. In introducing this somewhat novel subject in an elementary text-book, it is explained that this operation is still primarily an art and not a science, and that our knowledge of the chemistry and physical changes which take place in the preparation and cooking of foods is at present very meagre. Nevertheless, the authors in some thirty-five pages have collected a large amount of scientific data on cooking foods and on the use of condiments, and have given an exceptionally good exposition of the subject.

In many cases interesting chemical determinations bearing directly on food analysis, etc., have been considerably restricted for want of space, yet the determination of specific gravity, specific rotatory (spelt rotatary) power, calorific value, and hydrogen ion concentration—subjects usually well treated in practical physico-chemical text-books—receive a comparatively large amount of attention. The book is well produced with clear diagrams, and the price reasonable judging by present-day standards.

J. REILLY.

Éléments d'astrophysique: introduction à l'étude de l'énergétique solaire et stellaire. Par Dr. Albert Nodon. Pp. viii+244. (Paris: Albert Blanchard, 1926.) 20 francs.

THE author has produced a useful book of reference based on his public lectures delivered at Bordeaux. The contents are divided into two parts. Part 1 contains some seventy paragraphs, in which are outlined the recent advances in astrophysics made possible by well-known theoretical and practical investigators. Part 2 includes tables of notation, physical constants, explanatory notes, and bibliography arranged with reference numbers so as to amplify the paragraphs of Part 1. Although the book is intended, presumably, for general scientific reading, the arrangement of the subjects will scarcely commend itself to the beginner. Commencing with an account of modern ideas on the structure of the atom and the phenomena of radiation, the author then passes to such matters as the opacity of stellar atmospheres and radiation pressure. Paragraphs dealing with the sun follow those on stellar spectra, giant and dwarf stars, etc.

Many of the illustrations receive no explanation in the text, and a knowledge of instrumental equipment is assumed. We consider that the lack of detail in

some of the résumés detracts considerably from their value. No explanation is given, for example, of St. John's schematic section of a sunspot, reproduced on p. 100, neither is any reference to be found to the work of Evershed, A. Fowler, and Maunder on sunspots and their spectra. The usefulness of Part 2 would have been increased by fuller explanation or wider bibliography on matters (such as the distances and numbers of the spiral nebulæ) where conclusions are not yet generally accepted.

The Making of the Future. The Coal Crisis and the Future: a Study of Social Disorders and their Treatment. By P. Abercrombie, V. Branford, C. Desch, P. Geddes, C. W. Saleeby, and E. Kilburn Scott. Pp. xi + 111 + xlvi. (London: Leplay House Press; Williams and Norgate, Ltd., 1926.) 8*s.* 6*d.*; paper, 6*s.*

In this volume the coal problem is attacked from various angles by the several contributors, though a certain coherency is obtained, since most of the writers would appear to subscribe to the viewpoint of the 'sociologist.' The quality is, however, somewhat uneven, and it is to be feared that many readers will become impatient of the terminology and verboseness of certain of the writers. About one-half of the volume is devoted to an account of the "Conditions of Eutopian Repair and Reconstruction." This, though it may interest some readers, would have been improved by compression, as it is somewhat vague and at times irrelevant. The appendices do not appear to bear very directly on the problems of the coal industry. Several of the papers, however, are more concise and contain some interesting matter. Prof. Desch and Mr. Kilburn Scott contribute readable articles on the technical aspects of coal utilisation; Dr. Saleeby pleads on hygienic grounds for the elimination of the smoke nuisance, while Prof. Abercrombie describes the planning of the Kent coal-field on the basis of regional surveys.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Lief. 13 (II., 2B.; Bg. 1-4). 2 Abteilung, 2 Teil: *Pteridophyten und Anthophyten.* Band IX. 2: *Die Vegetationsorgane der Anthophyten. Organe besonderer physiologischer Dignität. A: Die Absorptionsorgane der parasitischen Samenpflanzen.* Von Prof. Dr. Adolf Sperlich. Pp. iv + 52. (Berlin: Gebrüder Borntraeger, 1925.) 4·50 gold marks.

THE section of this handbook of plant anatomy at present under notice discusses briefly the ascertained facts as to the haustoria of the parasitic or semi-parasitic flowering plants. Dr. Sperlich divides them into three groups: he gives most space to the haustoria of (1) the Rhinantheæ, Orobanchaceæ, and Balanophoraceæ, and (2) the less parasitic Santalaceæ, Loranthaceæ, and Olacaceæ, with which group he includes the wholly parasitic Rafflesiaceæ. He puts in a special section, but discusses very briefly, the more root-like but still morphologically distinctive organ, the haustorium of Cuscuta. Curiously enough, with reference to recent papers recently referred to in NATURE of February 6, p. 210, and subsequent correspondence (NATURE, March 27, p. 452), no citation is given of the paper by Mrs. Thoday (Sykes) upon Cuscuta, and the question of the possible presence and function of the phloem in the haustorium is not touched upon.

Les fleurs de la Côte d'Azur (De Toulon à Menton). Par Léon Marret. (Encyclopédie pratique du naturaliste, 21.) Pp. 428 + 112 planches. (Paris: Paul Lechevalier, 1926.) 40 francs.

THIS flora, which is well illustrated with text figures and some coloured plates, will be found of great service to botanists and plant lovers visiting the Riviera. It is divided into four main sections. In the first portion the native wild vegetation is described and figures are given of the more important wild plants of the region. The second portion is devoted to "Les Cultures ornementales"; that is, the introduced plants to be found in the gardens and parks of the Côte d'Azur. In the third part the industrial plants are dealt with; and finally a large section is devoted to "Les Cultures alimentaires." In the first portion the plants are referred to under their ecological formations, those of the sand dunes, maquis, garrigues, rocky situations, marshes and meadows, and mountains, and much interesting and useful information is given. The illustrations are scattered throughout the volume, and the reader may find it a little difficult to identify any particular plant or to find his way easily about the book. It is, however, a very useful volume and worthy of careful study by any one interested in the rich native and exotic vegetation of the Riviera.

Combustion in the Power Plant: a Coal Burner's Manual. By Thomas A. Marsh. Second printing, corrected. Pp. xi + 255. (London, Bombay and Sydney: Constable and Co., Ltd., 1926.) 12*s.* net.

As the title indicates, this book deals with the author's experience in the operation of steam boilers in central power plants, and in the main with American plants. Thus much of the contents has little direct bearing on conditions elsewhere. Twenty-five per cent. of the space is devoted to describing the coals of the United States and their behaviour in boiler furnaces.

The discussion of the relative suitability of the various patterns of stoker to different fuels does contain information of general application, and the author's experience of this and other problems of steam-raising on the large scale will be useful to boiler-house operators. They will also be entertained, for this is no dignified scientific treatise, and the writer never disdains enforcing an argument by means of an anecdote. H. J. H.

Le radium: découverte de la radioactivité et du radium, origine de l'énergie radioactive, le radium dans la nature, ses emplois usuels. Par F. Honoré. Pp. viii + 145. (Paris: Gauthier-Villars et Cie, 1925.) 18 francs.

M. HONORÉ is a member of the staff of *L'Illustration*, and his book is virtually an enlarged edition of a series of articles which he contributed to that journal. It therefore gives an attractive and popular account of the discovery, manufacture, properties and applications of radium and associated substances, which should appeal to educated members of the general public. Strangely enough, the artificial disintegration of elements by means of α-rays does not appear to be mentioned in this book.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Disposal of Scientific Journals.

THE "Universities' Library for Central Europe" was established towards the end of 1920 in order to co-ordinate and consolidate the securing by gifts, exchange and purchase, British books, journals, etc., for students, teachers and libraries in the universities of Central Europe. The last year or two has seen a change in the character of our work owing to the fact that the urgency for the distinctly charitable aspect of it has somewhat relaxed, and our task, while less serious from this point of view, in other directions has been considerably extended.

We have administered the book-funds of various universities and institutions in Austria, Czechoslovakia, Finland, Germany, Hungary, Poland and Rumania, established small select libraries in six different places abroad, on the subject of international problems, for the use of discussion groups of university students, and at the request of the Under-Secretary of State at the Foreign Office, have assisted the Parish Public Library at Malines, Belgium, with works of English literature. We have also arranged for regular and direct exchange of publications between Russian scientific institutions on one hand and similar institutions in Great Britain, India and Egypt on the other. Acting in conjunction with the League of Nations Committee on Intellectual Co-operation, we have undertaken to accept literature from other European countries for distribution anywhere in the United Kingdom, and similarly, the Universities' Library distributes all over Central Europe books and periodicals received from universities and learned societies in Great Britain.

In response to a suggestion made by the Editor of NATURE arising out of recent correspondence in the columns of this journal, the Committee has agreed to provide within the Society, a clearing-house for the reception and distribution of scientific books and periodicals from and between individuals and institutions in Great Britain. It is apparent that there are many persons and libraries which at times have to dispose of files of periodicals and other surplus works owing to the exigencies of space. This material often has no great market value, and yet no lover of his subject cares to destroy or sell it as waste paper. Even the indiscriminate giving of this literature does not always result in its most advantageous placing, and undoubtedly the systematic collection and distribution of such books and periodicals is a matter of national importance.

The organisation for such a work already exists, as will be seen, in the above Society, but such an addition to its activities will naturally entail some increase of expenditure; this may not be much more than the cost of packing and transport, but even so, the existing very limited funds of the Society are earmarked for its Continental work, and it will be readily appreciated that this Society must depend upon donations in order to enable it to carry out this further extension of its activities. It is therefore with confidence that we appeal to all readers of NATURE to contribute a small sum to enable this work to be fully developed. Any gift, however small, will be gratefully acknowledged. Any person or institution having surplus scientific literature which it is desired to place in a suitable library or other institution in the United Kingdom, is invited to communicate with me at this address.

B. M. HEADICAR,
Hon. Secretary.
Universities' Library for Central Europe,
London School of Economics,
Houghton Street, London, W.C.2, June 18.

New Facts regarding the Phases of Migratory Locusts.

THE work on *Locusta migratoria* L., which was published in Russia 1912–14, has been regarded by most entomologists as throwing an important new light on the origin of locust swarms. According to the Russian entomologists, two species, *Locusta migratoria* L. and *Locusta danica* L., are to be regarded as forms of the same species, differing in habits, yet intimately related, in that the two forms may emerge from the same egg-mass, occur in the same hopper swarms, and, as was demonstrated by laboratory experiments, can, by suitably altering the conditions, be changed from one form to the other.

Generalising from the observations of these workers and from the examination of a wide range of examples of migratory locusts from various countries, Uvarov (*Bull. Ent. Res.*, vol. 12, pp. 135-163, 1921) formulated the Phase Theory of the Periodicity and Migration of locusts, according to which periodical swarms are dependent for their inception upon the accelerated breeding of other non-migratory and closely related forms, which persist over a wide range in those countries subject to invasion by swarms. These two forms were named by Uvarov 'phases,' in the case of the South Russian species, the solitary locust being the *danica* phase, and the swarming the *migratoria* phase.

Working about the same time in South Africa on *Locustana paradalina* (Walk.), Faure (*Jour. Dept. Agric.*, Union S. Africa, Sept. 1923) has shown that this locust possesses these two phases, and that the solitary phase, which mingles with the swarms of migratory locusts, is also the locust which occurs on the veldt singly and in small loose swarms during the off-season of the migratory phase.

Another important locust of the Old World is *Schistocerca gregaria* Forsk. (= *S. peregrina* Oliv.), which ranges from India to N. Africa, and occurs as a major pest in some years in the Sudan.

As the result of certain recent observations made by the writer, it is claimed that this locust also comes within the terms of the Phase Theory, in that another species of the same genus (*S. flaviventris* Burm.) has now been ascertained to be the solitary phase of *S. gregaria*.

The opportunity for proving the existence of this relationship, which had already been suspected, was met with when, following the abnormally heavy rains in December 1925, *S. flaviventris* gave evidence of great breeding activity on the Red Sea coast north of Port Sudan early in the present year.

During the previous summer, *flaviventris* locusts could be found singly in this district. After the rains these were attracted to the beds of the watercourses which flow intermittently from the hills on the west towards the Red Sea. Here breeding went on undisturbed for some three months, probably three broods at least being produced, until by March adult locusts very strongly approaching the migratory locust in structure and external appearance were found in large numbers.

The threatened destruction of certain grain and cotton crops compelled the adoption of control measures. Following this, the incipient *gregaria* phase was thrown back to the *flaviventris* phase. This result was due apparently to the thinning out of the hopper swarms by the vigorous use of poison bait.

It is not proposed to draw too sweeping conclusions from these facts, since it is realised that much further work is needed before their true significance can be demonstrated. It is claimed, however, that the following additions to our knowledge have been made; namely, the working out of the main facts of the life-history of the *flaviventris* locust in the Sudan, the observation of the habits of the larval stages of both phases in the field and the proof by laboratory breeding tests, confirmed by field observations, of the convertibility of the solitary hopper into the swarming hopper by the overcrowding of individuals in breeding cages. The reverse process has also been tested with success, namely, the transformation of the black-marked swarming hopper into the green solitary hopper by the segregation of single individuals of the former in breeding cages. These experiments were based on the work of Plotnikov in Russia on *L. migratoria*.

In this connexion it was observed that after the treatment of any area with poison and the resultant destruction of a large proportion of the swarming hoppers, the remaining hoppers, which owing to moulting being in progress or for other reasons had missed the bait, invariably tended to assume the colour of the solitary hopper.

It is believed that in the case of this outbreak on the Red Sea coast, a migration of *gregaria* locusts did not take place. Whereas in March these were plentiful and breeding in the beds of watercourses, in May *flaviventris* adults alone could be found. The last brood, on attaining the winged state, dispersed into the surrounding country, there to assume their solitary life until next winter.

As regards the practical significance of these facts, it is perhaps not too much to assume that should they be found applicable to other regions in the Sudan, the basis for working out a practicable method for the control of the *gregaria* phase may be in sight, since by the early thinning out of the solitary phase in its breeding haunts, the production of the swarming phase can be prevented.

H. BENNETT JOHNSTON.
Wellcome Tropical Research Laboratories,
Khartoum, Sudan,
May 30.

Effect of Polarised Radiations on Animal Metabolism.

IN a previous note (NATURE, February 27, 1926) it was shown that *V. cholerœ* and *B. typhosis* grow more rapidly in polarised light than in ordinary light of the same intensity. Further work on the same subject has been continued by us, and a paper embodying the results obtained on the growth of *B. coli* and *V. cholerœ* has already been communicated to the *Indian Journal of Medical Research*.

The investigation has now been extended to higher animals, namely, rabbits and guinea-pigs, to see if the metabolic activity is accelerated by exposure to polarised radiations, as suggested by us in our previous note to NATURE as one of the possible explanations for the rise of temperature in the afternoon in the normal individual as well as in certain pathological conditions. The amount of carbon dioxide exhaled by the animals has been taken in these experiments as a measure of their metabolic activity.

Two female rabbits of about equal weight, pure white in colour, were put into two air-tight glass chambers of equal size with plane glass sides just big enough to accommodate the animals easily. Through a tightly fitting rubber cork fixed on the lid, two tubes were provided to serve as inlet and outlet for air. The outlet tube went right near the bottom of the chamber, while the inlet tube stopped short near the lid. Before entering the chambers the incoming air was made to pass through potassium hydroxide solution and a tower containing fused calcium chloride and soda-lime in order to free it completely from water vapour and carbon dioxide. The outgoing air from each chamber, after passing through two U-tubes containing pumice stone saturated with sulphuric acid, was bubbled through a strong solution of potassium hydroxide in potash bulbs with tubes of fused calcium chloride fixed at their ends, as ordinarily employed for accurate organic analysis, and then passed through tubes of baryta water to ensure that the whole of the carbon dioxide was being absorbed by the caustic potash.

The current of air through the system was maintained by means of a filter pump attached to a water-tap. The rate of current in the two systems, as indicated by the number of bubbles in the baryta tubes, was controlled and equalised by means of stop-cocks. Further confirmation of the equal amount of air passing through the two chambers was obtained by allowing atmospheric air to pass through each system, after disconnecting the device for intercepting carbon dioxide from the empty chamber, and weighing the increase in the two potash-bulbs due to the absorption of carbon dioxide. The animals were next put in the chambers, which were enclosed in the two partitions of a darkened wooden box, and control experiments were performed to measure the amount of carbon dioxide exhaled by the animals in the dark in half an hour. Before putting the animals in the chambers they were starved for six hours or more.

The chambers were lighted up with polarised and ordinary light of the same intensity by means of two tubes 7 cm. in diameter projecting from a wooden box containing a 100-watt metallum half-watt opal glass bulb. The lamp was rigidly fixed in front of one of the tubes, and the light in the other tube was obtained by reflection from a pile of plates inclined at the Brewsterian angle. The intensities of the polarised and the unpolarised beams were equalised by interposing blocks of glass placed vertically in the path of the beams until the radiant energy falling on a thermopile from the two sources produced equal deflexions in a sensitive galvanometer. The average polarisation as tested by Savart's polariscope (cf. Wood, "Physical Optics," p. 298, 1923 edition) was more than 90 per cent. For the sake of closer comparison results are given in ratios between the amounts of carbon dioxide exhaled by the two animals per kilogram of the body weight in a constant period of half an hour.

TABLE I.

Rabbit A exposed to polarised light.
Rabbit B exposed to unpolarised light.

Animal.	Weight.	Ratio in dark A/B.	Ratio in light A/B.	Ratio A/B in dark after exposure to light.
Rabbit A .	533 gm.	0·965 : 1	1·050 : 1	0·877 : 1
Babbit B .	562 ,,			

TABLE II.

Animals Interchanged.

Rabbit B exposed to polarised light.
Rabbit A exposed to unpolarised light.

Animal.	Weight.	Ratio in dark B/A.	Ratio in light B/A.	Ratio B/A in dark after exposure to light.
Rabbit B .	569 gm.	1·009 : 1	1·022 : 1	0·867 : 1
Rabbit A .	553 ,,			

Note.—The weight of both the rabbits increased during the course of the experiments.

TABLE III.

Guinea-pig A exposed to polarised light.
Guinea-pig B exposed to unpolarised light.

Animal.	Weight.	Ratio in dark A/B.	Ratio in light A/B.	Ratio A/B in dark after exposure to light.
Guinea-pig A .	473 gm.	0·881 : 1	0·969 : 1	..
Guinea-pig B .	517 ,,			

Note.—The animals were white in colour, but there was a big dark brown patch on the side of guinea-pig B.

From Tables I. and II. it would appear that when the animals were placed in the dark after exposure to light the order of their metabolic activities was reversed, that is, the animal exposed to the polarised light showed diminished activity compared to its fellow exposed to the ordinary light. This would seem to suggest that there is compensatory rest after the increased metabolic activity induced by the polarised radiations.

Further work is in progress.

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Energy Levels of the Carbon Monoxide Molecule.

IN a recent letter to NATURE (vol. 117, p. 376, 1926), Dr. R. C. Johnson shows that the third positive carbon bands are related to those recently discovered by Cameron (*Phil. Mag.* (7) 1, p. 405, 1926), and that the final states of the Cameron bands are identical with the final states of the fourth positive carbon bands. As the fourth positive bands are known to belong to the neutral carbon monoxide molecule from Leifson's absorption experiments (*Astro. Jour.*, 63, 73, 1926), Johnson concludes that Cameron's bands and the third positive bands also belong to the neutral carbon monoxide molecule. We have recently completed some experiments on the excitation of the carbon monoxide spectra by electron impacts which support the views of Johnson, and they enable us to extend the scheme of energy levels so that it includes all of the bands of carbon monoxide.

We employed hot cathode discharge tubes and measured the excitation potentials of the several systems by a photographic method. A part of the third positive bands appear at 10·2 volts in agreement with the energy level assigned to them by Johnson, but another set appears at 11·1 volts or at a 0·9 volt higher level. These bands were shown to have the same final states as the set which appears first, and when so analysed, indicate that they originate in a single state 8258 cm.$^{-1}$ above the first set. This difference in levels corresponds to 1·02 volts, in agreement with the difference in their measured excitation potentials. As this difference is rather large to be ascribed to a vibrational shift, we have concluded that the second set constitutes a different system, having final states identical with those of the third positive system but originating in an electronic level 1·02 volts higher than the zero vibrational level of the third positive bands. We shall refer to these bands as the 3A system. Their structure is quite different from the others, whereas they would be expected to be similar if they all belonged to the same system. The following bands constitute the 3A system: λ2295·2, 2389·0, 2489·9, 2597·1, 2711·35A.

Having now separated one set of bands from the third positive system, it is possible to arrange the remaining bands into two series having the same final states and having initial states differing by 2210 cm.$^{-1}$, which difference can be ascribed to a vibrational shift. Thus there are two initial vibrational levels for the third positive system and only one for the 3A system. When the molecule is in such highly excited states it cannot suffer very large nuclear displacements. The same thing is illustrated by the few initial states of the Ångström system.

The third positive bands have usually been ascribed to carbon dioxide, instead of to carbon monoxide, because it was believed that they are of too complex structure to belong to a simple diatomic molecule. However, their relation to the Cameron bands points strongly to carbon monoxide as their origin, as suggested by Johnson. Further evidence that carbon monoxide, and not carbon dioxide, is the origin of these bands has been obtained by the writers in collaboration with Prof. E. F. Barker of this laboratory. Carefully prepared and purified carbon dioxide was excited by electron impacts in a three electrode discharge tube through which the gas was caused to flow at a constant rate (Barker and Duffendack, *Phys. Rev.*, 26, 339, 1925). The gas passed through the region of excitation before it could come into contact with the filament, and oxide coated platinum filaments were used in order to reduce the amount of thermal dissociation, and so the amount of dissociation products that could find their way into the region of excitation was negligible.

With this apparatus, the bands of the third positive system were not observed unless a considerable voltage was applied to the electrodes. When they did appear (and they were always of feeble intensity) they were invariably accompanied by the Ångström bands. Their presence under these conditions can be accounted for by the dissociation that occurs in the discharge at high voltages. When, however, the flow of gas was stopped and the stagnant gas excited in the tube, these bands and the Ångström bands appeared strongly in the discharge at much lower voltages. At the same time the pressure in the tube increased, indicating that the carbon dioxide was being dissociated by thermal action at the filament. It is concluded from these experiments that the third positive bands, like the Ångström bands, belong to the neutral molecule of carbon monoxide.

In possessing the two parallel sets of electronic energy levels, carbon monoxide is, so far as the writers are aware, unique. It probably means that the molecule has two distinct types of spectral terms corresponding to different types of electronic orbits. It may be worth while to consider, as an hypothesis, that one set of levels is made up of triplet terms and the other of singlet terms in analogy with the term scheme for the 'corresponding atom.'

In pursuance of this idea, it would be concluded that the complex structure of the third positive bands may be due to the overlapping of bands from the several levels of the triplet terms. Separations of the order of magnitude as occur in the triplet terms of Mg would result in a superposition of the bands from the several levels and cause an apparent complexity of fine structure. The diminution in the triplet separations in the higher terms would result in a simplification of the structure of the bands originating at these levels, and this may account for the simpler nature of the bands of the 3A system. On the other hand, the singlet levels would produce bands of greater simplicity like those of the Ångström and fourth positive systems.

O. S. DUFFENDACK.
GERALD W. FOX.

University of Michigan,
May 30.

Hydrogen as Anion.

NOT every one can entertain the wild and woolly west—it is some feat! Still, I should be better pleased, if, instead of entertaining Prof. Lewis, I had led him to be serious and consider the depth of crime he is guilty of in aspersing the character of hydrogen as he has done. Being subversive of all that chemists have taught, the doctrine he preaches, that it is the analogue of fluorine and can act as an *anion* and as bigamist, is not one to be put forward in the light and airy manner he adopts—without considering the consequences. If its effect were confined to the Pacific coast, we here might regard such speculation with complacency—following the example of the Professor's countryman, who, during the civil war, expressed his readiness, rather than that it should come to an end to his disadvantage, to see every drop of blood shed from every vein of every one of his wife's relations. When, however, the morals of Cambridge and Oxford suffer, especially when one whom I long sought to train in the ways of righteousness, whose hand and eye work I have always greatly admired, preaches it as gospel in the tabernacles of Belgian, British and French chemists, I feel bound to protest. Men of his type, with an ever waxing clerical diathesis, are dangerous to society, when they begin to imagine and preach heresy—their accolytes tend to take them seriously, not realising that they are but acting the Huck Finn to some distant Tom Sawyer.

Let us admit that to-day chemistry is mainly a Huck Finn-Tom Sawyer business: any one who was present at the recent Faraday Society discussion on explosions and has listened to talks on tautomerism and polarity at the Chemical Society must see that such is now our condition. We just "let-on": the laboratory is fast passing into insignificance, the close study of *materia chimica* is a practice of the past, the judicial spirit is gone, engulphed in the Scandinavian wave, jesuitry prevails instead.

Prof. Lewis merely "lets on": he has no solid ground of evidence. His contention involves the assumption that calcium hydride is an electrolyte. Hittorf's early definition: "Electrolyte sind Salze" still remains the one concise and consistent statement concerning the facts. No pure binary hydride has yet been shown by valid evidence to be an electrolyte, let alone a salt. Prof. Lewis very properly raps me over the knuckles on account of my reference to potassium—an obvious howler. Incidentally, let me say, nothing is more strange than the way in which blunders are unconsciously made in writing and, being made, remain undetected until after an interval—only recently, when filing my letter, did I suddenly realise what a fool I had made of myself.

Prof. Lewis might, however, have taken the hint I gave him. The Bardwell experiment was not made with the metallic hydride but with a solution of the hydride in an eutectic mixture of lithium and potassium chlorides—both electrolytes. Is it not rational to suppose that only the chloride was electrolysed and that hydrogen was but the product of a secondary change? In other words, that it was displaced by the 'nascent' chlorine—hence its appearance at the anode. Bardwell makes no reference to an evolution or appearance of chlorine but calmly assumes that the hydride acts as the electrolyte. Even Prof. Lewis, I imagine, will not contend that the chlorides are unaffected by the current.

Hydrogen, however, will take care of itself. What concerns me is the future of our science. All my life, an advocate of training in the use of scientific method, I find little or no evidence in our ranks of the complete intellectual probity the practice of the method involves. The young student goes to the university in full honesty of purpose, his parents expecting that he will be trained for his life-work. Instead of science he finds nescience. The consequences are already seen to be disastrous both to scientific and industrial progress. Men who are both rational and reasonable, with some breadth of knowledge and outlook, observant and reflective, fit to take charge of posts of importance and responsibility, are not to be found among young chemists to-day. The wrong type of man is being forced into the profession and, even when one of the right type comes forward, the superficial training that is given but unfits him for the service of the world.

HENRY E. ARMSTRONG.

The Sensitivity of Selenium Cells.

MR. THORNE BAKER'S observations on the enhanced light sensitivity of selenium cells actuated by alternating, instead of direct, current (NATURE, June 19, p. 858), are possibly related to some phenomena investigated recently by Mr. J. W. Avery and myself. We have found that selenium cells of a particular type (those made to the design of Prof. H. Thirring) display, when used in the ordinary way with direct current, appreciable and persistent polarisation effects. Almost accidentally it was discovered that this polarisation disappeared as a consequence of prolonged exposure of the cell to the operation of a drying agent. By the same process the 'dark' conductance of the cell was reduced in the proportion of about 4 to 1, while the 'light' conductance was scarcely altered. The dried cell had thus become much more sensitive to light. We have attributed both the polarisation observed and a large part of the 'dark' conductance of the undried cell to the presence of a film of water in parallel with the selenium between the electrodes, and our observations agree quantitatively with this assumption.

We have also obtained some evidence of the existence of a much more transient polarisation in the desiccated cell, leading to a difference of conductance according to whether alternating or direct current is used, but this work is, for the present, incomplete. What has been established is that quite apart from the question of current alternation, the sensitivity of certain selenium cells, and probably of others, can be greatly increased by the simple process of thorough drying. The record of our work on this subject has been completed for publication and will, it is hoped, appear shortly.

A. O. RANKINE.

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Luminous Night Clouds.

DR. G. M. B. DOBSON, in his recent Halley lecture on "The Uppermost Regions of the Earth's Atmosphere," makes mention of the phenomenon of 'luminous clouds' (NATURE, May 15, 1926, vol. 117, p. 697).

These clouds, discovered in 1885 by Prof. Ceraski, Moscow, may be observed in northern latitudes, 50°-60°, during the summer period, between the middle of May and the middle of August; in the southern hemisphere they are observed from November to February.

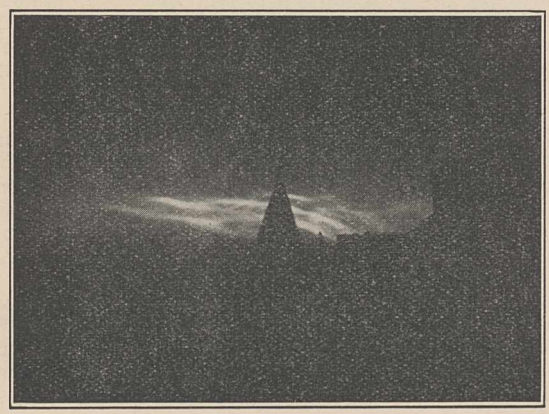

FIG. 1.—Luminous night clouds on August 8-9, 1925, 22 h. 47 m. U.T. Exposure 2 min.

FIG. 2.—Luminous night clouds on August 8-9, 1925, 23 h. 29·5 m. U.T. Exposure 3 min.

The 'luminous' clouds are rather like the 'cirri' in appearance, but they seem to gleam on the background of the segment of the dawn, whereas the common 'cirri' appear dimmed and dark when seen against the sky at dawn. The characteristic feature of luminous clouds appears to be, as indicated by O. Jesse, their unchangeable altitude over the earth's surface; on the average about 82 km. It is interesting to note that the Heaviside layer, which plays such an important part in radio telegraphy, is at the same height of 80 km.; moreover, according to Trowbridge (*Astrophys. Journal*, 1907), the tails of meteors are generally also observed at this same height (87 km.). These facts indicate peculiar properties for the layer lying at an altitude of 80-85 km. above the earth's surface; it seems possible that all phenomena observed at this height are closely connected with one another.

Our knowledge of luminous clouds is very incomplete and we have no satisfactory theory relating to their origin. The hypothesis of volcanic origin, maintained for some time after the first observations of luminous clouds in connexion with the eruption of Krakatao in 1883, had to be rejected, these clouds being observed almost every year, and independently of volcanic eruptions.

Lately (*Met. Zeitschrift*, Oct. 1925) a theory proposed by A. Wegener regards luminous clouds as being due to condensation of normal water vapour; this theory, however, has also met with many objections (*Met. Zeit.*, Mar. 1926.)

Luminous clouds, after being a vary rare phenomenon for a certain period of time, were again frequently observed during recent years. They were observed in Russia in 1916–19–20–22–23–24, and 1925; on the night of August 8-9, 1925, I succeeded in obtaining six photographs of these clouds from Leningrad at the Astronomical Observatory of the Russian Amateur Society for the Study of the Universe (Mïrovédénïé) and the Scientific Institute of P. F. Leshaft (Figs. 1 and 2). The measurements of the photographs showed that the clouds, having started from a point 13° to the east from north, moved with the velocity of 230 metres a second to the south-south-west.

A detailed account of these observations will shortly appear in the Journal *Mïrovédénïé* (vol. 15, No. 2, 1926).

We consider observations of luminous clouds to be extremely valuable and should feel greatly obliged if any one would send to us duplicates of observations made either at the present time or relating to any other epoch. Photographs would be especially valuable.

Guidance as to methods of making these observations may be found in an article by W. Foerster and O. Jesse in *Astron. Nachrichten*, Bd. 130, 1892.

V. MALZEV.

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June 14.

Magnetic Properties of Single Crystals of Iron.

REFERRING to the letter in NATURE for May 29, p. 753, by Messrs. Honda, Kaya and Masuyama, it will be noted that Fig. 1, showing the magnetisation curve for a large crystal of iron, indicates the occurrence of definite and distinct steps in the magnetisation curve, but no explanation is foreshadowed.

In the *Journal of the Institution of Electrical Engineers* for September 1920, vol. 58, p. 832, I suggested that such steps were likely to be found in the magnetisation of iron crystals on the probability that more than one configuration would be involved before saturation was reached. Any such steps would be hidden in commercial iron owing to the irregular arrangement of crystals and the resultant overlapping in their individual characteristics, but in an individual crystal with a wholly symmetrical arrangement one would expect a relatively sudden change of pattern falling into a different space-lattice.

It would be interesting now to have an X-ray examination made of the crystal to ascertain the configuration corresponding to each stage of the magnetisation curve.

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Climatic Changes during Geological Times.

By C. E. P. BROOKS.

I. GLACIAL AND GENIAL PERIODS.

AFTER the primary discovery of geologists that the various strata of rocks exposed at the earth's surface could be arranged in chronological order, and that when so arranged they represented a sequence covering a very long period of time, the most striking result of their investigations has concerned the great variations of climate which all parts of the earth's surface have passed through. Coral reefs have extended into the British Isles and central Europe, and evergreens have flourished beyond the Arctic Circle. At the other extreme, large areas now enjoying a temperate or even tropical climate were covered by thick ice-sheets.

The evidence for all these changes is now so abundant that the general facts can no longer be questioned, though there are still differences in the interpretation of details. Thanks to this patient accumulation of evidence, we are now well acquainted with the climatic history of most parts of the earth's surface. Only the very oldest strata, the Archæan, composed of gneisses and similar rocks, are so altered that they give practically no information as to the climate prevailing when they were formed. At one time they were believed to be remnants of the earth's original crust, born in fire, but although the uranium-lead and thorium-lead ratios show that, according to the usual method of computation, some of these rocks are so much as 1600 million years old, the astronomical calculations summed up by Harold Jeffreys point to the age of the solar system as being very much greater still. Hence it is very improbable that any parts of the original crust of the earth still remain accessible.

The sedimentary rocks formed in the succeeding Proterozoic era are in many localities sufficiently unaltered to indicate the conditions under which they were laid down. During the greater part of this era the prevailing deposits were sandstones, such as the thick Torridonian Sandstone of Scotland, and limestones, but in many widely separated areas glacial deposits have been found—near Adelaide in Australia, in the Himalayas, South Africa, the United States, the head of the Yang-tse River in China, and perhaps also in Scotland and the Varangerfjord in Norway. The glacial phenomena at the latter site are very fine; they may be of any age from Proterozoic to Permian, but are most probably Lower or Middle Cambrian. The succession of events is best shown in Australia, where ancient boulder-clays or 'tillites' have been found on two horizons separated by 9000 feet of conformable strata. The later of these two tillites occurs probably just below the base of the lower Cambrian. Two glacial horizons, one probably just pre-Cambrian and the other much older, have also been recognised in South Africa, and possibly in the United States and India.

The Palæozoic was thus ushered in by an ice-age, but by the Middle Cambrian all traces of glaciation, with the possible exception of the Norwegian, seem to have disappeared, and by the Upper Cambrian at least mild climates had developed in all parts of the world. The temperature was not the same in all latitudes; for example, the Archæocyathinæ, which are fully developed in Australia, are dwarfed and crippled in the Antarctic, but the zonal differences were less than at present. The Ordovician period was one of prolonged warmth; in the Silurian this general warmth continued, and corals spread into all latitudes, though in the Arctic only isolated dwarfed forms occur. The Silurian also gives us some evidence of the development of desert climates, while in south-east Alaska, and possibly in Tasmania, there are traces of ice action. In the Lower Devonian the faunal zones became more accentuated, and there is evidence of ice action at Table Mountain in South Africa and probably also in the Falkland Islands. In the Upper Devonian, however, the general warmth appears to have returned, and in the Old Red Sandstone extending from England to the Baltic States we have evidence of a widespread arid region, which Walther compares with the interior of Australia or with the Trans-Caspian desert. The prevailing warmth continued into the Lower and Middle Carboniferous, when thick coral reefs were formed in middle latitudes and a cosmopolitan flora spread over the greater part of the land surfaces, but in the Upper Carboniferous the ice-sheets returned over very wide areas.

This ice-age is generally termed the 'Permo-Carboniferous,' because when its remains were first discovered they were believed to fall mainly at the junction of these two periods. It now appears that the ice reached its greatest development in the Upper Carboniferous, when the ice-covered area was probably greater than at any other time in the earth's history. The most remarkable feature of this glaciation is the distribution of the ice-sheets—a large part of Australia, South Africa, India, eastern South America from southern Brazil to the Falkland Islands. This immense area, much of which is now within the tropics, was covered, not by local valley glaciers, but by immense regional ice-sheets. The striæ indicate that the ice moved southwards in Africa, but northwards in India, *i.e.* away from the equator, but in Australia the centre of dispersal lay to the south-west of Tasmania. Farther north there are some rather doubtful glacial deposits in Europe—Germany, France and Holland—and a large amount of quite definite evidence of glaciation in North America, where the glaciers appear to have attained a considerable size and to have reached the sea. The most interesting glacial deposits in North America, the 'varve' clays associated with the Squantum tillites, will be referred to later. No Carboniferous glacial deposits have yet been discovered in the Antarctic.

Apparently contemporaneous with the ice-sheets was the rich flora of the Coal Measures in North America, Europe and Asia, which developed from the cosmopolitan flora of the Middle Carboniferous, but in Australia, India and South Africa a new flora of hardier appearance developed above the glacial deposits—the Glossopteris flora.

In the Upper Permian the climate again became generally warm and dry, and this initiated a long period of genial climate which persisted with only minor interruptions throughout the Mesozoic and the greater part of the Tertiary. There was floating ice in the English chalk seas and in Australia in the Cretaceous, and Alpine glaciation in the Antarctic and

in the San Juan Mountains of Colorado in the Eocene, and perhaps in the Italian Alps in the Miocene, but the general impression given by the Jurassic coral reefs of Europe and the Upper Eocene Arctic flora is one of slight differences of temperature between different latitudes and warm ocean currents penetrating into the neighbourhood of the poles.

During the Pliocene the temperature began to fall rapidly, and it is probable that quite early in this period the Antarctic ice reached the sea, while a boreal fauna developed in the Arctic Ocean which spread out into the Atlantic, and early in the Quaternary penetrated into the Mediterranean. During the latter period glaciers formed on the mountain ranges in all parts of the world, developing into great ice-sheets in the north temperate zone, where there were four main advances of the ice—the well-known Gunz, Mindel, Riss and Wurm stages of Penck and Brückner's classification. Since the maximum of the Wurm there have been several minor oscillations, passing gradually into the present climate.

The outstanding features of this history are the alternation of glacial and genial periods and the association of glaciation with mountain-building, of warmth with periods of rest. The Lower Proterozoic glaciation was associated with great outpourings of lava, the Late Proterozoic-Early Cambrian glaciation coincided with a period of disturbance, the Upper Carboniferous glaciation followed the Hercynian folding, and the Quaternary glaciation followed the culmination of the Alpine folding. Minor periods of unrest, such as those of the Silurian or Cretaceous, were followed by minor deteriorations of climate. This orogenic-climatic cycle becomes more obvious when the dates are considered. The Quaternary glaciation was an affair of yesterday. The radio-active clock (according to the usual basis of calculation) gives the age of the Upper Carboniferous as 260 million years, and the base of the Cambrian as 500 million years. The interval between the two Proterozoic glaciations has not been defined exactly, but a reasonable estimate would be 200-300 million years. Thus each cycle of the geological seasons seems to have run its course in about 250 million years, giving a regular sequence which has been termed the "rhythm of geological time."

Before the causes of this grand climatic cycle can be discussed, however, the possibility has to be considered that the fluctuations were more apparent than real. In any region, such as Europe, the climatic sequence can be expressed in terms of variations of apparent latitude. This obvious fact has led to several theories of 'pole-wandering' and 'continental drift'—Simroth, Kreichgauer, and finally, the very complete and far-reaching theory of A. Wegener.[1] Wegener's work seems at first sight unassailable. The earth's surface is at present divided into a number of climatic belts—an equatorial rain-forest belt, two sub-tropical dry belts, two temperate rain belts, and finally two polar glacial caps. Now consider the climatic variations of western Europe. In the Upper Carboniferous there are the coal-measures—apparently the remains of an equatorial rain forest. In the Triassic there are desert sandstones—remains of the sub-tropical dry belt. During succeeding geological periods Europe passed successively through the warm temperate and the cold temperate belts until in the Quaternary it entered the polar glacial cap. Now go back to the Upper Carboniferous. If regions now in latitude 50° N. were on the equator, the south pole must have lain in some point now in 40° S. While Europe was much warmer than it is now, a large part of the southern hemisphere must have been much colder, and in fact a large part of the southern hemisphere now enjoying warm temperate or sub-tropical climates was then glaciated.

So long, however, as the continents remained in their present positions relative to each other, some parts of the southern glaciated region must fall in low latitudes no matter where the south pole is placed. Wegener gets over this difficulty in two ways. First, he considers that the relative positions of the continents have not remained the same. Continents are composed of masses of relatively light rock (sial), embedded in heavier rock (sima) which under long-continued pressure acts as a viscous fluid. Hence under the continuous action of any horizontally directed force the continents will drift through the sima. The east coast of America fits so neatly into the west coast of Europe and Africa that there is good warrant for believing that the two were formerly united and have recently drifted apart; there is some geological and biological evidence in support of this view. Similarly, though on less plausible grounds, Wegener effects a *rapprochement* of Africa, India, Australia and the Antarctic continent, the whole forming in Carboniferous times a compact continent or 'Pangæa,' centred near the south pole. But even this is not enough; parts of the glaciated area of Pangæa extended into temperate latitudes, and Wegener further supposes that the south pole described a wide curve through this primitive continent, so that different parts of the land area were glaciated at different times.

Wegener accounts for the long periods in which there is no evidence of ice action anywhere on the earth by supposing that during these periods the poles lay near the centres of extensive oceans, while during the glacial periods the poles lay near or over the land. In the Miocene the north pole is placed over Alaska, whence it moved eastwards across North America and Greenland to the neighbourhood of Spitsbergen. Thus the 'Quaternary' glaciation of America is older than that of Europe. The succession of glacial and interglacial periods is accounted for by Köppen[2] on astronomical grounds.

The whole work is wonderfully ingenious, and it has been accepted by many geologists. There are, however, a number of very serious objections to it. The forces which Wegener postulates to move the continents are twofold—a tidal force acting from east to west, which is indefinite but may be large, and a very small drift towards the equator which is common to all floating bodies. H. Jeffreys[3] considers that while the deeper layers of the sima are viscous, the surface layers are too rigid to allow these small forces to act. Joly's recent theory of the cyclic melting and solidifying of the sima[4] may provide an escape from this objection, and

[1] Wegener, Alfred, "The Origin of Continents and Oceans." Transl. by J. G. A. Skerl. London, 1924.

[2] Köppen, Wladimir, und Wegener, Alfred, "Die Klimate der geologischen Vorzeit." Berlin, 1924.

[3] Jeffreys, Harold, "The Earth; its Origin, History and Physical Constitution." Cambridge, 1924.

[4] Joly, John, "The Surface-history of the Earth." Oxford, 1925.

we may perhaps grant the possibility of east-west movement for which there is some geophysical evidence. But the "flight from the poles" is another matter, and in fact, according to Wegener's reconstructions, during a large part of geological time the main mass of land in the northern hemisphere was moving, not *from*, but *towards* the north pole. The evidence for these movements is entirely palæoclimatic, and needs to be very convincing to support such far-reaching deductions. Is it convincing? Leverett's comparative studies of European and North American glacial deposits do not bear out the assumption that the main part of the American glaciation is far older than the European. According to W. H. Dall the Miocene glaciation of Alaska is a myth, the main glaciation of that country having occurred in the Quaternary. The mild polar climates of the Upper Eocene cannot be accounted for by movements of the poles, since Berry has shown that a flora allied to the present temperate flora completely surrounded the north pole in high latitudes, forming a ring out of which it is impossible to bring the pole in any direction. The desert deposits of the Mesozoic are practically limited to the latitudes in which deserts are found at present. Wegener's reconstructions do not account at all for the climatic sequence in the Antarctic, as recently set out by Wright and Priestley.[5] There remains the Upper Carboniferous period.

[5] British (*Terra Nova*) Antarctic Expedition, 1910–1913, "Glaciology," by C. S. Wright and R. E. Priestley. London, 1922.

Most meteorologists would say that the development of extensive ice-sheets reaching sea-level within the tropics is inconceivable, and that for the Upper Carboniferous Wegener's theory offers the only possible solution. The succession of glaciations in different continents following a moving pole is not tenable in the light of recent geological work, which seems to demonstrate the approximate synchronism of the glacial maximum in all countries, but this scarcely affects the main problem. A more serious objection is the Upper Carboniferous glaciation of North America, which Wegener's reconstruction places on the equator. Evidence has been found that in Oklahoma, Arkansas, Massachusetts, Nova Scotia and perhaps in other regions also, powerful glaciers reached the sea, and icebergs or heavy shore ice transported large boulders fifty miles or more from their original source. The best development is seen in the Squantum beds near Boston, where, in addition to thick tillites, there are seasonally banded clays which are similar in all respects to the 'varve' clays formed during the retreat of the Quaternary ice-sheets in Sweden, Finland and North America. The glacial nature of these beds appears to be incontrovertible, and the well-marked seasonal banding appears to be incompatible with their formation on the equator. Whether Wegener's theory is adopted or not, the climatological problem presented by ice reaching sea-level within the tropics still remains to be solved.

(*To be continued.*)

On the Rare Earths.

THE group of about sixteen elements the oxides of which are popularly known as 'rare earths' are characterised by an exceedingly close relationship in their chemical and physical properties—a relationship which, in its intimacy, is not paralleled by any other group of elements. In consequence of this fact, the task of isolating the individual members of the group has been one of quite exceptional difficulty. Until recent years, practically every reported discovery of a new element of the group was proved, by later searching investigation, to be not one element, but two or more. In addition to this difficulty has been that of distinguishing an alleged new element from some other previously discovered element, with the result that one and the same element was discovered over and over again, each discoverer giving it a separate name. Hence, the chemistry and the nomenclature of the rare earths were for many years in a state of almost hopeless confusion from which they have emerged only during the present century, and particularly in the last decade.

The history of the discovery of the rare earths goes back to 1794 when Gadolin discovered the yttrium earths, out of which a considerable number of separate elements have since been identified. By the discovery of ytterbium and cassiopeium (or lutecium) by Auer von Welsbach in 1906, it was thought that the whole of the rare earths had been discovered, and it was not until the development of the atomic number rule by Moseley that it was found that a space in the series, corresponding to an element with an atomic number of 61, was vacant. There is now fairly conclusive evidence that, after a great amount of work by various investigators, including an exhaustive and negative examination of rare earth fractions by Prandtl and Grimm extending over a year, this element has been definitely identified by the use of the X-ray spectrum. There is also good reason for supposing that with the discovery of illinium, the name given to the supposed new element, the whole of the rare earth elements have been found and identified.

The term 'rare' as applied to these elements is relevant only in the case of a small minority of them. Cerium, believed to be the most abundant, is considered to be little, if any, scarcer than nickel, and many of the others are far from being scarce, even if concentrations of them are not common. On the other hand, a few of the elements appear to be among the rarest known, and this appears to be particularly true of erbium, and the element 61, which has so long eluded the searchers for it and even yet has not been found in measurable quantity.

The primary occurrences of the rare earth minerals in Nature are confined mainly to pegmatite dykes or pegmatitic rocks, considered to have been formed during the last phases of crystallisation and differentiation of an intrusive magma, that is to say, to the phase following acid rock formation. But rare earth minerals are usually not present in important concentrations in the primary rock formations, and it is only by the denudation of the containing rocks and the natural concentration of the relatively heavy minerals set free that accumulations representing any appreciable quantity of the material are formed.

The main source of the rare earths, so far, has been

monazite sands found in considerable accumulations in Travancore in India, Bahia State in Brazil, as well as in Ceylon and a number of other places in the world. The composition of monazite sand is complex, but essentially it consists of the phosphates of cerium and lanthanum. But the economic value of the sands depends on the percentage content of thorium minerals which are now used so extensively in the manufacture of the incandescent gas mantle. The cerium content has some economic value, being also used in small proportion in the incandescent mantle industry, and also for the manufacture of ferro-cerium, well known in the form of the sparking type of lighter.

The following are partial analyses of two samples of monazite sand, one from Travancore and the other from Bahia :

	Travancore. Per cent.	Bahia. Per cent.
Thoria	9·43	6·50
Ceria earths . . .	31·90	61·40
Lanthanum earths . .	28·00	
Yttria earths . . .	0·46	0·70

The yttrium earths have been used in the manufacture of the incandescent parts of Nernst lamps, but for most of the other rare earths no industrial outlet has been found. In some quarters it has been suggested that certain of them may prove valuable as catalysts.

With reference to the close association of the rare earths in Nature, it is obvious that since the chemist finds so much difficulty in separating these by methods of great refinement, the crude large-scale metallurgical processes of Nature must tend to segregate them in groups rather than separately. The rare earth group is scarcely unique in this respect; the platinum group of metals is a more or less parallel example where the so-called native platinum may be, and often is, a complex alloy of platinum, iridium, osmium, palladium, ruthenium and other metals. All of these metals possess closely related physical and chemical properties which lead to their segregation in the basic and ultra-basic differentiations of an intrusive magma. The rare earth minerals, however, mainly associate themselves with silicious and aluminous magmas.

The conception of atomic numbers and the history of the discovery that X-ray spectra could be used in the identification of previously unknown elements have formed the subjects of numerous articles and communications in the scientific and philosophical press and need only be briefly mentioned here. The names associated with these discoveries include, among others, those of Laue, W. H. and W. L. Bragg, and Moseley, to all of whom great credit is due for their respective parts. Moseley's work in connexion with the development of the atomic number rule has been especially valuable. In the field of the rare earths, the determination of the atomic numbers has revealed definitely the possible number of distinct chemical elements. Between barium with an atomic number of 56 and tantalum with an atomic number of 73 there is room for sixteen elements. Prior to 1923 it was possible to speak of only fourteen of these elements as definitely known, but with the discovery of hafnium with an atomic number of 72 by Coster and Hevesy by means of the X-ray spectra, and the later discovery by Prof. B. S. Hopkins and his associates of what seems to be element No. 61, the sequence from 56 to 73 is complete and justifies the claim that all the rare earths have been discovered. The X-ray method of investigation also leaves no room for assuming that the list of rare earth elements contains duplicated cases, and that the same element may be regarded as two distinct elements under different names. The indications obtained by that method are open to one interpretation only, and those characteristic of a given element are distinguished without difficulty and beyond reasonable doubt.

From its simplicity, ease and rapidity of the experimental examination, the determination of the X-ray spectrum is becoming of the greatest importance in the investigation of particular elements in a mixture, and in the control of separations; it will most probably, in a large degree, if not entirely, replace the much more complicated and troublesome examination of the light emission spectrum. Not only are elements identifiable by this method with a rapidity and certainty which far surpass those of other methods, but a comparison of the densities of the lines with that of the lines given by a known quantity of a foreign element will give approximate quantitative results.

The method of using the apparatus presents no difficulty. The apparatus is arranged in much the same way as an ordinary spectrometer; the incident light is replaced by the beam of X-rays from the material under examination, which forms the anti-cathode, in a vacuum tube. The diffraction grating is replaced by the crystal slice, and the telescope and eyepiece (or photographic plate) by an ionisation chamber by which the intensity of the reflected beam may be measured.

LITERATURE CONSULTED.

Levy, S. I. The Rare Earths. 2nd ed. London, 1924.
Prandtl, W., and Grimm, A. *Zeitschr. für anorg. Chemie*, vol. 136, No. 61, p. 283.
Noddack, W., and Tacke, Ida. *Metall u. Erz*, vol. 16 (5/5/26), pp. 985-6.
Lindgren, W. Mineral Deposits. 2nd ed. New York, 1919.
Rastall, R. H. Geology of the Metalliferous Deposits. Camb., 1923.
Harris, A. J., Yntema, L. F., and Hopkins, B. S. NATURE, June 5.

Television.

THE possibility of 'seeing by telegraph' was fully recognised many years ago. The discovery that the electric resistance of selenium varied with the intensity of the light falling on it suggested to Professors Ayrton and Perry, amongst others, that the method was theoretically feasible. It was soon found out that selenium failed to respond quickly enough to the rapid changes in light intensity necessary for television, and it was not until the photo-electric cell had been perfected that inventors seriously attempted to solve the problem. The analogous problem of sending photographs and pictures by telephone wires or by radio waves, or by both these methods, we can consider as solved. It is now done commercially. Doubtless great improvements in the method will be introduced, and before very long every one will accept it as a commonplace operation and cease to regard it as wonderful.

The problem of television, however, is an immensely more complicated one, and even the most optimistic of scientific men had begun to think that it would be

many years before the first glimmering of a practical method would be developed. We were therefore agreeably surprised on making a visit to Mr. J. L. Baird, at Motograph House in Upper St. Martin's Lane, London, W.C., to find that he had installed there a transmitter and a receiver which prove that he has made great progress in solving the problem. We saw the transmission by television of living human faces, the proper gradation of light and shade, and all movements of the head, of the lips and mouth and of a cigarette and its smoke were faithfully portrayed on a screen in the theatre, the transmitter being in a room in the top of the building. Naturally the results are far from perfect. The image cannot be compared with that produced by a good kinematograph film. The likeness, however, was unmistakable and all the motions are reproduced with absolute fidelity.

The general principle utilised by Mr. Baird is not difficult to understand. The image of the object to be transmitted is made to traverse a cell sensitive to light. This cell modulates an electric current. When the light on the cell is intense the current is large and when the cell is in shadow it is weak. At the receiving station the current controls a source of light which traverses a ground glass screen which moves in exact synchronism with the image at the transmitter. The spot of light is therefore bright when the light on the transmitter is intense and dark when it is in shadow. The light from the image moves over the screen about ten times a second. Hence, owing to the persistence of vision, a complete image is obtained.

Just as in the early kinematograph films, there is a constant flicker, but this will doubtless be got rid of in whole or in part in the new Baird 'televisor.' This is the first time we have seen real television, and, so far as we know, Mr. Baird is the first to have accomplished this marvellous feat. He had the first inkling of the method two years ago when he successfully transmitted shadows by electricity. We were told that a similar method of transmitting shadows has been independently devised in America. But his present method is as superior to the shadow method as a photograph is to a skiagraph.

It is natural that Mr. Baird and his partner, Capt. Hutchinson, should contemplate a great future for television. They are taking steps in the direction of having a broadcasting system of television for London. Every possessor of a 'televisor' will be in a position to see on his screen the performers in operas and plays as well as hearing them. They expect to make a start in this new system of broadcasting next year. The new discovery will in no way interfere with the ordinary British broadcasting. The Post Office officials, seeing the probable advent of a new British industry, regard the scheme with benevolent neutrality.

Those of us who remember the advent of the telephone in 1876, and remember also how little its importance was then realised, will hesitate to criticise this new invention. There is endless scope for improvement. Mr. Baird, who, like Graham Bell, is a Scotchman, has been so extraordinarily and so rapidly successful in the past that we have great hopes that he will soon perfect his invention to the commercial stage. We wish him every success. A. R.

Solar Surveys.

OUR Supplement this week will be read with great interest by specialists in solar research, and also by a considerable number of other readers to whom Dr. Hale's name is closely associated with the Mount Wilson Observatory and the progress of astrophysics. Since 1923 Dr. Hale has been engaged in perfecting an instrument for *visual* observation of the sun in monochromatic light; and the spectrohelioscope, as he calls it, is now permanently installed at his new solar laboratory at Pasadena. The recent increase of solar activity shown by sunspots, flocculi, and prominences has afforded him ample opportunity for testing the capabilities of the instrument. Its performance appears to have exceeded all expectations, and a rich harvest of results may be anticipated, especially with respect to observations of the sun's upper atmosphere and the hydrogen vortices registered in the light of *Hα*. These hydrogen vortices, which have been studied almost exclusively since their discovery in 1908 by Dr. Hale and his colleagues at Mount Wilson, are bound up with the problem of the nature of sunspots and their unexplained reversal of magnetic polarity at each spot minimum. The development of the spectrohelioscope, its uses as a powerful instrument of research, and a survey of results obtained to date are reviewed by him in this week's Supplement.

It is a matter for comment that the development of the spectrohelioscope was delayed by slight circumstances for more than fifty years. As Dr. Hale reminds us, the pioneers of solar spectroscopy, such as Jannsen, Lockyer, and Young, were fully aware of the principle involved; Young, indeed, constructed a spectrohelioscope for seeing the prominences at the sun's limb, but it was never applied for observing phenomena on the disc. The wide slit method for prominence work, introduced in the meantime by Zöllner and Huggins, was so successful that a narrow oscillating slit—one of the essentials of the spectrohelioscope—was abandoned, and later experiments, then directed to *photographic* registration in monochromatic light, resulted in the spectroheliograph by Hale and the velocity spectrograph by Deslandres. Thus the need for a visual survey of the sun's atmosphere projected against the disc persisted until the construction of Dr. Hale's spectrohelioscope.

Of the many interesting observations, described and beautifully illustrated in Dr. Hale's characteristic manner, attention may be directed to those by which the observer views in rapid succession the ascending and descending portions of the same hydrogen flocculus and the sunspots which may happen to lie beneath. Dr. Hale's enthusiasm and inventive skill are now being directed to the making of a modified form of spectrohelioscope which he hopes may be within the reach of amateurs. If these hopes are realised, the chances of detecting the exact moments of critical outbursts on the sun will, as he says, be greatly multiplied, and such observations should prove most valuable in determining the true relationships between solar eruptions and terrestrial magnetic storms.

Obituary.

MR. J. J. FLETCHER.

BY the death on May 15, at the age of seventy-six years, of Mr. J. J. Fletcher, who for thirty-three years was secretary of the Linnean Society of New South Wales, Australia has lost one of the ablest and most sincere as well as one of the most beloved of her scientific workers. He was one of the first two Australians to take a science degree at the University of London, and during his visit to England he came under the influence of the late Prof. Francis Balfour at Cambridge, an experience that exercised a lasting influence upon his work and ideals. For the last forty years his life has been devoted to the Linnean Society of New South Wales, and its work bears the imprint of his fine character in the standard which has been maintained throughout all these years. He joined the Society in 1881, and at the time of his death was the second oldest member. During the course of his tenure of the secretaryship of the Linnean Society he also controlled the general management of the Society's affairs and edited the *Proceedings*. But this list of duties gives no adequate idea of the extent of his services to biology in Australia. He took his work as editor very seriously, and few of the contributors to its *Proceedings* failed to receive very material help from him in the lucid presentation of their results and in completing their bibliographical references. He was as modest and tactful as he was helpful.

Since 1881 Mr. Fletcher contributed about thirty-five important papers to the Linnean Society, including twenty-seven zoological papers, dealing largely with kangaroos, earth-worms, and frogs. He was one of the first to investigate closely the embryology of the marsupials, for which purpose he made many expeditions to collect material. His knowledge of the Australian amphibia was unsurpassed. During later years he contributed some botanical papers dealing with phases of eucalyptus and acacia seedlings. The account of his careful study of the families Loranthaceæ and Proteaceæ has unfortunately not been completed. Much of the valuable information he possessed concerning these plants has gone with him, for he was unable to find time to prepare for publication more than a very small percentage of his valuable knowledge.

On his retirement from the position of secretary of the Linnean Society of New South Wales Mr. Fletcher was made president, occupying the chair during the years 1919 and 1920, and his numerous friends presented his portrait to the Society, with a request that it be hung in the Society's hall in recognition of the great work he had so successfully carried out. He was president of the Biology Section at the Melbourne meeting of the Australasian Association for the Advancement of Science in 1900. In 1921 he was honoured by the Royal Society of New South Wales as the recipient of the Clarke Medal, "awarded from time to time for meritorious contributions to the geology, mineralogy, or natural history of Australia." At the time of his death he was a member of the council of the Linnean Society of New South Wales and a trustee of the Australian Museum.

PROF. C. J. LINTNER.

BIOCHEMISTRY of fermentation has sustained a loss by the death of Geheimer Hofrat Prof. C. J. Lintner, who died at the age of seventy years on April 8 after a long and severe illness. The deceased was the son of Dr. Carl (afterwards Hofrat) Lintner, director of what is now the Agricultural High School, Weihenstephan, who was also the founder of the Scientific Station for Brewing at Munich.

Lintner graduated at Munich in 1882 under Adolf v. Baeyer. After spending some years of work in connexion with agricultural chemistry, he became assistant at the Institut für Garungsgewerbe, Berlin, after which he acted as assistant to Soxhlet at the Landwirtschaftliche Zentralversuchsstation, Munich. In 1888 he was appointed to a chair of technical chemistry at the Technical High School, Munich, becoming "ordentlicher" professor in 1896, his work dealing more particularly with fermentation chemistry.

As regards his researches, Lintner will be chiefly remembered by his work on enzymes, more especially the amylases, and on the transformation products of starch. In 1891 he claimed that one of the products obtained from starch paste when treated with malt amylase is an isomaltose. The existence of this alleged substance was denied by Brown and Morris in 1895, and doubt was thrown on its existence by Ling and Baker in the same year. In 1897, however, Ling and Baker obtained some positive evidence of the truth of Lintner's views, whilst in 1902 Syniewski confirmed the existence of isomaltose and re-named it dextrinose. The existence of the sugar was definitely established by Ling and Nanji in 1923.

Lintner was a man of extreme amiability, and his generous and modest character won for him the esteem of his colleagues and pupils. A. R. L.

PROF. FRANZ VON SOXHLET, emeritus professor of agricultural chemistry at the Technical High School in Munich, died early in May at the age of seventy-eight years. Soxhlet was a native of Brünn, and was appointed to Munich in 1879, where he became director of the central agricultural research station. He was well known for his work on the sterilisation of milk. He did not long survive his distinguished assistant Lintner, whose death was recorded in our issue of June 12 and is referred to again above.

WE regret to announce the following deaths:

Prof. F. N. Cole, professor of mathematics in Columbia University since 1895 and secretary for many years of the American Mathematical Society, distinguished for his work on the theory of groups and the theory of numbers, on May 26, aged sixty-four years.

Dr. Henry Skinner, president in 1909 of the American Entomological Society, who was known for his work on Lepidoptera, on May 30, aged sixty-five years.

Prof. Sidney Irving Smith, professor emeritus of comparative anatomy in the Sheffield Scientific School of Yale University and a member of the National Academy of Sciences since 1884, known for his work on invertebrates, notably crustaceans, on May 7, aged eighty-three years.

News and Views.

AN extraordinary general assembly of the International Research Council was held at Brussels on Tuesday, June 29. After agreeing unanimously, on the motion of the Executive Committee, to omit from the statutes words which have limited membership to allies and neutrals, the following motion proposed by the president of the Royal Society was passed unanimously. "That this meeting of the extraordinary general assembly of the International Research Council decides to invite Germany, Austria, Hungary and Bulgaria to join the International Research Council and the Unions attached to it and, in doing so, to indicate the institution which will act as adhering body."

THE second reading of the Public Health (Smoke Abatement) Bill was moved in the House of Commons last week by Mr. Chamberlain. So far as it goes, the Bill is a step in the right direction. The provisions of the 1875 Act are amended to include other kinds of smoke besides black smoke; temporary exemption is to be allowed for certain processes for the present; the power of local authorities to regulate the emission of noxious smoke is to be extended. No provision is, however, made for reducing smoke from private dwelling-houses, which in many places are the greatest sinners. While the time may not be ripe for compulsory prevention of smoke from private houses, this does not appear sufficient reason for not making some provision to bring about improvement by encouragement instead of penalty, such as by empowering local authorities to make a rebate on the rates for users of smokeless methods only. In the debate, several speakers referred to the advantage of the open fire—a pleasant radiant heat and plenty of ventilation. If these can be combined with smokelessness it will be the best solution. There is in the Bill no provision for standards of permissible smoke emission, and it is doubtful if much useful result will follow until such are set up. As Mr. Chamberlain admits, it is rather on the administration that we shall have to rely for improvement of the conditions of the atmosphere, a reliance scarcely justified by our past experience. It would give more hope of improvement if the Bill empowered the Minister of Health to fix standards of industrial smoke emission from time to time; but the necessary preliminary must be the finding of a reasonably accurate method of measurement. The natural sequence would then be: (*a*) Find a suitable method of measuring smoke from chimneys; (*b*) fixed standards of emission based on (*a*); (*c*) enforce such standards legally.

THE Office d'Information scientifique et technique of Paris, the initiation of which was noted in our issue for June 12, has favoured us with copies of two recent news bulletins, which are interesting to compare with similar issues of the allied Science Service in Washington. The French material has been well selected, and is of real scientific interest; the language is plain and the treatment straightforward, but its somewhat educational tone raises a doubt as to whether the presentation is sufficiently attractive to appeal to editors and readers of the popular Press; it may be, however, that the intellectual standard in France is higher than elsewhere. In the United States and England, it is the practice to attract the reader by one or more glaring headlines, to convey the gist of the information (which should contain news) in a short initial paragraph, and then to proceed with details and embellishment. The French procedure, as displayed in these bulletins, is more logical: the headlines are distinctly sober and lacking in 'pep'; the article begins with an explanatory or historical preamble, and the news is reserved for a later stage. Although this method will be preferred by the student, it is less effective in attracting the lay reader than the more sensational style of approach.

THE 'news' element of the bulletins is not strongly represented in the specimens before us, and in a few cases, for example, the articles on telegraphic reception and the nature of X-rays, the explanations given may convey little to the uninitiated. In about one-half of the items the information comes from the United States, and the remainder from France; when the Service gets better under way one may expect material from other countries to be included. The news appears to have been culled mainly from periodical literature—which must always constitute an important source—but it is to be hoped that first-hand news obtained from research workers and inventors will later become available; in this respect the American Service has been singularly successful. It is of happy augury that the French organisation is starting with high ideals: it will not try to serve both science and mammon; commercial profit is outside its scope and there will be no traffic with the advertiser; and it will preserve a rigid independence of all parties, groups and factions. Its sole aim is the prompt diffusion of scientific and technical knowledge in a way that will neither 'mystify the crowd' nor promote sophistry and error by over-indulgence in 'purple patches.'

WE are glad to direct attention to the letter on p. 10 of this issue referring to the proposed widening of the activities of the Universities' Library for Central Europe. The original letter in NATURE of May 22 relating to the disposal of scientific journals brought responses from scientific institutions, research workers and others, from which it was evident, as we suspected, that although of no commercial value, back numbers of scientific journals and similar publications would be of very real use if they could be distributed in the right quarters. Such a central distributing organisation already exists in the Universities' Library, and we trust that sufficient support will quickly be forthcoming to enable it to undertake the new function which it is now proposing to assume.

THE first number of the *British Journal of Psychical Research*, the editorial address of which is 16 Queens-

berry Place, South Kensington, S.W. 7, merits mention in this column owing to the claim made in a foreword by the editor that one of its objects is "to deal with ascertained facts in a strictly scientific manner." It is a fine ideal to start out with, but one very difficult of attainment, apparently, in this particular subject. The account of the "Model Psychic Laboratory" on pp. 11-20, with photographic illustrations, is the best article in the number. The laboratory in question is the National Laboratory of Psychical Research at Queensberry Place, and the article is very helpful in giving a clear idea of the arrangements and apparatus in use there. We note that future numbers will contain accounts of experiments with a young psychic known as Miss Stella C., whose portrait forms the frontispiece of this number. There is also a very full account of the first case of alleged mediumship which has come up for investigation before the officers of the Laboratory. This is dealt with by Mr. Harry Price under the title of "Pseudopsychic Manifestations due to Self-induced Hysteria." The conclusion that the phenomena were all due to evident hysteria appears to cover quite fully all the facts noted. The same author, in a shorter article entitled "A Plea for Accuracy," makes some very caustic comments on an article by an American investigator, who, in dealing with the problem of so-called psychic photography, makes the remark (in italics) that "*the plates never left my hand until the negative was developed in the dark room*," but innocently publishes alongside this statement the resulting photograph, showing a "psychic extra" on a photograph of himself in which his hands are clearly visible, and therefore could not have been holding the plate! The editor having thus set a high standard, both of accuracy in his own articles and of very candid criticisms of inaccuracies in those of other journals, we may express the hope that future numbers will worthily uphold his ideals.

THE Australasian Association for the Advancement of Science will hold its eighteenth meeting in Perth, Western Australia, during the week commencing Monday, August 23 next. Owing chiefly to the long and costly journey from other parts of Australasia, no previous meeting of the Association has been held in Perth; consequently Western Australia is making special efforts to secure a good attendance of members from other States and from New Zealand. Private hospitality in Perth during the meeting is being offered to all visiting members. The State Government has granted 1200*l.* towards defraying the cost of printing and publishing, and is giving free transit to visiting members over the W.A. Government Railways, whilst the Australian Commonwealth Government has granted for the Perth meeting the sum of [illegible] out of which travelling allowances will be made to members coming by the Transcontinental Railway. As the various countries bordering on the Indian Ocean have many scientific problems in common, the Perth local committee has sent invitations to representative scientific men in those countries to attend the meeting, hoping thus to make it an informal Indian Ocean Science Congress, and thereby to inaugurate closer intellectual co-operation amongst the Indian Ocean peoples. To anthropologists, botanists, geologists and zoologists, Western Australia offers features which are unique, even for Australia; and a series of excursions has been arranged to enable visitors to study these as well as the economic resources of the State in mining, agriculture, fruit-growing, forestry, etc.

THE retiring president of the Association is Lieutenant-General Sir John Monash, whilst the president-elect is Prof. Edward H. Rennie, of the University of Adelaide, who has chosen as the title of his presidential address "The Chemical Exploitation, Past, Present and Future, of Australian Plants." The chairman of the local committee is the Hon. P. Collier, Premier of Western Australia. The presidents of sections and the titles of their addresses are as follow: *A* (*Astronomy, Mathematics, and Physics*), Prof. Kerr Grant, "Atomic Transformation"; *B* (*Chemistry*), Prof. James Kenner, "Some Aspects of the Problem of Molecular Structure"; *B* 2 (*Pharmacy*), Mr. A. T. S. Sissons, "The Indebtedness of Pharmacy to Organic Chemistry"; *C* (*Geology and Mineralogy*), Sir Douglas Mawson, "The Igneous Rocks of South Australia—a brief survey of present knowledge relating thereto"; *D* (*Zoology*), Prof. Launcelot Harrison, "The Composition and Origins of the Australian Fauna, with special reference to the Wegener Hypothesis"; *E* (*Geography and History*), Prof. Ernest Scott, "The Discoveries of the Western Australian Coast, with especial reference to Dampier and D'Entrecasteaux"; *F* (*Ethnology and Anthropology*), Prof. F. Wood Jones, "The Claims of the Australian Aboriginal"; *G* (*Social and Statistical Science*), Major L. F. Giblin, "Federation and Finance—an Examination of the Financial Relations of States to a Federal Commonwealth"; *H* (*Engineering and Architecture*), Sir John Sulman, "Town Planning"; *I* (*Sanitary Science and Hygiene*), Mr. F. S. Hone; *J* (*Mental Science and Education*), Mr. P. Board, "Social and Economic Values in Education"; *K* (*Agriculture and Forestry*), Mr. C. E. Lane Poole, "Forestry and Land Settlement"; *L* (*Veterinary Science*), Prof. J. Douglas Stewart, "The Relationship of Veterinary Science to the Prosperity of the State"; *M* (*Botany*), Prof. A. J. Ewart, "Past and Future Development of Botanical Science"; *N* (*Physiology and Experimental Biology*), Prof. W. A. Osborne, "The Study of the Reflex." The hon. local secretaries for Western Australia are Mr. A. Gibb Maitland, Geological Survey, Perth, and Prof. N. T. M. Wilsmore, University, Perth, W.A.

AT the invitation of the Gas, Light and Coke Company, a large and distinguished scientific audience assembled on June 24 in the Company's offices in Horseferry Road, Westminster, to hear Prof. W. A. Bone lecture on "New Experiments on the Combustion of Carbonic Oxide." The experiments described, and in many cases beautifully reproduced, form part of researches which Prof. Bone and his

collaborators have been carrying out during the past three years at the Imperial College of Science, South Kensington, aided by fellowships given by the Gas, Light and Coke Co. and Radiation, Ltd., and described in detail in recent numbers of the *Proceedings of the Royal Society* (*e.g.* in the issue for April 1, pp. 615-44, 1926 [A]). The outstanding result of this work is that, contrary to former belief, carbon monoxide will, under suitable conditions, combine with oxygen in the absence of moisture. Mixed in the volumetric ratio of 2 : 1, at atmospheric pressure, these gases ignite with increasing difficulty as they are progressively purified from water vapour, but even after six months' drying over phosphoric oxide, they can be exploded by means of a sufficiently powerful condenser discharge. The union is facilitated by increasing the original pressure of the gaseous mixture, although it appears to reach a limiting value of about 98 per cent.

PROF. BONE stated that spectrograms obtained on exploding carbon monoxide with air, under 25 atmospheres pressure, showed the complete absence of 'steam lines,' thus proving that the presence of steam is not essential to the reaction, although under ordinary conditions it undoubtedly plays an intermediary rôle. High pressure increases the direct oxidation of carbon monoxide, whilst the presence of hydrogen, as in water gas, favours the indirect oxidation. All previous explanations of the mechanism of the combustion of carbon monoxide have assumed the continuous decomposition and regeneration of steam. Prof. Bone's 'ugly' fact destroys this 'beautiful' hypothesis, and although he has no definite substitute to advance, he believes that precedent ionisation of the combining gases is the most probable explanation. A pleasing feature of an excellent lecture was the manner in which Prof. Bone gave credit to his collaborators, Messrs. F. R. Weston, R. P. Fraser, and D. M. Newitt.

AMONG the items which are to be dealt with at the forty-fifth annual meeting of the Society of Chemical Industry in London, a session of outstanding interest will be that on Tuesday, July 20, when a symposium will be held on "Corrosion." In view of the fact that this symposium is a joint meeting of the British Chemical Plant Manufacturers' Association, the Institute of Metals, the Institution of Chemical Engineers and the Chemical Engineering Group, it cannot fail to be of very general interest. British contributions will be described by a group of recognised authorities, including Mr. Ulick R. Evans, who will deal with "The Fundamental Principles of Corrosion," Mr. P. Parrish, who will speak on "Corrosion and Erosion," and Dr. W. H. Hatfield and Messrs. T. G. Elliott and G. B. Willey, who will discuss "Chemically Resistant Steels." Possibly in no branch of metallurgy has there been such great advancement, both during and since the War, as in connexion with the production of resistant steels and acid-resisting irons. Novel methods of manufacture and the alloying of some of the less common metals with iron and steel have produced alloys of a chemical resistance quite unprecedented, and the steels which are to-day being produced to withstand corrosion are far in advance of the earlier forms of stainless steels, which are chiefly martensitic. The newer corrosion-resisting steels are austenitic, *i.e.* they are softened by quenching from a high temperature, as in the case of manganese steel, whilst the acid-resisting irons have been also greatly improved recently, both from the point of view of homogeneity and toughness, resultant upon careful methods of heat treatment. Another joint meeting on the same date, of the London Section of the Society of Chemical Industry and the Biochemical Society, is on "The Scientific and Industrial Problems presented by the Hormones—the Natural Drugs of the Body," to be opened by Dr. H. H. Dale.

IN his address to the Royal Geographical Society at the anniversary meeting on June 21, Dr. D. G. Hogarth pointed out how mistaken is the impression that no important work in geographical exploration remains to be done. Apart from polar regions, southern Arabia, and central Australia, where large virgin tracts of territory exist, there still remains a great deal to do in many parts of the world in the regions intervening between known and charted routes. For intensive surveys in topography alone there is still a great field, and an even greater one for specialists in various sciences. Dr. Hogarth commented on the ever-present appetite for the sensational which tends to divert public interest and available funds from serious work to spectacular achievements. Each air dash to the Pole probably absorbs the interests, energies, and funds sufficient to furnish a dozen expeditions which would bring a hundred times more copious and valuable returns to geographical science. As a subsidiary aid to land exploration, aircraft have proved valuable; and prolonged flights are no doubt of value in the development of aerial navigation, but they can add little of importance to geographical science. The work that is required to-day is not spectacular, but it is important and varied enough to absorb all the explorers and funds available.

THAT gold exists in sea-water is a well-known fact: that it can be profitably extracted is a belief that has enabled many a company promoter to batten upon a credulous public. This belief has now received another blow. At the annual general meeting of the Verein Deutscher Chemiker, held in Kiel on May 26-30 last, Prof. F. Haber communicated the results of a research which he and Dr. J. Jaenicke have been prosecuting for several years. Whereas earlier investigators found the gold-content of sea-water to be 5-10 mgm. per metric ton, their work on 5000 samples collected from many seas and from different depths has shown that the amount present is far smaller. Water from the South Atlantic contained less than 0·01 mgm. per ton, water from the bay of San Francisco a little more, and samples from the Polar seas four or five times this quantity. Melted ice from the Polar seas was often considerably richer in gold. The form in which the gold occurs in sea-water is not, as

previously supposed, as dissolved aurichloride, but as a mineral slime or as a constituent of the plankton organisms. Its separation is effected quantitatively by adding a minute amount of alkali polysulphide and a trace of copper, and then filtering through fine sand charged with sulphur. This process, however, would not be practicable on an industrial scale. Although there may be localities comparatively rich in gold, the attempt to discover them would resemble the task of hunting for a hypothetical needle in a haystack.

VISITORS to the Natural History Museum at South Kensington should find much to interest them in the greatly augmented series of enlarged models of disease-carrying insects and ticks, which has just been arranged for their benefit in the Central Hall of that institution, and of which a demonstration was given to representatives of the press on the afternoon of June 23. Initiated more than a quarter of a century ago by Sir Ray Lankester, with models of the then best known of the tsetse-flies, and of two typical mosquitos, and somewhat extended in more recent years, the series, with the latest additions, now embraces no fewer than eleven species of insects and three arachnids. The new models among the insects include representations of the internal anatomy of an infected malarial mosquito; the common household mosquito of the tropics, a carrier of the causal agent of Filariasis; the preliminary stages of the yellow fever mosquito; the tiny, midge-like transmitter of sand-fly fever, with its larva and pupa; a small West African horse-fly, which conveys the cause of Calabar swelling; the preliminary stages of one of the tsetse-fly carriers of sleeping sickness; the eggs and mouth-parts of the body-louse; and the preliminary stages and adult female of the tropical rat-flea, the most important carrier of plague. An addition to the models of ticks is a colossal representation of the transmitter of tropical African relapsing fever. Under the supervision of members of the Museum staff, the models have been executed with remarkable skill and attention to detail by Mrs. E. D. Blackman, Miss Grace Edwards, and Mr. A. J. Engel Terzi. Now that the importance of insect-borne disease to the British Empire and the world at large is receiving ever wider recognition on the part of administrators, it is well that the matter should be brought to the notice of the general public. To this end no better means than that afforded by this striking collection of models could possibly have been devised.

ENG.-VICE-ADMIRAL SIR ROBERT B. DIXON, Engineer-in-Chief of the Fleet, has accepted the presidency of the Junior Institution of Engineers for the year 1926–1927 in succession to Mr. J. S. Highfield.

MAJOR-GENERAL SIR MATTHEW H. G. FELL, K.C.B., C.M.G., has been appointed Director-General, Army Medical Services, in succession to the late Lieutenant-General Sir William B. Leishman, K.C.B., K.C.M.G.

PROF. PAUL SABATIER, For. Mem. R.S., of the University of Toulouse, and Nobel Prizeman in 1912 for chemistry, has been awarded the Albert Medal for 1926 of the Royal Society of Arts, in recognition of his distinguished work in science and of the services to industry rendered by his researches in physics and chemistry, which laid the foundation of important industrial processes.

MR. G. S. W. MARLOW has been released by the Association of British Chemical Manufacturers to devote part of his time to the appointment of secretary and editor of the Faraday Society and secretary of the Institute of Physics, pending the completion of final arrangements for carrying on the official work of these bodies. Mr. Marlow was assistant secretary to the Institute of Chemistry from 1919 until 1925.

AN earthquake of unusual violence and long duration occurred in the eastern Mediterranean at about 10 P.M. on June 26. Much damage to property was caused in Crete, and apparently, to a less extent, in Rhodes. The principal shock, as in so many of its predecessors in south-eastern Europe, was felt over a very wide area, from the Ionian Islands and Greece to Cairo and so far east as Jerusalem. The disturbed area cannot be less than 1200 miles long from north-west to south-west, and about 800 miles wide, the total area being about 750,000 square miles. The epicentre was probably near Crete and between that island and Rhodes.

IN view of the enormous amount of scientific and other special information now available in periodicals and libraries, an association — The Association of Special Libraries and Information Bureaux — was formed to assist in making such information available to all who wish to use it. With the assistance of the Carnegie United Kingdom Trust the Association has undertaken, as one of its first activities, the compilation of a directory of sources of specialised information in Great Britain and Ireland. The general editorship of this work has been entrusted to Mr. G. F. Barwick, formerly Keeper of Printed Books at the British Museum.

PROGRESS is being made towards uniformity in the issue of wireless time signals. We learn that the signal from the Cape is now to be brought into line with the modified Onogo system recommended at the meeting of the International Time Commission in July 1925 and issued from the French stations since the beginning of this year. This signal is emitted from the Slangkop Wireless Station and originates at the Royal Observatory, Cape of Good Hope. The change requires the introduction of a new transmitting apparatus, the cost of which is to be defrayed by the Union Government. Multiplicity in the form of time signals is nothing but a disadvantage, and the change will be a great satisfaction to users of the signal and especially to mariners. It is expected to come into operation early in 1927.

THE Royal Sanitary Institute is celebrating its jubilee by holding an Imperial Congress at the Central Hall, Westminster, on July 5-10, under the presidency of the Minister of Health, the Right Hon. Neville Chamberlain. More than 1000 delegates have been appointed to attend by Government Departments,

including the Ministries of Health of England, Scotland, and Northern Ireland, the Ministry of Agriculture, H.M. Office of Works, the Home Office, War Office, Board of Control, and the Air Ministry. Many foreign governments, and municipal authorities, learned societies, and universities throughout the United Kingdom will also be represented. In connexion with the celebrations a handbook has been prepared recording the history and activities of the Institute, together with special articles dealing with sanitary progress during the fifty years 1876–1926, from the medical, engineering, architectural, parliamentary, legal, public administration, colonial, military, and naval aspects.

THE American Chemical Society, which was founded in 1876, celebrates its fiftieth anniversary in Philadelphia, Pennsylvania, U.S.A., on September 6-11 next. It is anticipated that some 3500 chemists from all parts of the world will be present. The Society will meet in eighteen divisional gatherings, dealing with various branches of pure and applied chemistry. Many of the divisions will hold special symposia of papers and addresses of importance from authorities in their respective fields. In addition, there will be two general meetings of the whole Society. No direct invitations or requests for the appointment of special delegates are being sent out; all non-American chemists are invited to attend and take part in the meeting on the same basis and under the same conditions as members of the Society. Foreign chemists expecting to attend the meeting should, if possible, communicate with Charles L. Parsons, Secretary, Mills Building, Washington, D.C., U.S.A.

THE latest catalogue of Messrs. Heffer and Sons, Ltd., Cambridge, (No. 269) is devoted to second-hand books on physiology, anatomy, medicine, zoology, biology, anthropology, and ethnology. Many of the works listed are from the libraries of the late Sir William Bayliss and Sir Francis Darwin. The publishers offer the catalogue free upon application.

MESSRS. Watts and Co. are about to reissue, in two volumes, Herbert Spencer's "Autobiography," which for some time has been out-of-print. They have also begun a new cheap series of volumes entitled "The Forum." Among future works will be "The Origin of Life," by Sir Edward Sharpey Schafer, and "The Goodness of Gods," by Dr. E. A. Westermarck.

MESSRS. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, have just issued another useful catalogue—No. 400—dealing with some 2000 second-hand works on botany, agriculture, early medicine and surgery, forestry, fruit-culture, gardens and gardening, herbals, modern medicine, and tobacco. It should certainly be seen by all readers interested in these branches of knowledge.

Our Astronomical Column.

THE ATMOSPHERE OF MARS.—In August 1924 Mr. Wright obtained at the Lick Observatory photographs of Mars in ultra-violet, yellow and red light. The former showed a larger image than the others, but gave scarcely any detail on the planet's surface. B. Fessenkoff, of the Moscow Astrophysical Institution, makes some calculations on the subject in *Astr. Nachr.* No. 5450. He concludes that the observed facts are best satisfied by supposing that the upper layers of the planet's atmosphere contain fine dust which is nearly opaque to ultra-violet light, but transparent to red and yellow light. As to the possibility of fine dust at great heights, reference may be made to the Krakatao eruption of 1883. The dust remained suspended in the upper air for more than a year, causing remarkable sunsets all over the world.

THE POLAR COMPRESSION OF URANUS.—An article by C. Wirtz in *Astr. Nach.* No. 5441 gives a new estimate of the oblateness of Uranus by comparison of its brightness at the Uranian equinoxes and solstices. The inclination of the axis is so high that at the solstices, which occurred in 1861 and 1903, the terminator practically coincides with the planet's equator, and the outline appears almost circular; at the equinoxes, which occurred in 1882 and 1924, the poles are on the terminator, the oblateness reaches its maximum and the light a minimum. A discussion of all the available determinations gives the magnitudes as $5{\cdot}46^m$ at maximum, $5{\cdot}67^m$ at minimum. The light-range is concluded to be between $0{\cdot}15^m$ and $0{\cdot}25^m$, from which a compression in the neighbourhood of $\frac{1}{10}$ is deduced. The author concludes that long-continued photometric measures by modern methods would determine the compression more accurately than micrometrical measures of the disc. The range in the values found by the latter method is considerable.

CEPHEID VARIABILITY.—In an article on the δ-Cephei problem, published in the *Atti della Pontificia Accademia delle Scienze* (*Nuovi Lincei*), the Rev. J. G. Hagen, S.J., Director of the Vatican Observatory, deprecates the antagonism which has arisen between the two theories which have been advanced to explain the variability of the light emitted by stars of this type. In some papers, especially those in English, the pulsation theory is referred to as the generally accepted theory, while, in a recent publication of the Ottawa Observatory, it is asserted that the ordinary binary theory may almost certainly be definitely ruled out of court. Such statements are scarcely justified in view of the fact that no clear and precise answer has yet been given to the questions: (1) Where does the impulse for the pulsations come from? And, (2) how are the pulsations maintained uniform for centuries? A natural answer is furnished to both of these queries if a δ-Cephei star is regarded as a binary system; the pulsations would then be periodically excited by the approach of the satellite and would last only from one eruption or light maximum to the next. In this way the mathematical theory of pulsations receives the mechanical basis hitherto lacking, and, moreover, the undulations observed in the descending branches of the light curves find their most obvious explanation. On the other hand, no invincible argument against the presence of a satellite has ever been brought forward. So far as analogy with other celestial phenomena is concerned, there is in the entire heavens no well-proven example of periodic changes due solely to the internal forces of a star, especially now that some long-period variables have revealed themselves as binary systems, whilst striking examples of light eruption are provided by comets approaching the sun.

Research Items.

THE PERUVIAN QUIPUS.—Baron Nordenskiöld continues his study of the quipus, the systematically knotted cords found in Peruvian graves, in the second part of No. 6 of his "Comparative Ethnographical Studies" (Göteborg: Elanders Boktryckeri Aktiebolag). He here follows up his previous suggestion that the quipus have a calendrical significance by a detailed study of seven quipus on a numerical evaluation of the knots according to their position and the colour of the cords. As regards the ancient Peruvian calendar, the statements of early writers are ambiguous and contradictory as to the division of the year into months, the extent to which the distinction between the lunar and solar year was recognised, and the date on which the year began. It is possible that this confusion arose out of the fact that the more intimate and accurate knowledge of the calendar was confined to the priests, with whom the whites were less likely to come into contact, while the common people, from whom these writers obtained their information, used the lunar year; the solar year, divided up into months of thirty days with five intercalary days, being the property of the learned and not in general use everywhere. Certain results common to the quipus here examined are found to emerge from the numerical evaluation. It would appear that the Incas worked with solar years of 365 days and with months of either 29½ or 30 days, the classification of knots according to the colour of the strings producing both results on the same quipus. The number 7 has special significance. The Incas worked both with synodical months and with a division of the year into 12 months of 30 days plus 5 extra days. It is possible that they knew and reckoned with a synodical revolution of Jupiter calculated at 397 days. The results obtained support the statements of the old writers.

STONE IMPLEMENTS FROM NORTH-WEST PERU.—Relics of a remarkable lithic industry found in north-west Peru are figured and described by Mr. C. Barrington Brown in *Man* for June. Flakes apparently made by human agency were first observed in 1911 at Punta Picos, south-west of Tumbez, on the sandy surface of an ancient sea floor now sixty feet above sea-level. They were of the simplest type and of various materials, showing in every case one side as a single fracture. Later similar flakes, with a few showing secondary pressure flaking along an edge, were found at many different sites, on hilltops and slopes, river terraces and plains. In 1924, on the occasion of a second visit to that locality, not only large quantities of flakes, several reworked, were found, but also stone implements of a skilled manufacture, polished axes, mortars, bowls, etc. At the head of a canyon was found a piece of worked slate which may be a phallus. In three places flakes were found with modern Inca remains which may have been due to Inca occupation of ancient sites. So far, finished implements have been found in one locality only. In the majority of cases no pottery fragments, no bones, and no metal were found. The most interesting and important site is that of El Estero, a small pond 22 miles inland due east from Cabo Blanco on the highest point, at an elevation of 85 feet above sea-level, of a low pass through the Buitre hills. Most of the axe-heads and implements were lying on the surface a few yards from the trail. The area of habitation covers about 1000 square yards with an accumulated thickness of reddish-grey earth of about 4 feet. Here thirty-one axe-heads were found, all except one showing a feature unique in axe-heads, the sides and butt being filed down into a flat or slightly concave face. The butts are provided with protuberant ears of unusual shape. Two examples from Ecuador in the British Museum have the protuberant ears but not the typical flattened butt and sides. The absence of pottery suggests a pre-Inca industry.

BIRDS IN SOUTH AMERICA.—Comparatively little is known of the migration of birds in the southern hemisphere, and in order to some extent to repair this blank, A. Wetmore spent ten months in the southern States of South America, particularly to observe North American birds in their winter quarters, and of these more especially the waders. The results of this expedition, which lasted from June 1920 until April 1921, have recently been published (Smithsonian Institution, *United States National Museum Bulletin*, 133, "Observations on the Birds of Argentina, Paraguay, Uruguay, and Chile"). They comprise much more than the main object of the journey, for his travels in Argentina, Paraquay, Uruguay, and Chile brought the author in contact with many native birds, regarding which he has made comprehensive and excellent field notes. The descriptions of several racial forms new to science have already appeared in other scientific publications, but are here repeated. Many valuable notes on migration, a detailed itinerary, a good map, and many excellent photographs of the various types of bird country, add to the interest of this contribution to the knowledge of South American bird life.

THE SOURCE OF HYDROGEN SULPHIDE IN THE BLACK SEA WATERS.—It has long been known that the upper layers of the waters of the Black Sea only are free from hydrogen sulphide, which is present from the depth of 150 metres downwards, so that no life except bacteria is possible between 150 metres and the bottom (2188 m. in the deepest parts). Nothing was known, however, as to the origin of this hydrogen sulphide, and only recently Prof. B. L. Issatchenko has proved that it is produced from the sulphates dissolved in water by anaerobic bacteria similar to *Microspira æstuans*, known from the northern seas. The Black Sea organism is exceedingly active and can produce so much as 0·3 gm. of hydrogen sulphide per litre of water. Apart from this organism, there are in the bottom mud of the Black Sea some other bacteria able to produce hydrogen sulphide from albumins, but their productivity is far lower and the conditions for it in the depth of the sea are less favourable. Another problem investigated by Prof. Issatchenko was why the surface layers of water are free from hydrogen sulphide. This was formerly ascribed to the presence of an intermediate layer populated by bacteria which are able to oxidise hydrogen sulphide produced in the deeper waters. No such bacteria could be found by a systematic sampling of water, and it is concluded that the oxidation of hydrogen sulphide in the upper layers is due simply to the circulation of water (*Priroda*, 1925, Nos. 4-6).

DUSTING BY AEROPLANE AGAINST MOSQUITOES.—Circular 367 of the United States Department of Agriculture is devoted to an account of experiments carried out for testing the possibilities of employing aeroplanes in the control of the breeding of Anopheles mosquitoes. The authors, Messrs. W. V. King and G. H. Bradley, mention that Paris green was distributed from aeroplanes on the extensive marshes and swamps near Mound, Louisiana, in 1923 and

1924. As the Paris green is effective in very small quantities, it was diluted by mixing with an inert carrier, fine silicious earth being mostly used. No special difficulty was experienced in distributing the insecticide over open water or rice fields: the most difficult conditions encountered were in heavily wooded areas where the water was protected by dense foliage. In the latter conditions a larger amount of the arsenical is required as compared with about half a pound per acre in open areas. The two final tests of 1924 gave particularly clear-cut results. In areas overgrown with aquatic vegetation, 88 per cent. to nearly 100 per cent. of the Anopheles larvæ were destroyed. Controls were made by the use of open porcelain pans of water containing ten larvæ each. These were placed at the different stations before the dust was applied by aeroplane, and were examined the following day for the percentage of larvæ killed.

GENETICS OF THE CABBAGE TRIBE.—The cabbage tribe forms an interesting variation group. All the forms of cabbage, kale, kohl rabi, brussels sprouts, broccoli and cauliflower, are believed to have been derived from the wild *Brassica oleracea* found on various European coasts, for example, on the cliffs at Dover. The ancient Greeks recognised three varieties. The others have appeared since, but little is known as to how or when. Mr. M. S. Pease (*Journ. Genetics*, vol. 16, No. 3) is making a genetical study from crosses of savoy, kale, and kohl rabi. Kale is found to have two independent factors, in the absence of which the cabbage heart develops, one factor giving an intermediate condition. Malinowski found three polymeric factors for heart in certain other cabbages. The heart factor also shows linkage with a number of others, and some of these linkages, as of curly leaf with heart, are of peculiar character, showing a strict association between degrees of hearting and degrees of smoothness. Although there is difficulty in classifying degrees of hearting, Pease obtained consistent results by growing the F_3 and F_4 and back-crossing. A peculiar monstrosity (*Asparagodes*) in which leafy outgrowths occur on the midribs of the leaves, was first described in Gerarde's "Herbal," but is believed to be as old as the Greeks. It behaves as a simple dominant in crosses. Another independent factor gives the difference between the purple and green types. Pease distinguishes in addition two linkage groups, one containing a factor (*a*) for heart, (*b*) for tallness, and (*c*) for curliness of leaves. The other group contains the other hearting factor as well as factors for petioles, lyrate leaves, and broad leaves. Thus four linkage groups have already been recognised, while the number of chromosome pairs is nine. Difficulties of observation arise from the fact that the multiple factors frequently give an apparently continuous series of variations, and self-sterility is also involved.

UNUSUAL FORMS OF FOSSIL CRINOIDS.—Among the unusual forms of crinoids described by F. Springer (*Proc. U.S. National Museum*, vol. 67, art. 9, 1926) are those in which the stem loses its characteristic shape, becomes coiled, and the columnals (stem plates) are flattened or concave at the inner side and consequently crescentic or elliptical in cross-section; the cirri, instead of occurring in whorls around the stem, are borne only in two rows at the flattened or concave side. In such crinoids there is a tendency for the crown to bend back upon the stem, and for the stem to coil around it in the opposite direction in such a way that the crown may be tightly enclosed within the coil and completely enveloped by the cirri. This character, which was evidently protective, originated independently in a number of unrelated genera ranging from the Silurian to the Carboniferous. Other crinoids are described with the arms in a recumbent position instead of being outstretched or folded together as is the case with existing forms; in these the arms were normally pendent, with the dorsal side pressing backward upon the calyx and stem.

THE DEPTH OF ORIGIN OF EARTHQUAKES.—More than any other living man Mr. R. D. Oldham has helped to bring the science of seismology to its present vigorous state, and his latest contribution to the subject is, like most of his work, of fundamental importance. Dealing with *episeisms* (surface shocks) as opposed to *bathyseisms* (deep-seated shocks), Mr. Oldham shows that the depth of origin can be calculated from an empirical formula based on the intensities at a point directly above the disturbance and at another distant point (*Q.J. Geol. Soc.*, vol. 82, 1926, p. 67; and *The Observatory*, March 1926, p. 86). Loss of energy by absorption is allowed for from a study of earthquakes that have been worked out in great detail. Applying the formula to 5605 Italian shocks that occurred between the years 1897 and 1910, he finds that 90 per cent. originated at depths of less than 8 km.; and only 1 per cent. gave a depth greater than 30 km. From the long-distance records of bathyseisms, Prof. Turner has found that most of these disturbances originate at a depth of about 200 km., with smaller proportions at about 100 km. and 500 km. Fracturing of the rocks of the outer crust is by far the most probable cause of the surface shocks, but this explanation is out of the question for bathyseisms. Changes of state accompanied by changes of bulk might cause the long-distance earthquakes and at the same time fracture the surface rocks, thus leading to a nearly simultaneous episeism. The San Francisco earthquake was a compound phenomenon of this kind. The local effects indicated a depth of 20 km., while the long-distance records gave 140 km. Seismology thus becomes the study of two very different types of earthquakes.

GEOLOGICAL TIME.—In the *Phil. Mag.* for May 1926, pp. 1055-74, Dr. Arthur Holmes gives a review of all the evidence in favour of the longer estimates of geological time which have been based on lead-ratios. The adverse criticisms by Prof. Joly are shown to be founded either on faulty data, or on speculations that are not necessarily true. The sodium method is rejected on grounds already reviewed in NATURE (April 24, p. 592). It is suggested that the discrepancies in thorium minerals are due to the fact that lead present as oxide or silicate would be more easily removed by percolating waters than the lead in uranium minerals, which is most probably present as a highly insoluble uranate. An analysis of atomic weight determinations on lead from thorium minerals supports this conclusion, and shows further that there can be very little actinium D in 'uranium lead.' Thus the ages calculated from the lead-ratios of uranium minerals, if they are otherwise free from suspicion, cannot be more than a few per cent. too high. The variation in the radii of uranium haloes is shown to be explicable by other hypotheses besides that advocated by Joly, so that no evidence is valid along this line of attack until the istopic constitution of 'uranium' has been revealed. It is concluded that the time elapsed since the crystallisation of the middle pre-Cambrian pegmatite-minerals of Norway, Sweden, Texas, Ontario and Africa is of the order of 1000 million years. No higher ages are yet well established, though the age of the oldest rocks must, of course, be considerably greater than these of the middle pre-Cambrian.

RATE OF AERATION OF WATER.—W. E. Adeney has published a series of observations in which he has determined the rates of solution of oxygen, expressed in percentages of saturation, by films of de-aerated fresh, or salt waters, 0·05 cm. thick, when uniformly exposed to the air, and independent of evaporation and downward streaming ("On the Rate and Mechanism of the Aeration of Water under Open-air Conditions," *Sci. Proc. Roy. Dublin Soc.*, 18 (No. 20), 211-217, April 1926). This has been followed by determinations of the rate of solution by quiescent columns of water. Owing to the cooling produced by evaporation, minute streamlets sink towards the bottom. In the case of salt water, density changes also assist the mixing. Movements occurring at the surface facilitate the saturation of the water with gas. Quantitative results are given for certain limiting cases, and suggestions made as to the probable values under various intermediate conditions.

SPECTRA OF EXPLODED METALS.—In the *Scientific Papers of the Institute of Physical and Chemical Research*, Tokyo, vol. 4, No. 48, T. Hori describes some interesting experiments on the spectra of exploded metals by the method of Anderson. A thread of mercury contained in a fine capillary tube, when exploded in that way, gave a good continuous spectrum crossed by some absorption lines of mercury. Other metals gave a less satisfactory continuous background, but when exploded in the form of fine tubes containing mercury, many absorption lines were seen on the continuous spectrum produced by the mercury. Under reduced pressure the Swan spectrum appeared in absorption by this process, owing to the presence of oil in the explosion chamber. A satisfactory substitute for mercury as the source of the continuous background was found in incandescent carbon particles produced by placing asbestos fibre saturated with petroleum at the exploding centre. Several absorption spectra—including bands of compounds and series and non-series lines of elements—were produced by this device. In the same volume (No. 56) Messrs. Fukuda, Kuyama and Uchida record the appearance of several lines, forbidden by the spectroscopic selection rules, in the spectra of constricted arcs *in vacuo*, while Fukuda, in No. 55, records the production of similar lines in vacuum tubes carrying heavy discharges.

CARBON TETRAFLUORIDE.—In the issue dated May 31 of the *C. R. Acad. Sci.*, Paris, Messrs. P. Lebeau and A. Damiens give an account of the preparation and properties of carbon tetrafluoride, CF_4, from which it would appear that the compounds previously described under that name were far from pure. By the direct action of fluorine on various forms of carbon and passing the products of the reaction through a vessel cooled with liquid air, a colourless liquid is obtained which, from its varying boiling-point, is obviously a mixture. The most abundant constituent of this mixture was isolated by repeated fractional distillation and was found to boil at about −150° C. The gas is odourless and without action on water, is not attacked by aqueous or by alcoholic potash (differing from the gas hitherto described as carbon tetrafluoride by Moissan and by Chabrié), and is not even attacked by fused potash at 740° C. Its composition was established by the reaction with sodium heated to 500° C., which is according to the equation $CF_4 + 4Na = C + 4NaF$. It also reacts with metallic calcium at about 700° C., giving calcium fluoride, calcium carbide, and carbon. A repetition of the work of Chabrié has established that the substance described by him as carbon tetrafluoride was a mixture, the principal constituent of which was a fluochloride, CCl_2F_2.

PROPAGATION OF RADIO WAVES.—Radio engineers are making strenuous endeavours to understand the mechanism of radio transmission. The Radio Corporation of America and its associated companies are making systematic researches, both theoretical and experimental, to discover this mechanism. They admit that electric currents in wires, in a vacuum and in electrolytes, can be explained by means of the electron, but the structure of the electromagnetic field still remains a mystery. Each new discovery in long-wave and short-wave propagation is eagerly studied with this end in view. This is shown in the paper read by E. F. W. Alexanderson on radio wave propagation to the Academy of Swedish Engineers in July of last year. After describing the various phenomena generally referred to as 'fading,' he divides the waves sent out from a radio station into the earth-bound wave, which is guided by the proximity of the conducting earth, and the space wave or high angle radiation, which is guided by refraction in an ionised layer in the upper atmosphere. Long-wave telegraphy depends mainly upon the earth wave. Short-wave long distance communication depends entirely upon the space wave. Broadcast reception depends upon the earth-bound wave for near stations, and on the space wave for distant stations. It is stated that at a distance of about 100 miles from the station the intensities of the two waves are nearly equal. It has been found that at a distance of ten miles from a fifty-metre station the plane of polarisation of the space wave has been twisted by between 20° and 30°. It follows that at some distance between 60 and 90 miles the twist would be 180°. The earth-bound wave maintains its vertical plane of polarisation; the two waves, therefore, may cancel one another at a distance of about 100 miles. This explains 'blind' spots. As a model of radio transmission, he discusses the motion of a horizontal rubber sheet actuated by a vertical shaft making rotatory oscillations. Straight lines drawn on the rubber sheet will appear to have a wave motion. In order to reconcile the old and new points of view he thinks it necessary to prove that the electron is an entity with an aurora reaching from it into infinite space.

A NEW REFLEX CAMERA.—Reflex cameras possess many advantages, particularly in regard to instantaneous photography, over those of the ordinary type. The 'Press' reflex camera recently placed on the market by Messrs. J. H. Dallmeyer, Ltd., 31 Mortimer Street, London, W.1, should help, in large measure, to meet the demand for an instrument of this type at a reasonable price. We have examined one of these cameras, and find it a serviceable and well-made instrument, easy to manipulate, and capable of giving excellent results. It is fitted with a single wind, self-capping, focal-plane shutter, giving speeds from $\frac{1}{5}$th to $\frac{1}{1000}$th of a second and capable of adjustment for time exposures. The shutter runs very close to the plate, and is smooth and easy in action. The hood is detachable and can be fixed at right angles to its normal position. The reversing back is fitted with a hooded focussing screen, which can be used when the camera is mounted on a stand and critical focussing is required. Sufficient extension is provided to enable objects at a distance of about 18 in. to be brought into focus. The camera can thus be employed for photographic work in the laboratory. The outstanding feature of the equipment is the Dallmeyer 6 in. focus, f/3·5, anastigmatic lens, which gives excellent definition over the whole field. Its large aperture makes it extremely useful for very short exposures, as in certain types of Nature photographs, or for indoor and other work under restricted lighting conditions.

Explosions in Gaseous Media.

A GENERAL discussion on different aspects of explosions in gaseous mixtures took place at a meeting of the Faraday Society held on June 14 at the Institution of Mechanical Engineers, Westminster. The afternoon session, presided over by Prof. H. B. Dixon, was devoted to the consideration of explosions viewed quite generally. In an introductory survey of the subject, Dr. Garner pointed out the large number of factors which have to be considered. The rate of travel of a flame in a gaseous mixture appears to be intimately connected with the amount of preheating—probably by radiation from the flame-front—and with the thermal conductivity of the mixture. It is probable that catalysis also plays an important part in the spread of flame, and a number of substances were mentioned which can be regarded as positive and negative catalysts respectively. Dr. Garner described a possible mechanism which he termed energo-thermal catalysis.

The ignition temperatures of gas mixtures are very important both from the academic and the practical points of view; Prof. Dixon described recent results which he in conjunction with Messrs. Harwood and Higgins had obtained. Using the concentric-tube method, the temperature to which the furnace must be heated before ignition of the gas mixture takes place is dependent upon the time the hot gases are allowed to remain in contact; the true ignition temperature is taken as being that at which the gases unite immediately after mixing. There appears to be a crucial pressure for each gas at which the ignition point is highest; above and below this pressure the ignition point falls. Using the method of adiabatic compression, comparisons were made between the results obtained with two different pieces of apparatus in which the rates of compression were not identical: the lag between the completion of the piston stroke and the recoil due to explosion is shortest when the compressions are highest.

Methods of measurement of the radiation emitted during explosions in closed vessels were described by Prof. David. The infra-red radiation in coal-gas air explosions is at a maximum during the explosion period and before the mean gas temperature attains its maximum value; it is assumed that the radiation is therefore mainly due to chemical activity and not simply to temperature. The introduction of infra-red radiation can speed up the combination in a closed vessel provided that (1) the radiation is of the kind which is absorbed by the combustible gas; (2) nitrogen is present as a constituent of the inflammable mixture; and (3) the mixture composition is such as to be favourable to the formation of oxides of nitrogen during combustion. In the discussion, Mr. Finlayson suggested that the shape of the explosion vessel might have an important effect upon the results obtained, and Dr. Ellis showed some interesting photographs of the mode of flame propagation in closed vessels of different shapes.

The subject of ionisation in gas explosions was introduced by Dr. Garner and Dr. Saunders. It was pointed out that the results obtained by different investigators are not in entire agreement, but the following tentative conclusions can be drawn: (1) The ionisation occurring in gas explosions is mainly thermal, although certain experiments seem to indicate that a small fraction is due to chemical change. (2) Ionisation plays no part in the ignition of gases. (3) It appears unlikely that the ionisation of the gas in front of the explosion is the cause of the propagation of the detonation wave. (4) The action of anti-knocks and knock inducers in the petrol engine cannot be explained on the theory that these substances change the ionisation in the explosion wave. Similar views were expressed in a communication from Dr. Lind.

The importance and the applicability of rates of flame propagation were discussed by Dr. Payman in presenting the results of experiments by Prof. Wheeler and himself. The conditions of flame propagation under which the 'law of speeds' has been found to hold were considered, and it was pointed out that from this law it is possible to calculate the speed of uniform movement in any mixture with air of an industrial gas, the speed of uniform movement of the individual gases with air being known. In the discussion on this paper the point was raised whether the speed of uniform movement could truly be regarded as a physical constant. A short account of recent experiments in Prof. Bone's laboratory was given by Dr. Fraser, and photographs were exhibited showing the movement of the flame in carbon-monoxide-oxygen mixtures. Prof. Jorissen contributed to the discussion some remarks on the limits of inflammability of gases.

The rates of detonation of cyanogen-oxygen mixtures were dealt with in a paper by Dr. Campbell and Prof. Dixon. The detonation velocities in the rapid mixtures appear to be almost independent of the diameter of the containing tube. This is not the case with mixtures largely diluted with nitrogen; in the most highly diluted, the detonation wave is probably never established. From the velocities in the rapid mixtures the mean specific heats of mixtures of carbon monoxide and nitrogen at high temperatures have been calculated.

At the evening session, under the chairmanship of Sir Dugald Clerk, explosive reactions were considered in reference to internal combustion engines. In a brief introduction Sir Dugald Clerk reviewed the work on this branch of the subject carried out by himself and others during the last fifty years. Prof. David discussed the extent to which incomplete combustion of the charge is responsible for limiting the pressures developed in gas engines; about 10 per cent. of coal-gas remains unburnt at the moment of maximum pressure. Various factors which may affect the rate of combustion in gas engines were touched upon. The greater the degree of turbulence of the gaseous charge the more rapidly will inflammation spread; the temperature of the gas engine charge appears to have only a slight effect on the rate of inflammation, but it seems possible that the radiation from the cylinder walls may exert an appreciable influence.

From his experiments with petrol engines Mr. Tizard advanced the view that the dissociation of carbon dioxide at the temperatures reached is sufficient to account for the important fact that maximum power first occurs with slightly 'rich' mixtures and remains practically constant over a considerable range in strength of mixture. In regard to the possibility of detonation of a 'pure' fuel, this appears to depend upon whether a certain temperature, characteristic of the substance, can be exceeded. Anything which lowers the maximum temperature reached during the explosion will tend to stop detonation. The view was put forward by Messrs. Sims and Mardles that metallic anti-knock compounds suffer thermal decomposition, and that the colloidal metal so produced brings about a decrease in volume of the unburnt charge ahead of the flame. Easily oxidisable metals like lead, nickel and iron give positive results as anti-knock compounds, whilst silver and gold are not effectual. Prof. Dixon, Prof. Marks, Messrs. Finlayson, Kay, Sutton, Whatmough and others, contributed to the discussion.

C. C.

The Eastman Universal Colorimeter.

THE Eastman Kodak Company, of Rochester, N.Y., U.S.A., has placed on the market a very useful colorimeter (Fig. 1) which has a greater range of utility than many other instruments of this kind. Originally designed by L. A. Jones (*Journal of Optical Soc. America*, 4, 420, 1920) for use in connexion with war-time problems of visibility and the measurement of the colours of sea and sky, it has been adapted, by the addition of various accessories, for the majority of laboratory and industrial requirements.

The fundamental basis of its action is the phenomenon of the so-called "subtractive colour mixture."

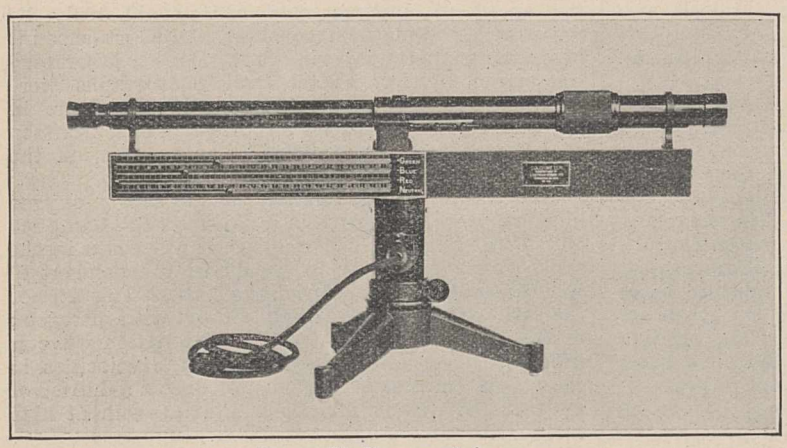

FIG. 1.—The Eastman colorimeter.

To illustrate this we may imagine three colour filters for which, in turn, the main absorption is in the red, green, and blue parts of the spectrum; thus the filters will appear blue-green, magenta, and yellow, respectively. It will easily be understood that by using these in pairs, the primary colours red, green, and blue may be produced in the transmitted light.

For the purposes of the colorimeter these subtractive primaries (blue-green, magenta, and yellow colour filters) are used in the form of long and thin wedges of dyed gelatine, suitably mounted so that various thicknesses of the absorbing medium can be introduced into the light beam by sliding the wedge parallel to its own length. By this means it is possible, for example, to 'mix' varying amounts of yellow with blue-green in order to obtain a series of greens varying from blue green to yellow green, and so on; the use of all three wedges in considerable thicknesses will produce the darker colours. A neutral wedge and supplementary colour filters are added to increase the colour range, which includes all hues and saturations up to high values. Only some of the most highly saturated colours cannot be matched, such as, for example, a very strong emerald green.

The colorimeter is so built that light derived from a standard electric lamp and passing through the wedges illuminates one half of the field of view, while the other half is illuminated by light from the object under test. Thus the colours of objects may be measured *in situ*, or samples may be specially mounted and illuminated for examination in the fittings which are provided; these include one designed for opaque objects, another for colour filters, and another which is designed to intensify the hue component in colours of low saturation by the use of multiple reflections from the coloured surface.

The colour scale is necessarily arbitrary, but it is claimed that an adequate permanency of the wedges has been secured, so that the instrument as it stands should be of utility for such industrial purposes as the standardisation of paints in manufacture and the like, but it is not easy to judge how far the scales of separate instruments of this kind would agree.

In order to convert the readings of the instrument into the usual colorimetric terms of 'hue, saturation, and brightness,' a special calibration of the wedges would be necessary; the accurate transformation would always be a somewhat cumbersome process, though time could be saved by suitable tables and graphical methods.

The instrument is well made and finished, and is very simple in operation. Provided that the difficulty of dealing with highly saturated colours is borne in mind, it should meet the needs of many who have to make colorimetric measurements. L. C. M.

The World's Forestry Congress.

THE World's Forestry Congress was held at Rome on April 29-May 5. The meeting was preceded by a visit on April 27 to the Milan Exhibition, at which a certain number of delegates inspected the forestry exhibit and a section dealing with wood-utilising machinery. Fifty-eight countries were represented at the Congress, most having from two to five Government delegates and a varying number of others who represented their countries but were not specially deputed to do so. Most of the European countries had strong deputations, as also had the United States of America. The heads of the delegations representing Great Britain and the Government of India respectively were Lord Lovat and Prof. E. P. Stebbing.

At a preliminary meeting of the Technical and Scientific Committee on April 28, the honorary presidents, president, and vice-president of the Congress were elected, and afterwards the presidents and vice-presidents of the five sections into which the Congress was divided for working purposes. The presidents of the Congress were Italians. The vice-presidents were from Germany, United States, Great Britain, Dutch East Indies, Japan, and Norway, and the presidents of sections from Sweden, Czechoslovakia, Spain, France, and Brazil.

The opening meeting of the Congress was held on April 29, H.M. the King of Italy and M. Mussolini being present. This was followed by a general meeting, and later by a meeting of heads of delegations at which the work to be carried out was finally sanctioned. Two days, May 31 and June 1, were devoted to a visit to the Forest School at Florence, and to an excursion to the forest of Vallombrosa. Three days were allowed for the work of the sections, each section having three meetings of three hours each. Sections I. and III. met at the same hours, and sections II., IV. A and IV. B. It was not therefore possible for any one delegate to attend all the meetings of each section. Since many Governments were well

represented this would have been immaterial had the agenda of each section been confined to well-defined branches of forestry. Unfortunately, however, there was a certain amount of overlapping, and this proved somewhat of a hardship. Some transfers of subjects were made between sections, at the request of presidents and vice-presidents. It became inevitable, but proved rather confusing for the rank and file of the delegations.

Briefly, Section I. confined itself to questions dealing with forestry statistics, policy, economics, legislation and instruction in sylviculture; Section II., trade and industry in timber, and in forest products in general; Section III., technical problems relating to sylviculture and forest management; Section IV, A, control of torrents, reafforestation of mountain areas, plant diseases and wind damage, forestry propaganda and improvement of game and fisheries; Section IV, B, tropical forestry resources, sylviculture, protection and management and research in tropical forests, uses and export of tropical timbers. Resolutions on these matters were passed by each section and were accepted at the final general meeting of the Congress on May 5.

Linguistic difficulties were of course a great trouble, and resulted in an enormous waste of time. The languages declared for use were French, English, German, Italian and Spanish. The last two were given up at the outset. French was the language used from the chair at all meetings, and was the language (with English) used in the daily reports of agenda, etc., issued during the meeting. But translations into English or German had constantly to be made during the meetings. It is obvious that a certain responsibility rests on Governments in this matter, and that however eminent a man may be in his own branch of study, he loses the greater part of his utility to his Government, and wastes the time of an International Congress, if he can only speak his own language.

Some 247 papers were presented to the Congress, a proportion only being read in précis form. That the Rome Congress was a success is beyond doubt. A careful study of the proceedings will show that work of a very valuable character was accomplished, which should prove of use to the Governments of the various countries which have forest areas of importance to conserve.

University and Educational Intelligence.

CAMBRIDGE.—Mrs. Pilcher, sister of the late Prof Lewis, has offered her brother's house, 2 Fitzwilliam Road, to the University in accordance with his wishes. The rent is to be devoted to the Mineralogical Museum, particularly to the purchase of specimens and books.

Mr. A. J. Dorward, Trinity College, has been appointed University lecturer in moral science. Dr. Cobbett, Trinity College, has been re-appointed University lecturer in pathology. Mr. A. Hutchinson, Pembroke College, has been elected professor of mineralogy in succession to Prof. Lewis, who died on April 16 last.

The Council of Trinity College is inviting applications from Bachelors of Arts, or those admitted to the title of a degree, for a Rouse Ball travelling studentship in mathematics, the purpose of which is to enable the student to study mathematics or the application of mathematics in a foreign university or school.

The Master and Fellows of Pembroke College announce that they will shortly make an election to a Stokes Studentship for research in physics or subjects cognate thereto. The value of the studentship is between 400*l.* and 450*l.* a year, and the tenure will be for three years with the possibility of renewal for a further period not exceeding five years. Candidates may be of either sex and must be between 23 and 30 years of age. They must have shown capacity for research in mathematical or experimental physics or in subjects cognate thereto, such as physical chemistry or the study of physical laws in relation to living matter. Preference will be given to graduates of the University of Cambridge.

The Henry P. Davison scholarships have been awarded to F. P. R. Howard, Trinity College, A. Macdonald, St. John's College, and C. D. G. Nicholson, Jesus College. The scholars will proceed to Harvard, Yale, and Princeton Universities respectively.

GLASGOW.—At the graduation ceremony on Wednesday, June 23, busts of the late Sir William Macewen were presented to the University and to Lady Macewen.

The following were presented for the degree of Doctor of Science (D.Sc.): Mr. R. V. Hansford, for a thesis entitled "A Description of a High Frequency Generator utilising Thermionic Valves and forming part of a Modern High-Power Radio-Transmitting Station," with additional papers; Mr. J. P. M'Hutchison, for a thesis entitled "Researches in Radioactivity with the Radio-Elements Radium D and Radium E."

LONDON.—Mr. Justice Tomlin (chairman), Sir Amherst Selby-Bigge, Sir Cyril Cobb, Sir Josiah Stamp, Sir Cooper Perry, Mr. A. D. Lindsay, Miss Bertha S. Philpotts, and Prof. T. P. Nunn are, according to the University of London Bill recently introduced in the House of Lords by Lord Balfour, to be the first Commissioners of the University of London.

Sir William Beveridge, Director of the London School of Economics, has been elected Vice-Chancellor for 1926–27 in succession to Prof. E. A. Gardner.

Mr. W. C. Clinton has been appointed as from August 1 to the University chair of electrical engineering tenable at University College. Mr. Clinton was educated at the Central Foundation School, the Technical College, Finsbury, and the City and Guilds College. In 1894 he was appointed assistant in the Electrical Engineering Department at University College, and since 1907 has been assistant professor of electrical engineering. His published work includes "Electric Wiring," "The Science of Illumination" (translated and modified from the German of Dr. L. Bloch); and numerous articles in the *Proc. Phys. Soc.*, *Phil. Mag.*, and other scientific and technical papers.

Mr. P. A. Buxton has been appointed as from August 1 to the University readership in medical entomology tenable at the London School of Hygiene and Tropical Medicine. Mr. Buxton was a fellow of Trinity College for the period 1916-21. In 1921-24 he was medical entomologist to the Palestine Government, and in 1924-25 leader of the expedition from the School of Tropical Medicine to the South Pacific. Since March last he has been Director of the Department of Medical Entomology at the London School of Hygiene and Tropical Medicine. He has published a book entitled "Animal Life in Deserts" (London, 1923), and numerous articles in scientific journals.

The title of reader in pharmacognosy in the University has been conferred on Mr. T. E. Wallis, in respect of the post held by him at the School of Pharmacy. Mr. Wallis was educated at Owen's School, Islington (1885-1892), and Birkbeck and King's Colleges (1899-1900). His published work includes "Analytical Microscopy, its Aims and Methods," "Botany: an Outline of Classification" and "Practical Pharmacognosy."

Prof. A. J. Clark, who occupied the University chair of pharmacology at University College, has resigned on his appointment to the chair of materia medica in the University of Edinburgh; Dr. G. V. Anrep has resigned from the University readership in physiology tenable at the same College, on his appointment as lecturer in physiology in the University of Cambridge.

Mr. Major Greenwood has been appointed as from August 1 to the University chair of epidemiology and vital statistics tenable at the London School of Hygiene and Tropical Medicine. The title of reader in medical statistics was conferred on Mr. Greenwood in January 1915 in respect of the post held by him at the Lister Institute of Preventive Medicine. He was Milroy lecturer at the Royal College of Physicians in 1922, and is honorary secretary of the Royal Statistical Society and of the Section of Epidemiology of the Royal Society of Medicine. He has published a number of papers on medical statistics and industrial medicine.

Prof. W. W. C. Topley has been appointed as from August 1 to the University chair of bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine. Prof. Topley was educated at St. Thomas's Hospital and the University of Cambridge. He was director of the Institute of Pathology at Charing Cross Hospital (1911–22), and since 1922 he has been professor of bacteriology in the University of Manchester and director of the Public Health Laboratories. In 1919 he was Goulstonian lecturer to the Royal College of Physicians, and in March last he delivered the Milroy lectures in experimental epidemiology there. He has published numerous papers dealing with bacteriology, epidemiology, and immunology.

The degree of *D.Sc.* in botany has been conferred on Miss M. H. Carré, the Imperial College (Royal College of Science) and Bedford College, for a thesis entitled "Chemical Studies in the Physiology of Apples."

ST. ANDREWS.—The University Court has appointed Mr. A. D. Peacock, senior lecturer in zoology at Armstrong College, Newcastle-on-Tyne, in the University of Durham, to the vacant chair of natural history in University College, Dundee. Mr. Peacock's experience in the teaching of zoology and in research work, chiefly in entomology, extends from 1909 to the present time, that period being broken by service as an entomologist in the Government Agricultural Department of Southern Nigeria and by military service from 1914 until 1919, when his entomological knowledge was made use of for research and instruction in the Medical and Sanitary Services under the War Office. In this department of investigation he has published many valuable scientific papers. Miss Edith Philip Smith has been appointed to the lectureship in botany in University College, Dundee. Miss Smith, who studied botany at Edinburgh, Oxford, and Harvard, was a lecturer in botany in King's College, London, and has for the past four years been demonstrator in botany in the University of Edinburgh. Her publications include a number of papers embodying the results of research, chiefly in plant physiology. Mr. A. O. Adamson having vacated the post of assistant in natural history in the United College, St. Andrews, on his having been awarded a Commonwealth Research Scholarship, Miss Christina H. Sutherland has been appointed to succeed him.

DR. H. H. HODGSON has been appointed head of the combined departments of colour chemistry and general chemistry at the Huddersfield Technical College.

Contemporary Birthdays.

July 2, 1862.	Sir William H. Bragg, K.B.E., F.R.S.
July 4, 1848.	Lord Sydenham, G.B.E., F.R.S.
July 5, 1862.	Prof. G. H. F. Nuttall, F.R.S.
July 6, 1857.	Sir Hercules Read, F.S.A.
July 6, 1865.	Sir Hugh K. Anderson, F.R.S.
July 6, 1873.	Mr. Sidney George Brown, F.R.S.
July 8, 1861.	Prof. J. Arthur Thomson.

Sir WILLIAM BRAGG, who succeeded the late Sir James Dewar as Fullerian professor of chemistry in the Royal Institution, was born at Westward, Cumberland. Educated at Market Harborough Grammar School, and King William's College, Isle of Man, he graduated at Trinity College, Cambridge, in 1884 as third wrangler. His mathematical studies had been pursued under the guidance of Dr. E. J. Routh. Elected in 1885 to the chair of mathematics and physics in the University of Adelaide, he returned to England in 1908 to take up the professorship of physics in the University of Leeds, transferring, in 1915, to a similar chair in University College, London. In that year Sir William was allotted the Nobel prize for physics, jointly with his son, Prof. W. L. Bragg, for their services in promoting the investigation of crystal structure by means of X-rays. The Royal Society awarded its Rumford medal in 1916 to Sir William, on the ground of his researches in X-ray radiation.

Lord SYDENHAM, Governor of Victoria from 1901 until 1904, is of Lincolnshire extraction, and he was educated at Haileybury and the Royal Military Academy. Entering the Royal Engineers branch in 1868, he participated in the 'eighties in much active service. Lord Sydenham was president of the British Science Guild in 1917–20.

Prof. NUTTALL was born in San Francisco. Since 1906 he has been Quick professor of biology in the University of Cambridge. He has written many memoirs concerning bacteriology, entomology, parasitology, and hygiene.

Sir HERCULES READ engaged early in the service of the British Museum, under the inspiring influence of Sir Augustus Franks. He became keeper of British and medieval antiquities and ethnography in 1896, retiring in 1921. Sir Hercules has been twice president of the Society of Antiquaries, namely, for the period 1908–14, and again 1919–24. He is Hon. LL.D. Edin.

Sir HUGH ANDERSON was born at Hampstead. Educated at Harrow, Cambridge, and, for his medical studies, at St. Bartholomew's Hospital, he has been, since 1912, Master of Gonville and Caius College, Cambridge.

Mr. SIDNEY BROWN, electrical engineer, was born at Chicago, but he is of English parentage. He was educated at Harrogate College, and University College, London. Mr. Brown is responsible for many very ingenious inventions applicable to submarine cables, telephones, airships, aeroplanes, and radio, and also of a gyroscopic compass. He is the author of a number of original contributions to science.

Prof. J. ARTHUR THOMSON was born in East Lothian, and he was educated at the Universities of Edinburgh, Jena, and Berlin. Since 1899 he has been Regius professor of natural history in the University of Aberdeen. He was Terry lecturer at Yale in 1924. Prof. Thomson has written many books on natural history subjects, which have a wide vogue. He is Hon. LL.D. Edin.

Societies and Academies.

LONDON.

Royal Society, June 24.—J. C. **McLennan** and A. B. **McLay**: On the structure of the arc spectrum of gold.—Nearly all the wave-lengths known to belong to the gold arc-spectrum have been classified. The most important wave-lengths not yet classified are six that were found to be absorbed by the vapour in the under-water spark of gold. These wave-lengths undoubtedly involve the metastable term $1D_3^2$. Zeeman-effect experiments will probably furnish the best means of definitely settling any features of the arc-spectrum of gold not yet clear.

J. C. **McLennan** and H. G. **Smith**: On the series spectra of palladium.—The regular arc-spectrum of palladium, involving disturbances of a single electron outside a core of nine 4_3 electrons, includes very nearly all the strong lines of the arc, and most of the faint lines of wave-length longer than 3400 Å.U. In the region of shorter wave-lengths there is also a large number of faint lines, apparently belonging to the arc-spectrum, for which no place can be found in the regular series system. These faint lines can probably be ascribed to a secondary-series system. The analysis of the spark-spectrum has shown that $(4_3)^8\ 5_1$ and $(4_3)^9$ are of almost equal stability, and consequently terms of this type should occur with considerable prominence in the arc-spectrum, but might not combine readily with the regular terms. An attempt to find a clue to this part of the spectrum by means of the inter-combinations has been unsuccessful. Similar configurations are also likely to be prominent in the spark-spectrum.

A. M. **Tyndall** and L. R. **Phillips**: The mobility of ions in air (Part iii.).—Measurements of the mobilities in air containing organic vapours over a range of concentration extending up to saturation show in every case a reduction in mobility by the addition of vapour, though the amount depends upon the constitution of the vapour and the sign of the ion. The gradient of the mobility vapour pressure curve for the negative ion is in general steep at low concentrations, but falls off later. In the case of the homologous series of normal aliphatic alcohols the steepness increases as one ascends the series. Similar effects have been observed for the positive ion, but the initial drop in mobility is much less marked. The relative effects of the various vapours seem to depend upon (1) a 'clustering coefficient' determined by the combined effect of any permanent electric moment and an induced electric moment in the neutral molecule, (2) the effective diameter of the cluster.

L. C. **Jackson**: Investigations on paramagnetism at low temperatures (Part ii.).—Orientated sections of the crystal are suspended in a non-homogeneous magnetic field and the forces exerted on them are measured by means of a Pettersson quartz micro-balance sensitive to 10^{-6} mgm. The magnetic field is produced by a large accurately constructed coil and its value is determined from the current strength and the coil dimensions. Data for the three principal susceptibilities of cobalt potassium sulphate are given for temperatures down to $-100°$ C. The principal susceptibility parallel to the symmetry axis of the crystal is also given for nickel ammonium sulphate and manganese ammonium sulphate. The principal susceptibilities all obey the law $\chi(T+\Delta)=$constant over the range of temperature investigated.

Sybil **Cooper** and D. **Denny-Brown**: Responses to rhythmical stimulation of the cerebral cortex.—Electrical and myographic records have been made of movement produced by rhythmical stimulation of the cerebral motor cortex. Rates of 18 to 68 per second were used. In the electromyograms the primary waves follow the rate of stimulation, and secondary waves are at present giving an average total frequency of 120 per sec. The mechanical records show rhythmic tremor corresponding in frequency with rates of electrical stimuli applied to cerebral cortex, even at 68 per sec. This confirms, and extends to higher frequencies, the original observations of François-Franck and Pitres.

Karl **Pearson**: Researches on the mode of distribution of the constants of samples taken at random from a bivariate normal population.—This paper deals with the distribution in samples, regardless of their size, taken from a large normal population of some of their 'compound' constants By compound constants is meant not simple constants like means, standard deviations, or coefficients of correlation, but functions of these constants. The actual curves of distribution of the standard deviations of arrays, and of the regression coefficient are obtained. Also the distribution of the means of arrays as determined by the regression line of the sample is studied, and all the moments of this distribution are determined, but it has not been possible to determine its curve of distribution. Even when sampling from a normal population, the curves of distribution of compound constants (like those of the majority of simple constants) are not themselves normal, nor are the relations between them linear. It follows accordingly that the so-called 'probable errors' of these constants are of relatively small significance in exactness, especially in the case of *small* samples, where their values are usually given by physicists and astronomers, as measures of accuracy of observation.

Lord **Rayleigh**: Further spectroscopic studies on the luminous vapour distilled from metallic arcs.—The appearance of high series members in the luminous vapour is due to their narrowness. In the arc these lines are so broad as to overlap; as the vapour emerges and expands, they become narrow and can be resolved. Enhanced lines occur in the distilled vapour, though in diminished intensity relative to the arc lines. In some cases, *e.g.* magnesium, they fade out very rapidly compared with the arc lines. The resonance line of mercury $1_1S'-1p_2$ gains intensity relative to all other lines as the vapour matures. The same is true of calcium; but the corresponding line of magnesium behaves in the opposite manner. A luminous jet of one metallic vapour is able in many cases to excite the vapour of another metal injected into it, but generally only if the ionisation potential of the first metal exceeds the excitation potential of the spectrum line in question.

Sir William **Hardy**: A microscopic study of the freezing of gel (Part i. and Part ii.).

Sir William **Hardy** and Millicent **Nottage**: Studies in adhesion (i.).

T. **Moran**: The freezing of gelatin gels.

W. **Jevons**: The more refrangible band system of cyanogen as developed in active nitrogen.—Modification of the λ3590 ($n''-n'=-1$) group and of some of the 'tail' bands is discussed. As regards the λ4216 and λ3883 groups, the afterglow develops especially lines of low m values and bands of high n' values. As n' increases the intensities of the bands in each group tend to show an alternation as well as a general increase. Bands with $n'=1$ are the weakest. The λ3590 group (like the above) is shortened in the low wave-length direction, but (unlike the above) it is prolonged in the high wave-length direction in the afterglow as compared with the arc, and also consists of headless bands. On the

assumption that these bands have $n'' - n' = -1$, the absence of heads follows from the non-development of high m lines, and the high wave-length extension is in accordance with the enhancement of high-n' bands.

J. A. V. **Butler**: The equilibrium of heterogeneous systems including electrolytes (Part i.).

(The late) Mrs. Hertha **Ayrton**: Primary and secondary vortices in oscillating fluids: their connexion with skin friction.—Mrs. Ayrton demonstrated the existence of pressure differences on the lee side of obstacles in oscillating water and showed that vortices were formed in the liquid. These vortices were called 'primary' vortices when their full strengths were attained in one oscillation, and 'residual' vortices when more than one oscillation was required for their full development. The word 'secondary' is now substituted for 'residual.' Instantaneous photographs show that primary vortices occur near the ends of a tank in which water is oscillating and also near the nodes of stationary waves in such a tank, whilst secondary vortices spread throughout the remainder of the water.

T. T. H. **Verschoyle**: Isotherms of hydrogen, of nitrogen and of hydrogen-nitrogen mixtures at 0° and 20° C. up to a pressure of 200 atmospheres.—Experimental determination of isotherms of binary mixtures has been limited almost exclusively to mixtures of oxygen and nitrogen. It appears to be tacitly assumed that, for mixtures of the permanent gases, pv-values at normal temperatures are linear functions of composition. Isotherms of three mixtures of hydrogen and nitrogen have been measured at 0° and 20° C., and the results prove that the pv-values for the mixtures are far from being linear functions of the composition. Actually, a small admixture of nitrogen with hydrogen has relatively little influence on the pv-values, whereas a small addition of hydrogen to nitrogen has a comparatively great effect.

E. W. **Marchant** and J. L. **Miller**: The loss of energy in metal plates of finite thickness, due to eddy currents produced by alternating magnetic fields.—The energy lost due to eddy currents, produced by an alternating magnetic field, due to a flat circular coil, when placed near metal plates of different thicknesses, reaches a maximum for a certain thickness of plate. With a frequency of 50 cycles the loss is a maximum with copper plates about 0·4 cm. thick. A similar effect has been observed with zinc plates, though the maximum is not so definite. The mathematical theory worked out by Prof. Proudman is consistent with these results. The shape of the curve of the magnetic field is assumed to approximate to a Bessel function of zero order; a new integral is given for determining magnetic fields due to a coil of wire in terms of Bessel functions.

W. **Sucksmith** and H. H. **Potter**: On the specific heat of ferro-magnetic substances.

L. B. **Pfeil**: The effect of occluded hydrogen on the tensile strength of iron.—Tensile tests during electrolytic pickling of carbon-free iron are discussed. With iron in the ordinary finely crystalline condition, occluded hydrogen may result in a 10 per cent. reduction in tensile strength and an 80 per cent. reduction in elongation: the fracture, instead of passing *through* the crystals, as is normally the case, may pass only *between* the crystals. With single crystals, occluded hydrogen does not appreciably affect movement on the slip planes, but it materially decreases the cohesion across the cubic cleavage planes, the cohesion in certain cases being reduced to 5 tons per square inch. When the parallel portion of a test piece is made up of two large crystals, the weakest point is, in general, the intercrystalline boundary; the strength here is only about half that of the boundary between small crystals. The difference is due to the irregular path of the intercrystalline fracture in finely crystalline iron.

T. E. **Allibone**: The infra-red secondary spectrum of hydrogen.

D. C. **Rose**: The scattering of alpha particles through small angles.—The single scattering of alpha particles through angles from 1°·2 to more than 8° has been measured. A nearly parallel beam of alpha particles was projected perpendicularly on a thin gold foil and the number of particles emergent at the different angles was counted. The relative number of particles scattered at the different angles show that the nuclear field obeys the inverse-square law of force fairly closely, for distances between $0{\cdot}4 \times 10^{-10}$ cm. and $1{\cdot}7 \times 10^{-10}$ cm. from the nucleus. This region includes the K shell of electrons (radius, $0{\cdot}69 \times 10^{-10}$ cm. for gold) calculated from Bohr's model of the atom. Other experimenters have shown that the nuclear field obeys the inverse-square law of force for distances between $0{\cdot}5 \times 10^{-10}$ cm. and $3{\cdot}2 \times 10^{-12}$ cm. from the nucleus. The absolute number of particles scattered show that over the same range the field corresponds to a nuclear charge within 5 per cent. of the atomic number times the elementary electronic charge. The results are not accurate enough to detect the shielding effect due to the K shell of electrons. The curves indicate that the K shell is not ionised to any appreciable extent. Wentzel's criterion for single scattering has been extended.

V. H. **Stott**, D. **Turner** and H. A. **Sloman**: Effects of thermal treatment on glass as shown by precise viscometry.—A new viscometer for molten glass has been designed; prolonged measurements can be made on the same specimen subjected to various heat treatments. The determination depends on the thickness of glass which adheres to a thin iridio-platinum wire withdrawn from the glass at a known velocity. The apparatus is capable of a precision of the order of ± 3 per cent. of the viscosity, which is equivalent to a temperature error of about 3°. At sufficiently high temperatures the viscosity of a particular glass is a function of temperature only. Below 1200° the glass is generally in a heterogeneous form yielding discordant viscosity values; the heterogeneity is not directly connected with devitrification, which takes place at approximately 950°. The glass, in its high-temperature state, may be cooled to room temperatures and reheated an indefinite number of times without change of state if the cooling and heating be not too slow.

J. E. **Lennard-Jones** and Miss B. M. **Dent**: The forces between atoms and ions (ii.).—Earlier results are extended to provide a complete table of forces between the monovalent and divalent ions of the inert gas type.

J. **Topping** and A. E. **Ludlam**: Tables of $\log K_0(x)$ over the range $x = 2$ to $x = 12$ at intervals of 0·001.

B. **Lambert** and K. T. **Hartley**: An investigation of the effects of variations in the radiation factor on the efficiency of Dewar vessels.—The rates of evaporation of liquid oxygen and cooling of hot water have been determined in special Dewar vessels, with one or both of their vacuum-adjacent surfaces silvered, and with polished deposits of silver, gold, platinum, and copper on the vacuum-adjacent surface of the inner vessel, the outer vessel being plain glass. The result obtained by silvering the inner vessel only is almost as good as that obtained by silvering both surfaces. Silvering on the outer vessel only reduces

the efficiency by about a half. With different metal surfaces on their inner vessels, the order of efficiencies of the vessels should be that of the emissivities of these metals. This is the case for all the vessels with respect to hot water—the order being, silver, gold, copper, and platinum—but for liquid oxygen the copper-coated vessel is the least efficient. The dominant wave-length at the temperature of liquid oxygen approaches that corresponding to the 'characteristic frequency' of copper. For energy in this region of wave-lengths the emissivity of copper will therefore be high, so that copper vessels will necessarily be inefficient as containers for liquid oxygen.

J. E. **Lennard-Jones** and W. R. **Cook**: The molecular fields of hydrogen, nitrogen and neon.

H. **Florey**: Observations on the resolution of stasis in the finer blood-vessels.

T. S. P. **Strangeways** and Honor B. **Fell**: Experimental studies on the differentiation of embryonic tissues growing *in vivo* and *in vitro* (ii.). The development of the isolated early embryonic eye of the fowl when cultivated *in vitro*.

Nesta **Ferguson**: The Aloinæ—a cytological study, with especial reference to the form and size of the chromosomes.

Optical Society, June 10.—L. C. **Martin**: The distribution of light in elementary optical images. A series of calculations have been made on the distribution of light near the 'star focus' of a centred lens system in the following cases: (*a*) Freedom from aberration, (*b*) primary spherical aberration, (*c*) zonal spherical aberration. In the two latter cases the condition chosen is that when the least residual phase differences amount to $\pi/2$. The characteristic extra-focal effects are determined, and the effect of primary spherical aberration is discussed. In the case of zonal aberration the greatest axial intensity is not found at the focus giving least phase residuals. In both cases of aberration a concentration closely resembling in some respects the 'Airy' disc characteristic of zero aberration is found.—T. **Smith**: (1) The stationary value of axially symmetric functions. The formula for the stationary value of a function is put into a form which shortens the calculations involved in applying it to functions which possess special kinds of symmetry, such as that corresponding to symmetry about an axis. (2) Note on the criterion for the best position of focus. The position in which the amount of energy within the first dark ring of the diffraction image of a point is a maximum is suggested as not unlikely to correspond with the best focus found by visual observation in the presence of moderate amounts of aberration.

PARIS.

Academy of Sciences, May 25.—L. **Lecornu**: The rotating millstone.—P. A. **Dangeard**: Researches on the cellular formations contained in the cytoplasm of the Peronosporæ.—Alfred **Rosenblatt**: Algebraical varieties of three dimensions of which the types satisfy the inequality $P_g \leqq 3(p_g - p_a - 3)$. — Pierre **Humbert**: The q-harmonic functions in hyperspace.—R. **Gosse**: On a note of M. Lainé.—**Goursat**: Remarks on the preceding communication.—Georges **Valiron**: Meromorph functions without asymptotic values.—A. **Toussaint** and E. **Carafoli**: Contribution to the study of the plane flow of fluids. A new mode of applying the coloured thread method possessing certain advantages over that previously used (Marey, Hele-Shaw). The paths can be followed by the kinematograph.—Albert **Nodon**: A colloid condenser. This condenser is composed of two sheets of aluminium separated from each other by a material such as canvas, the pores of which are filled up with a thick paste of colloidal ferric oxide and glycerol. This arrangement fulfils the functions of an electrostatic condenser of great capacity, when submitted to an alternating current.—R. **Forrer**: The structure of the atomic magnet. Demonstration of the existence of a doublet in nickel.—H. **Mineur**: The theory of the partial entanglement of the ether.—W. **Kopaczewski** and W. **Szukiewicz**: The periodicity of colloidal reactions.—Jean **Barbaudy**: The miscibility, densities, and refractive indices of mixtures of methyl alcohol, benzene, and water.—P. **Chevenard**: The dilatometric anomaly of the paramagnetic nickel-chromium alloys; an alloy suitable for an expansion pyrometer. The nickel-chromium alloy suggested in an earlier communication as suitable for use in a pyrometer shows an anomaly at the temperature of 550° C. To remove this anomaly it is sufficient to increase the amount of manganese, to incorporate a small percentage of iron, and to replace a part of the chromium by tungsten. The new alloy (commercial name Pyros), besides nickel, contains 7 per cent. chromium, 5 per cent. tungsten, 3 per cent. manganese, 3 per cent. iron.—Raymond **Quelet**: The synthesis of derivatives of para-bromoallylbenzene.—A. **Kastler**: Contribution to the study of pollucite. The pollucite examined proved to be non-radioactive and contained 30·5 per cent. of cæsium.— —**Legrand**: A relation between the amplitudes of the annual rise of the Nile, the Niger and the Mekong.—J. **Lacoste**: Earthquakes observed in central France in 1925. Seven earthquakes were noted, the more important being on September 26, December 3 and 9. Details are given of the three mentioned.—Armand **Renier**: The existence of coal balls in the coal basin of Asturia.—J. **Giaja** and X. **Chahovitch**: The inefficacity of pilocarpine to affect the energy metabolism in the absence of the suprarenal capsules.—A. Vedel **Tåning**, The position of the cephalic disc in the Echeneideæ in the course of ontogenesis.—Ph. **Joyet-Lavergne**: The vital colorations of the gregarines and the characters of sexualisation of the cytoplasm.—Y. **Manouélian** and J. **Viala**: The enhancement of the virus of rabies and the Negri bodies.

ROME.

Royal National Academy of the Lincei, April 18.—Leonida **Tonelli**: Quadrature of surfaces.—A. **Angeli**: Anomalies of certain reactions. A number of cases are quoted in which a reaction of one substituent group in an organic compound may be retarded or even prevented by the introduction into the compound of another substituent.—Federico **Sacco**: The tunnel at Drink (Valle d'Aosta).—Achille **Russo**: The ex-conjugants derived from the first accessory conjugation between impure gametes in *Cryptochilum Echini* produce pure gametogens and pure gametes, which renew the principal cycle.—Alessandro **Weinstein**: The speed of propagation of the solitary wave.—Giorgio **Vranceanu**: Dirichlet's theorem.—Arnaldo **Masotti**: An extension of Blasius's formula.—Eligio **Perucca**: The cause of 'flying shadows.' If the phenomenon of flying shadows is one of diffraction, it must be more complicated and more indirect than is indicated by Armellini's theory. The absence of chromatism and the velocity with which these shadows are propagated suggest that the cause should be sought in the earth's atmosphere.—Enrico **Fermi**: The intensity of prohibited lines in intense magnetic fields.—Franco **Rasetti**: The polarisation of the light emitted by electronic shock.—Giorgio **Piccardi**: Ionisation potential of silver. By means of the flame method of Rolla and Piccardi, values ranging from 7·37 to

7·67 volts are obtained for the ionisation potential of silver, the mean being 7·46 volts. In view of the inaccuracy introduced by the impossibility of avoiding slight sparkling of the fused metal, this result agrees satisfactorily with the value, 7·54 volts, derived from the limits of the spectral series.—Carmela **Ruiz**: New investigations on barytes from Racalmuto, Sicily. Measurements of two specimens of barytes, occurring together with calcite and sulphur at Racalmuto, gave the axial ratios, $a:b:c = 0{\cdot}81558 : 1 : 1{\cdot}31467$, and the density 4·42-4·43 at 18°-19°.—Gustavo **Cumin**: Geological observations on the island of Asinello and on neighbouring rocks (Carnaro). The island of Asinello and the neighbouring rocks are mostly Cretaceous, Eocene measures appearing only on the principal island. Their coast morphology is the result of an aerial erosive action, on to which the marine action has been superposed.—F. Stella **Starrabba**: Monthly distribution of the eruptions of Japanese volcanoes.—Giulio **Cotronei**: Dark and light fibres in the insular organ of *Petromyzon marinus*.—B. **Monterosso**: The structure of the body of *Peroderma cylindricum* Heller, in relation to the cellular theory.

VIENNA.

Academy of Sciences, May 14.—V. **Oberguggenberger**: Determination of altitude of the pole at the Innsbruck Observatory with the help of Oppolzer's zenith telescope.—V. **Pietschmann**: A new deep-sea fish of the order Pediculati.—E. **Keller**: Curved perspectives.—M. **Kohn** and A. **Zandmann**: Communication on bromo-phenols, xxi. Display of new halogen-phenols from *m*-chloro-phenol.

Official Publications Received.

Department of the Interior: U.S. Geological Survey. Bulletin 781B: Geology of the Baxter Basin Gas Field, Sweetwater County, Wyoming. By Julian D. Sears. (Contributions to Economic Geology, 1925, Part 2.) Pp. ii+13-29+plates 2-6. Water-Supply Paper 542: Surface Water Supply of the United States, 1922. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. iv+74+2 plates. 10 cents. Water-Supply Paper 546: Surface Water Supply of the United States, 1922. Part 6: Missouri River Basin. Pp. vii+349+2 plates. 35 cents. Water-Supply Paper 552: Surface Water Supply of the United States, 1922. Part 12: North Pacific Slope Drainage Basins. A: Pacific Basins in Washington and Upper Columbia River Basin. Pp. v+203+2 plates. 25 cents. Professional Paper 138: Mining in Colorado; a History of Discovery, Development and Production. By Charles W. Henderson. Pp. iv+263+1 plate. 1 dollar. Professional Paper 140A: Geology of the Latah Formation in relation to the Lavas of the Columbia Plateau near Spokane, Washington, by J. T. Pardee and Kirk Bryan; Flora of the Latah Formation of Spokane, Washington, and Coeur d'Alene, Idaho, by F. H. Knowlton. (Shorter Contributions to General Geology, 1925.) Pp. iv+81+31 plates. Professional Paper 140B: Fossil Proboscidea and Edentata of the San Pedro Valley, Arizona. By James Williams Gidley. (Shorter Contributions to General Geology, 1925.) Pp. ii+83-95+plates 32-44. Professional Paper 140C: Pleistocene Plants from North Carolina. By Edward Wilber Berry. (Shorter Contributions to General Geology, 1925.) Pp. ii+97-119+plates 45-57. Professional Paper 140D: Shore Phases of the Green River formation in Northern Sweetwater County, Wyoming. By Wilmot H. Bradley. (Shorter Contributions to General Geology, 1925.) Pp. ii+121-131+plates 58-62. (Washington, D.C.: Government Printing Office.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77, 1925. Pp. iii+388+11 plates. (Philadelphia, Pa.)

Fortieth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1918–1919; with accompanying Papers—The Mythical Origin of the White Buffalo Dance of the Fox Indians, by Truman Michelson; The Autobiography of a Fox Indian Woman, by Truman Michelson; Notes on Fox Mortuary Customs and Beliefs, by Truman Michelson; Notes on the Fox Society known as 'Those who Worship the Little Spotted Buffalo,' by Truman Michelson; The Traditional Origin of the Fox Society known as 'The Singing Around Rite,' by Truman Michelson. Pp. viii+664. (Washington, D.C.: Government Printing Office.) 2·75 dollars.

Journal of the Manchester Egyptian and Oriental Society. No. 12. Pp. 59. (Manchester: University Press; London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.* net.

Proceedings of the Imperial Academy. Vol. 2, No. 3, March. Pp. v-vi+93-147. (Ueno Park, Tokyo.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 15: The Resistance of the Airship Models measured in the Wind Tunnels of Japan. By the Wind Tunnel Committee specially appointed by the Aeronautical Council of Japan. Pp. 84. (Tôkyô: Maruzen Kabushiki-Kaisha.) 2 yen.

Annual Report of the Zoological Society of Scotland for the year ending 31st March 1926. Pp. 59+6 plates. (Edinburgh.)

Observatoire de Zi-ka-wei. Notes de sismologie, No. 7: Mouvements sismiques des magnétomètres à Zi-ka-wei et à Lu-kia-pang (1877–1924). Principaux sismogrammes, 1925. Par le Rev. P. E. Gherzi. Pp. 33+7 planches. (Zi-ka-wei, Chang-hai.)

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 2, No. 19: The Wheatstone Bridge as the Means of Measuring Linear and Angular Dimensions at a Distance, and its Application to Borehole Surveying. By Prof. Henry Briggs. Pp. 223–229. 1*s.* Vol. 46, Part 2, No. 20: On Fertility in the Domestic Fowl. By Dr. F. A. E. Crew. Pp. 230–238. 9*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation to be submitted at the Fourth Annual General Meeting on June 9th, 1926. Pp. 32. (London: Millbank House, Millbank, S.W.1.)

Spisy vydávané Přírodovědeckou Fakultou Masarykovy Univerzity (Publications de la Faculté des Sciences de l'Université Masaryk). Čis. 64: Oblastní odtoková mapa Moravy (Carte géographique du débit d'eau relatif de la Moravie). Napsal Dr. Fr. Koláček. Pp. 13+1 tab. Čis. 65: "Tanytarsus connectens." Par Dr. Jan Zavřel. Pp. 47+1 tab. Čis. 66: Morfologický vývoj Hlučínska (The Morphological Development of Hlučín). Napsal Dr. Fr. Vitásek. Pp. 38+1 tab. Čis. 67: Terasy dolní Svitavy a dolní Svratky (Les terrasses de la Svitava inférieure et de la Svratka inférieure.) Napsal Fr. Říkovský. Pp. 17+3 tab. Čis. 68: O absorpci chlorovodíku a kysličníku siřičitého v kyseliné sírové a v kyseliné octové [Pokračování] (On the Absorption of Hydrogen Chloride and Sulphur Dioxide in Sulphuric Acid and Acetic Acid [Continuation].) Napsal Václav Čupr. Čis. 69: O *W*-kongruencích s fokálními plochami přímkovými (Sur les congruences *W* dont les surfaces focales sont réglées). Napsal J. Klapka. Pp. 31. (Brno: A. Píša.)

Sborník Vysoké Školy Zemědělské v Brně (Bulletin de l'École supérieure d'Agronomie, Brno). Sign. C1: Oxydimetrické studie o antimonu (Oxydimetric Studies on Antimony). Napsal Prof. Dr. J. Knop. Pp. 22. Sign. C2: O gravimetrickém poměru mezi antimonem a antimontetroxydem (Observations on Gravimetric Proportion between Antimony and Antimony-Tetroxide). Napsal Prof. Dr. J. Knop. Pp. 10. Sign. C3: Implantace volných fragmentů kostních pomocí omenta u psů (Implantation des fragments osseux libres à l'aide de l'omentum chez les chiens). Napsal Prof. Dr. Theodor Dohnal. Pp. 18+5 tab. Sign. C4: Studie o změnách, zvláště analýtickych konstant tuku máselného, vlivem paprsků ultrafialových (A Study of the Changes, particularly of Analytical Constants of Butter Fat, under the Influence of Ultraviolet Rays). Napsal Dr. Josef Špinka. Pp. 38. Sign C5: Příspěvek k poznání nutritivního významu látek ve vodě rozpustěných pro vodní zvířata (A Contribution to the Knowledge of the Nutritive Importance of the Substances dissolved in Water for Water-Animals). Napsal Dr. Jan Podhradský. Pp. 53+3 tab. Sign. C6: Stupňování vzrůstu zvířat vitaminovými preparáty z obilních klíčků (Stimulation de la croissance des animaux par les préparations des vitamines des germes du blé). Napsal Dr. Jaroslav Kříženecký a Dr. Jan. Podhradský. Pp. 60+16 tab. Sign. D1: Rok hladu u Abies Nordmanniana Lk. 1 Část: Varianty jehlic (A Year of Hunger at Abies Nordmanniana Lk. 1 Part: The Variants of Spines). Napsal Prof. Dr. Otakar Vodrážka. Pp. 13+1 tab. Sign. D2: Synthesa škrobu u různých rostlin za přítomnosti solí vápníku a sodíku: Fysiologicko-oekologické výzkumy (The Synthesis of Starch in different Plants under Presence of Salts of Calcium and Sodium: Physiologic-œcological Researches). Napsal Prof. Vasil Sergějevič Iljin. Pp. 27. Sign. D3: Nové rody Lycoriid (s bezkřídlými samičkami) z lesní půdy (Genres nouveaux des Lycoriides (avec des femelles aptères) du sol de forêts). Napsal Antonín Vimmer. Pp. 16+1 tab. (Brně: A. Píša.)

Diary of Societies.

MONDAY, JULY 5.

ROYAL INSTITUTION, at 5.—General Meeting.

CONFERENCES.

MONDAY, JULY 5.

ROYAL SANITARY INSTITUTE (at Guildhall), at 3.—Right Hon. Neville Chamberlain: Inaugural Address.

TUESDAY, JULY 6.

ROYAL SANITARY INSTITUTE (at Mansion House, Central Hall, and Institution of Civil Engineers), at 10.—Sections A (Sanitary Science and Preventive Medicine), C (School Hygiene). Discussions: Sanitary Authorities; Engineers and Surveyors; Sanitary Inspectors.

WEDNESDAY, JULY 7.

ROYAL SANITARY INSTITUTE (at Caxton Hall, Central Hall, and Guildhall), at 10.—Sections A (Sanitary Science and Preventive Medicine), E (Hygiene of Food), F (Hygiene in Industry). Joint Session with Maternity and Child Welfare Conference. At the Royal Sanitary Institute, at 3.—Prof. C. E. A. Winslow: Appraisement of Health Administration.

THURSDAY, JULY 8.

ROYAL SANITARY INSTITUTE (at Central Hall and Institution of Civil Engineers), at 10.—Sections B (Engineering and Architecture), D (Personal and Domestic Hygiene). Discussions: Port Sanitary Authorities; Veterinary Inspectors.

FRIDAY, JULY 9.

ROYAL SANITARY INSTITUTE (at Central Hall and the Institution of Civil Engineers), at 10.—Section B (Engineering and Architecture). Discussions: Medical Officers of Health; Veterinary Inspectors; Health Visitors.

Supplement to NATURE

No. 2957 JULY 3, 1926

Some New Possibilities in Solar Research.

By Dr. GEORGE E. HALE, For. Mem. R.S.

FORTY years ago I began a series of visual and photographic studies of the sun. Recently I have returned to this work, after an interval of enforced absence. My instrumental equipment is now augmented by the addition of a spectrohelioscope, a simple device for monochromatic vision which we owe in its essence to the pioneers of solar research. This renders visible a host of important phenomena hitherto concealed from view by the overpowering brilliancy of the sun's disc. Chief among these are the radiating and absorbing regions of the hydrogen atmosphere, visible with the spectroscope in profile at the sun's limb, and revealed in projection by spectroheliograms of the disc, but now accessible, wherever they may be situated, to visual observation with instruments of moderate size.

All readers of NATURE who are familiar with its early volumes will remember the discoveries of Janssen and Lockyer in 1868. At the total solar eclipse of that year, Janssen, who was observing in India, was so impressed by the brilliancy of the lines in the spectrum of the prominences that he determined to look for them in full sunlight. He did so, and was at once rewarded. The bright light of the sky around the sun, which ordinarily hides the prominences from us, gives the spectrum of scattered sunlight. Entering the spectroscope through a slit from one to three-thousandths of an inch wide, it is spread out into a band from a few inches to forty feet in length, depending upon the dispersive power of the spectroscope. Its intensity may thus be reduced indefinitely. The bright lines of the gaseous prominences, however, are essentially monochromatic. High dispersion separates them more and more widely, without greatly weakening them. They thus become readily visible on a fainter background of dispersed skylight. The principle involved was first stated by Lockyer in 1866 and successfully tested by him in 1868, before the news of Janssen's discovery had reached Europe. This application of the spectroscope opened a new and productive era in solar physics, enlisting the active efforts of astronomers in England, France, Italy, Germany, and the United States.

Naturally these observers wished to see not merely the spectra of the prominences, but also their forms. In his well-known book, "Contributions to Solar Physics" (p. 578), Lockyer describes how the first steps were taken:

"In my first paper I gave some drawings procured by causing the slit to pass slowly over the prominence. By this means a number of sections of varying length was obtained, which, placed side by side, gave an idea of its shape. The slit then used was extremely narrow, and was radial to the sun's limb. It was obvious that in this way the true shape of the prominence could not be seen unless the slit were moved with sufficient rapidity to allow of persistent images. At the very outset Janssen and myself attempted to accomplish this, Janssen by giving a rotatory motion to a direct vision spectroscope, I by giving an oscillating motion to the slit, in which I was followed by Young, who afterwards expanded it."

Prof. Young's account of his instrument is as follows:

"The eye-piece of the instrument has an apparatus attached, which, however, thanks to the high dispersive power, I find unnecessary.

"It was early proposed by Janssen to use a vibrating or rotating slit in order to make visible the form of a solar prominence, but as Zöllner has shown, the mere opening of the slit answers just as well, the light of the protuberance being diluted to precisely the same extent in either case.

"It occurred to me in connexion with a suggestion of Professor Morton, that by interposing at the focus of the eye-piece a diaphragm which should move with the vibrating slit, the light of the neighbouring portions of the spectrum might be cut off and this dilution avoided. Mr. Clark has devised and constructed a very beautiful mechanical arrangement by which this simultaneous and accordant motion of slit and diaphragm is effected by the rotation of the small fly-wheel shown in Fig. 1.

"But I find, that although seen in this way, the prominences appear very bright; yet the working of the apparatus always causes a slight oscillation of the equatorial, which interferes with the definition of details, and I prefer to work with the slit simply opened." (Young, NATURE, Dec. 8, 1870.)

The introduction by Zöllner and Huggins of the wide slit method and the superb views it afforded of the prominences at the limb led to its universal adoption, and the oscillating slit was abandoned. Although Lockyer and Young often examined the spectra of sun-spots and other regions of the photosphere, and repeatedly described reversals and distortions of hydrogen

and other lines, I can find no indication that the oscillating slit device was ever tested for the observation of the forms of eruptions or other phenomena on the disc. Nevertheless, the credit for building the first spectro-

FIG. 1.—Active prominence, 140,000 miles high, photographed by Ellerman at Mount Wilson, July 9, 1917, with the *K* line of calcium. The small disc represents the comparative size of the earth.

helioscope (as I have named the instrument) and applying it to the observation of prominences at the limb belongs to my old friend Prof. Young, who was also the first to take photographs of the forms of the prominences through an open slit (*loc. cit.*).

THE SPECTROHELIOGRAPH.

The principle of the spectroheliograph, which does not differ greatly from that of Young's instrument with oscillating slit, occurred to me in 1889.[1] It involves the use of a spectroscope with a fixed second slit, through which a single line is admitted to a photographic plate. The whole spectroscope is mounted on steel balls, and moved slowly by a motor across the solar image, which, like the photographic plate, remains stationary. Or the spectroscope may be fixed in position, and the solar image and plate moved at the same speed across the first and second slits respectively. A monochromatic image of the sun is thus gradually built up on the plate from countless successive images of the narrow second slit.

After some preliminary experiments at the Harvard Observatory, I obtained photographs of prominences with a simple spectroheliograph at the Kenwood Observatory in the spring of 1891. In January 1892, with an improved spectroheliograph, I succeeded in photographing the chromosphere and prominences (Fig. 1) surrounding the sun and the bright flocculi[2] revealed on the disc by the use of the *H* or *K* line of calcium.

About this time Deslandres introduced the velocity spectrograph for photographing the *H* or *K* line in successive sections of the sun. Evershed soon constructed and systematically employed a spectroheliograph, and in 1893 Deslandres also began work with a spectroheliograph, which he employed for photography with the calcium lines and with some of the narrower dark lines. In 1903, with the Rumford spectroheliograph attached to the 40-inch refractor of the Yerkes Observatory, Ellerman and I first photographed the bright and dark hydrogen flocculi on the disc and noted especially the long dark flocculi (Fig. 2) identified as prominences projected against the sun (named 'filaments' by Deslandres, who has studied them extensively at Meudon with the spectroheliograph and velocity spectrograph). Five years later, at Mount Wilson, aided by plates sensitised for photography in the red, Ellerman and I discovered large vortices

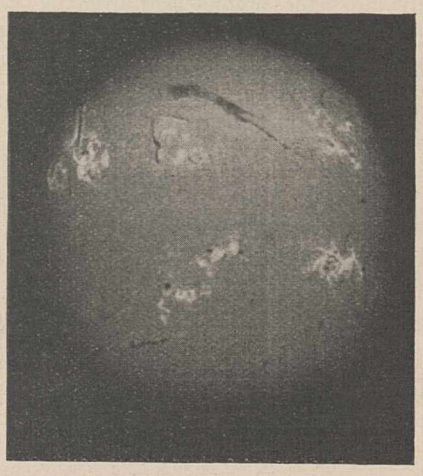

FIG. 2.—Hydrogen (*Hα*) flocculi, photographed with the 13-foot spectroheliograph at Mount Wilson, February 17, 1926, at $10^h\ 00^m$. All of these could be seen in Pasadena with the spectrohelioscope.

surrounding sunspots (Figs. 3 and 10). The Hα line, with which the vortices were found, is much more

[1] I afterwards found that it had been first suggested by Janssen, embodied in a practicable design by Braun (not constructed), and unsuccessfully tested by Lohse.

[2] Flocculi is a general term applying to all markings, bright or dark (excepting sunspots), photographed by the spectroheliograph on the sun's disc.

effective than the more refrangible hydrogen lines for the study of the hydrogen atmosphere of the sun. Its situation in the red also adapts it for visual observations, particularly at low altitude stations where smoke and haze may seriously interfere with work at the violet end of the spectrum. With a spectroheliograph of high dipsersion, *Hα* shows also the 'alignments' discovered by Deslandres, which constitute a reticular structure of wide mesh associated with the filaments.

The spectroheliograph, in addition to providing a method of photographing the chromosphere and prominences at the sun's limb, has thus made possible the daily study of the solar atmosphere in projection against the disc. But useful as it has proved, the need for a similar means of visual observation has persisted for many years.

Fig. 3.—Hydrogen (*Hα*) vortices surrounding the bipolar sunspot of September 1924, photographed by Lewis Humason at Mount Wilson with the 13-foot spectroheliograph.

The Spectrohelioscope.

My first attempts to observe the hydrogen flocculi visually were made on Mount Wilson with the 60-foot tower telescope and 30-foot spectroheliograph soon after the discovery of the *Hα* vortices in 1908. A disc carrying a large number of radial slits was mounted just above the wide first and second slits on a vertical bearing standing midway between them. Each of these radial slits, when near the axis of the collimator, thus produced a spectrum, and by adjusting the grating (or prism) the *Hα* line could be brought into coincidence with the corresponding slit on the opposite end of the same diameter. A given displacement of the first slit produced an equal displacement of the *Hα* line in the opposite direction. Thus, when the disc was rotating, the observer, looking through a positive eye-piece focussed on the slits coinciding with the *Hα* line, saw an image of a portion of the sun in hydrogen light. Unfortunately, the slits were too wide and too few in number, and for many years I had no opportunity to bring the method into effective form.

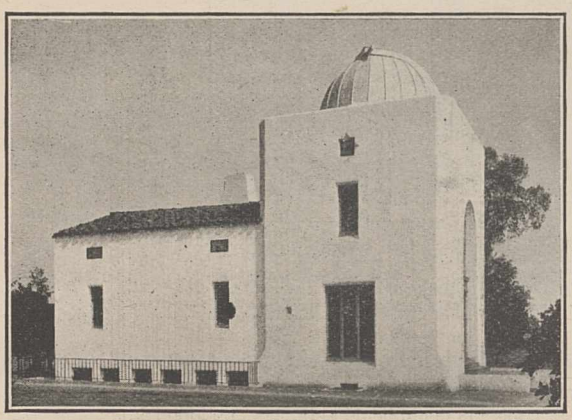

Fig. 4.—Solar Laboratory in Pasadena. The second mirror of a cœlostat beneath the dome sends parallel rays vertically downward to a 12-inch objective, giving a 2-inch solar image on the slit of the spectrohelioscope in the basement. By a simple change, a Cassegrain reflector of 18 inches aperture, giving a solar image either 6½ inches or 16½ inches in diameter, can be substituted for this objective.

In 1923 I renewed the effort, with results which have been described in these pages (Nature, October 25, 1924, p. 628). At that time, however, the apparatus was crudely mounted, and its consequent inefficiency, at a period of low solar activity, gave me no measure of its actual powers. Recently the same optical parts, now adequately mounted in my new Solar Laboratory in Pasadena (a branch of the Mount Wilson Observatory), have yielded results of greater interest.

A very brief description of the instrument will suffice. Imagine a reflecting spectroscope of 6 inches aperture and 13 feet focal length, standing vertically in a well beneath the laboratory (Fig. 5). A solar image 2 inches in diameter is formed on the slit by a 12-inch objective.

A cœlostat, with second mirror, mounted beneath a dome at the summit of a low tower (Fig. 4) sends parallel rays of sunlight vertically downward to the 12-inch objective, which stands 18 feet (its focal length) above the slit. Electric slow motions, controlled by buttons within easy reach of the observer, permit the objective to be focussed and the solar image to be moved in any direction across the slit. Thus all parts of the limb or disc can be examined in quick succession.

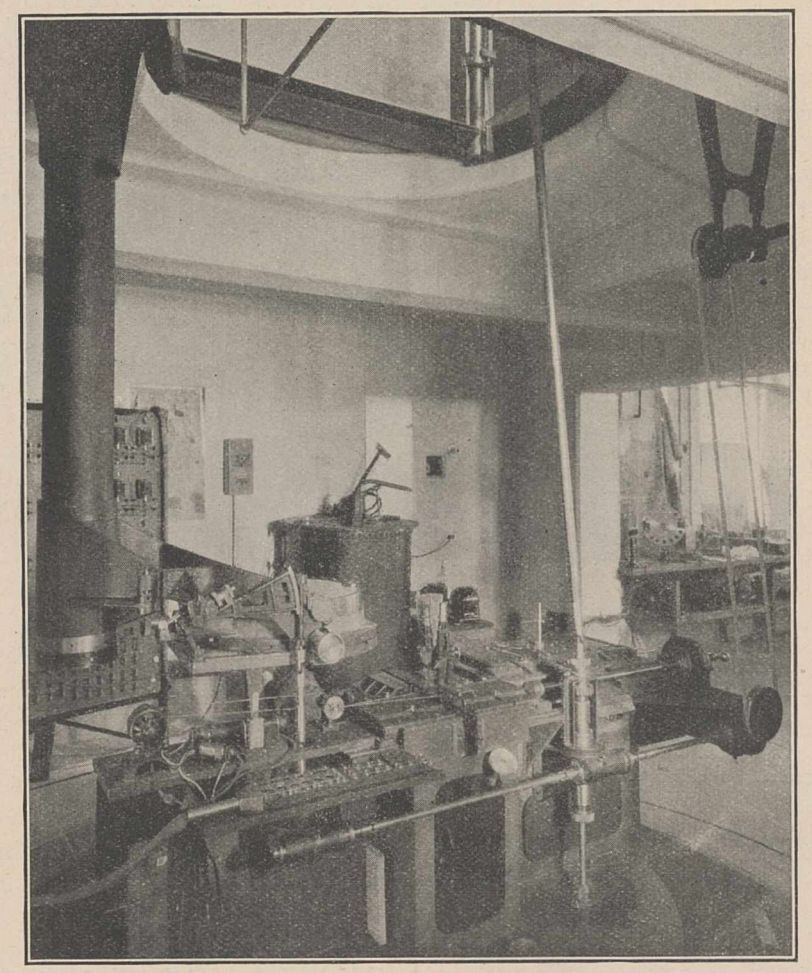

FIG. 5.—Upper end of combined spectrohelioscope, spectrograph, and spectroheliograph, mounted vertically in a well 10 feet in diameter and about 80 feet deep. The oscillating slit-bar and binocular eye-piece may be seen near the middle of the instrument. These are ordinarily employed with a reflecting spectroscope of 13 feet focal length, also designed for use as a spectroheliograph. By turning its optical parts out of the way, the instrument is transformed into a Littrow spectrograph of 75 feet focal length, suitable for researches on the magnetic fields in sunspots.

The second slit lies in the plane of the spectrum, formed by a large plane grating, ruled by Jacomini on the ruling machine of the Mount Wilson Observatory. The first order spectrum, which is very bright, is usually employed. The *Hα* line is brought into coincidence with the second slit, which is narrower than the (dark) line. The slits are carried at opposite ends of a horizontal bar, which can be oscillated (usually through a range of a quarter of an inch) about a bearing half-way between them (Fig. 6). As the optical arrangements are such that the second slit constantly bisects the oscillating *Hα* line, a monochromatic window, one-quarter of an inch wide, is thus provided through which to view the sun. A positive eye-piece magnifying about 2·5 diameters, mounted on the binocular body of my Spencer microscope, is used for observing the hydrogen atmosphere through this window. The speed of the driving motor is fast enough to give a persistent image. As the (visible) length of the window thus employed is about half an inch, a considerable portion of the 2-inch solar image can be seen at once.

I was agreeably surprised when I first tried this apparatus on January 16 of the present year. I knew from previous experience that the prominences at the limb and the more conspicuous dark and bright flocculi on the disc would be visible, but I was scarcely prepared for the delicate details of structure, both dark and bright, which appeared in good contrast on the disc. At that time (as in the earlier work) I was using five

slits at each end of the bar, instead of one. These were only one-twelfth of an inch apart, restricting the field of view to this width. The central image in the eye-piece, corresponding to the *Hα* line, was flanked on either side by brighter images of the same region, formed by the light of the continuous spectrum. Thus, in examining a spot region the hydrogen flocculi above and about the spots could be seen in the central image while the underlying spots and photosphere appeared in the side images—a convenient means of comparison. Frequently in the hydrogen image the spots are entirely concealed by flocculi, and in tracing the spiral structure in a vortex to its objective, it is advantageous to be able to see the spots simultaneously. For this and other reasons two or more second slits may sometimes be preferred to one. By means of a special device, however, similar comparisons can be easily made with only one second slit.

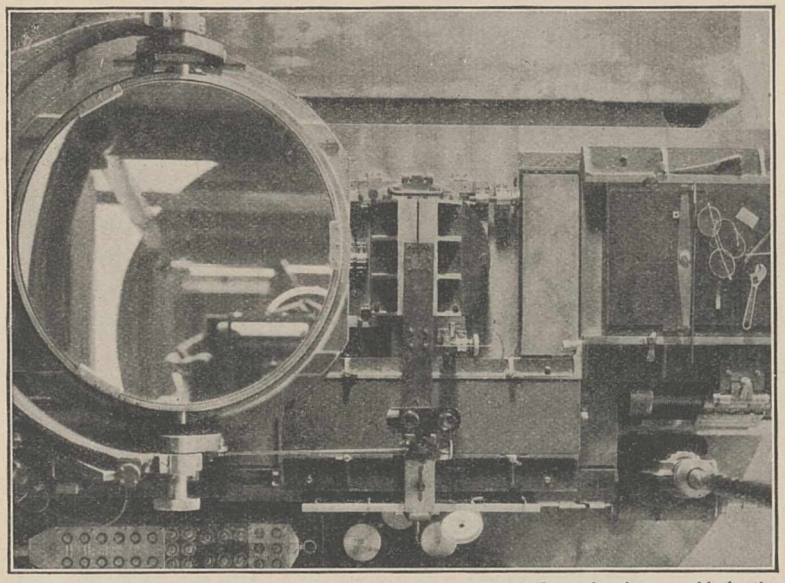

FIG. 6.—Plan of spectrohelioscope. The oscillating slit-bar, mounted on a bearing movable by the micrometer screw near the centre of the photograph, is driven by a motor at the left (shown in Fig. 5). The observer looks through the binocular eye-piece, which is focussed on the second slit. The 18-inch concave mirror of the Cassegrain reflector, the driving mechanism and sliding plate-holders of the spectroheliographs, and the buttons for electric control, may also be seen in the photographs.

Exploring the Solar Atmosphere.

As a quick and effective means of exploring the entire solar atmosphere the spectrohelioscope is unrivalled. In a few minutes one may run completely around the limb, not only observing the chromosphere and prominences projecting beyond it, but also following with equal ease those which extend on to the disc and appear there as dark absorbing masses. Such a prominence, from a spectroheliogram taken some years ago by Ellerman on Mount Wilson, is illustrated in Fig. 7. It will presently appear why objects of this nature can often be better seen with the spectrohelioscope than they can be photographed with the spectroheliograph.

The utility of the spectrohelioscope as a scouting auxiliary of the spectrograph or spectroheliograph is thus apparent. Hitherto the observer with these instruments has often worked blindly, not knowing in advance what phenomena of the solar atmosphere lie between him and the visible structure of the photosphere. A few minutes of visual observation may now enable him to select interesting regions for special study, or to avoid areas where eruptions, vortices, or other active phenomena may interfere with measurements requiring a more normal state of tranquillity. Such selections can also be made with the spectroheliograph, but far less quickly and effectively. The fact that very different phenomena are observed when the second slit is set on different parts of the *Hα* line is a vital factor here.

Effects of Level and of Radial Motion.

In our early work with the spectroheliograph, M. Deslandres and I independently utilised the principle of photographing cross-sections of the calcium flocculi at different levels by setting the second slit in successive exposures at various distances from the centres of the *H* and *K* lines. As these lines widen in descending through the calcium atmosphere toward the photosphere, it is obvious that if the second slit is set at a given distance from the centre, none of the higher

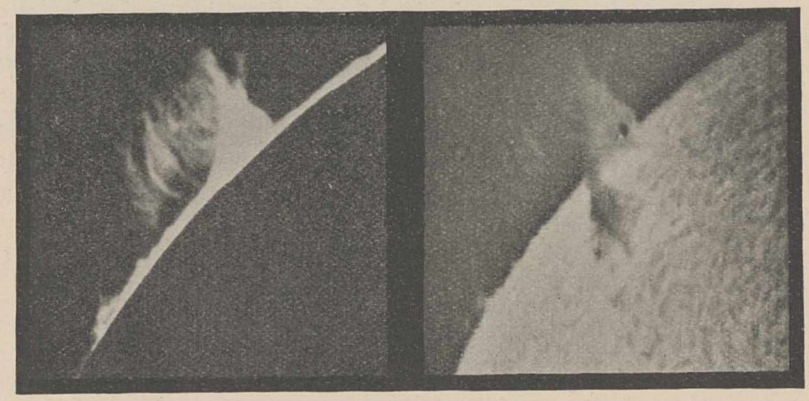

FIG. 7.—Solar prominence partly projected upon the disc, photographed by Ellerman at Mount Wilson with the 13-foot spectroheliograph (using *Hα*) May 22, 1916. At the left is a longer exposure of the same prominence, made with the disc covered.

calcium vapour, which gives a narrower line, can be included in the photograph. Similar work was afterwards undertaken with the hydrogen lines, where the second slit compatible with good definition and contrast.[3] But the discriminating power of high dispersion is very advantageous in many cases, and a means of utilising it without the limitations incident to the simultaneous use of only two second slits, or the delays involved in making a series of exposures like that in Fig. 8, is clearly desirable, especially in the case of rapidly changing eruptions. This is afforded by the spectro-helioscope, because of the ease of quickly shifting the position of the $H\alpha$ line on the second slit while observations are in progress. Of the various devices I have employed for this purpose, perhaps the simplest is a piece of plane parallel glass, mounted on trunnions just below the oscillating second slit. When this glass plate is tipped up or down, the line is displaced to red or violet. A scale in the eye-piece shows the exact position of the line on the slit. This is readily converted into a 'blink' apparatus for comparing the images of the flocculi corresponding to the red and violet edges of the line. An electro-magnet for tipping the plate and two adjustable stops to define its limits serve for this purpose.

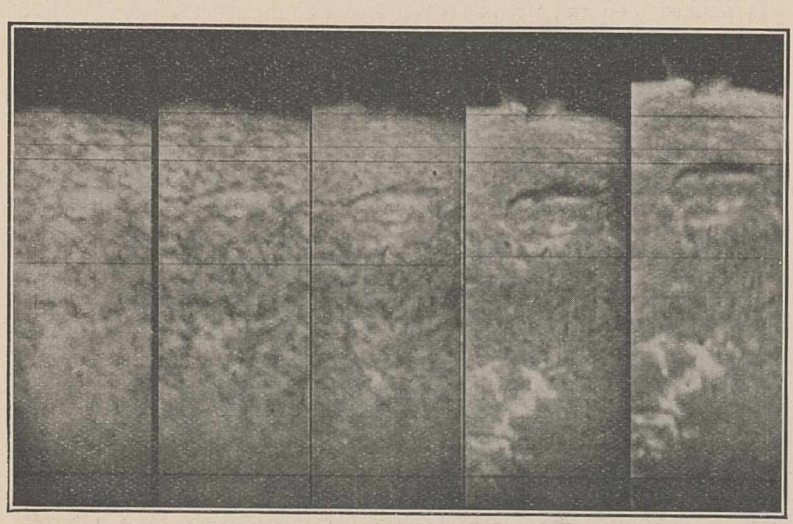

FIG. 8.—Five exposures by Ellerman with the 13-foot spectroheliograph, showing the changes in the flocculi corresponding to second-slit position, ranging from λ6564·36 (left) to the centre of $H\alpha$ (May 29, 1916).

velocity of the gas in the line of sight is often of greater significance than its level.

Fig. 8 illustrates the different appearances of a given region of the solar atmosphere when photographed with the second slit at various distances from the centre of $H\alpha$. Many studies of this kind have been made at Mount Wilson, and these have been supplemented by other investigations based upon photographs taken with a single first slit, an optical system giving two spectra of the same region of the sun, and two second slits, one set on the red side of $H\alpha$ in one spectrum, the other on its violet side in the second spectrum, equidistant from the centre of the line. Two photographs of the same region of the hydrogen atmosphere thus obtained simultaneously often show remarkable differences, as Fig. 9 illustrates. In this picture of an active spot region the bright eruptive flocculi appear in both photographs, because the corresponding bright $H\alpha$ line was wide enough to overlap both of the second slits. The dark flocculi, produced by the cooler gas at a much higher level, gave a narrower line, displaced to the red because of the rapid descent of this gas. The structure of this rapidly falling gas is consequently shown only in the lower photograph, made with the second slit set on the red side of the line.

The power of the spectroheliograph thus to single out gaseous masses moving rapidly in the line of sight is one of its most valuable properties. This effect can be minimised, if it is desired to record on a single plate all bright and dark flocculi moving at moderate radial velocities, by using the lowest dispersion and widest

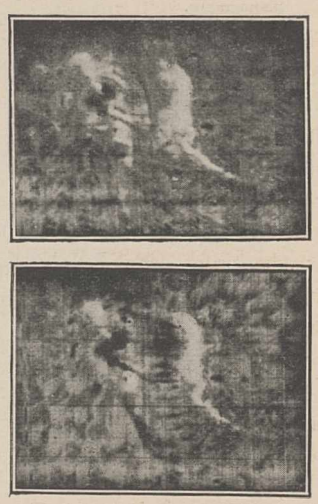

FIG. 9.—Two photographs of the hydrogen flocculi associated with an active sunspot group, made simultaneously with light from the violet (upper) and red (lower) sides of the $H\alpha$ line. The bright eruptive regions are similar in the two cases, while the lower photograph shows also the dark flocculi caused by the absorbing gas at higher levels, descending toward the photosphere.

With a device of this kind, or with a micrometer screw which permits the oscillating bar (and thus the second slit) to be displaced toward red or violet (shown near the centre of Fig. 6), it is fascinating to watch the changes in the appearance of the flocculi, and to distinguish between ascending and descending gases. In fact, we have here a special means of analysing the $H\alpha$ line and of separating the complex elements of which it is composed. Areas in the solar atmosphere which give rise, for example, to bright $H\alpha$ lines dis-

[3] Or (if higher dispersion is employed) the $H\alpha$ line may be caused automatically to move back and forth across the narrow second slit during the exposure.

placed toward the red frequently lie in the line of sight or in such close proximity that they cannot be distinguished in photographs of the *Hα* line in the spectrum of the region. Thus in measuring the displacement of this line near spot groups or in other parts of the sun's disc we are dealing with an integrated effect, representing the superposition of the various *Hα* lines given by the superposed or closely contiguous areas in question. With the spectrohelioscope many of these areas can be separately distinguished and their radial velocities determined by moving the line back and forth over the second slit and noting the displacement from its centre, towards red or violet, when a given bright or dark structure reaches its maximum of intensity. Furthermore, the width of the bright or dark *Hα* line corresponding to any detail of structure can also be measured by taking the scale readings, to red and violet, at which this structure disappears. Indeed, it would not be difficult, by a simple photometric device, to determine the exact intensity curve of the line given by any of the small flocculi.

I am referring to observations within the boundaries of the dark *Hα* line and its two wings (each of which is about as wide as the dark line itself), and not to the large local displacements which are often seen in or near active spot groups. It should be added, however, that the spectrohelioscope is also well adapted for the observation of the rapidly moving gases which give rise to these large displacements. The form of the gas moving at any given velocity can be seen by setting the oscillating slit at the corresponding distance from the centre of the line.

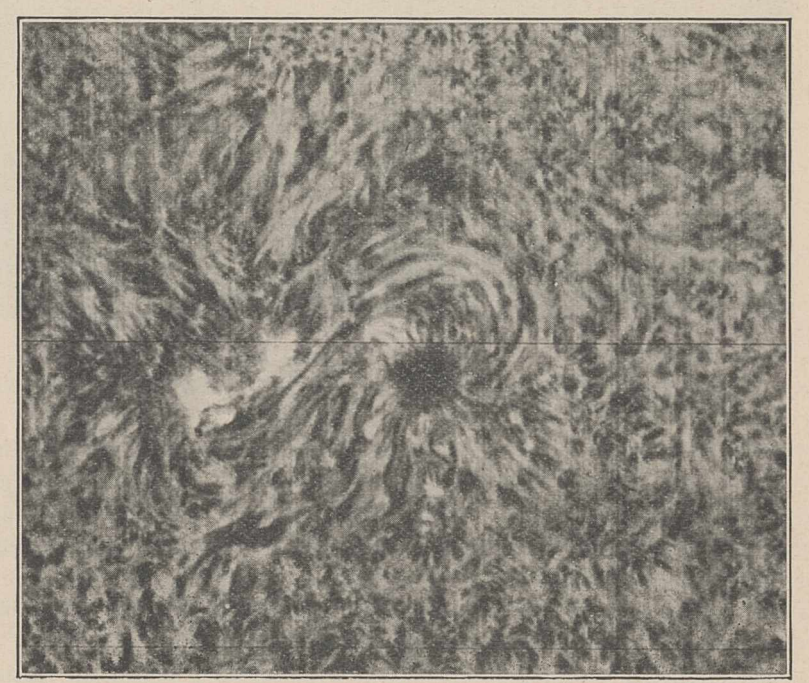

Fig. 10.—Hydrogen (*Hα*) vortex photographed by Benioff at Mount Wilson with the 13-foot spectroheliograph. Simple vortices of this character are selected for determining the law of storms in the solar atmosphere.

Prominences, Filaments, Vortices, and Eruptions.

Even for the observation of prominences projecting outside the limb, the oscillating slit has some advantages over the wide slit. This is because the former shows them in essentially monochromatic light, and thus often permits details to be seen which are confused with a wide slit because of the superposition of gaseous masses moving at different velocities in the line of sight. By setting the oscillating slit on different parts of the line, portions of the prominence moving at different velocities can be seen separately, as in the case of the flocculi just cited. Prominences in which there are marked internal differences of radial velocity sometimes do not appear at all on the disc at the slit position which shows them best outside the limb. A turn of the micrometer screw, however, suffices to reveal them in strong contrast, either as filaments or in other forms.

This suggests the use of a spectrohelioscope as a guiding device for a spectroheliograph, permitting the *Hα* line to be frequently readjusted on the second slit of the latter instrument during exposures, so as to record all phenomena at the limb and on the disc in strongest contrast. The spectrohelioscope itself may also be used for photography, either in the form described here, provided with an auxiliary camera and right-angle prism for visual observations between exposures on small areas; or as a spectroheliograph with oscillating slits, capable of photographing the entire solar disc. With the former arrangement, the changes in the appearance of given areas when *Hα* is moved across the second slit may be recorded, perhaps even in the form of moving pictures.

I cannot dwell, however, on the remarkable phenomena thus brought to view. Some of them are illustrated in Figs. 2 and 11, but these spectroheliograms are quite inadequate to show the delicate details,[4] and they of course fail to indicate the effect of shifting the line on the slit. Brief reference should be made, however, to observations of vortices and eruptions.

I have previously described in Nature our researches

[4] This remark refers to our spectroheliograms with 2-inch solar image. The details of the vortex structure are best shown by our spectroheliograms of the 6½-inch solar image given by the 60-foot tower telescope on Mount Wilson (see Figs. 3 and 10). I am not yet certain whether the most delicate details on such photographs can be so well seen with the spectrohelioscope.

at Mount Wilson on the law of sunspot polarity.[5] This is part of a more general investigation on the law of whirling storms in the sun, which we find to be much more complicated than the terrestrial law. The bipolar vortices which constitute typical sunspots are of opposite polarity in the northern and southern hemispheres of the sun, and these polarities are reversed at each sunspot minimum. The available evidence favours the view that this magnetic change is due to a reversal in the direction of whirl in the vortices that produce the spots and their magnetic fields. These vortices in the photosphere are accompanied by secondary vortices in the overlying atmosphere, recorded (as in Fig. 10) by the spectroheliograph. From a preliminary study[6] it appears that the direction of whirl in about 80 per cent. of the high-level vortices accompanying single spots (or the preceding spots of bipolar groups) corresponds with that of terrestrial storms, and does not reverse at sunspot minima.

The above results were derived from an examination of spectroheliograms, but I have found the spectrohelioscope a very useful means of continuing the investigation. If, as often happens, a prominence (or filament) occurs as a dark flocculus near a spot, its spiral form may at once indicate the direction of whirl in the vortex. Owing to differences in radial velocity, a slight change in the position of the *Hα* line on the oscillating slit is frequently necessary to show such a vortex clearly. For detailed studies of vortex structure and changes of form, both in plan on the disc and in cross-section at or near the limb, the spectrohelioscope has also shown its efficiency.

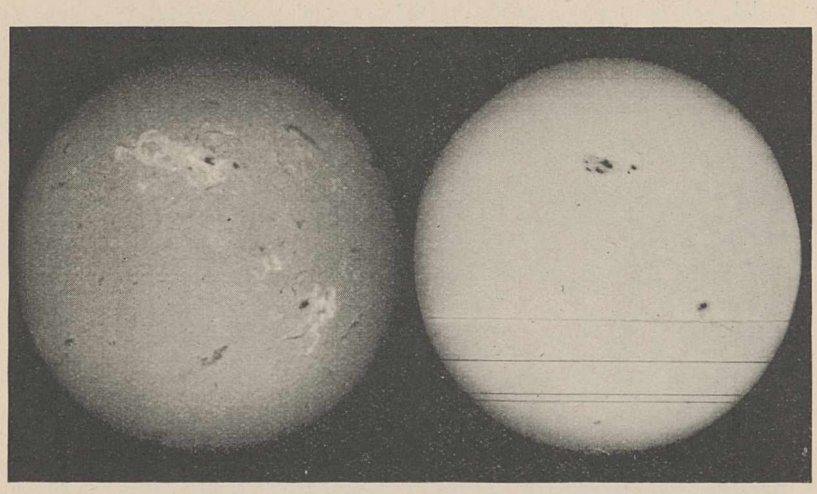

FIG. 11.—Bright eruption in great sunspot group at 22° N. latitude, photographed at Mount Wilson with the 13-foot spectroheliograph, January 24, 1926, at 9h 34m Pacific standard time. The image on the right is a direct photograph of the sun, obtained simultaneously with hydrogen (*Hα*) image on the left. This eruption was detected independently in Pasadena with the spectrohelioscope.

This instrument is also of great service for the detection of such violent outbursts on the sun as I observed on January 24 (Fig. 11) and 25, 1926, preceding the great aurora and magnetic storm of January 26 and 27 already described in NATURE (February 6, p. 208). The eruption, which continued for several hours on January 25, surpassed in brilliancy all solar phenomena I have ever before seen, and exhibited rapid changes of form.[7] Because of the ease of glancing occasionally during the day at probable regions of activity, and of instantly finding the best possible position of the second slit on *Hα*, the spectrohelioscope should greatly assist in determining the true relationship between solar eruptions and terrestrial auroras and magnetic storms. If, as I hope, an inexpensive instrument can be built for the use of amateurs, the chances of detecting the exact moments of critical outbursts will be greatly multiplied. A small spectrohelioscope for this purpose, and improved oscillating and rotating slits to replace the oscillating bar hitherto employed with the 13-foot spectrohelioscope, are now under construction and will soon be ready for trial.

[5] "Sunspots as Magnets, and the Periodic Reversal of their Polarity," NATURE, January 19, 1924, p. 105.

[6] Hale, "A Test of the Electromagnetic Theory of the Hydrogen Vortices surrounding Sunspots," *Proc. Nat. Acad. Sciences*, **11**, 691-696, 1925.

[7] For a brief description of these observations, and some suggestions regarding other applications of the spectrohelioscope, see "Visual Observations of the Solar Atmosphere," *Proc. Nat. Acad. Sciences*, **12**, 286-295, 1926.

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*