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National Needs.

"The great trouble is that the civilisation of to-day is still of a very low degree. We talk big and think small. Only a few of us even know how to read . . . we need a long initiation in almost any subject before our reading about it is likely to be of any value."—ELLWOOD HENDRICK : "Percolator Papers".

THE present sore trouble of the world, which has long been surely coming upon us owing to the inconsidered action of all nations, will not be without its compensations, if we be led to probe into the causes and to reorganise our operations upon considered lines.

The call is upon us all to turn our attention to affairs of State. Scientific workers especially have to recognise that they have been selfish in their too exclusive devotion to experimental study and the immediate development of their discoveries ; that they have soared entirely above the heads of the community and in no way prepared the masses to understand the profound changes brought about in our life by the scientific forces at work in industry. Brains and brawn were never so far apart as now. Although this is the case, it was never so clear that a wise socialism is foreshadowed as the only possible way of avoiding the downfall of our civilisation. In some way or other, the nations must come to work together. Competitive industry, as we have known it in the past, is ceasing to be possible : it pays no one and is but a disguised civil war. Mechanisation is bringing about its own defeat : the cost of displacing human labour is becoming prohibitive. Man is ever there ; capital will not long be, at present rates of taxation : we shall soon be forced to return to *manu*factures.

The chief duty before us clearly is—to make all men work : a machine which is idle has no right to be. Nature herself ever works and necessarily dies if she cannot. Man alone of her works is ceasing to be natural and fast becoming a mere parasite.

The country is now in the hands of a Government elected upon a National ticket ; the popular expectation is, that it will be Rational and rise superior to party. There is, however, an ominous preponderance of men of rigid outlook bearing political labels ; few are known to profess a belief in government by scientific methods. Probably the Prime Minister alone can attach any real meaning to the term 'scientific'. He was long an attendant at Royal Institution lectures and grew up in a scientific atmosphere. Very remarkable, at the recent Faraday celebration in Queen's Hall, was the entirely sympathetic way in which he entered into the spirit of the occasion, outshining all other speakers in clearness of perception of the service rendered to the world by Faraday, especially the moral value of the example set by this great experimentalist. His father-in-law, we know, was the most sympathetic of Faraday's biographers. Probably Sir John Simon comes next to Mr. MacDonald. He at least has breadth of outlook and a severely logical mind.

It is much to be feared that the men who have taken upon themselves to govern us cannot possibly fathom the depth of present-day world activities: the overwhelming complexity of the issues; the subtle problems they present; the hopeless difficulty of meeting the naturally selfish dictates of human nature. Earl Grey being all but out of action, there is no prophet in the field of politics. We need a Disraeli, a man of imagination, able to grasp our modern problems and be a constructive leader. If the recent election have shown one thing more than another, it is that the country is prepared to follow a clear lead. In this particular, Mr. MacDonald and his small band of devoted followers have set a noble example.

Nothing could be more definitely painted upon the wall than the failure of our public schools to train the ruling classes in any proper way. The 'science' introduced into them has been to no purpose—no effective teaching has been given in the logic of method. Consequently, the calculated practice of scientific argument—the habit of sound scientific thought—plays no part in our affairs; it has no considered place in our Civil Service. This is one of the matters of urgency, calling for fullest consideration, at the present moment. Unless and until our universities and schools are brought into harmony with the times, no real progress can well be made. Oxford most needs reformation: the present neglect of a broad culture by the University is a national danger. As to the schools, it should be deemed a criminal act to bring up a boy or girl upon literary study alone, without training in the judicial method.

Our schools still teach little more than the worship of words and those largely words of the past. The men in charge of them, with few exceptions, have no feeling for the wide issues of practice and scientific leadership. We are a strange people: intensely practical in our general outlook, we place ourselves in the hands of those who cannot possibly become masters of the intricate situation which confronts us. Teachers as a class in no way grasp the responsibilities of their position, let alone the dangers of the times. They are too much of one school and, with rare exceptions, of an unadventurous type. Complaint of the inflexible nature of the material they produce is rampant everywhere.

Lafcadio Hearn, writing from Japan, in August 1893, in an outspoken letter to Ellwood Hendrick, after remarking how terribly tragic modern life is becoming, directs attention to its hopeless contradictions. These, he says,

"can only be recognised and reconciled through a profound knowledge of social conditions, not in the abstract only but in the most complex operations. This is the theoretical recognition. The practical recognition requires special hereditary gifts—intuitions—instincts—powers. Mere education in business alone won't do. That only makes servants. Masters must be natural masters of men. Life is an intellectual battle but not a battle to be fought out by mere chess-combinations. It is also a battle of characters. . . . I do not see much likelihood of moral development . . . morals have been at a standstill since the beginning of history: we have made no apparent progress in that. Then comes the question, Are we not developing immorally?"

There can be little doubt as to the answer. The Hollywood atmosphere in which the masses now live—the scorching, motor habit, developed as a mere means of escaping from the boredom of mental vacuity—the condition of the Press, which for the most part has no soul beyond sexuality and sport: all these things are proof sufficient that there is no real intellectual progress to be recorded. The masses have learnt to read—but "the hungry sheep look up and are not fed". The body scientific—those who hold the keys of knowledge—makes no calculated effort to provide them with food. The literary class, as a body, has no message; brought up upon words alone, with myopic uncultivated vision, it can only use words to describe the obvious.

Not so long ago, starting from Huxley and Herbert Spencer, a body of men representative of natural science, in its various branches, made a determined effort to galvanise the schools into practical scientific activity and make education an introduction to life: the attempt has been a failure. Scarce any of the band remain. Modern scientific workers—the professional researchers—no longer take interest in such matters. Occasionally someone kicks: Prof. Irvine Masson is the latest example. The bookmen hold the field: what public conscience there may be is stilled by free education and scholarship grants. We have little right to complain of politicians, so long as we make no effort to train them to their office by bringing about the revolution which every thinking man knows to be long overdue in our school system.

Meanwhile the industrial shoe pinches terribly. There isn't enough leather to make it a comfortable fit. We are so pampered into the belief that we can live on industrialism, that no real thought is given to the problem as a whole. The fetish of what is supposed to be cheapness is worshipped without any consideration of its consequences. No sense of the meaning and value of agriculture has been bred into the community.

The mathematicians can discuss the Unseen Universe with great popular effect. Yet they make no attempt to stem the ignorance of the money-changers or help them to devise a rational system of banking which will enable us to do without the gold we cannot have, wherewith to back the counters issued as money—so that commerce may be controlled and its operations made facile, not the sport of speculators. The multitude obviously does not understand the meaning of the term *standard*: the professed economists have not the wide equipment that is needed for their task.

Men now need to be so trained that they learn to work together—without losing their souls. No trade to-day is free; some combine is at work which prevents each one from being fair. So long ago as 1894, Hearn could write to Hendrick prophetically:

"The tyranny of the future must be that of Organization: the monopoly, the trust, the combination, the associated company . . . much more powerful than the robber-baron . . . these are infinitely less human—having no souls."

Hearn spoke as an artist, of course. Still, his plaint is justified in a tyranny such as is being exercised over milk production, by the great combines now coming into action as universal purveyors. Water has long since passed into public control: milk someday perhaps will be seen to be of even greater consequence and cared for properly.

We have no food sense worth calling a sense: biology to this end is not taught in the schools; women decline to cook and are deluding themselves into a belief in canned foods. Our ignorance of all essential things is monstrous. Scared by a few bacteria, we systematically spoil our milk. We are even threatened with synthetic food. Machinery, using the sunshine of past ages, is to put the nose of our present sun out of joint and make the farmer a back number. Our only salvation is the natural horse sense that is in us. Meanwhile, proof is being quietly accumulated that if we but choose to cultivate our land with considered care and knowledge, we can make not two but many blades of grass to grow where one is now starved—and largely feed ourselves, with food of a quality unprocurable from elsewhere. These are the things to be considered in framing our national, rational policy. Fair trade in food should be the first demand satisfied, however tentatively we may proceed. To this end, we need to develop a great scientific organisation. The farmer's chief protection should be—our determination to help ourselves!

In future, the scientific worker, to be worthy of the name, must justify himself through social service in the first instance. Our situation is so grave that he must be militant without delay and in every quarter.

H. E. A.

A Doctrine of University Functions.

Universities: American, English, German. By Abraham Flexner. Pp. ix+381. (New York, London and Toronto: Oxford University Press, 1930.) 16*s*. net.

THIS volume is an expansion of three lectures, given at Oxford in 1928, which excited a considerable amount of journalistic comment by reason of the author's severe animadversions upon the University of London. Apart from sensational attractions of that kind, any study of the functions and organisations of universities written by so well-informed and acute an inquirer as Dr. Flexner is bound to be worth careful attention; and a dispassionate reader of the present book must admit that it is a weighty and timely work, in which the author has set down, with the utmost directness and clarity, criticisms and positive views that demand the anxious consideration of all who are concerned with university policy.

In the courageous performance of his task, Dr. Flexner has felt obliged to dwell long and to fall heavily upon the errors and follies of certain universities. No one could accuse him here of patriotic partiality; for if he has chastised the University of London with whips, he has chastised some of the greatest of American universities with scorpions. Indeed, the reviewer felt that it was indecent for him, a foreigner, to be present at the merciless castigation of these famous institutions; and, in his embarrassment, turned over quickly the more deeply ensanguined leaves. Doubtless it is salutary for an institution to have its sins shown up without fear or favour, but in doing the thing so thoroughly Dr. Flexner has incurred certain risks. Human nature being what it is, there is the possibility that the institutions which might have profited most from his admonitions will harden their hearts against him and seek to defend their ways; it is also possible that the great achievements of the universities which fall most under the author's scourge may be forgotten, notwithstanding his generous praise; and above all, there is the danger that the reader's attention may be distracted from the main purpose of the book—which is to develop a positive doctrine of university functions and to use criticism of activities which the author regards as misguided simply to throw into clear relief those which he deems to constitute the proper work of a modern university.

Dr. Flexner's idea of a university (he borrows the phrase, of course, from Cardinal Newman) is expounded in the first chapter. Universities, being highly representative organs of national consciousness, must differ, sometimes in important features, in different countries; but in the ideal university "we should see to it that in appropriate ways scholars and scientists would be conscious of four major concerns: the conservation of knowledge and ideas; the interpretation of knowledge and ideas; the search for truth; the training of students who will practise and 'carry on'" (p. 6). Here, in brief, is the theory which, expanded in an illuminating manner in subsequent pages and from time to time throughout the book, is the basis of his criticism of what is, and of his hopes with regard to what may be. In the author's view—constantly reiterated—universities should resolutely concentrate upon the 'concerns' he has laid down for them, leaving other educational functions, however important they may be, to be carried out elsewhere.

This does not mean that universities are to be cloistered institutions, remote from the world and its practical problems. On the contrary, a main charge in Dr. Flexner's indictment of existing universities is that they fail to recognise fully their obligation to give intellectual guidance to the community; that they suffer too wide a 'social lag' to exist between their interests and activities and the urgent problems of the day; and that they confine their study of those problems within far too narrow a field. His point is that while a university should care greatly about the important problems that arise in the practice of any of the major professions, such as engineering, medicine, or teaching, or in the practice of government, or in the sphere of economic relations, its attitude towards them must be strictly theoretical: that is, it must seek to solve the problems but has no concern with exploiting the solutions. Having solved one problem, the university research worker must pass on to another, leaving developments and practical applications to those concerned with them.

One can scarcely fail to recognise the nobility of Dr. Flexner's concept of universities as places where thought and disinterested inquiry are pursued upon the highest levels, and where the best minds of each generation are trained for intellectual achievement. It is perhaps realised most closely at the moment in the Hebrew University of Jerusalem, an institution finely directed and inspired, and as yet uncorrupted by age or prosperity. Among the universities which Dr. Flexner reviews, none rises so near to his ideal as this shining example; but Oxford and Cambridge and the German universities come nearest. It is a relief to an Englishman's fears to find our ancient universities placed so high, and it is also interesting in view of the serious discrepancy between their practices and the author's canons of university behaviour.

Judged by those canons, Oxford and Cambridge give far too much attention to what is in effect secondary education, and have been misled (Jowett's work at Balliol is the capital instance) by the notion that training for service is a proper function of a university. Nevertheless, there is in them something, a little difficult to explain, which makes them great institutions of learning. They have their honours schools, and they permit—though it can scarcely be said that they help—men of outstanding force to become centres of really advanced work and thought. Above all, their traditions make it impossible for them to degrade their dignity and to waste their spiritual resources by pandering to the demands which have drawn American universities so far from the true path. There remains, however, very much to be done if they are to play the part that modern universities should play in the affairs of a great nation and in the interests of civilisation as a whole; and many pages are given by Dr. Flexner to the detailed exposition of his ideas as to the directions which the required developments should take.

Dr. Flexner cannot understand in what sense the University of London is a university at all. The institutions which it comprises are too heterogeneous in quality and purpose, and the control exercised by the central machinery over policies is too limited and indirect to secure the unity essential to a real university. Moreover, he finds much to criticise in the constitutions and powers of the two highest organs, the Court and the Senate. Incidentally, in stating (p. 237) that the Court "contains no professors", the author makes an error which could so easily have been avoided that one is led to wonder whether his statements of fact elsewhere may not be vitiated by mistakes which tend, as in this instance, to give improper support to important inferences. It may be further noted, in this connexion, that Dr. Flexner does not mention that the statutes ensure in the Court a clear majority of persons who are also members of the Senate—a provision which makes very remote some of the evil possibilities he foresees.

The greatest weaknesses of the University of London as Dr. Flexner sees it are, first, that, regarded as the body governing its constituent institutions, it is almost entirely external to them all, and next, that some of the constituent institutions and much of the work done in most of them have no proper place in a university. To some extent the provincial universities fail in the same way ; but their unity saves them, and, on the whole, they represent—as do the American State universities—" an amazing achievement within a brief period ".

It is not possible to summarise here Dr. Flexner's interesting and sympathetic account of the German universities. It is well known that there are several respects in which their position and methods contrast almost violently with those of the English universities. Most conspicuous is their dependence upon the State and the way in which, notwithstanding that dependence and the evils it has recently brought about, they have, on the whole, conserved their *Lehrfreiheit* and *Lernfreiheit*. Equally characteristic and different from English practice is the responsibility they cast upon the student, who " is treated as a man from the day he matriculates ".

It would also take too long to consider Dr. Flexner's treatment of important specific problems of university work and organisation—such as the organisation of medical research and training, upon which he writes with admitted authority. On the other hand, the reviewer cannot resist making an attempt to set down some of the doubts with regard to Dr. Flexner's theory of universities which his admiration of the author's largeness and loftiness of view has not prevented from rising.

One of the greatest of American teachers once voiced a distrust of all " rational, clear-cut, temple-like " systems of thought. William James's epithets together with the feeling they expressed come into one's mind in contemplating Dr. Flexner's conception of the educational institutions of a country with the universities, Olympian in their elevation and their detachment, at the top. One questions whether the universities can perform with full efficiency the high, abstract functions he rightly allocates to them, if their activities are restricted to those functions with the rigour which he would enforce. Granted that a university may (for the sake of the fees) give too much attention to ' secondary ' teaching, and may be tempted (for the same reason or better ones) to interpret too widely its duty in the matter of ' service ', is it not true, nevertheless, that some contact with these things, in their higher, more definitely intellectual forms, is necessary to preserve in the loftier regions of the institution a proper balance and sense of reality ?

The argument is put here from the point of view of the university. From the point of view of professional or ' service ' institutions, it seems obvious that direct contact with the spirit of exact inquiry which lives in a university, and with the atmosphere of intellectual adventure which should prevail in it, is the best if not, indeed, the only means of maintaining a high level of professional teaching and study. Dr. Flexner's opinions here (we respectfully suggest) are influenced by a view of the " training of the mind " which any psychologist (if he believed in psychologists) would assure him is sadly out of date. This is illustrated by his story of the professor's wife whose " powers trained elsewhere " enabled her to produce " an excellent loaf ", and of the " astonished Bridget's " comment : " That's what education means—to be able to do what you've never done before ". In brief, Dr. Flexner's censure of the ' service ' activities of universities—where they are not plainly justified by the low intellectual level of the institutions condemned—is based upon an uncritical acceptance and a far too sweeping application of Bridget's theory of education.

Lastly, it seems possible that the same tendency to take an abstract and too simplified view has prevented Dr. Flexner from doing justice to the University of London. One would gather from his pages that the good work done in the more important institutions is done in spite of the constitution rather than with its aid ; yet that is by no means the view held, as a rule, in the institutions themselves. For example, Prof. Hearnshaw's centenary history of King's College shows how that institution was rejuvenated—one might almost say recreated—by entering into the new teaching university ; and Sir William Beveridge recently gave impressive evidence of how the peculiar combination of autonomy with central control, which Dr. Flexner finds so illogical, serves to foster the individuality of the colleges, while tending to maintain common standards of efficiency—to say nothing of a common university consciousness—in all. But to offer these critical remarks is not to deny the outstanding importance of a book the value of which will become more clear the more thoroughly it is studied.

T. P. N.

Laboratory Technique in Physical Chemistry.

Ostwald-Luther Hand- und Hilfsbuch zur Ausführung physiko-chemischer Messungen. Unter Mitwirkung von W. Bothe, W. Gerlach, R. Gross, H. v. Halban, R. Luther, F. Paneth, F. Weigert. Herausgegeben von C. Drucker. Fünfte, neubearbeitete Auflage. Pp. xix + 979. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1930.) 52 gold marks.

"OSTWALD-LUTHER", the preface to the first edition of which is dated 1893, is a work which is known in every laboratory of physical chemistry in the world. It has, in its successive editions, proved a reliable guide to experimenters, and many of the methods which, in the early editions, were perhaps not very well known even in physical chemical laboratories specialising in this type of work, are now commonplaces in technical laboratories. The book has never professed to give a course of experiments suitable for the use of students, but seeks to explain the principles of methods which are used, or are likely to be used, in research work, and the great progress which has been made in the development of such methods has called for a considerable extension in the scope of the book.

It is clear that, even in a book of nearly a thousand clearly printed pages, it is impossible to enter into detail regarding all the experimental technique which the modern physical chemist must have at his disposal. What may reasonably be expected is that the book shall deal with the broad fundamental parts of the subject in some detail, and that it shall provide indications where fuller information on special points can be found. In the last respect, it may reasonably be anticipated that in a book of this size and price an international outlook shall be maintained, and it must be said at once that, in spite of the obvious distaste towards a criticism of a previous edition that it fell short in this respect, a distaste expressed in the preface, much more could usefully have been done in taking account of the contributions of British and American workers. There would be no useful purpose served in entering into detail on this point, but in many parts of the book there is no mention of important work which should have found a place. In some cases this work is merely mentioned by references to German abstracts, a practice which has nothing to recommend it, since the English-speaking chemists have long possessed reliable abstracts in their own language, and will not welcome a journey to a large public library in order to turn up, in a collection of German abstracts, the reference to a paper which is on their own shelves in the original. It is essential that the authors of such a work as this shall not only have read the paper in the original, but that they shall also provide their readers with a reference to the latter.

It is clearly impossible within the limits of space imposed on a reviewer to enter into a detailed discussion of the whole of such a comprehensive work. What has been done, therefore, has been to select a few representative sections at random, and to see how far these cover the more recent work which they profess to describe.

The section on transport numbers gives a fairly comprehensive account of the Hittorf method, with a useful example of calculation, but it is much too brief in connexion with the direct method. Although references are given to some papers by McInnes, no attempt is made to describe in any way the apparatus used. It may be said that space did not allow of this. If this is so, it may be suggested that the by no means negligible space used in giving the names and addresses of German firms supplying squared paper, slide rules, logarithm tables, glass, etc., could have been better utilised, since no user of the book will be likely to trouble himself with such matters.

In the section on surface tension, the methods described are somewhat old-fashioned, and the corrections to be used in the capillary tube method are not given. The section on the viscosities of gases is poor, and the rule for the ratio of length to diameter of the tube, given at the top of p. 313 (from a very old paper by Meyer), is misleading, since the real factor is the nature of the flow in the tube, about which nothing is said. No account is given of measurements at high temperatures. The section on the specific heats of gases is also far from satisfactory, and recent collective accounts of the subject are not mentioned. Not even a reference is given to more recent experimental methods used for the determination of the ratio of specific heats, or to measurements by the explosion method, except those of German authors. The whole section on this subject occupies only about two pages. In the section on dielectric constants there are only five references, all to German authors, the whole of the recent American work being unmentioned. Spectrometry in the infra-red is represented by three lines of type, no reference being made to recent important English work.

It is possible that the sections chosen for notice were unfortunate. To them, at least, the criticism to which the authors take exception applies completely. English and American readers will not feel satisfied, after the purchase of large and expensive German books, if information which they might reasonably expect to find in them is missing.

Although the present edition of "Ostwald-Luther" is far from being up to date in some sections, and is overburdened with too much irrelevant matter, the classical parts of the work, if they may be so called, remain, and those who have no edition of the book in their possession will find it of the greatest value in the physical chemistry laboratory. The information on the more recent advances will also serve a useful purpose, provided that the reader remembers that there is much good work, some even fundamental, to which no reference whatever is made. The printing and paper are of the best quality. J. R. P.

Physiological Perception of Position.

The Physiology of the Vestibular Apparatus. By Mario Camis. Translated and annotated by R. S. Creed. Pp. xiv + 310 + 27 plates. (Oxford: Clarendon Press; London; Oxford University Press, 1930.) 21*s.* net.

PROF. CAMIS deserves the thanks of all physiologists for bringing together into one book the mass of knowledge—very largely of modern growth—concerning the vestibular apparatus of animals. The gap thus filled, and the extent of his service, is amply shown by the long and complete bibliography given in the book—where, save for de Cyon's polemical book of 1908, the last treatise devoted *entirely* to this field is Ewald's "Nervus Octavus", which appeared so long ago as 1892.

The author commences with an interesting account of Marey's cinematographic demonstration in 1894 of the righting movement by which a falling cat drops upon its paws—a demonstration not only of interest because of the dynamical problem it set, but also as one of the first results of the cinematographic method developed, and largely originated, by Marey himself. The dynamical problem is discussed and solved, and the subject of the dropping cat—which at one time or another has fascinated most young people, and Clerk Maxwell amongst them, if we are not mistaken—is then itself dropped, to give place to an account of the older work on the physiology of the labyrinth. This brief historical survey deals chiefly with the theoretical conclusions of Flourens; of Goltz; of Crum Brown, Breuer, and Mach; of de Cyon; and finally of Ewald. Next follow chapters on the anatomy of the vestibular apparatus and of its central nervous connexions, and on the operative methods used in experiments.

A chapter upon the effects of experimental lesions of the labyrinth is followed by a complemental one upon the effects of stimulation, and that by an interesting and valuable discussion upon the labyrinth as the organ of the sense of space. The theories and speculations of de Cyon are ably summarised here in their bearing on the philosophical teaching of Kant; and there follows an account of other views with regard to the functions of the labyrinth. This closes the story of the older work and views on the function of the labyrinth. The remaining half of the volume under review deals with the modern investigations and conclusions.

Modern investigation has been directed, chiefly by Magnus and his pupils, to the function of the vestibular apparatus and its connexions in the *reflex* activities of the animal; and Prof. Camis prefaces his description of this work with a brief account of Sherrington's development of the reflex theory. This is followed by an excellent summary of the work on non-labyrinthine postural and righting reflexes; and that by a description of the labyrinthine reflexes and their influence on the tone of limb muscles. A following chapter is given to the description of the relations of the labyrinth to the eyes; then comes an analysis of labyrinthine reflexes, and an interesting appendix on the terminology and classification of reflexes. Later chapters are devoted to the adequate stimulus for the receptive end-organs of the labyrinth, and to the nervous connexions of the vestibular apparatus.

Prof. Camis presents this complex subject in a most clear and readable manner. Our debt to him is great; but we have another debt to acknowledge. Not only is Dr. Creed's translation so good that we forget that the original was written in Italian, but he has also added many notes which increase the value of the book.

Short Reviews.

Brain, Mind and the External Signs of Intelligence. By Dr. Bernard Hollander. Pp. 288. (London: George Allen and Unwin, Ltd., 1931.) 12*s.* 6*d.* net.

The book opens with an introduction in four parts: the nature of the mind, the ascent from unconsciousness to self-consciousness, the development of the human mind, and the development of the human brain. Into these twenty-five pages is compressed a great deal of important matter lucidly treated.

Chapter ii. is devoted to a critical account of the results of the experimental physiology of the cortex cerebri. To follow this admirable historical résumé, a considerable amount of previous knowledge of cerebral physiology is needed, so that the layman may be somewhat puzzled by the contradictory accounts of the results of experiments upon the cerebral cortex. The omission of the name of Gall from this discussion is curious, since Gall undoubtedly held views far in advance of those of his contemporaries. Indeed, for locating 'moral sentiments' in 'mere matter', he was expelled from Vienna.

Dr. Hollander, of course, believes in the localisation of cerebral function, and in particular inveighs against the notion that the brain 'acts as a whole'—a vague statement to which no qualified neurologist would to-day subscribe. The work of Head and Gordon Holmes on the localisation of 'emotive reaction' in the thalamus is duly referred to, and the James-Lange theory of the peripheral origin of emotion is promptly dismissed. The chapter on the histology of the cerebral neurons is excellent, though here again the unfortunate lay reader—for we presume Dr. Hollander writes also for him—must crave for an illustration or two, to render visible to him such things as 'arborisations', 'axons', and 'dendrites'. It is curious not to find 'synapsis' in the index.

It should, however, be said that the diagrams, illustrations, and portraits provided are excellent; indeed, the book is quite valuable for these alone.

The author gives expression to a number of much-needed cautions on the subject of the correlation of intellect and size or weight of the brain. A large portion of the work is occupied with a detailed study of the functional importance of the human frontal lobes, and here, as elsewhere, there are full references to original sources in clinical and other literature. D. F. F.-H.

Gmelins Handbuch der anorganischen Chemie. Achte völlig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. System-Nummer 26: *Beryllium.* Pp. viii + 180. 30 gold marks. System-Nummer 58: *Kobalt.* Teil B: *Die Ammine des Kobalts.* Pp. xxv + 376. 58 gold marks. (Berlin: Verlag Chemie G.m.b.H., 1930.)

THE new volume on beryllium will be welcomed on account of the interest which is being taken in the commercial production of the metal and of its alloys, known to have valuable properties. The literature has been reviewed up to May 1930 and the result is a very useful compendium of information. It must, of course, be borne in mind that this is a work of reference, in which results are recorded so far as possible in chronological order, rather than a textbook to guide the reader in his choice. Thus, many methods are described of obtaining beryllium from its chief ore, including the separation of the metal from aluminium by means of the different solubilities of their fluorides, although no preference is indicated. Again, there is no hint to show that electrolytic methods of reduction are to be preferred to purely chemical methods. While the volume contains a list of references to researches on the alloys of beryllium, the detailed account of the alloys must be sought in other volumes of the work.

The immense group of the cobalt ammines has grown not only in extent but also in importance since the well-known researches of A. Werner gave the clue to modern developments of the theory of molecular structure and of valency. Thus, a separate volume is now devoted to this subject, which includes between two and three thousand derivatives, practically all of which fall into the scheme of classification, which is carefully explained in the opening chapter. This is followed by the systematic treatment of the ammines of bivalent and of tervalent cobalt, the latter occupying the greater part of the volume. The literature is reviewed to the end of 1929.

Geologie der Steinkohlenlager. Von A. Dannenberg. Band 2, Teil 2. Pp. 125-270. (Berlin: Gebrüder Borntraeger, 1930.) 14 gold marks.

THE part of this work under notice deals with some of the coalfields in eastern North America. Among those in the United States it describes the fields of West Virginia and those of the Appalachians—both the northern basins in Kentucky and Tennessee around the famous Cumberland Gap, and the southern basins in Alabama and Georgia, including the Birmingham fields and the Cahaba and Coosa basins. The part also describes the Michigan coal basins and those of the series grouped as the Western Interior Basin, which ranges from Iowa southward across western Missouri, Kansas, Arkansas, and Oklahoma, and is continued to the south of the Arbuckle Mountains into Texas. A brief reference is given to the coal of Alaska. The rest of the part is devoted to the coalfields of the maritime provinces of Canada and Newfoundland.

In reference to each field, the author describes the succession of the sediments and coal seams and the tectonic structure of the field and gives reference to the literature. The summary of the southern part of the western interior field is of special interest owing to the extensive recent literature upon it.

Chemische Bindung als elektrostatische Erscheinung. Von A. E. van Arkel und J. H. de Boer. Deutsche, von den Verfassern autorisierte Ausgabe von Li Klemm und Wilhelm Klemm. Pp. xx + 320. (Leipzig: S. Hirzel, 1931.) 15 gold marks.

THIS monograph deals with the study of compounds from the point of view of Kossel's theory and the method of calculation of Born, in which Coulomb forces and a force of repulsion varying inversely as a higher power of the distance are assumed. It carries the theory as far as is possible in this direction and gives a useful and suggestive picture of many important properties of compounds which are amenable to this treatment. The applications of the newer quantum theory, including wave mechanics, find only a subordinate place, and the theory of covalent compounds is necessarily very restricted. Within the limits imposed by the method of treatment, the book provides a useful summary of recent investigations and also includes many numerical results of value.

The Jungfraujoch Scientific Station.

PHYSICISTS and meteorologists who are interested in the upper atmosphere, and biologists who wish to study the effects of different altitudes on living organisms, have hitherto been severely handicapped in Europe for lack of adequate facilities for their investigations, yet in spite of this much valuable work has been done in the past. But such places as the observatory on Mont Blanc, the Capanna Margherita on the summit of Monte Rosa, and various Alpine huts which have at different times served as laboratories for scientific work, are difficult of access. Situated as they are amid the higher peaks of the mountains of central Europe, and accessible only after crossing glaciers and snowfields where human transport alone is available, the problem of provisioning and maintaining a scientific expedition and arranging the carriage of its equipment is a very serious one and has imposed a limit on the duration and the scope of the investigations which have been undertaken. Moreover, the available accommodation has been but scanty and protection from storm and frost inadequate, while the risk has to be run that communications may be severed by a change in weather. The outlook has, however, been completely altered by the establishment on the Jungfraujoch of a properly built and well-equipped laboratory, which was formally opened at the beginning of July. The illustrations accompanying the present article are from a *Festschrift* published to commemorate the occasion.

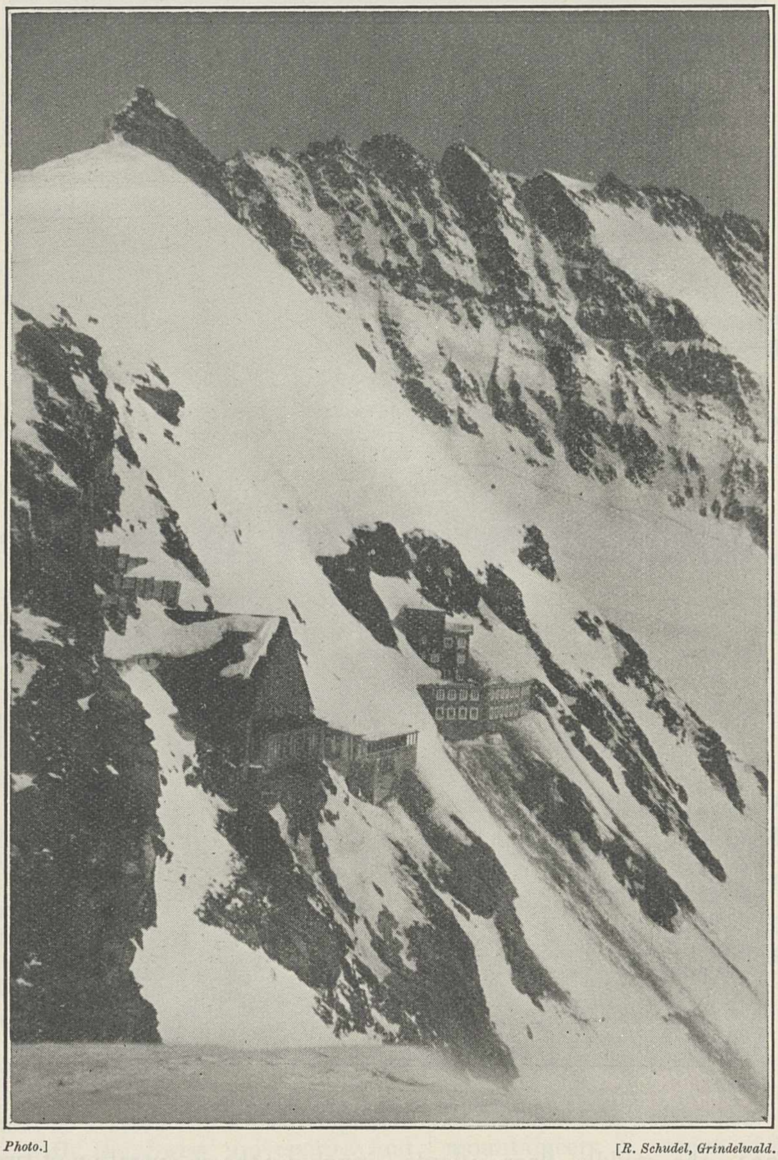

Photo.] [R. Schudel, Grindelwald.

FIG. 1.—General view of the Jungfraujoch Scientific Station.

The idea of building such a laboratory is no new one, for it dates back to the days when the Jungfrau railway was first planned. The scheme received the ardent support of the late Prof. A. de Quervain and was fostered by the Swiss Naturforschende Gesellschaft; but lack of funds for long prevented its realisation. Recently, however, the co-operation of Switzerland, Germany, France, Great Britain, Austria, and Belgium, with further financial assistance from the Rockefeller Foundation and from other benefactors and the invaluable aid of the Jungfrau Railway Company, has made possible the foundation of an international research station.

The Jungfraujoch Scientific Station has been built at an altitude of 3457 metres (11,340 ft.), on a shelf formed by blasting in the rock face which falls steeply towards the snowfields from which the Great Aletsch glacier takes its origin. The laboratory faces south, with the panorama of the Bernese Oberland before it, and a short ascent to the summit of the Jungfraujoch gives an uninterrupted view towards the north. Its general position is shown in Fig. 1.

The building in the foreground is the Hotel Berghaus at the terminus of the railway: beyond this is the new scientific station, access to which is gained through a tunnel in the rock connected with the railway station. Fig. 2 shows a closer view of the laboratory and gives a good idea of its construction.

The laboratory is substantially built of stone to the designs of Messrs. Pfister, of Zurich, and the roof is specially strengthened to withstand falls of stone or snow from the mountain slope above. The walls are cork-lined to ensure warmth, and the living-room and bedrooms are, in addition, panelled with wood. The main block is of two stories, and is surmounted at one end by a tower of three additional stories.

Photo.] [R. Schudel, Grindelwald.

FIG. 2.—Jungfraujoch Scientific Station from the west.

On the ground floor (Fig. 3) are an entrance lobby, cloak-room, six research-rooms (two of which each afford room for two working places), a workshop, a dark-room, store-rooms, a stable for animals, an electric power switch-room, and a fresh-water reservoir. On the first floor (Fig. 4) are situated a living-room, administrative bureau, nine single bedrooms, one four-bedded room, a bathroom, kitchen, and dark-room. In the tower, the lower floor is designed as a botanical laboratory and gives access to the flat roof of the main building; the middle floor affords quarters for the attendants, and the upper floor is devoted to the library, in which there is an optical projection apparatus. Above the library is an open-air terrace, which is partly roofed over as a protection against falling stones.

Electric power for heating, lighting, and cooking is obtained from the railway, and as a precaution against temporary failure of this supply an emergency lighting circuit is installed which is supplied with current from accumulators. Every research-room is supplied with running water and is fitted with a switchboard from which electric power may be obtained for experimental purposes at both high and low voltages. Valuable gifts of scientific apparatus have already been received from industrial firms.

The laboratory has been built with the view of encouraging research in both the physical and biological sciences; and it is certainly well adapted for the purpose. The benches in the research-rooms are ample and so arranged as to leave plenty of floor space available for the erection of special apparatus. The windows, which are double-glazed, are not very large; but in spite of this the general lighting of the rooms is extremely good: indeed, the glare from the snow-fields around renders the provision of sun-blinds essential. The research-rooms themselves are of good size, and it would be a mistake to suppose that only one research worker can be accommodated in each. Each is large enough to permit of work involving the co-operation of two or three persons. The building as a whole is, indeed, larger than might be anticipated, when the great difficulties that had to be faced in its construction are borne in mind.

The scientific station is designed to be complete in itself. Not only does it afford working space and sleeping quarters, but the kitchen also is adequate for the provision of meals for the occupants. The Hotel Berghaus is close to the laboratory, and at first sight it would possibly seem easier to take meals there. But it must be remembered that the number of tourists who are brought by the railway to the Jungfraujoch is very large, and that at the height of the season the hotel accommodation is liable to be taxed to the utmost.

It will be seen from Fig. 1 that the laboratory is quite separate from the hotel. It can only be entered from behind through a tunnel; and though this is connected with other galleries in the rock through which tourists can pass freely, it should not be difficult to keep out the inquisitive intruder: the research workers are therefore not likely to be inconvenienced materially by the tourist traffic.

For the purpose of meteorological observations the laboratory itself is not altogether ideal, since the rock face rises steeply above it and it only affords a free view in one direction. The snowfield on the summit of the Joch does not suffer from this disadvantage, as it commands an all-round view. For the meteorologist an even better site is to be found on the rocky peak, the 'Sphinx', the top of which is 400 feet above the laboratory. This can be reached from the Joch, and it is being rendered even more accessible for tourists by the Jungfrau Railway Co. It is hoped before long to establish a small meteorological station on this point.

The new research station is readily accessible from Interlaken by the Scheidegg and Jungfrau railways, and there will be no difficulty in carrying up both delicate and bulky apparatus. So short are the communications and so frequent the train service that little delay should occur if additional apparatus has to be procured during the course of a research, while telephonic communication with the Swiss universities and laboratories will be easy. The laboratory will be available for work all the year round, summer and winter alike. It may fairly be claimed that the disadvantages under which so many of the earlier high altitude expeditions laboured have now been overcome, and with the full laboratory facilities at their disposal research workers at the new station should be the better able to attack with success many problems which are as yet unsolved.

It would, no doubt, have been an advantage if the laboratory could have been built at a still higher altitude; but no other point in the Alps so high as the Jungfraujoch can be reached with such ease; the Gorner Grat, for example, which can be reached by train from Zermatt, is more than 1000 feet lower. Though the altitude of the new scientific station may seem but moderate

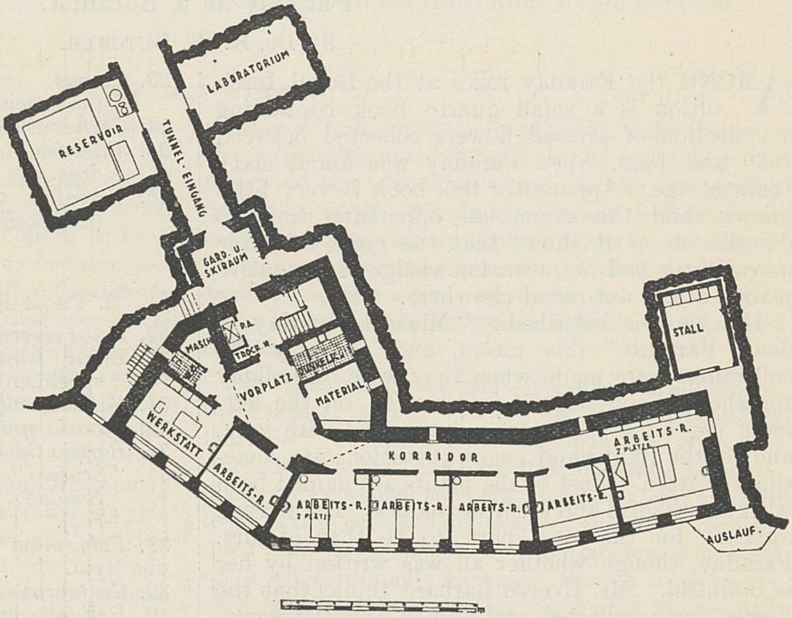

FIG. 3.—Plan of ground floor with research-rooms.

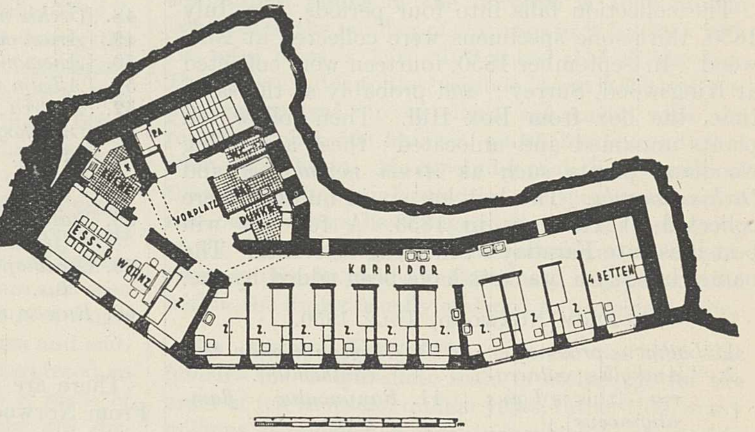

FIG. 4.—Plan of first floor with living-room and bedrooms.

in comparison with the heights reached by mountaineers in recent years, it is a point of some interest to physiologists that genuine mountain sickness is by no means unknown amongst those who ascend to the Jungfraujoch from the lowlands and have had no time to become acclimatised. After all, the barometric pressure is only about 500 mm. of mercury at the laboratory.

The direction of the Jungfraujoch Scientific Station is vested in a council, consisting of a president, Prof. W. R. Hess, of the University of Zurich, and two representatives of each of the following bodies: the Swiss Naturforschende Gesellschaft, the Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften of Berlin, the University of Paris, the Royal Society of London, the Akademie der Wissenschaften of Vienna, the Fonds National de la Recherche Scientifique of Brussels, and the Jungfrau Railway Company. There is in addition an executive committee, of which the officers are Prof. W. R. Hess, president; Prof. A. Kölliker, of Zurich, treasurer; and Prof. L. W. Collet, of Geneva, secretary.

Faraday as a Botanist.

By Dr. R. W. Butcher.

Among the Faraday relics at the Royal Institution is a small quarto book containing a collection of pressed flowers collected between 1850 and 1853, when Faraday was about sixty years of age. Apparently this book is very little known, and this seems an opportune time to describe it, as it shows that the great scientific investigator had no mean knowledge of his native plants, a fact not noted elsewhere.

The book is inscribed: " Michael Faraday to Joan Barnard " (his niece), and probably the collections were made when they were on holiday together. Each page is numbered; on the left-hand pages the specimens are mounted with gum, and on the right-hand pages quotations are sometimes written. Most of the plants are named both with the English and scientific names. The writing appears, for the most part, to be that of Mrs. Faraday, though whether all was written by her is doubtful. Mr. Evelyn Barnard thinks that the flowers were collected and named and the verses chosen by Michael Faraday and written in the book by Mrs. Faraday.

The collection falls into four periods. In July 1850, thirty-one specimens were collected at Norwood. In September 1850, fourteen were collected at Kingswood, Surrey; and probably at the same time, the box from Box Hill. Then follow ten plants unnamed and unlocated; these are spring woodland plants such as *Arum maculatum* and *Orchis mascula*. The last lot, six in number, were collected at Hastings in 1853. A full list will best illustrate Faraday's collecting activities. The names in square brackets have been added by me.

1. From Norwood, July 1850.

1. *Lathyrus pratensis*.
2. " *Anthyllis vulneraria* " [this is *Lotus uliginosus*].
3. *Lotus corniculatus*.
*4. *Lonicera periclymenum*.
*5. *Rosa canina* [*Rosa arvensis* also on same page].
*6. " *Rosa rubiginosa* " [this is *Rosa micrantha*].
*7. " *Hypericum perforatum* " [this is *Hypericum pulchrum*].
8. *Hypericum* [*humifusum*].
9. *Hypericum Androsæmum*.
*10. *Chrysanthemum leucanthemum*.
11. *Ranunculus flammula*.
*12. *Papaver rhœas*.
13. *Vicia Cracca*.
14. " *Fumaria* " [this is *Vicia hirsuta*].
15. *Potentilla Tormentilla*.
16. *Juncus* [*communis*].
17. *Digitalis purpurea*.
18. *Polygala vulgaris*.
19. [*Lathyrus montanus*].
20. *Lysimachia nemorum*.
21. *Lysimachia nummularia*.
22. *Scutellaria galericulata* (no specimen).
23. *Tamus communis* (no specimen).
24. *Chelidonium majus*.
*25. *Veronica Chamædrys*.
26. *Veronica officinalis* (no specimen).
*27. " *Veronica serpyllifolia* " [this is *Veronica montana*].
28. *Erythræa Centaurium*.
*29. *Anagallis arvensis*.
*30. *Campanula rotundifolia*.
31. *Asperula odorata*.

2. From Kingswood, September 1850.

*32. *Erica cinerea*.
33. *Erica tetralix* (no specimen).
34. *Calluna vulgaris*.
35. *Linaria spuria*.
36. *Bartsia Odontites*.
37. " *Senecio* " [this is *Solidago virgaurea*].
38. *Polygonum Persicaria*.
39. *Centaurea scabiosa*.
40. *Helianthemum vulgare*.
41. *Anagallis cœrulea* [this is a dwarf *Veronica Buxbaumii*].
42. *Scabiosa arvensis*.
43. *Clematis Vitalba*.
44. *Achillea Millefolium*.
45. *Buxus sempervirens* (from Box Hill).
46. *Agrimonia Eupatoria*.
47. *Trifolium procumbens*.

3. Unnamed and Unlocated.

48. [*Orchis mascula*].
49. [*Arum maculatum*].
50. [*Anemone nemorosa*].
51. [*Allium ursinum*].
52. [*Lastrea Filix-Mas*].
53. [*Ornithogalum nutans*].
54. [*Hedera helix*].
55. [*Primula vulgaris*].
56. [*Anthriscus sylvestris*].
57. [*Hypnum molluscum*].

4. Hastings, 1853.

58. *Statice Armeria* (from Castle Hill).
59. *Ornithopus perpusillus*.
60. *Rumex acetosella*.
61. *Sedum anglicum*.
62. *Trifolium subterraneum*.
63. [*Erodium cicutarium*].

* With quotation.

There are several points of interest in this list. From Norwood there is a collection of plants from a district now covered with houses. Of the Surrey plants, the most interesting are *Hypericum Androsæmum* and *Veronica Buxbaumii*; the former because it is by no means a common plant, and the latter because it indicates how common this plant, introduced about 1835, had become. The other Surrey plants are recorded by Brewer in the " Flora of Surrey " as common. Apparently, Faraday also noted the difference between *Lotus corniculatus* and *Lotus uliginosus*, though he did not name the latter correctly. Of the Hastings plants, *Sedum anglicum* may be considered a first county record, as in the " Flora of Sussex " the earliest record is 1878.

Considering the literature available at that time, the naming of the plants is remarkably accurate; the mistakes are shown in the list and illustrate the collector's difficulties—difficulties with which some who remember their first attempts to name wild-flowers will sympathise.

The order of the plants in the book is probably the order in which they were collected, closely allied plants being put together when collected at the same time.

Quotations are written by the side of eleven of the plants and these are indicated in the list with an asterisk. Some quotations are assigned to their author, but most are anonymous.

My best thanks are due to Sir Robert Robertson (hon. treasurer) and to Mr. Cory (librarian) of the Royal Institution, for enabling me to examine the book, and to Mr. Evelyn Barnard, donor of the book to the Royal Institution, for information.

News and Views.

His Majesty the King has approved the following awards this year by the president and council of the Royal Society in respect of the two Royal Medals: Royal Medal to Sir Richard Glazebrook for his distinguished work in experimental physics; Royal Medal to Prof. W. H. Lang for his work on the anatomy and morphology of the fern-like fossils of the Old Red Sandstone. The following awards of medals have also been made by the president and council: Copley Medal to Sir Arthur Schuster for his distinguished researches in optics and terrestrial magnetism; Davy Medal to Prof. A. Lapworth for his researches in organic chemistry, particularly those connected with tautomerism and the mechanism of organic reactions; Sylvester Medal to Prof. E. T. Whittaker for his original contributions to both pure and applied mathematics; Hughes Medal to Prof. W. L. Bragg for his pioneer work on the elucidation of crystal structure by X-ray analysis.

We print as a Supplement to this week's issue the evening discourse entitled "Beyond the Milky Way", delivered by Sir James Jeans on Sept. 29 during the centenary celebrations of the British Association. Starting with the star system of which we are a part, Sir James takes us outside it into the realms of interstellar spaces and the extra-galactic nebulæ, and in his characteristic and lucid manner leads us to a consideration of the hypothesis of the expanding universe. The extra-galactic nebulæ known to astronomers present a bewildering variety of size, shape and brightness, but after eliminating those which are not seen edge on, the remainder may be arranged in a single continuous sequence, beginning with spheres and ending with flat discs. This sequence is interpreted as showing evolutionary development from a mass of rotating and shrinking gas. The nebulæ are distributed fairly uniformly through space, and are regarded as condensations of a universal primeval gas. Recent observations have shown that the nebulæ are receding from the galaxy and from each other at speeds approximately proportional to their distances; the universe appears to be expanding like a balloon during inflation. This is in accord with relativity considerations, but it makes the ages of the stars considerably less than we have hitherto believed. The hypothesis of an expanding universe was dealt with in the British Association discussion which we printed as a supplement to Nature of Oct. 24, and it also formed the subject of Sir Arthur Eddington's presidential address to the Physical Society delivered on Nov. 6. Sir Arthur pointed out that the theory of the 'expanding universe' can also be regarded as the theory of the 'shrinking atom', and he envisaged a cosmic being, whose body kept pace with the expanding intergalactic spaces, looking down on the atomic drama and watching the actors growing smaller and smaller and the action faster and faster until "One last microscopic blur of intense agitation. And then nothing."

Sir Arthur Eddington's presidential address to the Physical Society was entitled "The Expanding Universe". After a brief sketch of the system of spiral nebulæ, he described the necessity of introducing the cosmical constant 'lambda', and went on to show that the ideal universe postulated by Einstein some years ago is unstable. If initial expansion is set up, it will continually increase. From a study of the wave equation of the electron, Sir Arthur has recently found a theoretical value of the cosmical constant, and from this he deduces the following values. The equilibrium radius of the universe is 1068 million light-years, the number of electrons in it is $1{\cdot}29 \times 10^{79}$. Its total mass is $1{\cdot}08 \times 10^{22}$ times that of the sun. The recession due to the 'lambda' term is 528 km./sec. per megaparsec, in excellent agreement with the round number 500 km./sec. which has been adopted from observation. He concludes that the recession of the spiral nebulæ, indicated by the spectroscope, is a real one; others have suggested that the reddening of the light may arise in some other way. The universe doubles its radius in 1300 years, a space included within the limits usually assigned to geological time.

Sir Arthur Eddington pointed out that this favours the intermediate scale of stellar life (of the order of ten thousand million years, rather than many millions of millions), a conclusion which he reached in another manner last year by considering the motion of the interstellar gas in our galaxy; it was found that this motion was unlikely to persist for the periods required by the longer scale. The intermediate scale permits the theory that stellar energy is derived from the transmutation of hydrogen into other elements, though the theory of the annihilation of atoms is still tenable. He made an interesting suggestion about the cosmic penetrating radiation. The only source which can be considered to be arranged symmetrically about the earth is the whole universe. These radiations go back to the early days of the universe, and have probably circuited it several times. Their wave-length is probably some four times as great as its primitive value, so that a correcting factor should be applied before making deductions from it as to the origin of the rays.

JOHANNES BOSSCHA, the centenary of whose birth falls on Nov. 18, was regarded as the leader of Dutch physicists. Born at Breda, he was initiated into physics by van der Willigen. In 1850 he entered the University of Leyden, and two years later took his degree with a dissertation on the differential galvanometer, his work being done in the physical laboratory at Leyden, then under the direction of Rijke. After a short stay at Berlin he became an assistant in the laboratory, where he did much work in connexion with the law of the conservation of energy, the e.m.f. of the Daniell cell and multiplex telegraphy. Ten years of his life were devoted to secondary and technical education in Holland and the provision of facilities for scientific studies. In 1873 he became a professor and in 1878 the director of the Polytechnic at Delft; in 1885 he was made secretary of the Dutch Society of Science at Haarlem. He also reorganised the Dutch Meteorological Service. He made original researches on the velocity of sound and on heat. Much of his later life was devoted to the study and editing of the correspondence of Huygens. He died in the spring of 1911 and an appreciation of his work by Kamerlingh Onnes was published in NATURE for May 25, 1911.

MANY of our readers must have seen with regret the announcement in the daily Press that a serious outbreak of fire occurred at the University of St. Andrews in the early morning of Nov. 3. We learn that considerable damage has been done to the new building which contains the chemical and physical laboratories of the United College of St. Salvator and St. Leonard. The entire roof of the physical laboratory and part of that of the chemical laboratory have been destroyed. Two large Hilger spectroscopes and other instruments used in physical research have been badly injured. A large amount of valuable apparatus has been completely destroyed as well as many chemical specimens illustrating Prof. J. Read's researches. It is remarkable that many specimens of the products obtained by the late Prof. Purdie and Principal Sir James Irvine have escaped. An unofficial estimate places the amount of damage, which is covered by insurance, at £10,000. Fortunately, the fire did not reach the chemical research laboratory at the north end of the block or the adjoining building, which houses the natural philosophy lecture rooms and museum, where much interesting historical apparatus is preserved.

THE Royal Photographic Society has arranged a series of annual exhibitions illustrating photography in the service of man. The third of the series was opened on Nov. 9 at the Society's house at 35 Russell Square, London, W.C.1. It is devoted to colour photography, and will remain open on each weekday from 10 A.M. to 5 P.M. until Nov. 28. Demonstrations of modern colour processes will be given at 7 P.M. on Nov. 18 and 25, on which days the exhibition will remain open until 9 P.M. In its historical section, the exhibition honours a host of scientific workers and inventors too numerous to mention individually. Overshadowing all the rest are the names of Clerk Maxwell and Ducos du Hauron, whose discoveries form the foundation of most of the practicable methods of colour photography. The most brilliantly colourful section of the exhibition represents the four main photomechanical processes: collotype, half-tone photogravure, and photolithography. Great progress, has been made in simplifying colour printing during the last thirty years. Coloured prints of great beauty were produced many years ago, but they were very costly owing to the large number of printings necessary for each; twelve, sixteen, or even more different printings being often made. To-day, exquisite replicas of paintings often take no more than seven printings, and even this is deemed a very complicated process. Most modern colour reproductions are made with three or four printings.

THERE is in one of the showcases at the exhibition a specimen page of a popular daily picture paper printed in colour. This seems like prophecy. How long will it be before our great daily papers print their pictures in colour? Photolithographic reproduction in colour by offset printing is now capable of yielding an enormous output, and can be employed on comparatively rough paper. The methods of colour photography which may be used by the amateur are also very well represented. Mosaic screens of all kinds and transparencies obtained with many of them are shown. Then there are examples of various apparatus employed for making three colour-separated negatives, including cameras in which the three exposures are made simultaneously, and 'repeating backs' which allow negatives to be made consecutively. The automatic repeating back is said to make three consecutive exposures in a total time of about one second. This apparatus is now employed for recording in clinical medicine. There is a great deal more: two-colour photography, Lippmann photography, colour reproduction by diazo processes, colour cinematography, all of great interest. The exhibition is probably one of the finest of its kind which has ever been produced in Great Britain.

IN a paper read to the Illuminating Engineering Society on Oct. 30, Mr. P. Good discussed the lessons to be learnt from the recent flood-lighting display. He considers that the cost of flood-lighting was not an extravagance. He pointed out that a sum of £50,000 would equip and endow in perpetuity the proper lighting of the façade of the National Gallery. Another way of considering the matter is this: one per cent of the expenditure of the B.B.C. on music and entertaining would maintain the flood-lighting carried out in London for the International Illumination Congress this year for a whole year, and provide illuminated fountains in Trafalgar Square as well. Mr. Good made two useful suggestions for utilising the advertising value of flood-lighting. He advocated that buildings, some hospitals, for example, which are at present defaced by advertisements for the purpose of raising money, should instead invite the advertiser to paint and flood-light their building so that it makes an attractive picture. The advertiser might be permitted to have a very small notice invisible to everyone except those close by, and be left to advertise in the Press what he had done. Mr. Good's second suggestion was that as there are many streets in London and its suburbs with bare plots of land utterly disfigured with advertisement hoardings, these should be removed and the advertisers could turn the waste-land into little gardens with small notices stating who had provided them. Mr. Good is certain that the lighting engineer, with the illimitable possibilities of flood-lighting, now has an opportunity for developing a new technique of advertising to replace the present blatantly self-assertive methods.

ACCORDING to a dispatch from the Peking correspondent of the *Times* in the issue for Nov. 4, it has now been established to the satisfaction of the members of the Geological Society of China that Peking man was capable of fashioning and using stone implements with considerable skill. At an early stage in the investigation of the cave of Chou Kou Tien, the discovery of a piece of quartz not of immediately local origin was considered by Dr. Andersson to be evidence of the possibility that the early inhabitants of the cave used stone for implements; but a search prosecuted continuously for four years failed to produce further support of this view. It would appear, however, that artefacts in considerable number have now been found in the cave, as well as evidence of the use of fire. These artefacts have been submitted to a close examination, with the result already mentioned; they have also been accepted by the Abbé Breuil, who is now on a visit to China. He is said to regard them as indicating that life was intelligently organised at the time of Peking man, who must have had a much more primitive predecessor. This can only mean that the implements are relatively advanced in type. This is confirmed by Prof. Elliot Smith's letter to the *Times* for Nov. 5. He says that he is informed that the implements are well-shaped and not unlike the Chellean type of Europe. Prof. Elliot Smith adds that the new discoveries are due to Mr. W. C. Pei, the young Chinese palæontologist to whom we owe the discovery of the skull in December 1929. Further details and a more precise indication of the character of the implements will be awaited with interest. The close associations of a specific type of implement with this early type of man, in conditions which admit of more or less precise geological dating, still further enhances the significance of Peking man.

DR. MARGARET MEAD, of the American Museum of Natural History, sailed in the middle of August from New York for New Guinea, where she will spend two years in ethnographical field work. Dr. Mead is accompanied by her husband, Dr. Reo Fortune, who will investigate the religious and social organisation of certain tribes, on lines parallel to those to be followed by Dr. Mead in her study of the women and children and the attitude of the sexes respectively to certain matters of cultural and biological import. Dr. Mead will also be engaged in the collection of notes and specimens to be used in the preparation of models for installation in the South Sea Hall of the American Museum. These models will be similar to those of the inhabitants of the Admiralty Islands which have been set up as a result of Dr. Mead's recent expedition to Melanesia and are described in *Natural History*, vol. 31, pt. 5. In the same issue, Dr. George C. Vaillant, assistant curator of Mexican archæology, describes four very remarkable and instructive models of temples in Central America which have been presented to the Museum, two through the good offices of the secretary of the Trustees, Mr. Clarence L. Hay, one by the Carnegie Institution of Washington, and one by the Government of Mexico. The temples are representative of the characteristic cultures of Central American archæology, one being a model of Uaxactun E-vii-sub., the oldest Mayan temple yet discovered, the others, models of the Toltec pyramid of the sun of Teotihuacan, the Aztec temple of Teopanzalca, and the Totonac temple of Tajin, Vera Cruz. The advantage of these models in revealing the qualities and beauties of Central American architecture and art to the untrained eye is immediately apparent from an inspection of the photographs with which Dr. Vaillant's article is illustrated.

DR. RICHARD WOLFRAM, of Vienna, gave a lecture, illustrated by lantern-slides, on the sword dances of Austria to the English Folk Dance Society at Cecil Sharp House on Nov. 4. Dr. Wolfram dealt with these dances with special reference to their origin and meaning. As generally understood, the dances are regarded as survivals of a ritual dance, related to the fertility cult, in which is represented the sacrifice of the principal performer. Dr. Wolfram, however, maintains that they are to be attributed rather to the tendency of young men to form secret societies. Hence he relates them to the ceremonial of the secret initiatory rite. In this connexion, he directed attention to the morris dance, which means the dance with blackened faces, the dancers with blackened faces representing the army of the dead, just as the troops of children who beg at festival times are also to be regarded as representing the army of the dead. Dr. Wolfram laid considerable stress on the similarity which he finds underlies the English dances and those found throughout the Germanic peoples.

ONE of the most interesting exhibits at the Faraday Centenary Exhibition at the Albert Hall was a huge new valve manufactured by the Metropolitan-Vickers Electrical Co., Ltd. It stands ten feet high, is fourteen inches in diameter, and weighs more than a ton. Its water-cooled steel anode weighs 3 cwt., and hydraulic jacks are required to facilitate demounting and accurate assembly. Its filament current is approximately 500 amperes, and, according to the *Metropolitan-Vickers Gazette* for November, its filament emission of 160 amperes represents the almost inconceivable electron flow of three hundred thousand billions of electrons per second. It was built for operating the main transmitter at the Rugby G.P.O. radio station, where it will replace a bank of fifty high-power valves. No glass is used in its construction, only steel, copper, and porcelain. The possibility of making such a huge valve was first suggested by the discovery in the research laboratory of the company that oil distillates had remarkable properties. They can be boiled at a fairly high temperature without decomposition, and yet at room temperature their rate of evaporation is so small that they can be placed inside a radio valve without impairing the vacuum. Its low volatility proved that an oil distillate is an ideal liquid to replace the mercury of the vapour pump. Using this liquid, an exceedingly high vacuum is obtained even at the highest power input. In the event of repairs being necessary the valve is completely demountable. Only ordinary engineering tools are used to make repairs. The manufacture of valves of 500 kilowatts, the largest in the world, has now been demonstrated and the possibility of constructing even larger valves has been proved. In fact we may say that the transmission of power on a large scale by radio has been shown to be practicable. These large radio valves mark the beginning of a new era in engineering practice.

In a leading article in the *Engineer* for Oct. 30 a strong appeal is made for increased support from the shipping and shipbuilding industries for the Froude Laboratory and National Experimental Tank at the National Physical Laboratory, Teddington. The annual cost of the Laboratory and Tank is about £12,000, of which £7000 is earned in fees, while, up to now, the Department of Scientific and Industrial Research has given pound for pound to all sums contributed by the industry for research. With this assistance, the sum required from shipbuilders and shipowners is £2500. In the course of the article, figures are given as to the number of designs submitted and the numbers in which improvements were made. Out of thirty tests made in 1930, no fewer than five brought about an increase in efficiency of 20-30 per cent. Moreover, there are no signs of slackening in the efforts of other nations. Improvements have been made in the tanks at Hamburg, Berlin, and Spezia, while new tanks have been built at Rome, and in Holland and the United States. The new tank in America is 1920 ft. long. It is true that shipping and shipbuilding are both suffering severely from the decrease in the trade of the world, but Great Britain and Northern Ireland still own twenty million tons of shipping, against the four million tons of Germany, and the 9,500,000 tons owned by France, Holland, and Italy collectively. Where so much is at stake it does not seem an unreasonable hope that so small a sum as £2500 will be forthcoming.

The Lord Mayor's Show is an annual civic event in London of popular interest. This year it had an added interest in that, at the request of the new Lord Mayor, Sir Maurice Jenks, the pageant illustrated the progress of industry aided by science. The leading car was from the National Institute of Industrial Psychology and bore at its foot a large oil-can, "Industrial Psychology oils the wheels of Industry". Then came three cars illustrating the radio industry and showing a modern 'radio' home, the earth girdled by radio, and a symbolic tableau including the arms of the Radio Manufacturers' Association. The cinematograph industry was represented by cars portraying by tableaux the sciences which have contributed to its development, early apparatus, a modern film studio, and modern picture and sound production. The transport industry was illustrated by early and modern forms of bicycle and motor-car, including *Bluebird*, the motor-car in which Sir Malcolm Campbell made the land speed record, and *Miss England II.*, the motor-boat in which Mr. Kaye Don made the present water speed record. The Gas Light and Coke Company had cars showing the scientific application of gas in industry and in the home; one car carried a gas-heated annealing furnace in operation. The British Electrical Development Association, Inc., was mainly responsible for a car representing symbolically light, heat, and power, the three principal applications of electrical energy. Modern electrical communications were represented on a car by Imperial and International Communications, Ltd., designed to demonstrate the cable and wireless links maintained by this company, which owns more than half the world's submarine cables and a widespread system of wireless services. The Lord Mayor's Show this year was a useful piece of propaganda on behalf of science in industry.

In a pamphlet entitled "The Social Function of Science", Prof. C. H. Desch directs attention to the need for greater effort to make the influence of science felt in the world of citizenship and to bring home to the public the value of the services which science, rightly interpreted, can render to the community. The continuous subdivision of science both in research and in teaching not only results in excessive specialisation, but also widens the gap between the physical and the biological sciences. Prof. Desch, asserting the importance of developing real social sciences, points out that the evolution of these sciences will assist in a synthesis or union of the sciences which will remove the isolation of the specialist in different fields and promote contact with life. As illustrating the need for science in national life, Prof. Desch refers to the growing recognition of social well-being as the true object of industry and the need for scientific minds, free from party prejudices, to bring into the political field the ideas of international co-operation which in industry and economics have already made rapid progress where scientific principles have control. Similarly, scientific methods of thought might well be applied to questions of finance, particularly to distinguishing between positive and negative values in regard to wealth, etc., and there is still great disproportion in Great Britain between the control of industry exercised by technical as compared with purely financial or commercial interests. Scientific men cannot disclaim responsibility for the purposes to which the knowledge they acquire is applied, and the application of scientific method to the study of social facts is urgently needed if society is to be preserved from anarchy. The problem is chiefly a matter of education and of research. Scientific workers are called upon to co-operate in an attempt to interpret to

(*Continued on p.* 833.)

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Beyond the Milky Way.*

By Sir JAMES JEANS, F.R.S.

OUR earth is one of a system of nine planets which, with millions of smaller bodies—asteroids, comets, and meteors—circle round the sun; our sun is one of a system of millions of stars which circle about one another; this star-system is one of millions of star-systems—and here, so far as we know, the sequence ends abruptly. These star-systems are the biggest objects known to science; there is nothing beyond them except the great universe itself. They form the largest subdivision of the universe, and it is from this circumstance that they derive their special importance to science.

THE GALACTIC SYSTEM.

Our own special system of stars—the system of which our sun is a member—is called the galactic system, because it is bounded by the Milky Way. In shape it is known to be somewhat like a disc or a coin or a cart-wheel. Perhaps the last of these three comparisons is the best, because it has recently been found that the whole system is rotating. Early investigators, Sir William Herschel in particular, believed, for inadequate reasons, that the hub of this wheel must be somewhere near the sun; we now know that it is so remote that even the brightest stars near the hub are invisible to our unaided eyes. Indeed, we can see no stars which are more than about 3000 light-years away, while the hub of this great wheel of stars is probably something like 40,000 light-years away. We still do not know the size of the wheel with any approach to accuracy, but its diameter is probably of the order of 200,000 light-years.

This great wheel is held together by the gravitational attractions of the different stars of which it is composed. As a consequence the outermost stars move most slowly and take the most time to perform a complete revolution, just as in the solar system the outermost planets move most slowly and take longest to describe their orbits round the sun. The sun probably moves round the hub at about 200 miles per second, and requires something over 200 million years to perform a complete revolution.

We can estimate the mass of the wheel by calculating the gravitational pull it exerts on the sun to keep this from flying off into space. It is found that this mass is certainly more than that of 100,000 million suns, and may quite possibly be twice, or even four times, this. Probably the greater part of it represents matter in the form of stars. If so, as the average star has less mass than the sun, the galactic system must contain well over 100,000 million stars. Actual star-counts confirm this estimate.

EXTRA-GALACTIC SYSTEMS.

In the early days of astronomy the galactic system was assumed to be the only system of stars in the sky. Then it began to be conjectured by Kant and Herschel that it was only one of innumerable systems. Recent research has confirmed this conjecture very fully. If you look to the north of the star Beta in the constellation of Andromeda you will, if your eyesight is good, see a faint, hazy patch—the Great Nebula in Andromeda. It looks at first like diffused starlight—as though a bit of the Milky Way had broken loose and wandered off to the south. The astronomer Marius described it as looking like candle-light seen through a horn. When this vague patch of light is viewed through a powerful telescope a certain amount of detail begins to appear. But to study it properly we must photograph it, with an exposure of many hours. We then find that the nebula is far larger than it appears either to the unaided eye or on looking at it through a telescope; roughly speaking, it covers twenty times as much sky as the full moon. The part we can see with the unaided eye is only a small central region—a comparatively bright fuzzy mass. Coiled round this is a detailed structure which lies completely hidden until it is brought to light by a long exposure photograph (see Fig. 1). Just as, in 1609, Galileo's tiny telescope broke up the Milky Way into separate points of light which he at once identified as

* Evening discourse delivered before members of the British Association in the Central Hall, Westminster, on Sept. 29.

stars, so modern high-power telescopes break up the outermost regions of this nebula into separate points of light, which we can identify as stars (see

FIG. 1.—The Great Nebula (M 31) in Andromeda.

Fig. 2). We may be sure they are stars, because many of them show the same peculiarities and characteristics as the stars of our own system; among them we recognise variable stars of regular Cepheid type, irregular variables, helium stars, and novæ. Many of these special types of stars are so peculiar, so uniform in their behaviour, and so similar to one another, that we can estimate the distance of the nebula from the apparent faintness of the examples we find in the nebula. According to Dr. Hubble's most recent estimate, its distance is such that its light takes just over 800,000 years to reach us.

We can no longer doubt that, in its outer parts at least, this great nebula is a system of stars essentially similar to our own galactic system. We recognise the cart-wheel shape at once, the brighter fuzzy centre, the only part we can see without high telescopic power, forming the hub. The spectroscope shows that this cart-wheel too is in rotation —again like our galactic system. But it is spinning much faster; while our system requires about 200 million years for a complete revolution, this nebula gets round once every 17 million years or so. Its greater agility is due in part to its smaller size; it has only about a quarter of the diameter of the galactic system—50,000 light-years as against perhaps 200,000 light-years.

Again, this structure can be weighed by calculating the force which the system as a whole must exert on its outermost members to restrain them from running off at a tangent into space. We find that the weight of the whole nebula is quite small compared with that of our galactic system—about 5,000 million suns, as against perhaps 200,000 million suns for the galaxy.

These two cart-wheels are not the only such systems in the sky; millions of others can be observed. They are the objects we commonly describe as extra-galactic nebulæ.

A random collection of such nebulæ may seem at first to exhibit a bewildering variety of size, shape, brightness, and constitution, but a scientific study soon reduces them to law and order. Size and brightness are found to go together, and variations in both originate mainly in differences of distance. The nebula which appears small also appears faint, and does both merely because it is far away. If we could put all the extra-galactic nebulæ in a row at the same distance from us we should see that they were all of about the same size and the same brightness. Here and there in the sky Nature performs this experiment for us. An example is shown in the upper half of Fig. 3,

FIG. 2.—A small part (left-hand top corner) of the Great Nebula (M 31) in Andromeda, showing separate stars.

where we find a cluster of nebulæ which we believe to be physically related, because they all show approximately the same motion in space, like a flock of birds. The members of such a flock are presumably all at about the same distance, and it is significant that they all appear to be of about the same size and brightness. The nebula in the lower half looks ten times as big because it is about ten times as near. The nebulæ still appear to be of very different shapes, but this is partly because they are differently oriented with respect to ourselves; we see them along different lines of sight.

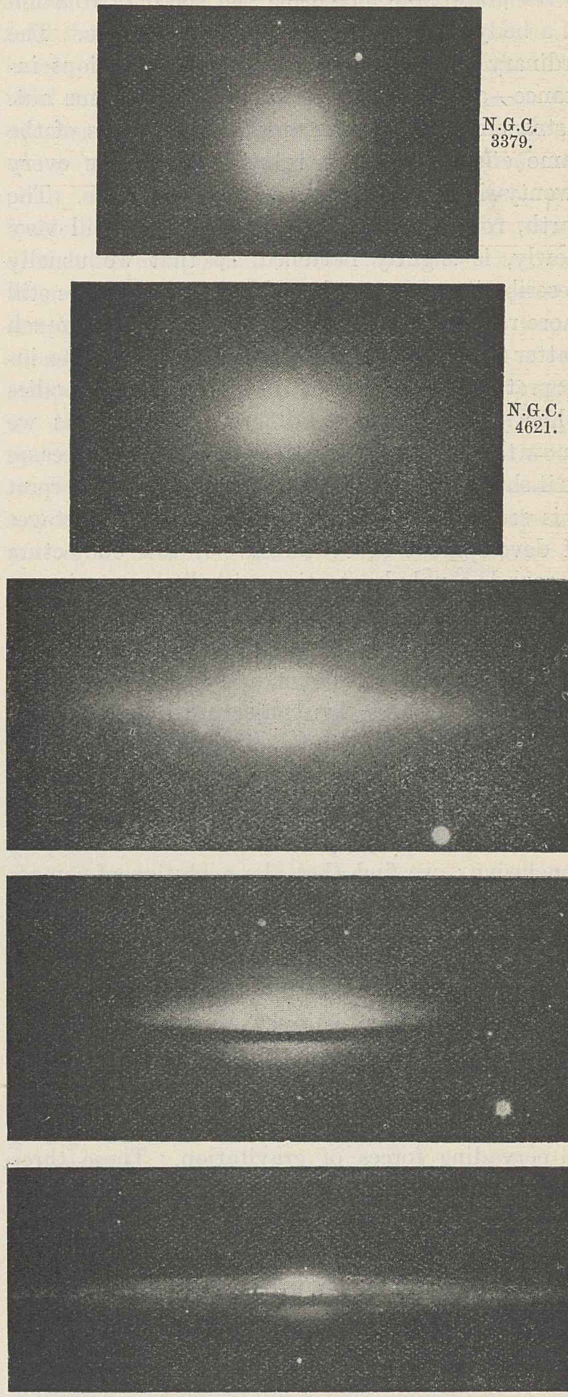
We can avoid all complications caused by the different orientations of the nebulæ by the very simple device of rejecting all those which are not seen edge on, and confining our attention to those that are. We can do this quite recklessly, as some two million nebulæ can be seen in all.

In this way we can eliminate all the purely

Mt. Wilson Observatory.

FIG. 3.—Cluster of nebulæ in Pegasus and the nebula N.G.C. 7331, which looks ten times larger, because it is about ten times nearer.

geometrical effects arising from differences of distance and of orientation, and are left with real physical differences of shape and constitution. We find that by far the greater number of our edge-on nebulæ can be arranged in a single continuous sequence (cf. Fig. 4); it is in brief a sequence which begins with spheres and ends with flat discs, although other features besides shape change as we move along it. The nebulæ at one end of the sequence consist solely of round fuzzy masses, and even the most powerful telescope shows no stars in these. About half-way along the sequence stars first begin to appear—in the outer edges of the nebulæ. Then, further along, come nebulæ similar to the Great Nebula in Andromeda, which consist of a comparatively small central fuzzy mass, surrounded by vast crowds of stars. At the extreme end of the sequence we have pure clouds of stars such as our own system. The comparison of the cart-wheel remains quite a good



N.G.C. 3379.

N.G.C. 4621.

N.G.C. 3115.

N.G.C. 4594.

N.G.C. 4565.

FIG. 4.—A sequence of nebular configurations providing a sort of cinematograph film of the birth of stars.
From "The Universe Around Us", by courtesy of the University Press, Cambridge.

one throughout the second half of the sequence, because the nebulæ here generally have a thick central projection, the hub of the wheel, while the rest of their structure is flat.

In brief, our sequence is one of nebulæ arranged in order of flatness, and this suggests a simple theoretical interpretation of the sequence.

We know how increasing the speed of rotation of a body results in a flattening of its shape. The ordinary Watt governor provides an obvious instance—as the engine runs faster it flattens out. Astronomy provides innumerable instances of the same effect. The sun rotating only once every twenty-six days is an almost perfect sphere. The earth, rotating more rapidly, although still very slowly, is slightly flattened, so that we usually describe it as orange-shaped. Jupiter rotates still more rapidly—once every ten hours—and is much flatter in shape. It is natural, then, to try to interpret our sequence of nebulæ as one of bodies which are rotating at different speeds. As we know that the speed of rotation of a body increases as it shrinks, it seems likely that we may interpret this sequence of nebulæ as one of different stages of development or evolution. If this conjecture is sound, a nebula starting with little rotation at first and shrinking in size would gradually increase its speed of rotation as it shrank, *and would move steadily along the sequence as it did so.*

The way to test this conjecture is to calculate for ourselves how a mass of rotating gas would change in shape as it condensed and shrank. Although the mathematical analysis is not simple, and cannot be very precise, it is, I think, fairly conclusive ; we find that the evolution of a mass of rotating and shrinking gas would be represented almost exactly by passage along the sequence.

The Breaking-up of the Universe.

Let us look at the problem in its broadest aspects. Mathematical cosmogony suggests that the shapes of astronomical bodies are moulded by three main agencies, in addition, of course, to the universal and all-pervading forces of gravitation. These three are (1) rotation, (2) tidal action, (3) gravitational instability. The general effect of all three is to break up large bodies into smaller, so that the universe tends to evolve from a few large bodies to many small ones.

Let us consider these three agencies in turn, beginning with rotation. The simplest example of its action is to be found in the formation of binary stars. As a rotating star shrinks, its rotational momentum must remain always the same throughout its continual diminution of size, so that the star finds it necessary to push ever more and more of its mass out, away from its axis of rotation. First it flattens itself and so pushes its equatorial regions away from its axis. With further shrinkage this expedient becomes inadequate, and the mass stretches itself out into a torpedo-shaped body, spinning about its shortest diameter, the ends of this torpedo being, of course, farther from the centre than if it had retained its symmetrically flattened form. When this expedient also fails, the torpedo develops a sort of waist round its middle, in this way pushing even more of its substance to its own ends ; this waist gets thinner and thinner until finally it fades into nothingness, and we are left with two detached bodies revolving about one another—the normal binary star. Rotation has broken one star into two (see Fig. 5*a*).

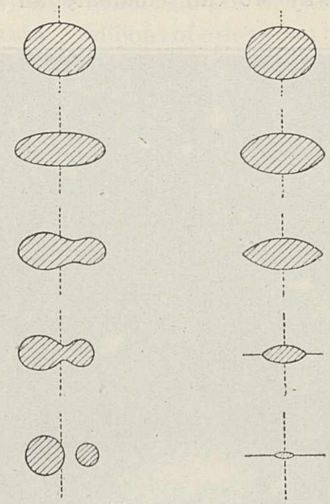


Fig. 5.—Sequence of configurations of rotating masses of liquid and gas.

From "The Universe Around Us", by courtesy of the University Press, Cambridge.

Mathematical theory shows, however, that a purely gaseous mass could not break up in this way ; the process we have described only occurs in bodies whose central regions are less compressible than a gas. When a purely gaseous body shrinks, and so increases its speed of rotation, the first result is again for it to become flatter in shape. But it never assumes the elongated torpedo-shape; its equator merely spreads out more and more until finally it becomes a sharp edge. The mass of gas has now assumed the shape of a double-convex lens. After this stage has been reached the mass cannot adjust itself to further shrinkage by a mere change of shape. It is like a fly-wheel which is rotating too fast for safety. With any further increase of speed the fly-wheel bursts, and, in the same way, the rotating mass of gas scatters matter out from its equator into its equatorial plane. This is precisely what we see in our sequence of nebulæ (compare Figs. 4 and 5*b*), and it suggests that, up to this point of their evolution at least, the nebulæ are rotating masses of gas.

The second of our three principal agencies is tidal action. Just as the sun and moon raise tides in our oceans, so any two astronomical bodies which come sufficiently near to one another raise substantial tides on one another's surfaces. We have seen how the earth's orange-shaped flattening, due to its rotation, is only the first link in a long and varied chain of configurations. So with tidal action—the feeble tides which the sun and moon raise in our oceans are only the first link in an equally long and varied chain of phenomena. As the tidal forces become more intense, simple tidal waves give place to huge excrescences of matter, and finally to terrific distortions of figure, which may end in the body being torn into two or more pieces by the tidal pull of its near neighbour.

Surrounding every massive body there is a danger-zone whose radius can be calculated. Any smaller body enters this danger-zone at the peril of its life, for there are large chances that it will be torn to pieces, and these chances become a certainty if it stays inside the danger-zone long enough. The simplest instance of the result of such action is probably to be found in the earth-moon system. Although this is far from certain, it is likely that the earth and moon originally formed a single body which was torn into two as a result of the tidal action of a larger body, probably the sun. A more striking instance is provided by Saturn's rings. These are known to consist of myriads of infinitesimal moons, each describing an orbit round Saturn at the speed appropriate to its distance. They are believed to be the broken fragments of a single moon which fell within the danger-zone surrounding Saturn and stayed there. The tidal forces of Saturn would continue to break up the unfortunate moon until each individual piece was small enough to resist their disruptive tendency—for the cohesive attraction varies as the square of the linear dimensions, while the disruptive tendency of tidal action varies as the fourth power. The asteroids—the swarm of tiny planets which circle round the sun between the orbits of Mars and Jupiter—may owe their existence to a similar occurrence. We have further instances of the same effect in the few observed cases in which comets have been broken into several pieces, or into swarms of meteors, by the tidal pulls of the sun or Jupiter.

The more weakly a body is held together, the more feeble the tidal forces which are needed to tear it asunder. Now by the time that a rotating mass of gas has reached the critical shape of a lens with a sharp edge, the matter of its equator is so weakly held that any tidal pull, no matter how feeble, will suffice to break it up. The equator of the nebula is in the state of a fly-wheel which is just about to burst; it will break first at its weakest point. The tidal action of distant bodies will raise tides on the equator of the rotating nebula, and the point at which these tides are highest will be the weakest point, since the gravitational hold of the nebula is feeblest there. Generally there will be two points of high tide antipodally opposite to one another, and when the nebula breaks up it will be through matter streaming away from these; thus we ought to see a lens-shaped mass with matter streaming out of two antipodal points of its equator. This is exactly what we do see when we view nebulæ full on, although our sequence of nebula (Fig. 4) naturally could not show it, because we saw them edge-on. Whenever, as for instance in Fig. 1, we can study the ejected matter in detail, it shows a marked tendency to form two symmetrical streams.

The third agency, gravitational instability, is the instability which must necessarily affect a mass of gas spread uniformly and acted on only by the mutual gravitational attractions of its molecules. The theory of its action is very simple. We know that every system tends to pass to a configuration of stable equilibrium in which its potential energy is a minimum. Now when a gas is spread uniformly through space, its gravitational potential energy is not a minimum but a maximum; it can fall to innumerable other states, all of which will have lower total energy. The process of so falling consists physically in the gas forming condensations and aggregating about these.

Mathematical theory not only shows that this process must occur; it also provides a formula giving the mass of each aggregate. Thus it is easy to test whether any group of bodies was formed by gravitational instability or not; we need only calculate the masses predicted by theory, and compare them with the observed masses of the actual bodies. Perhaps the planets of the solar system provide the simplest example of bodies formed by gravitational instability. It seems probable that a passing star pulled out a long filament of matter from the sun by its tidal action, and that gravitational instability then moulded the matter of this filament into the present planets. To test the conjecture, we calculate the masses of bodies which would be formed in this way; we find that they agree closely enough with the actual masses of the planets.

Still another example of the action of gravitational instability can be seen in the nebulæ we have been discussing. When a rotating nebula throws off streams of matter from its equator, this matter will at first be uniformly spread in filaments lying in the equatorial plane. These are not in stable equilibrium ; they can lessen their potential energy by forming into condensations, and accordingly do so. These are the condensations which we see gradually forming in the nebulæ as we pass along the sequence, and which we believe to be stars in the making. Again we can test our conjecture by calculating the masses of the condensations as predicted by theory; again we find that these agree well enough with the observed masses of actual stars.

We may, then, be fairly confident that this is the way the stars come into being ; the sequence of nebular configurations shown in Fig. 4 is, in effect, a sort of cinematograph film of the birth of the stars. We see rotation resulting first in a flattening of figure and then in a break-up of the nebula, tidal action determining the mode and place of this break-up, and finally gravitational instability carving up the ejected matter into stars. We notice that all the three principal cosmogonic agencies are called into play to bring the stars into being.

It cannot be claimed that this is the whole story of the evolution of the spiral nebulæ, since the spiral arms spread farther into space than can be accounted for by the centrifugal effects of rotation alone. There must be other factors at work, and these we do not yet understand ; the formation of the spiral arms remains a mystery. Possibly the theory of relativity may provide an explanation in time, but it has not done so yet.

Nevertheless, the agreement between theory and observation is good enough for us to feel on fairly safe ground in tracing the evolution of the universe back from stars to nebulæ. But how did the nebulæ themselves come into being ? The conjecture which at once comes to the mind is that the nebulæ may have been formed by the same process as the stars ; just as the stars came into being as condensations in a tenuous uniformly spread gas —the outer fringes of the nebulæ—so the nebulæ may themselves have previously come into being as condensations in an earlier mass of uniformly spread tenuous gas, the agency this time being gravitational instability acting alone. This can never be more than a conjecture, but, as we shall now see, there are strong arguments in its favour.

We have already seen how differences in size and brightness between nebulæ of the same shape are almost entirely due to a distance effect. In other words, the faintness of a nebula gives us a measure of its distance. This and other methods of a somewhat similar kind make it possible to estimate the distances of all nebulæ, even the very faintest, with fair accuracy. The faintest which can be observed photographically in the 100-inch telescope prove to be at the amazing distance of about 140,000,000 light-years. Dr. Hubble finds that the two million nebulæ which lie within this distance are fairly uniformly spaced at about 1,800,000 light-years apart. We can construct a model by taking apples and spacing them at about 10 yards apart until we have filled a sphere a mile in diameter. This will use about 300 tons of apples. This sphere is the fragment of space we can see in the 100-inch telescope ; each apple is a nebula containing matter enough for the creation of several thousand million stars like our sun ; each atom in each apple is as big as Betelgeux, with a diameter slightly larger than that of the earth's orbit.

The circumstance that the nebulæ are found to be fairly uniformly distributed through space gives a certain *a priori* plausibility to the conjecture that they may have originated from a primeval gas spread uniformly through space. But the real argument in its favour is that once again we can calculate the masses of the condensations that would form under the influence of gravitational instability, and once again we find that each condensation would have something like the same mass as the observed nebulæ. Or, to put the same thing in another way, the conjectured primeval gas would break up into condensations at distances apart comparable with the 1,800,000 light-years which Dr. Hubble finds for the average distances of the actual nebulæ. Thus although, from the nature of things, we can never know the truth for certain, there are good reasons for conjecturing that the nebulæ came into existence as condensations formed by a primeval gas which was spread uniformly, or at least with some approach to uniformity, throughout space.

Cosmogony presents us with a picture of the evolution of the universe—a cinematograph film—in which big bodies continually break into smaller ; the film shows the one for ever changing into the many. We see, conjecturally at least, one primeval gas producing millions of nebulæ, each nebula then producing millions of stars, many of these stars breaking up into binary or multiple systems, or perchance changing into a solar system and producing millions of planets, comets, and meteors. Even this is not the end of the story, for planets may break up and form satellites, satellites may break up and form rings of tiny moons, such as we see surrounding Saturn. The debris of all this breakage may form comets, and these may in turn break up into showers of meteors—tiny objects often no larger than a pea which we describe as ' shooting-stars ' when they hurl themselves to death in our atmosphere and suffer still further break-up into their constituent atoms.

The Scattering of the Universe.

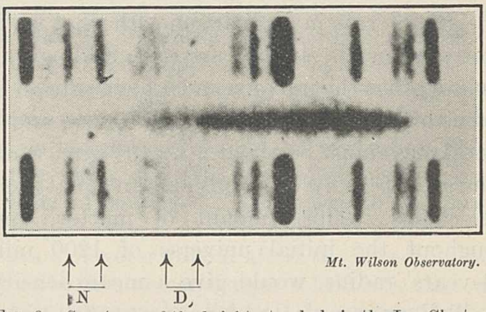
It might be thought that after all this breakage had occurred, the attractive forces of gravitation would tend to drag the broken fragments together again. The exact reverse appears to be the case. Not only is the substance of the universe for ever being broken into smaller pieces, but these pieces for ever tend to scatter farther and farther apart.

To take the example nearest home, the earth is for ever driving the moon farther away, through the agency known as tidal friction. When we watch the waves of the sea breaking against a sea-beach or a headland, we may reflect that their impact is not only slowing down the earth's rotation and so lengthening the day—it is also lengthening the month by driving the moon farther away from the earth. Incidentally it is also, through the solar tides, driving the earth farther from the sun, and so lengthening the year as well.

Again, every ray of sunlight that enters our eye carries mass with it ; eight minutes previously this mass was part of the mass of the sun. Every second the sun loses more than four million tons of mass, in the form of sunlight and sun-heat. As the result of this continual loss of mass, the sun's gravitational hold on its family of planets for ever weakens and these are driven farther off into space. The earth's orbit round the sun is not so much like a circle as like a coiled watch-spring—a spiral path for ever receding into the cold and dark of space.

The same tendency affects the galactic system as a whole. The stars of which it is formed continually scatter their mass broadcast in the form of radiation. As they do so, their gravitational hold on one another weakens, so that the whole galactic system for ever expands. It must be the same with the other star systems in space. Throughout the universe, all the smaller broken pieces, satellites, planets, stars, are scattering away from one another in apparent opposition to the laws of gravitation.

Still more surprising and sensational is the recent discovery that the largest pieces of the universe—the great extra-galactic nebulæ we have been discussing—are to all appearances engaged in a similar scattering. When proper allowance is made for the rotation of our own system of stars, all, or nearly all, the nebulæ appear to be receding from it, the nearer nebulæ with small speeds, and the more remote nebulæ with greater speeds ; in general speed is approximately proportional to distance. This simple law seems to hold to the very farthest of the nebulæ—Hubble finds that for every million light-years of distance there is a speed of recession of about 105 miles a second. The last nebula to be investigated at Mount Wilson shows a speed of recession of 12,300 miles a second (see Fig. 6) ; its distance, as estimated from its faintness, being about 105 million light-years. On the face of it, this looks as though the whole universe were uniformly expanding, like the surface of a balloon while it is being inflated, with a speed such that it doubles its size every 1400 million years.



Mt. Wilson Observatory.

Fig. 6.—Spectrum of the brightest nebula in the Leo Cluster.

At the top and bottom are the spectrum of an ordinary star. The pair of lines N are the *H* and *K* lines of calcium in their normal position. The middle spectrum is that of the nebula. The pair of lines D are the *H* and *K* lines of calcium displaced to the red by a fifteenth of their wave-length, this corresponding to a speed of more than 12,000 miles a second.

One of the great puzzles of astronomy at the present moment is whether these apparent motions of recession are real or not. The only evidence for them is that the nebular spectra show displacements to the red, which, interpreted in the most obvious way as Doppler effects, give the speeds already mentioned. Yet every spectroscopist knows that many factors besides motions of recession may redden light.

There is one strong theoretical argument in favour of regarding the apparent speeds as real. Einstein's original cosmology supposed the universe to be as full of matter as a universe of its size could possibly be without violating the theory of relativity. Recently, Lemaître of Louvain has shown that a universe of this type would not be static—there would be an unstable quality about it. The condensation of the primeval gas into distinct nebulæ, and the imprisonment of a large part of its free energy in these nebulæ, would cause the whole universe to start expanding, in which case it would continue to expand, its radius finally increasing exponentially with the time, until it ended up as an empty universe—finite matter spread through infinite space. Throughout the motion the relative speed of recession of any two nebulæ would be exactly proportional to their distance apart, so that, at first glance at least, this theory seems exactly to fit the observed facts. It not only provides a suggestion as to why the nebulæ may be receding; it goes much farther and predicts that they must be receding. If Einstein's relativity cosmology is sound, the nebulæ have no alternative—the properties of the space in which they exist compel them to scatter.

Yet the very magnitude of the apparent speeds casts doubt on their reality; they would reduce the whole existence of the universe to a mere flash—at any rate in comparison with what we have recently believed. If they are real, Eddington has calculated that the universe must have started from a radius of about 1200 million light-years, and that its total mass must be about $2{\cdot}3 \times 10^{55}$ gm., which is the mass of $1{\cdot}4 \times 10^{79}$ protons and an equal number of electrons. This amount of matter, spread throughout the initial universe of 1200 million light-years' radius, would give a mean density of $1{\cdot}4 \times 10^{-27}$ gm. per c.c. So far as we can tell from the masses of the extra-galactic nebulæ, the present average density of matter in space appears to be not less than 10^{-30} gm. per c.c., which, with the same amount of matter, would assign a radius of 13,200 million light-years to the universe—only eleven times its initial value. If, then, the motions are real, the universe is only at the beginning of its career; it cannot have doubled many times since it started. As it appears at present to be doubling in size every 1400 million years, the few doublings which these figures permit cannot have occupied more than 10,000 million years at most.

General calculations on the ages of astronomical bodies point to far longer periods of time. Both single stars and binary systems show an approximation to equipartition of energy which must have taken far longer than this for its establishment. If we concede that the universe has expanded to many times its original size, so that the stars were initially far more closely packed than now, the figure originally calculated of a few millions of millions of years may have to be reduced by a good deal, but not, I fear, by enough to remove the conflict of evidence.

In any event a piece of evidence remains which cannot be dismissed in this way. Spectroscopic binaries consist of pairs of stars revolving round one another. Observation reveals a complete sequence; it begins with systems which appear to have just broken into two as the result of rotation—pairs of stars describing circular orbits, and almost in contact—and ends with systems in which the two stars are far apart and describing elliptical orbits. Observation also shows that the stars at the beginning of the sequence are many times more massive than those at the end. It seems likely that those which are now at the end must have begun at the beginning, and lost the greater part of their mass in the form of radiation. To do this would take millions of millions of years, quite regardless of whether the universe was expanding or of what it was doing.

Considerations such as these make it very difficult to believe that the universe can be such an ephemeral concern as the apparent speeds of recession of the nebulæ would suggest.

There is, however, every reason to hope that within a very short time we shall know the truth about this puzzle, and, whatever the solution may be, there seems to be a considerable chance that it may provide us with a clue, perhaps even with a key, to the structure of the universe as a whole. Such a clue—and still more, such a key—would be of the utmost value. Until quite recently the man of science, like most men, accepted the fundamental ingredients of our experience—space, time, matter, and energy—more or less at their face value. The most obvious and superficial interpretation suggested by everyday experience was assumed to correspond fairly closely to ultimate reality. The theory of relativity has shown that we were utterly wrong about space and time, and we are beginning to suspect that we are still just about as far wrong about matter and energy. The concept of an expanding universe may prove after all to be a false scent, and the truth may lie in some other direction, but in either event the observed phenomena must mean something, and their true interpretation, when it is found, may carry us a step on towards the solution of the greatest mysteries of the external world—the nature of space, time, matter, and energy, and of the combination of all these which constitute the physical universe.

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the public the results of science in civic as well as in industrial life, and to extend the task of co-ordination so as to assist the growth of co-operation and the emancipation of industry and society from false values and mechanisation of life.

SCIENTIFIC information is disseminated in Germany in several ways. There is the scientific news service "Pallas", edited by Dr. Paul Neuburger, Berlin-Zehlendorf, Cecilienstr. 10. This distributes in very clearly printed typescript a foolscap sheet appearing about every other day. The paragraphs are of general interest and seem suited for immediate use in the daily press of German-speaking countries. The Reichszentrale für wissenschaftliche Berichterstattung Pressestelle, Berlin, N.W.7, Unter den Linden, 38, is another information bureau issuing scientific news. Its items seem suited for immediate use in scientific, technical, and educational journals, and by translation without further condensation they might be utilised in English journals. A good deal of the material is taken from *Forschungen und Fortschritte*, a journal of research and scientific progress appearing three times a month in some twelve pages under the editorship of Dr. E. Kiessling, Berlin, N.W.7, Unter den Linden 38. There are two editions, *Korrespondenzblatt*, printed on one side only of the paper, for 5 marks quarterly, and *Nachrichtenblatt*, printed on both sides, for 3 marks quarterly. The reprinting of signed articles is only permitted with acknowledgment of the source. This journal is written for more scientific and academic readers. The separate authors are specialists intimately concerned with the researches they describe. Special paragraphs are devoted to a diary of coming congresses and reports of international scientific organisations. *Die Naturwissenschaften*, edited by Dr. Arnold Berliner, and published by Verlag Julius Springer, Berlin, W.9, Linkstrasse 23-24, is a weekly journal of science. It is now in its eighteenth year and is the official organ of the German Association of Men of Science and Physicians. *Die Naturwissenschaften* may be particularly commended to those who are trying to acquire some general familiarity with scientific German in various fields. The editor is to be congratulated on having kept this journal alive during the difficulties of the past few years.

SIR ALEXANDER RODGER, chairman of the Department of Forestry, Section K (Botany) of the British Association, gave a short review, on Sept. 25, of the inception and development of forestry in the Empire during the last hundred years. Sir Alexander said that although forestry has, in some European countries, been long regarded as an important part of scientific knowledge, the 'forest sense' and the importance of forestry have only recently begun to come to the fore in Great Britain. With few exceptions, forestry was little understood throughout the Empire before the beginning of the present century. Sir Alexander quoted extracts from various recent forest reports, which showed that, until comparatively recently, the neglect and failure to apply the most elementary principles of forest management have led to direful results. The last twenty to thirty years have seen a realisation of the immense value of the forests of the Empire, depleted as many of them are. Since 1900, and even more since the War, the value of the forests has been continually impressed upon governments by imperial and other conferences. Technical instruction has of recent years made great strides, especially in Great Britain, where forest officers are trained for many parts of the Empire, and forest research in India, Canada, Australia, and Great Britain has attained an importance never before recognised for it. The skilled use of exotics also has turned out to be of the greatest importance in Australia, New Zealand, India, and elsewhere.

IN his Cantor Lectures at the Royal Society of Arts on "Some Recent Developments in Microscopy", Prof. L. C. Martin reviews a number of developments in microscopy, especially those respecting which not much has yet been published, such as ultra-microscopy, the theory of dark-ground illumination and resolving power with it, Gerhardt's interference method, and ultra-violet microscopy (*Jour. Roy. Soc. Arts*, Aug. 21 and 28, 1931, pp. 871 and 887). For the quartz homogeneous system employed for ultra-violet microscopy, it is necessary to use an immersion fluid of refractive index of 1·4961, and a solution of glycerin and water is employed. This mixture is, however, hygroscopic except in the driest atmosphere, and absorption of water vapour alters the refractive index. To obviate this, as cane-sugar solution is also transparent to ultra-violet light, it is suggested that a mixture of the glycerin and cane-sugar solutions of the proper refractive index may be made in such proportions that it neither absorbs water nor evaporates, but remains constant. The proportions would have to be adjusted for varying degrees of atmospheric humidity.

THE new Ramsay Memorial Laboratory of Chemical Engineering at University College, University of London, is to be opened on Nov. 26 by H.R.H. Prince George. The Laboratory is designed to provide a post-graduate training in the principles underlying the design, fabrication, and operation of all kinds of chemical plant. Special features of the building are a large industrial laboratory in which semi-large scale plant can be erected and tested, a well-equipped workshop in which plant units may be fabricated or repaired, a drawing office, and a general experimental laboratory. Special laboratories are devoted to the study of fluid flow, heat transfer, and the examination of fuels. Provision is also made for the original investigation of chemical engineering problems, either on a small or semi-large scale. The building is designed to accommodate fifty post-graduate students. Its erection and equipment have been made possible by the generous contributions of a number of firms of chemical manufacturers and chemical plant manufacturers.

THE new laboratory for physical chemistry in the University of Freiburg im Breisgau was opened on Oct. 30. At the same time honorary degrees were conferred on Lord Rutherford, Prof. Siegbahn, and Prof. Goldschmidt. The old laboratory was one of the first institutes for physical chemistry erected in Germany. The new laboratories are especially well equipped with apparatus for carrying out chemical analysis by X-rays, and extensive facilities are available for investigating the composition of minerals and alloys by chemical, radioactive, and spectroscopical methods. A large section of the laboratories is devoted to the study of diffusion phenomena, especially in alloys.

TEN years ago, on March 29, 1921, John Burroughs died. His writings, full of close observation of wild life, expressed with studied simplicity, have done much to encourage an interest in Nature in America and beyond. The John Burroughs Memorial Association has commemorated the tenth anniversary by the publication of "The Slabsides Book of John Burroughs", and one of the chapters appears in *Natural History* (New York, Sept.–Oct. 1931). It contains personal recollections of the poet-naturalist and of his life at his mountain retreat, the rustic cabin of Slabsides, near Riverby, by Clyde Fisher, whose friendship with Burroughs extended through many years. The article brings out very simply the ideas which governed the poet's life and writings, and the author's photographs add to the intimacy of his theme.

AT a meeting of the Royal Microscopical Society held on Oct. 21, Prof. K. Fujii of Tokyo, Prof. Victor Grégoire of Louvain, and Prof. O. Rosenberg of Stockholm were elected honorary fellows of the Society.

THE Streatfeild Memorial Lecture will be delivered at the Institute of Chemistry on Nov. 20, at eight o'clock, by Dr. J. V. Eyre, who will take as his subject "Recent Advances in the Fermentation Industries".

THE American Association for the Advancement of Science will hold its eighty-ninth meeting at New Orleans on Dec. 28, 1931–Jan. 2, 1932, under the presidency of Prof. Franz Boas, professor of anthropology, Columbia University.

AT the anniversary meeting of the Mineralogical Society, held on Nov. 3, the following officers were elected: *President*, Sir John S. Flett; *Vice-Presidents*, Dr. G. F. Herbert Smith, Prof. C. Gilbert Cullis; *Treasurer*, Mr. F. N. Ashcroft; *General Secretary*, Mr. W. Campbell Smith; *Foreign Secretary*, Prof. A. Hutchinson; *Editor of the Journal*, Dr. L. J. Spencer.

THE following officers have been elected for the Cambridge Philosophical Society for the year 1931–32: *President*, Prof. A. Hutchinson; *Vice-Presidents*, Mr. G. Udny Yule, Dr. W. H. Mills, Mr. F. T. Brookes; *Treasurer*, Mr. F. A. Potts; *Secretaries*, Mr. F. P. White, Dr. J. D. Cockcroft, Dr. H. Hamshaw Thomas; *New Members of the Council*, Dr. R. H. Rastall, Mr. C. F. A. Pantin, Mr. N. F. Mott.

THE following appointments have recently been made by the Secretary of State for the Colonies: Mr. C. E. J. Biggs, agricultural officer, Uganda, to be senior agricultural officer, Uganda; Mr. W. J. Badcock, to be agricultural officer, Uganda; Mr. G. D. P. Olds, to be agricultural field officer, Malaya. The following assistant conservators of forests have been appointed: Mr. F. G. Harper and Mr. F. J. Lyon (Gold Coast); Mr. C. V. Wallace (Sierra Leone); Mr. D. G. B. Leakey (Kenya); Mr. R. G. Miller (Northern Rhodesia); Mr. F. H. Landon (Malaya).

AT a general meeting of the Société française des Électriciens on Nov. 7, it was decided to confer the title of honorary member on Mr. Percy F. Rowell, secretary of the Institution of Electrical Engineers, in recognition of his work in establishing close collaboration between the French society and the Institution of Electrical Engineers, particularly during the Anglo-French Congress held in Paris in 1913, the meeting of the Institution held in France in 1929, and the Faraday celebrations held in London in 1931.

IT is announced by Science Service, Washington, D.C., that Prof. Theodore Lyman, emeritus professor of physics in Harvard University, has been awarded the Frederick Ives Medal of the Optical Society of America for his pioneer work on the ultra-violet spectrum of hydrogen gas. Prof. Lyman's name is commemorated in the 'Lyman series' of the hydrogen spectrum, which, with the series detected by Balmer and by Paschen, are of fundamental importance in modern views of the energy levels within the atom.

THE council of the Institution of Civil Engineers has awarded the Indian Premium for the session 1930–31 to Mr. G. C. Minnitt (Bombay). It has also made the following awards for the session 1930–31 in respect of selected engineering papers, published without discussion: A Telford Gold Medal to Mr. Herbert Addison (Giza, Egypt), and Telford Premiums to Mr. H. A. Sieveking (London), Dr. William Blackadder (Aberdeen), Mr. R. F. Legget (Montreal), and jointly to Messrs. R. G. C. Batson and H. R. Mills (Teddington). In respect of papers read at students' meetings in London, or by students before meetings of local associations, during the same session, the following awards have been made: The James Forrest Medal and a Miller Prize to Mr. I. W. G. Freeman (London), and Miller Prizes to Messrs. V. A. C. Durand (Cardiff), F. C. Ball (London), T. A. Burnside (Glasgow), F. R. Paynter (Newcastle-on-Tyne), D. H. McPherson (Glasgow), S. G. Barrett (Manchester), E. H. Ely (London), and H. E. Orr (Yorkshire).

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just issued a 'clearance' list of nearly 1000 second-hand books on geology, meteorology, mathematics, astronomy, chemistry, and physics. The prices asked are very reasonable.

THE Cambridge University Press announces for early publication Vol. 4 ("Meteorological Calculus: Pressure and Wind") of Sir Napier Shaw's "Manual of Meteorology". The work will contain a summary of contents and an index to the four volumes. The same house also gives notice of "Partial Differential Equations of Mathematical Physics", by Dr. H. Bateman, and "Cartesian Tensors", by Dr. Harold Jeffreys.

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.]*

Viscosity of Liquids.

I WAS extremely interested to read, in NATURE for Oct. 24, Prof. G. W. Stewart's letter, in which he states that his X-ray diffraction experiments strongly support my theory of viscosity, and I look forward with eagerness to reading the full account of his results. We are both in agreement that the liquid state is more akin to the crystalline than to the gaseous state, and it is in this connexion that I wish to direct attention to another result of my theory which bears on this point, more especially as fuller publication has, by various mischances, been delayed.

I postulate that liquid viscosity is due to an interchange of momentum between adjacent layers, effected not, as in a gas, by a passage of molecules from one layer to the other, but by a temporary union of molecules, which does not endure for longer than the very brief time required for the molecule to acquire a common velocity of translation—a temporary holding of hands between individuals of two parallel rows moving past one another rather than a stepping bodily from one row to the other. The nature of the union need not be discussed here; all that is demanded of it is that it should produce momentarily a common velocity of the molecules. This leads to the expression

$$\eta = \frac{2m\nu}{\sigma}$$

where m is the mass of a molecule, σ the average distance between the centres of molecules, and ν the frequency of junction per second, which is also, of course, the frequency of disjunction, since the union is of negligible duration. The variation of ν with temperature is an essential feature of the theory, but I am not at the moment concerned with that, but rather with the value of ν at the melting point of the liquid.

Suppose that we make the assumption, which may appear startling, that when a solid is melted it still retains in the liquid form sufficient of its crystalline character for the molecules to possess a frequency of vibration which is practically the same as that of the solid form at the melting point. This is not so remote from Lindemann's theory, in which he derives the frequency of vibration of the solid state of elementary substances at the melting-point from the assumption that melting takes place when the amplitude of the atomic vibration becomes about equal to the average distance apart of the atoms. There is fairly good agreement between the values derived from other methods and those found from Lindemann's formula, which is

$$\nu = C\sqrt{\frac{T_m}{AV_A{}^{2/3}}}$$

where T_m is the melting point, A the atomic weight, and V_A the volume of a gram-atom at temperature T_m. Suppose that we substitute the frequency ν so found in the viscosity formula. Since $\sigma = \left(\frac{V_A}{N}\right)^{1/3}$, and $m = \frac{A}{N}$, where N is Avogadro's number, we obtain for the viscosity η_m at the melting point

$$\eta_m = 2C\frac{(AT_m)^{1/2}}{(NV_A)^{2/3}}.$$

Lindemann gives for the constant C the value $2{\cdot}8 \times 10^{12}$. Substituting this, and the value $6{\cdot}06 \times 10^{23}$ for N, we have

$$\eta_m = 7{\cdot}82 \times 10^{-4}\frac{(AT_m)^{1/2}}{V_A{}^{2/3}}. \quad . \quad . \quad (1)$$

The following table shows the calculated and experimental results for elementary substances, of which the viscosity of the liquid form in the neighbourhood of the melting point can be found from published experimental data. For many liquid metals the viscosities, as found by different workers, show such large discrepancies that they have not been used.

Element.	Melting Point.	Viscosity of Liquid in the Neighbourhood of the Melting Point.	
		Calculated.	Experimental.
Mercury .	234·2° Abs.	0·0283	0·021
Bromine .	265·7	0·0132	0·0147
Iodine . .	386	0·0198	0·0235
Chlorine .	171	0·0104	0·0143
Oxygen .	54	0·0038	$>$0·0019
Hydrogen .	14	0·00051	$>$0·00013

As regards the viscosities of liquid oxygen and hydrogen, only one determination, that of J. E. Verschaffelt, exists, namely, at 90° abs. for oxygen ($\eta = 0{\cdot}0019$), and at 21° abs. for hydrogen ($\eta = 0{\cdot}00013$), temperatures which are respectively 67 per cent and 50 per cent above the melting point. It is certain that the viscosities at the melting point must be considerably higher than those shown in the table.

It should be emphasised that the constant in formula (1) is not arbitrary, but taken from Lindemann's formula. When this is remembered the agreement between experiment and calculation must be considered as very satisfactory, and furnishing a strong confirmation of the conception of the liquid state put forward, namely, that liquids at the melting point behave as crystals which have, so to speak, lost their general rigidity, while retaining local memory of their former state. I have sketched the argument leading to formula (1) as briefly as possible: I hope to make it a little more convincing when I have more space at my disposal.

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Anomalous Variation of the Electrical Conductivity of Quartz with Temperature at the Transformation Point.

FOR many years the variation of electrical conductivity of crystalline dielectrics with temperature has been studied by different physicists; for example, A. Joffé [1] has studied this problem with quartz, calcite, ammonium-alum, and copper sulphate, and found that their conductivity σ is expressed by $\log \sigma = \frac{A}{T} + B$, where T is the absolute temperature, A, B the material constants. More recently, W. Seith [2] has also studied this problem with lead chloride and iodide crystals and deduced the expressions $\sigma = Ae^{-Q/RP}$ for the chloride, and $\sigma = A_1e^{-Q_1/RP} + A_2e^{-Q_2/RP}$ for the iodide, where A, A_1, A_2 and Q, Q_1, Q_2 are material constants, T the absolute temperature, and R the gas constant. But no one has noticed that there exists any anomalous change of the electrical conductivity of quartz at the temperature 573° C.

It is well known that the index of refraction, specific heat, Young's modulus, and other physical properties of quartz, except its electrical conductivity, show anomalous changes at its $\alpha \rightleftarrows \beta$ transformation.

According to the investigation by X-ray analysis on the structure of α and β quartz given by W. Bragg and R. E. Gibbs,[3] the projective area of a triangle formed by silicon atoms on the plane perpendicular to the principal axis becomes smaller by its rotation at the transformation $\beta \longrightarrow \alpha$. Thus, it might be expected that the electrical conductivity of quartz would increase

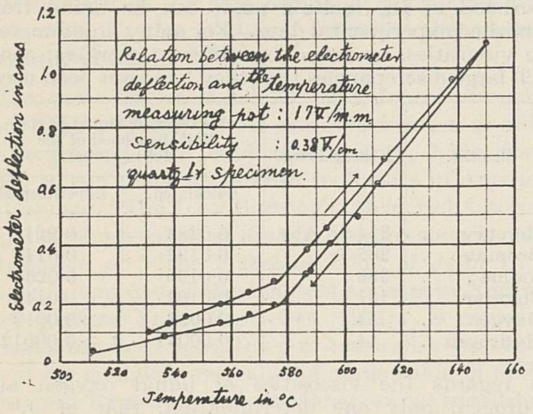

FIG. 1.

considerably at the $\alpha \longrightarrow \beta$ transformation. We measured the change of electrical conductivity of quartz with temperature with special precautions and accuracy, especially in the temperature range about 500°–650° C.

We used two different methods in our experiments. In one, we measured the voltage drop with time produced by a standard resistance connected with the specimen and the earth in series (the stationary value

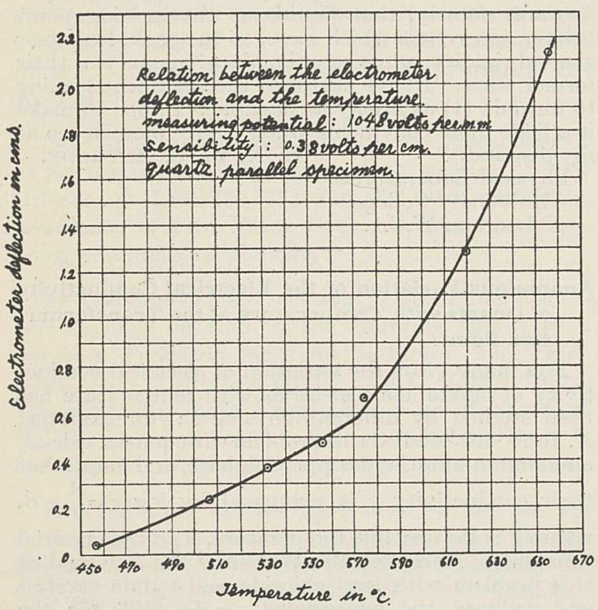

FIG. 2.

of the voltage drop will be proportional to the electrical conductivity of the specimen); and in the other, we measured the accumulation of charge on the specimen with time, and the conductivity is calculated by the ratio of the initial current (the initial tangent of the accumulating curve) to the applied voltage. Some of our results are given herewith.

Fig. 1 shows the variation of the electrometer deflection due to the voltage drop of the standard resistance of 800,000 ohms with temperature for a quartz plate cut perpendicular to its optical axis. The ordinate is proportional to the electrical conductivity of the quartz. The arrows in this diagram show the results for heating and cooling, and the time intervals for heating and cooling are nearly the same and equal to about fifteen hours. Thus, the electrical conductivity of quartz varies anomalously at the $\alpha \rightleftarrows \beta$ transformation temperature 573° C. Fig. 2 shows a similar result for quartz plate cut parallel to its optical axis. In this case also the anomalous change of the electrical conductivity occurs at the transformation temperature 573° C. Fig. 3 shows the result by the accumu-

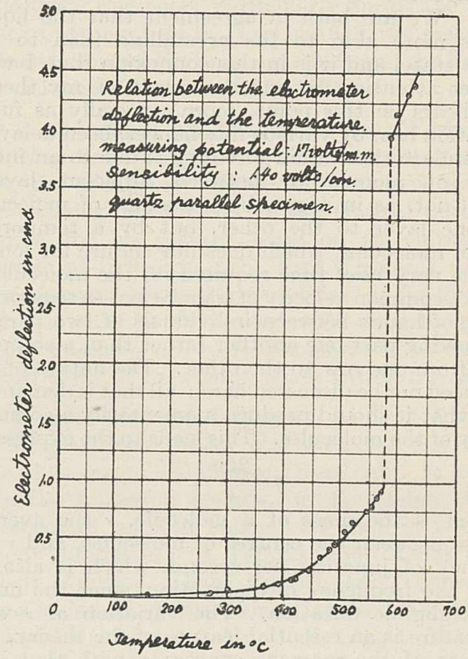

FIG. 3.

lation charge method with the parallel quartz plate. In this case the conductivity increases discontinuously at the temperature 573° C.

There is considerable difference between the results given in Figs. 2 and 3 on the variation of the electrical conductivity at the transformation point, but this is an apparent difference only, because, in Fig. 2, the stationary value of the conductivity is taken and in Fig. 3 the initial value of it is considered. We have already shown that the electrical conductivity of dielectrics is of two kinds, namely, true and apparent, and the latter decreases with time and tends to the stationary value.[4] It is the apparent conductivity which is measured in the experiments above on quartz.

Hence we conclude that the electrical conductivity of quartz increases with temperature, and at its transformation point, 573° C., it shows an anomalous variation similar to that of the other several physical constants of quartz.

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[1] *Ann. der Phys.*, **72**, 495; 1923.
[2] *Zeit. für Phys.*, **56**, 802; 1929.
[3] *Proc. Roy. Soc.*, A, **109**, 405; 1925.
[4] *Sci. Rep. Tôhoku Imp. University*, **18**, p. 231; 1929: **19**, p. 69; 1930: **20**, p. 1; 1930.

Control of Prickly-Pear by the Cochineal Insect.

I HAVE read with interest the communications of Messrs. C. T. Jacob [1] and W. B. Alexander [2] on this subject. Referring to the introduction of the cochineal insect into India, the latter remarks: "In India, the offer was considered at a conference of the entomologists of the various provinces, and it was decided not to accept it, on the ground that prickly-pear was largely used for hedges, and that, where it threatened to become a pest, it could easily be eradicated, as abundant cheap labour was available". I am constrained to state that neither the first part nor the latter portion of this statement describes the real facts. I may state that, though the Government was not very enthusiastic about the introduction of this new insect, it never had any conference of provincial entomologists or gave any such opinion regarding the necessity for, or the easy method of, eradicating prickly-pear when needed. In South India the prickly-pear has been felt to be a very serious pest and nuisance for years, and the Government has been spending a great deal of money in getting the same eradicated in various ways without any appreciable success until now. Nor has it ever been felt by any responsible person that "it could easily be eradicated, as abundant cheap labour was available".

Anyone travelling, even along the railway tracts of South India, can easily form an idea of the extensive areas of valuable arable and pasture lands overrun by this terrible pest. It is not only harmful in harbouring dangerous reptiles, etc., as Mr. Jacob puts it, but also is in every way an undesirable weed. Among other things, it blocks up village footpaths, covers the banks and foreshores of streams and rivers, encroaches badly and quickly on cultivated areas, and in fact makes the whole country-side very unsightly. The introduction of this cochineal, though through a private agency, was certainly not a "thoughtless importation" of a strange animal; on the other hand, it is being felt as a real boon. By its steady and effective work of controlling the weed (*O. dillenii*) the insect has not only helped in the saving of thousands of rupees usually spent year after year to keep the same under some control, but it has also been clearing the country-side remarkably and very satisfactorily.

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Madras, South India,
Sept. 24.

[1] NATURE, **128**, 117, July 18, 1931.
[2] NATURE, **128**, 226, Aug. 8, 1931.

Control of Humidity of Air Currents.

PROF. J. B. SETH [1] has described a method of obtaining air currents of which the humidity can be regulated. I do not doubt that his method is a good one, though I have no experience of it. But may I point out that humidifying the air by mixtures of sulphuric acid and water is also a good method, provided that certain precautions are taken. It is perhaps unsuitable if large volumes of air are required. The air should be blown, not sucked, so that any leaks which may occur will be outwards. The air should not be bubbled through the acid, for that imparts to it an acid spray, which is most difficult to remove; it should pass through several Woulfe's flasks, containing pumice well wetted with the acid. Nearly all the humidifying (or drying) of the air takes place in the first Woulfe's flask, to which the gradual alteration in the strength of the acid is almost confined. After the last Woulfe's flask, arrangements should be made for drawing off a sample of the air stream; it may be bubbled through an indicator to show that it is free of acid; or it may go past a dew-point apparatus, enclosed in glass. This is most important, as it provides a method of hygrometry, perhaps the most suitable for this particular purpose. I have recently figured a convenient dew-point instrument.[2]

P. A. BUXTON.
London School of Hygiene and
Tropical Medicine,
University of London, Oct. 12.

[1] NATURE, Oct. 10, p. 638.
[2] *Bull. Entom. Res.*, vol. 22, p. 431.

WE have read with interest the communication of Prof. J. B. Seth in a recent issue of NATURE [1] on a method of obtaining air currents of various relative humidities. The method described by Prof. Seth makes use of the principle of admixing appropriate proportions of desiccated and saturated air; it appears to be assumed, however, that saturation may be effected by bubbling air through a bottle full of water. In a recently published paper [2] we have shown that this assumption, which is very commonly made, is not justified. Passage of air at a rate of approximately 60 c.c. per min. through a Dreschel wash-bottle full of water produced a relative humidity of only 80 per cent; whereas at the same and much higher rates of flow complete saturation was obtained by admitting steam into the air current and condensing out the excess moisture under thermostat conditions. Lower relative humidities were obtained quantitatively by suitably admixing saturated and desiccated air.

Since the failure of the 'bubbling method' is undoubtedly attributable to factors connected with hydrostatic pressure, clearly it cannot be overcome merely by increasing either the number of bottles or the depth of liquid. The point to which we desire especially to direct attention is the doubt that must be associated with any method of saturating a stream of air that depends on its passage vertically through a column of water.

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[1] NATURE, Oct. 10, p. 638.
[2] *Trans. Faraday Society*, **27**, 248; 1931.

Short Wave Reception and Ultra-Radiation.

A FEW years ago W. Kolhörster [1] referred to the possible connexion between short wave fading and the fluctuations of ultra-radiation, and suggested comparative investigations. Up to now such investigations have not been undertaken, so that still nothing is known concerning this.

In the following I wish to direct attention to an undoubted analogy in the changes in short wave reception and in the changes in intensity of ultra-radiation during terrestrial magnetic disturbances. This permits conclusions to be drawn as to a connexion between the two phenomena.

The auditory reception strength for short wave long-distance reception increases gradually for a few days before a magnetic disturbance, until, on the day of the disturbance, it decreases suddenly, even to inaudibility. It first increases again in the course of the following days, there being a slow increase but for superimposed fading effects.[2] Corlin [3] has now been able to derive statistically a completely inverse picture from his ultra-radiation observations in northern Sweden in the winter of 1929–30. According to this, the strength of the radiation decreases slowly and continuously for some time before a disturbance, jumps strongly upwards at the beginning of the disturbance (the impetus stage), and then slowly becomes less again during the further course of the disturbance (the main oscillation stage) and its after-effects. This agreement must be more than accidental, and permits the conclusion, made with all due reservation, that increase of ionising ultra-radiation makes reception conditions worse, and conversely. The known deterioration of reception during the daylight hours, when there is an increase in ionisation in the upper layers of the atmosphere due to the ultra-violet radiation from the sun, also affords evidence for this inverse proportionality between reception strength and ionising radiation. W. M. H. SCHULZE.

Neue Mühle-Königswusterhausen,
near Berlin, Oct. 9.

[1] W. Kolhörster, *Naturwiss.*, **15**, 126; 1927.
[2] K. Stoye, *Funk-Bastler*, **38**, 593; 1928: **39**, 617; 1931.
[3] A. Corlin, *Lund Observatory Circular*, **1**, 3; Mar. 31, 1931.

Rhythmic Breaking of Ship-waves.

ON a recent voyage from Australia, I observed a phenomenon in connexion with ship-waves to which no reference is made in the literature on waves with which I am acquainted. Dr. Vaughan Cornish's book on "Waves of the Sea", etc., makes no mention of it.

The diverging waves produced by the motion of the ship increase in height and steepness on the near-side as they move outwards from the ship and then

FIG. 1.

break towards the ship. The fact to which I wish to direct attention is that this breaking is, under favourable conditions, regularly periodic.

Prof. Hartung of Melbourne, who was a fellow-passenger, was kind enough to take some photographs of this effect (Fig. 1). Two parallel bands of foam are very definitely shown, a third not quite so definitely. Occasionally as many as half a dozen such parallel breaks in the wave-crest could be seen, though more frequently these are broken by transverse bands of turbulence. KERR GRANT.

Australia House, London W.C.2.
Oct. 8.

Constitution of the White Dwarf Stars.

IT is generally held that the white dwarf is in the degenerate state in the sense of the statistics of Fermi and Dirac. This assumption leads to another consequence bearing on the relative abundance of elements in the same star. Assuming further that (i) all atoms of various elements in the white dwarf are stripped of their extranuclear electrons, and (ii) all kinds of nuclei of atoms are formed entirely from protons and electrons, the thermo-equilibrium among them is determined from Milne's equations.[1] The simplified form is

$$\frac{1}{m_E}\left(\frac{c_E}{q_E}\right)^{\frac{2}{3}} = \frac{\mu}{m_P}\left(\frac{c_P}{q_P}\right)^{\frac{2}{3}} + \frac{\nu}{m_e}\left(\frac{c_e}{q_e}\right)^{\frac{2}{3}} + \frac{2}{h^2}\left(\frac{4\pi}{3}\right)^{\frac{2}{3}}U \quad . \quad (1)$$

with the equation of nuclear formation of an element E from μ protons (P) and ν electrons (e),

$$\mu P + \nu e \rightleftarrows E + U,$$

where m, c, and U denote respectively the mass of an atom, the concentration and the heat of formation. μ and ν are expressed by Z (the atomic number), and the mass of an atom as follows:

$$\mu = \frac{m_E}{m_P}, \quad \nu = \frac{m_E}{m_P} - Z_E. \quad . \quad . \quad (2)$$

Usually the first teim of the right-hand side of (1) is negligibly small.

U is calculated from the mass-defect, with the result that U increases monotonically with the mass number of the element. As all terms of the right-hand side of (1) are positive, it is quite clear that the nuclear concentration of an element increases with its atomic weight (almost proportional to its square). Therefore it may be concluded that the heavy radio-elements exist abundantly in the white dwarfs.

SEITARÔ SUZUKI.

The Kyushu Imperial University,
Fukuoka, Japan, Sept. 16.

[1] *Mon. Not. Roy. Ast. Soc.*, **90**, 769; 1930.

Dehydration of Salts.

IN the course of some investigations it was found advantageous to have a uniform and general method of dehydration. Such a method was found in the extension of the drying process applied originally to 2-nitro-*p*-cresol.[1] In general, dehydration was carried out by distilling a neutral liquid of high vapour tension containing the hydrated salt or its aqueous solution.

As an example, crystals of copper sulphate were placed in toluol and the latter distilled off until no further water could be detected in the distillate. The anhydrous copper sulphate so obtained, though lacking in cohesion, frequently retained its original crystalline form. Dried over solid paraffin in a desiccator, the copper sulphate was found as whitish fragile crystals free from water.

In a similar manner the dehydration of magnesium chloride and various salts of iron, nickel, and cobalt was carried out. This method practically eliminates decomposition of the product and side reactions, such as oxidation and reduction. Owing to its elasticity as regards medium, temperature, and pressure, the process may be of general application.

An attempt to extend Stephen's acetic anhydride dehydration of stannous chloride[2] to other salts met with but partial success.

Although dehydration was in most cases achieved, (1) the process was limited to solids in a finely divided condition; (2) in most cases the reaction was sluggish and required heating; (3) the dehydrated salts were found to retain tenaciously some acetic acid and its anhydride, a feature apparently general in the case of salt-acid mixtures.

MAURICE COPISAROW.

Research Laboratory,
145 Alexandra Road,
Manchester, S.W., Oct. 8.

[1] Copisarow, *Jour. Chem. Soc.*, 251; 1929.
[2] *Jour. Chem. Soc.*, 2786; 1930.

Research Items.

Prehistory of West Africa.—In *Africa*, vol. 4, no. 4, M. P. Laforgue reviews the present state of our knowledge of the stone age in West Africa. Both the major divisions of stone age culture are represented with a distinct but ill-defined period of transition, revealed by a large number of 'Tardenoisian' implements. The African palæolithic peoples, like the Eurasian, lived in caves, rock-shelters, and in the forests, where they were succeeded by the neolithic peoples, as is shown by superimposed deposits. Three zones of prehistoric culture can be distinguished in strongly marked local developments of a basal culture: (1) a Saharan zone north of 18° N.; (2) a Sahelian zone between 18° and 14° N.; (3) a Soudanese zone between 14° and 4° N. The Saharan zone is distinguished by the use of flint and limestone. Weapons predominate, and the implements attain great perfection of form and technique. They point to a northern and eastern origin, and have been attributed to nomad hunting tribes. Pottery is rare and implements of agriculture non-existent. It is in this zone that the greater number of palæolithic sites are found, Mousterian industries predominating. (2) The Sahelian sites show a predominance of tools and the implements of agriculture. All kinds of stone are employed; arrow- and lance-points are found, but without the refinement of those of the Saharan zone. The industry as a whole is agricultural. Pottery is abundant; it is ornamented by the use of the tips of the fingers. (3) In the Soudanese zone, limestone is generally in use, the implements being axes, hammer-stones, grinding-stones, and numerous flakes of limestone and basalt, of which it is not possible to determine the use. Evidence from this part of Africa, especially in the forested area, is scant.

Indian Place-Names.—In the *Indian Antiquary* for October, Rai Bahadur Hira Lal discusses the origin of the place-names of the Central Provinces. During the times of Srî Râmacandra a great part of what is now the Central Provinces was, according to recent interpretation, Daṇḍakâranya or Daṇḍaka forest. The forest was inhabited by wild tribes, among whom the Gonds were prominent, as they are still. It is likely, therefore, that the place-names were in the language of the aboriginal tribes, especially of the Gonds and Oraons, though many of them have undoubtedly been Aryanised. Relics of tha Sabars' or Śavaras' language have been pointed out, for example, in Janasthâna from *jaitan*, 'below', or Daṇḍaka, 'full of water'. The following are examples of aboriginal names of Gondi origin which have undergone scarcely any change:—A large number of names derived from trees, for example, 'Barelî' from 'barelî', 'banyan' (*Ficus bengalensis*); 'Markâḍîh' from 'markâ', mango. In the single district of Jubbulpur alone there are more than fifty villages named 'Pipariâ' from 'pîpar' (*Ficus religiosa*). The Aryan names carry a suffix, for example, 'Belgâon' from 'bel', a tree, and 'gâon', a village. Certain names are derived from wild animals, birds, insects, etc., as applied to places to which they resorted; 'Malpârâ' from 'mal', a peacock, 'Koṇḍigâon', from 'Koṇḍâ', a bullock. Similar names are common in Aryan nomenclature; for example, 'Bâghpur' from 'bâgh', a tiger, 'Hâthîgadh' from 'hâthî', the elephant. Trees and animal names are joined with words signifying water; for example, 'Aunrâbândhâ', from 'aunrâ', a tree, and 'bândh', embankment, 'Bâghḍabri', tiger-pool. Examples of reptiles and birds are Nagpur, 'Cobra city', Kavâkhâpâ, 'Crow hamlet'. Onomatopœic names imitate the sound of running water or the cry of birds heard in the vicinity, such as Daldali, Murmur, Luṭluṭâ, Rigrigâ, Tuturiyâ.

False Killer Whale in Ceylon Waters.—The stranding of a large school of killer whales, *Pseudorca crassidens*, containing 167 individuals, upon the shores of Velanai in Ceylon, has already been mentioned in NATURE, and now Dr. Joseph Pearson describes the occurrence in more detail (*Spolia Zeylanica*, vol. 16, p. 199, Aug. 1931). Unfortunately the carcases were much decomposed before they were examined at the place of stranding, but one complete skeleton and twelve skulls were preserved for the Colombo Museum, and of these Dr. Pearson records the dimensions. He tentatively suggests that the occurrence of the species, which he regards as a cold-water form, in tropical seas may possibly be connected with a seasonal migration during the breeding season, in order that the young may be born under less rigorous conditions than those of higher latitudes. He cites the fact that the Ceylon school contained many pregnant females and appeared in August, a winter month in Antarctic seas. But our recollection is that the large Dornoch Firth school of October 1927, to which the author makes no reference, also contained pregnant females. It would appear that the three appearances off Ceylon and Southern India, and the rare appearances in the North Sea (two, however, of schools containing a hundred individuals or more), are indications of casual wanderings, occasionally in mass, of a species the headquarters of which may be in sub-Antarctic oceanic waters.

A Virus Disease of Roses in Australia.—A rose disease, known in Australia as 'rose wilt' and 'die back', began to become prevalent during 1908–1912, reached serious proportions in Victoria by 1915, and an alarming increase in the number of plants affected was observed in 1928. This disease, which is restricted to Australia and New Zealand, generally appears in epidemic form, causing great damage in a season, then seems to lose its virulence for some seasons, when it suddenly appears again. The first sign is a curiously recurved appearance of the leaves on young shoots. Defoliation then occurs, commencing at the tips of the shoots and progressing downwards, the 'rose wilt' stage, followed by discoloration and death of the stem, and this 'die back' condition may extend into the older wood. Prescott, Rossi, and others noted the presence of a bacterium in the diseased parts and assumed the disease to be caused by this organism. B. J. Grieve, investigating the disease on behalf of the National Rose Society of Australia (*Australian Jour. Exper. Biol. and Med. Sci.*, vol. 8, pt. 2, 1931, p. 107), finds, however, that in the early wilt stage organisms cannot be detected in the diseased tissues; these appear only in the late 'die back' stage and are probably adventitious. It was proved that both the unfiltered and the filtered juice from diseased plants produced the disease in healthy plants inoculated with it, thus demonstrating that the disease is an infective one and is caused by a filterable virus. A Seitz filter which did not permit a small bacterium to pass was employed. Experiments to test if the rose aphis is a vector yielded inconclusive results.

Tree Growth and Weather.—Having devised a special recording apparatus for the purpose, Hirokichi Nakashima gives very full figures for growth in length for the tree *Pinus nigra* Arnold, var. *austriaca* Höss, in Japan, in the *Journal of the Faculty of Agriculture*, Hokkaido Imperial University, vol. 22, part 2. Growth is most vigorous from the end of May until the middle of July, and only during a relatively short period is an increase in height of the tree to be noticed. By July 19, 90 per cent of the extension growth had taken place. Increase in height is most marked in the evening; in the morning, just after sunrise, the increase is nil, or there is even a slight decrease in height. During the period of vigorous growth, evaporation has the most definite effect upon growth: on a sunny day, the morning cessation of growth is followed by more vigorous growth in the evening; but on a cloudy day, both fall in growth rate and subsequent increases in length are less marked. In the period that follows, when but a little extension takes place, the most significant factor seems to be the wind, a surprising effect being noted of windy weather which results, on the whole, in a greater increase in length.

Radium in Hawaiian Lavas.—Continuing his work on the radium content of rocks, C. S. Piggot has investigated thirteen samples of lavas from various islands of the Hawaiian group (*Am. Jour. Sci.*, July, 1931, pp. 1-8). The average amount determined is $0{\cdot}96 \times 10^{-12}$ gm. of radium per gm. of rock, the range being from 0·75 to 1·47. The rocks examined are basaltic, with one exception, the latter being a trachyte which gave 0·94, very near to the mean value for the series. Five of the samples were selected to represent various flows of different ages from Kilauea crater; all show practically the same radium content. four being 0·94 and the other 0·90. Poole and Joly in 1924 recorded 0·96 for a ropy lava from Kilauea. Piggot points out that the radium content of Hawaiian basalts is not very different from that determined for sixteen samples of granite from the eastern seaboard of North America from Georgia to Greenland (0·90). The average contents hitherto found for granite rocks range from 0·55 for Antarctica to 6·00 for the Aar Massif, so Piggot's result for granites need not be considered abnormal, though it is unusually low.

Cooling Effects of Ice on the Oceans.—The degree to which ice has an effect in reducing the temperature of the waters of the North Atlantic Ocean was one of the subjects investigated by the United States Expedition in the *Marion* to Davis Strait and Baffin Bay in 1928. In a comprehensive account of Arctic ice in Part 3 of the results of this expedition (United States Treasury Dept., *Coast Guard Bulletin* No. 19), Mr. E. H. Smith points out that glacial ice, which is only two per cent of the ice brought south by the Labrador current, melts mainly in coastal waters, and so cools oceanic waters only indirectly by the mixing of the two waters. The extent of this mixing, considering the ocean generally, is small. Further, he shows that in the area of the Atlantic invaded by pack ice the annual melting counteracts the solar warming of an 80-ft. surface layer by 6° F. Taking the limit to which solar warmth can penetrate as 480 feet, Mr. Smith concludes that melting pack ice opposes the warming of these 480 surface feet by only 1° F. The mean temperature rise by solar heating of the same thickness of surface water is calculated from observations to be 2·1° F. Thus the chilling of the North Atlantic by ice melting is about one-half of the warming during the summer. This was found to be only 10 per cent of the total cooling effect resulting from the cold waters of the Labrador current. Since the relative proportions of ice and water are the same in the East Greenland current, it may be assumed that this figure of 10 per cent applies to the entire North Atlantic. These results support previous suggestions of Dr. G. Schott and Comdr. Campbell-Hepworth that the agency chilling the North Atlantic is not melting ice but cold water.

Determination of the Yard in Wave-lengths of Light.—Dr. A. E. H. Tutton has published the results of a direct evaluation of the yard in terms of the primary standard of length, the wave-length of the red cadmium line (*Phil. Trans.*, A, vol. 230, pp. 293-322). The determination was actually based upon the yellow neon line, but since the absolute wave-length of this is accurately known, the results may be readily reduced to the basis of the cadmium line. The baseline directly measured in wave-lengths was considerably longer than in any previous determination; the counting of more than five thousand fringes in a continuous sequence is a feat calling for a remarkable degree of visual endurance, and in fact was only achieved as the result of prolonged familiarity and practice. The micrometric comparisons involved in relating this baseline (1/16 in.) to the standard yard were greatly facilitated by the use of fiducial marks ruled by the late Prof. Grayson with almost superhuman skill. Their width was extraordinarily small—half a wave-length, as against fifteen in the case of the standard yard and metre—and they were spaced with even more extraordinary accuracy, of the order of one hundred-thousandth of an inch. Incidentally they dispose very effectually, as Dr. Tutton remarks, of the rather prevalent belief that objects smaller than one wave-length are necessarily invisible. A complete set of measurements was also made, using the red hydrogen line $H\alpha$. Dr. Tutton's final conclusion is that the yard contains 1,420,210 wave-lengths of red cadmium light.

Cathode Phenomena in the Glow Discharge.—Two papers by Prof. A. Güntherschulze and F. Keller, in the issue of the *Zeitschrift für Physik* for Aug. 15, contain much new information about the phenomena at the immediate surface of the cathode in the glow discharge between cold electrodes. This is a subject which has been little investigated, partly because of its difficulty, and partly perhaps because attention has been concentrated recently on other discharge forms of commercial importance. It has been found that the phenomenon of the primary dark space—the thin dark layer on the surface of the cathode, *within* the cathode dark space—is much more general than had been supposed, it being reported that this is present in discharges through oxygen and nitrogen, where it could not be detected by Dr. F. W. Aston and more recent investigators. It is found that the primary dark space disappears when the cathode fall in potential is raised to about a thousand volts, and it is suggested that this is because the positive ions proceeding towards the cathode then attain for the first time sufficient energy to excite the gas. Simultaneously, with a cathode of magnesium alloy in helium, a new cushion of green magnesium light appears on the cathode surface, and this in turn is separated from the electrode by a minute dark layer. It may prove possible to study cathodic sputtering very directly by this new method, the intensity of the green light being taken as a measure of the amount of magnesium vapour present in the neighbourhood.

Organic Compounds of Gold.—Gibson and Colles, in the *Journal of the Chemical Society* for September, describe the preparation of some co-ordination compounds of gold tribromide with substances such as pyridine, quinoline, and isoquinoline. They state that they have been unable to prepare some of the substances described by Kharasch and Isbell (NATURE, Sept. 5, p. 415). The substance previously used in such work and considered to be gold tribromide is shown to be hydrated bromoauric acid, probably $HAuBr_4$, $3H_2O$. The methods of preparation of this substance and of pure gold tribromide, which is almost insoluble in ether and is regarded as $(AuBr_3)_2$ with the gold having a co-ordination number of 4 and not truly tervalent, are described in detail. Although the new co-ordination compounds were expected to be soluble in ether and hence suitable for use with the Grignard reagent, they were generally sparingly soluble, although the Grignard reaction could be carried out and diethyl gold bromide obtained. The yield was, however, smaller than with methods previously developed.

Low Temperature Carbonisation Test.—There exists a scheme of the Department of Scientific and Industrial Research whereby the staff of the Fuel Research Board tests, at public expense, processes for the carbonisation of coal at low temperatures. In accordance with the scheme a plant of the Leicestershire (L. and N.) Coal Distillation Co., at Ashby de la Zouche, has been tested and the report recently issued (London: H.M. Stationery Office, 9*d*. net). In this process the coal is carbonised in a revolving retort heated internally by products of combustion diluted with the gas leaving the retort. The coke product is quenched with water, whereby it is divided into two fractions, one which floats and one which, owing to a high ash content, sinks. The floating portion is briquetted with pitch and, if desired, recarbonised. The yield of clean fuel was 7·4 cwt. per ton of coal, and of tar 14 gallons per ton of coal. The gas is too poor to be of use. Although the yields of products are low, it is pointed out that the raw coal is practically unsaleable, and the product, owing to the character of the coal, makes an excellent fuel for open grates. It is, however, a process only applicable to the poorly caking coals such as occur in the Midlands.

Astronomical Topics.

New Comet.—Mr. J. W. Durrad, of Leicester, has announced the discovery on Nov. 5 of a new comet, visible to the naked eye. On Nov. 9 it was near σ Ursæ Majoris and moving about 4° a day south preceding.

The Leonid Meteors.—Although the rich shower of Leonids is not due until next year, the experience of 1898, combined with the tolerably rich display last year, gives ground for expecting something in the present year. The Computing Section of the British Astronomical Association has been working on the orbit of Tempel's Comet for the last two years. The date assigned as the most probable one for the comet's perihelion is Nov. 1, 1932. If this is near the truth, the comet will make a fairly close approach to the earth about mid-November. Its orbit, according to the calculations, is half a million miles nearer to the earth than it was in 1899, so there are good grounds for hoping that the disappointment of November 1899 will not be repeated.

The most probable date is the night between Nov. 16 and 17. Last year the maximum was about the end of Nov. 16 or early on Nov. 17. Neglecting the effect of perturbations (which have not been calculated for meteors so far from the parent comet), we should expect them to be six hours later this year, owing to the odd quarter day in the year. Hence the richest part of the shower may not come until after dawn on Nov. 17. But watch should be kept through that night, also on the preceding and following nights, as there are some stray members detached from the main stream. The radiant (in the sickle of Leo) does not rise until about 11 P.M., so the watch need not begin until then. Jupiter will be some 10° to the right of the radiant, and will form a convenient guide to it.

Motion of the Perihelion of Mercury.—The point that first attracted astronomical attention to Einstein's general theory of relativity was the close accord that it brought about between the calculated and observed motion of Mercury's perihelion. The agreement was undesigned, and resulted from the initial assumptions without any manipulation. It is not surprising, however, that the result caused closer examination to be made of the amount of the observed motion. *Mon. Not. Roy. Ast Soc.*, vol. 91, No. 9, contains an article on the subject by Dr. J. K. Fotheringham. He refers to an article by von Gleich in *Astr. Nach.*, vol. 241, which emphasises the need of correcting Le Verrier's value of the motion, in view of the evidence that is now available of changes, both secular and periodic, in the rate of the earth's rotation. This is a matter to which Dr. Fotheringham has given much attention; he has applied the latest values of the accelerations and fluctuations, and re-examined the discussions of the transits of Mercury that were made by Dr. Innes and Prof. de Sitter. His result for the excess of motion of Mercury's perihelion above that given by Newtonian theory is so close to Einstein's value that he feels justified in assuming that the Einstein motion applies also to the earth's perihelion. He then obtains 43·95″ for the observed centennial excess of motion of Mercury's perihelion above the Newtonian value. This is as close to Einstein's theoretical value, 42·9″, as could be expected. Fotheringham expresses indebtedness to von Gleich for having shown the necessity of considering the effect of changes in the earth's rotation.

Calendar Reform.—We have received from C. C. Wylie, secretary of an association in Iowa that is interesting itself in the subject of the reform of the calendar, a summary of the views expressed by various groups in the United States. They are printed under four headings: "Astronomy", "Banks", "Education", "Transport". The second group is practically equally divided for and against revision; the other three have decided majorities for revision, reaching 90 per cent in the third group. All the groups favour the retention of the 12-month division; a recent investigation in England (NATURE, Oct. 10, p. 610) had a similar result, so that the suggestion of a 13-month year may be ruled out for the present. The main reason is probably its failure to divide into quarters, but the widespread prejudice against the number 13 may have influenced some voters.

It should be noted that the 13-month division is not the complete novelty that some people imagine. In ancient times, when most nations began their months at the new moon, seven years in nineteen were given a thirteenth month.

Recent Excavations at Vinča.

THE report on the excavations at Vinča in the summer of 1931, which was presented to Section H (Anthropology) of the British Association on Sept. 25, on behalf of Prof. M. Vassitz, fully confirmed previous opinion as to the importance of this site, which is now being excavated through the generous assistance of Sir Charles Hyde. It would seem to be abundantly clear that we now know the place, the time, and even the race of what is, up to the present, the farthest outpost to the north-west of Ægean civilisation. It dates possibly from the end of Early Minoan III, and certainly from the beginning of Middle Minoan I. It flourished until the arrival of the Romans about the year A.D. 6. The knowledge gained from Vinča, in Prof. Vassitz's opinion, poses new problems in pre-history not merely in relation to its immediate neighbourhood, but also in regard to a larger area, the Danube basin. It makes new methods of approach to the history of the Danube basin essential.

In the excavations of 1930 a depth of 8·8 metres was reached on one part of the site. Between the strata containing the earliest house remains which show a rectangular construction (down to 8·6 metres) and the original loess surface is a stratum of black earth about 7 metres thick, formed during the pit-dwelling period. In this, at a depth of 9·3 metres, a rectangular house foundation was discovered; but, apart from this, the site was marked from 9·1 to 9·3 metres by the contours of pit-dwellings. The pits are varied in shape, but the majority are round. There are cases of two pits connected by a neck. Apparently the pits were floored from time to time with a layer of clean clay, and in one case traces of reed walling or flooring were found.

In the same stratum as the pit-dwellings a tholos tomb was discovered with a dromos of unusual length approaching it. It contained nine skeletons. The tomb was roughly circular and 1·5 metres in diameter. It was probably roofed over with a wooden structure; for across the skeletons were traces of wooden beams charred or oxidised. Owing to the number of skeletons, in such a confined space, it was impossible to determine their original position or to allot the bones to individuals. One skeleton, however, it could be seen, lay on its face with the head turned on the left cheek and the left arm doubled beneath. All the heads, with two exceptions, were around the wall of the tomb, the feet to the centre. Interment was not simultaneous. The skulls, which are in a good state of preservation, differ in type, but have not yet been examined by an expert. This is not the first discovery of human remains on the site; but a skeleton, found in 1911 in a crouched position at a depth of 8·75 metres, was destroyed during the War. A number of fragments of skulls have been found at varying depths during the last three years, but they have been too small to afford any opportunity for drawing a conclusion from them.

The practice of burying the dead in the town and not in a separate graveyard can be paralleled at Sesklo (Thessaly), and in pre-Mycenæan times in the Ægean on Melos (Phylakopi). Another point in common with the Ægean is the interment of a number of persons in the same tomb.

The resemblance between the tombs of the Ægean and Vinča becomes the more striking and important in the light of a number of analogies and resemblances in other finds. This is especially marked in the plastic art. The type of head and face on the Vinča terra-cotta statuettes is the same as that of the. Cycladic marble statuettes. One head shows exactly the same perforations as are found in the so-called Egyptian dolls of the XIIth Dynasty. Vases in the form of human or animal bodies, or ornamented with human representations, are numerous. A naked female figure recalls the naked goddess of Kadesh, while it is to be remembered that Egyptian girls until puberty wore a belt only. Again, the Hyde vase found last year has early analogies only in Egypt. These occur there as early as the Vth Dynasty, while in the Ægean they do not appear until the Greek Archaic period, apparently copied from Egypt. Vinča was thus in touch indirectly with Egypt, the Ægean affording the link.

A prosopomorphous lid, showing two diametrically opposed faces, points to Cyprus, double rhytons to Enkomi in Cyprus and farther afield to Assyria. Small offering tables with circular depressions, and all the more important forms of pottery, have analogies in the Ægean. They occur at Vinča from the earliest time, the pit-dwelling period. The technique of ornamentation on fragments from the black stratum, in which the finger or a special tool was used in marking a thin slip, seems to be an imitation of the barbotin technique of Knossos, *MMa* and *MMb*. If this supposition be correct, it affords valuable evidence for dating the commencement of the Vinča settlement.

These and other finds bear witness to the high civilisation of Vinča. The settlement would appear to have been due to colonists choosing this point on the Danube for the exploitation of the mineral wealth around Avala Peak. These minerals were galenite, cinnabar, and an ore which it is proposed to call avalite, a silicate of chromium which was used as a cosmetic, producing the green colour which in Egypt was obtained for the identical purpose from malachite. There is evidence to show that the cinnabar was worked at Vinča for red colouring matter, while the galenite was used instead of antimony as a cosmetic, though lead may also have been extracted from it. It is also possible that part of the silver found at Troy II and in Crete *EM* III and *MM* I may have been obtained in the country around Vinča.

Chemistry of the Vitamins.

A DISCUSSION on the chemistry of the vitamins and related substances in Section B (Chemistry) of the British Association on Sept. 25 was opened by Sir F. Gowland Hopkins, who referred to the difficulties which have attended all attempts at the isolation or determination of the constitution of the vitamins, and then discussed the general nutritional importance of the vitamins and the extremely small concentrations at which they are effective. There are marked differences in the constitution of the vitamins. All doubts as to the individuality of vitamin A and vitamin D have now disappeared, and in general, deficiency of either of these vitamins gives a totally distinct picture in the animal. The discussion of the establishment of biological standards by an international committee in London has indicated that we have now a technique capable of practical results, and the physiologist's next task is to determine the mechanism of the action of the vitamins in the human body. Success in this field will undoubtedly reveal a good deal more about the body itself.

Prof. P. Karrer, in opening the discussion on vitamin A and the carotinoids, said that two of the ten basic substances at present known to belong to the carotinoid group of yellow pigments are hydrocarbons, lycopene and carotene, having the composition $C_{40}H_{56}$. The results of oxidation experiments indicate that lycopene has an open chain with thirteen double linkings. Carotene occurs in two modifications, the α-modification being highly optically active, while the β-form is inactive. The two isomers differ in melting point and absorption spectra, and isomerism is probably due to different arrangements of the double bonds, both carotenes containing eleven double bonds and two cyclohexene rings, substituted with methyl groups in the 2 : 2 : 6-positions relative to the chain. They may possibly be derived from lycopene by ring closure. Partial hydrogenation of the carotenes yields the dihydrocarotenes. Carotene is not identical with vitamin A from cod-liver oil, although highly active preparations of vitamin A on ozonisation, like carotene, give geronic acid, and vitamin A of cod-liver oil accordingly may contain in its molecule the same pseudo ionone system as carotene and a hydroxyl group, being an oxidation product of carotene.

Biochemical experiments with carotenes and vitamin A described by Prof. H. von Euler have indicated that two forms of carotene exist in plants and a third isomeride can be regenerated from carotene triiodide. Accordingly, it is suggested that there are several fat-soluble factors of the vitamin A type, and concentrates with an extremely high biological activity giving a Carr-Price reaction more than a hundred times as strong as carotene have been prepared. Prof. R. Kuhn described the methods elaborated for the preparation of α-carotene, and the effect of carotene preparations on the growth and liver oils of rats; and Dr. T. Moore contributed a further account of experiments in which the vitamin A content of the liver oil of rats has been increased to about 100,000 B.U. for the entire liver, equivalent to a century's supply at the minimal curative dose, by feeding rats with either carotene or preformed vitamin A. The individual liver oils gave colour values as high as 600 B.U. per mgm. After saponification and removal of the crystalline matter, concentrates having values of 1200 to 2000 B.U. per mgm. were obtained, the final values being largely independent of divergent values of the samples before saponification. The results indicated that conversion of the carotene was accompanied by at least a tenfold increase in colour value. The best concentrates, however, did not appear to be more than two to three times as active as crystalline carotene.

The constitution of lycopene resembles that of squalene, and Prof. I. M. Heilbron and Dr. R. A. Morton have found that fish and mammalian liver oils and concentrates show an absorption band in the ultra-violet (maximum 328 μμ) varying in intensity over the range 1-20,000, which can be determined to within ± 5 per cent. Spectroscopic evidence shows that liver oils contain two chromogenic substances which behave as separate entities, although kinship is not excluded. The 328 μμ band and the 562-583 μμ band in the antimony trichloride colour test are valid quantitative criteria of vitamin A potency. Available evidence regarding the molecular weight of vitamin A and the percentage of inactive substances in the richest concentrates indicates a very high molecular extinction coefficient at 328 μμ, and a chromogenic value for the intensity of the blue colour with antimony trichloride many times greater than that of any known sterol or carotinoid.

The afternoon discussion was devoted to a discussion on the chemistry of vitamin B and related problems. Prof. B. C. P. Jansen opened with an account of the method by which he and Dr. Donath isolated the anti-neuritic B_1 vitamin from rice polishings. Only about 30 mgm. of pure B_1 vitamin hydrochloride were obtained from 100 kgm. after several months' work, but replacement of the phosphotungstic acid by silico-tungstic acid gave a much better yield. Dr. R. A. Peters reviewed the various methods of separating and concentrating the vitamin B complex. Vitamin B_1, like B_4 and B_5, is soluble in absolute alcohol as hydrochloride but insoluble in lipoid solvents. It is stable to acid hydrolysis, even to boiling nitric acid, and is also resistant to benzoylation, oxidation, and reduction and treatment with nitrous acid. It is inactivated by alkali, and the view that B_1 is a tertiary base is further supported by its absorption on charcoal at *p*H 9·0. Vitamin B_4, which is liable to accompany B_1, is differentiated by prior adsorption on charcoal at acid hydrogen ion concentration, and by the wide divergence in the ratio B_1/B_4 in different dilute aqueous and alcoholic hydrochloric acid extracts. It is precipitated by mercuric sulphate, and destroyed on prolonged treatment with nitric acid. Vitamin B_5 follows B_1 in phosphotungstic fractionation and is probably basic. It is more stable to alkali than B_3. Vitamin B_3 is not extracted from the wheat germ by warm dilute 97 per cent alcohol, and although resistant to heat and acid hydrolysis when combined, rapidly disappears when liberated from combination.

In a discussion on the chemistry of vitamin D and related sterols, Mr. R. B. Bourdillon and Drs. E. H. Reerink and A. van Wijk dealt with crystalline preparations of highly antirachitic substances, the latter describing the isolation of a crystalline antirachitic reaction product, m.p. 115°-117°, by irradiation of ergosterol in pure peroxide-free ether. This product is not very stable in solution *in vacuo*, and oxidises very rapidly in presence of oxygen. Its physical properties vary somewhat with the exact isolation conditions. It is possible that the three products isolated by these workers and by Prof. A. Windaus are mixtures of different proportions of two nearly isomorphic antirachitic compounds, one being fairly stable and dextrorotatory, and the other less stable and lævorotatory or slightly dextrorotatory.

Prof. I. M. Heilbron and Mr. J. C. E. Simpson described the preparation of a series of ergosteryl ethers. Ergosteryl methyl ether closely resembles ergosterol itself as regards colour reactions and absorption spectra, but does not yield an antirachitic product on irradiation, an observation which points to the necessity of the free hydroxyl group for the production of the antirachitic vitamin.

Phosphorescence of the Sea.

An important article on the "Phosphorescence of the Sea" appears in the *Marine Observer* for November, which is published by the Marine Division of the Meteorological Office. Nothing is in reality known about this mysterious phenomenon, save that it is associated with floating animals, and possibly at times with floating plants. During the eleven years 1920–30, some 2200 observations were recorded and the localities of these are charted. The number of reports is affected by the number of observing ships and the lines of the main steamship tracks. But, even making due allowance for these and for the few routes across the Pacific, phosphorescence would seem to be more general near the sides of the oceans and of more frequent occurrence in the warm tropical seas. Thus in the Arabian Sea, which fulfils both these conditions, there are 500 records between the Red Sea and Ceylon, with a special preponderance near the ends of the line. Here monthly graphs show the largest percentage of observations in August, which is about midsummer in the water, but it is also the season of maximum forces of the currents of the East African and West Indian coasts.

The number of displays of phosphorescence in each month along a section across the North Atlantic from Newfoundland to the Bay of Biscay would also seem to fit in with the seasons when the great drift current of the Atlantic is at its strongest, namely, July to August to the east, and March to April to the west. Further support to this theory of the association of currents and phosphorescence is given by the figures shown in the counter equatorial currents, and there would seem also to be possible relationships with currents near Japan and in the Great Australian Bight.

The theory is that currents are carrying the floating animal life that produces the phosphorescence into new areas where it does not normally live, though why it should be stimulated to give its displays is unknown. It would appear that most of the animals in these currents are being carried to destruction, but the presence of differentiated phosphorescent organs in most forms is not consistent with its display being a morbid factor. Phosphorescence varies from sparks of light to a milkiness which may make every part of the deck visible and often fades to a multitude of globes beneath the surface of the sea. All variants of display may be found even in the same region, but we are not yet able precisely to associate the nature of the light with the phosphorescent animals. Why in one condition of the sea no phosphorescence is seen while in another it is brilliant—collections of the surface fauna showing precisely the same organisms—is quite unknown.

Acoustical Problems of Broadcasting Studios.

THE world-wide interest in broadcasting has, during the last seven years, stimulated research on architectural acoustics. An excellent survey of the result was given by N. Ashbridge in a paper on the "Acoustical Problems of Broadcasting Studios", read before Section G of the British Association in London on Sept. 25, and printed in full in *Engineering* for Oct. 16 and 23.

Although economic and practical considerations frequently prevent the adoption of an ideal specification, particularly when a studio has to be made in a building not designed for the purpose, in a new building, such as the Broadcasting House of the B.B.C. in Langham Place, London, almost ideal surroundings are provided for many of the studios. Continuous steel-frame construction is avoided, so as to prevent transmission to the studio of noises from other studios or from machinery. Traffic noises are excluded by the absence of direct openings to the street, fresh air being provided by a quiet ventilating plant serving one studio only, to prevent sound travelling along air-ducts from one studio to another. Walls, floor, and ceiling of a studio are made sufficiently rigid to avoid their tendency of acting as flexible diaphragms. Empirical rules have been found governing the shapes and sizes of studios and their reverberation periods.

It has been found that the physical property that determines almost entirely the value of the reproduction is the reverberation period, which should always be the same for a given size of hall. Although a small studio can readily be built to have plenty of room for an orchestra and a reverberation period of the same value as a concert hall, the intensity of sound in such conditions is often sufficient to be unpleasant for the performers and to overload the microphone. In a good studio the reverberation period is constant to within 20 per cent for all frequencies between about 40 and 10,000 cycles, although practical measurements usually cover only the range from 100 to 6000 cycles per second.

Many Continental studios have walls fitted with shutters having different surface treatment on each side, so that the reverberation period of each studio is variable. In Hamburg the volume of the studio can also be changed by moving the position of one end wall. The range of intensity of sound that can be tolerated by transmitter or receiver is less than half that produced by an orchestra. The position of the microphone in relation to the instruments of an orchestra involves complex factors.

University and Educational Intelligence.

CAMBRIDGE.—The following appointments have been made: A. E. Watkins, St. John's College, University lecturer in cytology; Dr. E. J. Maskell, Emmanuel College, University lecturer in plant physiology; W. J. Dowson, Christ's College, University lecturer in mycology; G. C. Grindley, University demonstrator in experimental psychology, and E. H. B. Boulton, St. Catharine's College, University lecturer in forestry (re-appointment).

H. R. Barnell, Downing College, has been appointed to the Frank Smart University Studentship in Botany.

The governing body of Emmanuel College invites applications for a research studentship which will be awarded in July 1932. Applications must be sent to the Master, Emmanuel College, Cambridge, in time to reach him not later than June 30, 1932. Preference will be given to candidates who have already completed one but not more than two years of research. The studentship, which must be held at Emmanuel College, and has a maximum annual value of £150, is awarded and normally held for two years. The successful applicant must be admitted by the University of Cambridge as a Research Student and begin residence in October 1932.

NOTICE is given by the Institution of Chemical Engineers that application forms for the 1932 examination for the associate-membership of the institution must be returned to the Hon. Registrar, Abbey House, Westminster, S.W.1, by Dec. 21. Copies of the application form and a memorandum on "The Training of a Chemical Engineer" are obtainable from the Hon. Registrar.

THE Chemical Society announces that applications for grants from its Research Fund must be made on forms obtainable from the Assistant Secretary, Burlington House, W.1, by, at latest, Dec. 1. It gives the reminder that the income arising from the donation of the Goldsmiths' Company is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry, and that the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal tar and allied industries.

APPLICATIONS for the following research fellowships for women are invited by the British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3:

a Senior International Fellowship in mathematics, physics, chemistry, geology, and biological sciences (including physiology and pathology), value £250 (offered by the International Federation of University Women); an American International Fellowship, value 1500 dollars (offered by the American Association of University Women); an International Residential Scholarship at Crosby Hall, value £100 (offered by the British Federation of University Women); a Swiss Research Fellowship in arts (including theology and jurisprudence), value 4000 Swiss francs (offered by the Swiss Association of University Women); a Rose Sidgwick Memorial Fellowship, value 2000 dollars; and an Ellen Richards Research Prize, value 2000 dollars.

The German university system is discussed in a report, published in the October number of the *Universities Review*, of a commission of investigation appointed by the Association of University Teachers. The materials for the report were gathered by a party of university teachers from Aberystwyth, Birmingham, Cardiff, Cork, Exeter, Liverpool, London, Manchester, Nottingham, and Oxford in the course of a tour in Germany during the Easter vacation, the universities visited being Berlin, Göttingen, and Hamburg. Among present-day tendencies noticed in the report is the increasing emphasis on 'bread-and-butter' studies at the expense of the traditional function of the university as a training ground in philosophic method. This is attributed to the revolution and the consequent freer entrance to and overcrowding of the universities, and the growth of unemployment. The large post-War increase in the numbers of students is also responsible for fostering the growth of an examination system somewhat similar to that of Great Britain, and for restricting individual contact between teachers and taught. Interest in physical training has developed notably since the abolition of compulsory military service, and some universities require all students to attend, unless medically exempted, during two semesters at the highly organised physical training courses provided. The complete absence of tutors and similar advisers is referred to as a disadvantage, only partially overcome by the issue of booklets containing advice to students, and by *Fachgemeinschaften* societies for establishing closer academic contacts between staffs and students working for the same examinations, and providing opportunities for joint discussions. The report is a sequel to a similar report prepared last year on the French university system.

The Bradford Education Committee has published a *Journal of Research* of the Bradford Technical College (vol. 1, 1930, pp. xii + 295). "I am anxious", says the chairman of the Technical Education Sub-Committee in the foreword, "that the volume of research in the College shall increase. I hope that the bi-annual publication of this journal will be possible"—hopes in which everyone interested in the importance of strengthening the link between technical education and industry will join. Far too little is known of the research work which proceeds steadily in technical institutions. Nor has the full capacity for research of which they are capable been yet realised by the institutions themselves. This volume will, we hope, range industrialists still further on the side of those who would break down the barriers which tend to prevent research development in technical institutions—regulations governing the superannuation of teachers form one of them. The majority of the papers now drawn together have previously appeared in various scientific publications. Well printed and clearly illustrated, they show powerfully the wide scope of the work carried out in one of our large technical institutions; they include descriptions of research carried out in practically all departments—textiles, chemistry, physics, mathematics, mechanical and electrical engineering. Invidious as it may be to name any of the papers which make up the volume, nevertheless its scope can better be seen if we indicate: "Bradford and Continental Systems of Yarn Manufacture", "Decomposition of Substituted Carbamyl Chlorides by Hydroxy-Compounds", "A Graphical Analysis of Stress", "The Measurement of the Voltage Amplification Factor of Tetrodes", "Refraction and Dispersion of Gaseous Carbon Disulphide", "Note on Green's Lemma and Stokes's Theorem".

Societies and Academies.

London.

Society of Public Analysts, Nov. 4.—**W. R. Schoeller** and **C. Jahn**: A reliable method for the quantitative separation of titanium from tantalum and niobium. The oxalate salicylate method for the separation of titania from the earth acids has now been perfected, with the result that an almost quantitative recovery of the earth acids is achieved, and that less than 1 mgm. of titania remains in the final pentoxides. The process is claimed to be accurate within 0·5 per cent.—**E. F. Waterhouse** and **W. R. Schoeller**: The separation of the earth acids from metals of the hydrogen sulphide group. The separation of tantalum and niobium from antimony, bismuth, and copper was studied. When the mixed oxides were fused with bisulphate, the mass dissolved in tartaric acid, and the clear solution treated with hydrogen sulphide, the sulphide precipitate was always found to be contaminated with earth acid. The co-precipitation is ascribed to hydrolytic decomposition of the tartaric earth-acid complexes. The separation is completed by further treatment of the sulphide precipitate.—**J. Reilly, N. Noonan**, and **P. J. Drumm**: The evaluation of the menthone content of peppermint oil. A method of determining menthone as its semicarbazone is described. In test experiments with pure menthone the results were approximately ninety-five per cent of the theoretical amount.—**D. M. Freeland**: The determination of vanillin in chocolate and cocoa butter. A 2 per cent solution of ammonia in 95 per cent alcohol is used to extract vanillin from cocoa butter, the extracts are evaporated at 70° C. to remove alcohol, the aqueous solution is extracted with ether, the ethereal extracts purified and evaporated at a low temperature, and the residue of crude vanillin dried and weighed. A volumetric method of determination is also described. For chocolate, the fat is first extracted with petroleum spirit.—**H. R. Ambler**: The direct determination of nitrogen in gases. All gases other than nitrogen are removed with only one manipulation of the sample, by (1) burning the combustible constituents in a regulated stream of electrolytic oxygen, and (2) absorbing the excess of oxygen by introducing pyrogallol into the same vessel in the presence of the gas. The residual gas, consisting of nitrogen, is then directly measured. A special combustion vessel is used.

Paris.

Academy of Sciences, Oct. 5.—**Emile Picard**: The fifth general meeting of the International Research Council.—**L. Massoutié**: Fermat's last theorem.—**Jacques Herbrand**: The theory of bodies of numbers of infinite degree.—**F. Leja**: A property of series of polynomials.—**Bertrand Gambier**: The simultaneous integration of two differential equations of the first order.—W. Fédoroff : A characteristic property of monogene functions.—Kiveliovitch : Shocks in the problem of a body attracted by two fixed centres.—Lucien Féraud : Properties resulting from the arithmetical nature of characteristic exponents.—Jean Louis Destouches : An equation of quantum mechanics.—A. Grebel : Automatic self-tightening bolts. A general discussion of the subject showing that the faults of existing devices are in part due to failure to grasp the problem as a whole.—R. de Mallemann : The molecular theory of electro-optical phenomena.—A. Piccard, E. Stahel, and F. Dony : The absorption of the penetrating gamma rays by lead screens 12-30 cm. thick. In the case of the thickest screen, allowing the passage of less than one millionth of the original gamma rays, a preparation of 6 grams of elementary radium was employed. There was no evidence of an ultra-penetrating component. This result, combined with the fact that at an altitude of 16,000 metres gamma rays are found, is contrary to the hypothesis according to which the cosmic rays would be the penetrating part of an ordinary radioactive effect.—Ch. Bedel : The electromotive forces developed between silicon and some substances in solution in hydrofluoric acid, sulphuric acid, and soda.—Charles Dufraisse and Marius Badoche : Researches on the coloured hydrocarbons : a violet hydrocarbon $C_{36}H_{22}$. This hydrocarbon is obtained by removing two atoms of hydrogen from dephenylorubrene.—André Meyer and Robert Vittenet : The azomethines of homophthalimide and its *N*-aryl derivatives.—S. Goldsztaub : The dehydration of the natural ferric hydrates.—Jacques Bourcart : Some new data on the problem of the limit between the Moroccan Haut-Atlas and Moyen-Atlas.—Henry Hubert : Researches on the climatology of French West Africa.—L . Grigorakis : The morphology and cytology of the Actinomyces.—R. Argaud : Veins with ribbed wall.—Ouang Te Yio : The physiological nature of the diastase secreted by the eclosion gland in the Plagiostomes (*Scylliorhinus canicula*). This diastase resembles trypsin, and acts in neutral or faintly alkaline medium. It acts at a much lower temperature than trypsin.—A. Perrier : Researches on the rôle of pectinase in the fermentation of coffee.—A. Blanchetière : The action of trypsin on solutions of monoamino acids, isolated or mixed.—G. Dinulescu : A larva of the gad-fly producing tumours in the duodenum of horses in Spain.

BRUSSELS.

Royal Academy of Belgium, April 11.—Paul Stroobant : The rotation of the galaxy and the solar apex shown by the radial velocities of the helium stars. A study in 1926 of the distribution of the radial velocities of the helium stars has led to the indication of a movement of translation of the whole of these stars.—E. De Wildeman : Concerning the northern limit of the tropical forest in the Mele region (Belgian Congo). Study of the causes of the contraction of the virgin forests in this region.—M. Dehalu : The observation of the total eclipse of the moon on April 2, 1931, at Cointe. The end of the totality was found to be $8^h\ 54^m\ 2^s$ by direct observations : from photographs the values $8^h\ 54^m\ 45^s$ and $8^h\ 54^m\ 41^s$ were obtained by two different methods of measurement.—Th. De Donder : Affinity (2). Fourth communication.—Lucien Godeaux : (1) Involutions of the second order of space. (2) The canonical pencil of a surface.—A. C. Seward : Some late Palæozoic plants from the Belgian Congo.—Constant Lurquin : The extension of the Bernoulli-Poisson law.—Ray. M. Bouillenne and P. Prévot : A plant association with *Empetrum* in the Fagnes de Clefay.—Mlle. M. Charpentier : The extension of Baire's problem to certain dependences considered in the theory of differential equations.—J. Genard : The scheme of levels of the diatomic vapour of sulphur.—P. Gilard : The ultra-violet transmission of glasses. A systematic study of glasses in which the proportion of one ingredient was varied. The influence of the addition of rare earths (cerium, didymium, neodymium, lanthanum) was also examined : these were not found to be specially favourable to the transmission of ultra-violet rays. The presence of the oxides of iron and manganese was found to be definitely unfavourable to the passage of the ultra-violet.—R. H. J. Germay : The calculation of the elliptical elements in the determination of the orbit of a planet from three observations.—R. Deaux : Conical helices.—Mlle. G. Schouls : The study of dynamic azeotropism.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 7, July 15).—Wilder D. Bancroft, J. W. Ackerman, and Catharine Gallagher : Optical sensitisation. Grotthuss (1818) showed that an alcoholic solution of ferric chloride is reduced by sunlight ; the alcohol reacts with the chloride preventing the reverse action. Similarly, solutions of ferric chloride and silver nitrate free from organic matter are reduced by light when light-sensitive dyes are added. Optical dyes in photography are light-sensitive and adsorbed by silver bromide, and they are, or become, reducing agents capable of reducing the bromide.—Wilder D. Bancroft and G. H. Richter : Reversible coagulation in living tissue (4). The chronaxie of the nerve portion of a frog muscle-nerve preparation—that is, duration of stimulus required to produce an effect where the voltage is twice the minimum effective voltage (Lapicque)—first decreases and then increases with addition of a coagulating solution. Chronaxie of both nerve and muscle passes through a maximum with varying hydrogen ion concentration at about the isoelectric point for many proteins. These results support Claude Bernard's view that anæsthesia is due to reversible coagulation of nerve protein.—R. E. Bowen : The cupula of the ear. A mucilaginous substance coagulates on the crista under the action of fixing agents to form the so-called cupula. The cupula does not exist as a definitely formed structure in the living ampulla. The tectorial membrane may similarly be a coagulation product.—B. R. Coonfield : The cilia of *Naphthys bucera*.—F. D. Murnaghan and A. Wintner : A canonical form for real matrices under orthogonal transformations.—R. B. Lindsay : Wave motion and the equation of continuity.—Edwin H. Hall : Electric conductivity and optical absorption in metals (supplementary).—Benedict Cassen : Electromagnetic fields derived from non-commutating potentials.—Howard B. Frost : Uncomplicated trisomic inheritance of purple verus red in *Matthiola incana*.—Ralph E. Cleland : The probable origin of *Œnothera rubricalyx* "Afterglow" on the basis of the segmental interchange theory.—Nelson F. Waters : Inheritance of body weight in domestic fowl. The Light Brahma breed is about twice the weight of the Single Comb White Leghorn, and breeding tests with these races suggest that the difference in weight between the breeds depends primarily on two pairs of factors, each of which affects the weight of the individual equally, and which together have cumulative effects. A genetically big bird grows more rapidly and more persistently than a genetically small bird, and hybrids are intermediate except in so far as they are affected by hybrid vigour. Maximum hybrid vigour seems to go with the completely heterozygous condition of all its allelomorphic pairs of genes and vice versa.

Official Publications Received.

BRITISH.

Journal of the Institute of Actuaries Students' Society. Vol. 3, No. 5. Pp. 291-354. (London: C. and E. Layton.) 3s.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 61, January to June. Pp. xli + 285 + 37 plates. (London.) 15s. net.

The Strangeways Research Laboratory, Cambridge. Report of Trustees for 1930. Pp. 16. (Cambridge.)

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the Year ended March 31, 1931. (M.O. 338.) Pp. 54. (London: H.M. Stationery Office.) 9d. net.

Government of India: Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1927, under the direction of Dr. S. K. Banerji. Pp. iv+132+6 plates. (Calcutta: Government of India Central Publication Branch.)

N.Z. Department of Scientific and Industrial Research. Bulletin No. 26: Influence of Season and Fertilizer on the Yield and Composition of a Typical Dairying Pasture, Nelson, N.Z. By T. Rigg and H. O. Askew. (Cawthron Institute Pasture Research Publications, Nos. 7, 8 and 10.) Pp. 32+35+14. (Wellington, N.Z.: W. A. G. Skinner.) 2s.

Proceedings of the Royal Irish Academy. Vol. 40, Section B, Nos. 5, 6, 7, 8, 9: The Synthesis of Chromano-Quinoline Derivatives, by Dr. Joseph Algar and T. A. M'Cullagh; Orientation in the Aromatic Ether Series, by J. Reilly, P. J. Drumm and B. Daly; Studies in the Pyrazole Series (Diazotisation of Aminophenyl Pyrazoles), by J. Reilly, B. Daly and P. J. Drumm; Lichenin and Lichenin Nitrate, by J. Reilly, Miss M. Hayes and P. J. Drumm; The Constitution of Fischer and Bülow's Pyrazole, by P. J. Drumm. Pp. 84-103. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

County Borough of Middlesbrough Education Committee: Constantine Technical College. Full Time Foundry and Metallurgical Courses. Pp. 12. (Middlesbrough.)

Australian Association for Fighting Venereal Disease (Victorian Branch). Report for Year ending December 31st, 1930. Pp. 11. (Melbourne.)

Journal of the Royal Statistical Society. New Series, Vol. 94, Part 4. Pp. 487-685+xvi. (London.) 7s. 6d.

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 8, September. Pp. 345-392+xl. (London.)

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 18: Technological Reports on Standard Indian Cottons, 1931. By Dr. Nazir Ahmad. Pp. iv+116. (Bombay.) 2 rupees.

Gold Coast Colony. Report on the Survey Department for the Year 1930-31. Pp. ii+26. (Accra: Government Printing Office; London: The Crown Agents for the Colonies.) 2s.

FOREIGN.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 85: The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Seasons 1926-27 and 1927-28. By Dr. W. Lawrence Balls and Armenag Eff. Bedevian. Pp. 61+27 plates. 5 P.T. Bulletin No. 100: Developments of the Existing System for Seed Supply of Cotton in Egypt. By Dr. W. Lawrence Balls. Pp. 11+3 plates. 5 P.T. Bulletin No. 101: Growth Fluctuations during the Development of Seed-Cotton. By Dr. W. Lawrence Balls. Pp. 15+2 plates. 5 P.T. Bulletin No. 104: The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Season 1926 to 1930, with a Discussion of Evasions of the Law. By Dr. W. Lawrence Balls and Armenag Eff. Bedevian. Pp. 28 + 23 plates. 10 P.T. (Cairo: Government Press.)

Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band 65: Synopsis Rosarum Spontanearum Europae Mediae: Übersicht über die mitteleuropäischen Wildrosen mit besonderer Berücksichtigung ihrer Schweizerischen Fondorte. Von Dr. Robert Keller. Pp. xii+796+40 Tafeln. Band 66, Abh. 2: Der Vogelzug in der Schweiz. Von Dr. Konrad Bretscher. Pp. 79-114+2 Karten. (Zürich: Gebrüder Fretz A.-G.)

Publications of the Observatory of the University of Michigan. Vol. 4, No. 3: The Spectral Variations of 25 Orionis and 52 (π) Aquarii. By Dean B. McLaughlin. Pp. 37-51. (Ann Arbor, Mich.)

Proceedings of the American Philosophical Society. Vol. 70, No. 4. Pp. 317-398. (Philadelphia.)

Proceedings of the United States National Museum. Vol. 79, Art. 10: Report on Birds recorded by the Pinchot Expedition of 1929 to the Caribbean and Pacific. By Albert K. Fisher and Alexander Wetmore. (No. 2876.) Pp. 66+10 plates. Vol. 79, Art. 18: Two New Lungworms from North American Ruminants, and a Note on the Lungworms of Sheep in the United States. By G. Dikmans. (No. 2884.) Pp. 4+2 plates. Vol. 79, Art. 19: A New Genus and New Species of Trematode Worms of the Family Plagiorchiidae. By John T. Lucker. (No. 2885.) Pp. 8+1 plate. (Washington, D.C.: Government Printing Office.)

Technical Books of 1930: a Selection. Compiled by Donald Hendry. (Twenty-third Issue). Pp. 28. (Brooklyn, N.Y.: Pratt Institute Free Library.)

Agricultural Experiment Station of the Rhode Island State College. Bulletin 228: Inheritance of Body-Weight in Domestic Fowl. By Nelson F. Waters. Pp. 105. (Kingston, R.I.)

U.S. Department of Agriculture. Circular No. 165: Plowing as a Control Measure for the European Corn Borer in Western New York. By H. N. Bartley and L. B. Scott. Pp. 28. (Washington, D.C.: Government Printing Office.) 10 cents.

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Hors Série. Résultats scientifiques du voyage aux Indes orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. Publiés par V. Van Straelen. Vol. 3, Fascicule 7: Opilions. Par Louis Giltay. Pp. 24. Mémoire No. 44: Considérations sur la stratigraphie du terrain Houiller de la Belgique, par Armand Renier; La faune continentale du terrain Houiller de la Belgique, par Prof. Pierre Pruvost. Pp. 282+14 planches. (Bruxelles.)

Sveriges Geologiska Undersökning. Ser. Aa, No. 168: Beskrivning till kartbladet Malingsbo. Av A. Högbom och G. Lundqvist. Pp. 181+1 tavla. 4.00 kr. Ser. Aa, No. 173: Beskrivning till kartbladet Göteborg Av R. Sandegren och H. E. Johansson. Pp. 141+1 tavla. 4.00 kr. (Stockholm: P. A. Norstedt and Söner.)

Pubblicazioni del R. Osservatorio Astronomico di Merate (Como) succursale del R. Osservatorio di Brera (Milano). N. 5: Ricerche sulla frequenza delle grandezze assolute delle stelle, delle diverse classi spettrali. Per Gino Cecchini. Parte 2: Distribuzione delle grandezze assolute. Pp. 112. (Milano: Ulrico Hoepli.) 30 lire.

CATALOGUE.

A Clearance List of Books on Geology, Meteorology, Mathematics, Astronomy, Chemistry, Physics, etc. (Clearance List "B".) Pp. 28. (London: Wheldon and Wesley, Ltd.)

Diary of Societies.

FRIDAY, NOVEMBER 13.

BIOCHEMICAL SOCIETY (at Imperial College of Science and Technology), at 3.—T. Moore: High Potency Vitamin A Concentrates.—S. H. Piper: X-Ray Analysis of Certain Long Chain Paraffins, Ketones, and Alcohols.—A. C. Chibnall: The Metabolism of Plant Waxes.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.—J. A. B. Smith: The Glyceride Fatty Acids of Certain Forage Grasses.—C. R. Harington and S. S. Randall: Synthesis and Properties of *i*-β-Hydroxyglutamic Acid.—W. L. Davies: The Inactivation of Lipase in Dairy Products by Traces of Heavy Metal Salts.—J. Pryde and R. T. Williams: The Structure of Borneol Glucuronic Acid Synthesised *in vivo*.—T. S. G. Jones and E. T. Waters: A Note on the Sugar of the Nucleic Acid of *Bacillus Tuberculosis*.—H. J. Phelps: The Influence of Hydrogen-ion Concentration on the Response of Tissues to Histamine.—P. V. McKie: The Nitrogen Metabolism of the Lupin Seedling.—A. C. Chibnall and R. G. Westall: The Estimation of Glutamine in the Presence of Asparagine.—J. M. Gulland and W. H. Newton: Observations on the Purification of the Oxytocic Principle of the Posterior Lobe of the Pituitary Gland.—*Demonstrations*:—S. H. Piper and A. C. Chibnall: Apparatus for Distillation in High Vacuo of Substances with a High Melting Point.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Lt.-Col. M. L. Ferrar: The New Penal System in the Andamans.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—Prof. A. E. Boycott, C. Oldham, and A. R. Waterston: A Trip to Kerry.—N. H. Odhner: New and Little Known African Land Shells.—Prof. S. Hirase: The Adaptive Modifications of *Stilifer celebensis* Kük.—F. F. Laidlaw: Notes on Zonitidæ from the Malay Peninsula with Descriptions of New Genera.—A. E. Ellis: The Habitats of Hydrobiidæ in the Adur Estuary.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—J. W. Hobson: The Care and Maintenance of the Industrial Steam Locomotive.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—W. A. Bishop: Short Wave Transmission.

INSTITUTION OF WELDING ENGINEERS (at Chamber of Commerce, Birmingham), at 7.—E. W. Thompson and A. Jeavons: Some Details of the Progress reached in Forge and other Welding in Boiler Works Practice.

MANCHESTER ASSOCIATION OF ENGINEERS (at Engineers' Club, Manchester), at 7.15.—J. E. Hurst: A Comparative Study of the Properties of British Pig Irons.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Annual General Meeting.

KEIGHLEY ASSOCIATION OF ENGINEERS (at Queen's Hotel, Keighley), at 7.30.—E. Clegg: The Industrial Smoke and Grit Problem.

INSTITUTE OF METALS (Sheffield Local Section) (at University, Sheffield), at 7.30.—E. A. Smith: Engineering Silver Solders.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society), at 8.—D. McDonald: Platinum.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—R. Gunn: Some Points in the Fitting of Contact Glasses.—F. Ridley: The Use of Antiseptics.

SATURDAY, NOVEMBER 14.

BRITISH MYCOLOGICAL SOCIETY (in Botanical Department, University College), at 11 A.M.—Dr. B. Barnes: Some Aquatic Fungi new to Britain.—T. H. Harrison: A Species of *Lambertella* Parasitic on Apple.—Prof. N. J. G. Smith: Some of the More Curious South African Fungi.—Dr. R. G. Tomkins: Measuring Germination.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. E. Yerbury: Present-Day Architecture on the Continent; Modern Buildings in Scandinavia.

MONDAY, NOVEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at University, Liverpool), at 7.—Prof. E. W. Marchant: Oscillographs.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. S. Goodhart-Rendel: Modern European Architecture.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—W. S. Barclay: The Basin of the Parana.

TUESDAY, NOVEMBER 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. B. S. Haldane: New Light on the Origin of Species (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—R. G. Glenday: Business Forecasting: A Quantitative Investigation of the Influence of Money on Trade Development.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of October

1931.—H. R. Hewer: Studies in *Zygœna* (Lepidoptera): (*a*) The Female Genitalia; (*b*) The Male Genitalia.—Dr. F. Gwendolen Rees: An Investigation into the Occurrence, Structure, and Life-Histories of the Trematode Parasites of Four Species of *Lymnæa* and of *Hydrobia jenkinsi* (Mollusca) in Glamorgan and Monmouth.—Dr. Awadh Behari Misra: On the Internal Anatomy of the Male Lac Insect, *Laccifer lacca* Kerr.—W. S. Bristowe: (*a*) A Preliminary Note on the Spiders of Krakatau; (*b*) The Mating Habits of Spiders, and a Description of a New Thomisid Spider from Krakatau; (*c*) Spiders of the Farne Islands.—Dr. G. S. Sansom: Notes on Some Early Blastocysts of the South American Bat *Molossus*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—H. C. Whitehead and F. R. O'Shaughnessy: The Treatment of Sewage Sludge by Bacterial Digestion.

ROYAL AERONAUTICAL SOCIETY (Students' Section) (at 7 Albemarle Street), at 6.30.—Prof. L. Bairstow: Applications of Aeronautical Research.

LONDON NATURAL HISTORY SOCIETY (Botany Section) (at London School of Hygiene and Tropical Medicine), at 6.30.—J. Ross: Common Wall Mosses.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at College, Loughborough), at 6.45.—N. B. Rosher: Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Seagrave Club, Wolverhampton), at 7.30.—B. G. Robbins: The Training of Young Automobile Engineers.

ROYAL SOCIETY OF ARTS, at 8.—M. Hochstadter, W. Vogel, and E. Bowden: The Pressure Cable: An Advance in the Construction of High Voltage Cable Installations.

ROYAL AERONAUTICAL SOCIETY (Bristol Branch).—Major J. S. Buchanan: High Speed Aircraft.

ROYAL PHOTOGRAPHIC SOCIETY.—J. Reid Moir: Ancient Men in East Anglia.

WEDNESDAY, NOVEMBER 18.

SOCIETY OF GLASS TECHNOLOGY (at University, Sheffield), at 2.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, I. D. Margary, R. Marshall, C. J. P. Cave, and L. C. W. Bonacina: Report on the Phenological Observations in the British Isles, from December 1929 to November 1930.—Sir G. T. Walker and A. C. Phillips: The Forms of Stratified Clouds: Part 1, Experimental; Part 2, Discussion.—W. Dunbar: Eighty Years Rainfall at North Craig Reservoir, Kilmarnock.

ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House, Tavistock Square), at 5.30.—Conrad Beck: The Substage Diaphragm and its Functions.—Dr. A. A. Tarkhan: The Effects of Fixatives and other Reagents on Cell-size and Tissue-bulk.

GEOLOGICAL SOCIETY, at 5.30.—Prof. A. C. Seward: (*a*) Fossil Plants from the Bokkeveld and Witteberg Beds of South Africa; (*b*) Carboniferous Plants from Sinai.—Dr. T. N. George: The British Carboniferous Reticulate Spiriferidæ.

ILLUMINATING ENGINEERING SOCIETY (at 4 Dowgate Hill, E.C.4) at 7.—R. H. Monier-Williams: The Tallow Chandlers' Company and their Craft.—W. J. A. Butterfield: The Historical Development of Gas Lighting.—J. Swinburne: The Early Days of Electric Lighting.

INSTITUTION OF AUTOMOBILE ENGINEERS (Leeds Centre) (at Hotel Metropole, Leeds), at 7.15.—B. G. Robbins: The Training of Young Automobile Engineers.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—W. Pratt: Turbine Gearing.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

ROYAL SOCIETY OF ARTS, at 8.—P. H. Jowett: The Royal Society of Arts Competition of Industrial Designs, 1931.

FOLK-LORE SOCIETY (at University College), at 8.—R. E. Enthoven: The Lime, Rice-Straw, and the Convolvulus in Indian Primitive Practice.

THURSDAY, NOVEMBER 19.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council.—At 4.30.—Prof. A. V. Hill: Myothermic Experiments on the Frog's Gastrocnemius.—J. E. Barnard and W. J. Elford: The Causative Organism in Infectious Ectromelia. Appendix—Filtration Experiments with Virus of Infectious Ectromelia.—V. B. Wigglesworth: The Extent of Air in the Tracheoles of some Terrestrial Insects.

LINNEAN SOCIETY OF LONDON, at 5.—Celebration of Robert Brown's Discovery of the Nucleus of the Vegetable Cell:—J. Ramsbottom: Robert Brown as Botanist.—S. Savage: Robert Brown as an Official of the Linnean Society.—The President: Reading of Brown's Contribution.—Lt.-Col. J. Stephenson: Relation of Brown's Discovery of the Nucleus to the History of the Cell Theory.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—B. G. Luff: Notes on the Mica Industry in Bihar, India.—F. W. Armstrong: Models of Mines and Orebodies.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—H. Constant: Aircraft Vibration.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.

CHEMICAL SOCIETY, at 8.—R. S. Cahn, A. R. Penfold, and J. L. Simonsen: Dehydrogeranic Acid.—W. Charlton, J. C. Earl, J. Kenner, and A. A. Luciano: The Nitration of Oximes.—Prof. C. S. Gibson and J. D. A. Johnson: 10-Chloro-5:10-dihydrophenarsazine and its Derivatives. Part XVII. Constitution of the Nitro-derivatives produced from 3-nitrodiphenylamine-6′-arsenic Acid and its Homologues.—R. P. Linstead: Investigations of the Olefinic Acids. Part VI. Lactonisation and Allied Additive Reactions. Part I. The System, $\alpha\beta$-acid-$\beta\gamma$-acid-γ-lactone.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Hospital for Tropical Diseases), at 8.15.—Clinical and Laboratory Meeting.

BRITISH INSTITUTE OF RADIOLOGY, at 8.30.—Dr. F. Roberts: Some Criticisms of the International Protection Recommendations.—G. E. Vilvandre: The Radiology of Gall-stones and the Gall-bladder.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Centre) (at Manchester).—Ll. B. Atkinson: The Mechanical Aspects of Electricity (Thomas Hawksley Lecture).

FRIDAY, NOVEMBER 20.

ROYAL SOCIETY OF MEDICINE (Physical Medicine Section) (at British Red Cross Clinic, Peto Place, N.W.1), at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Miss F. Lowater: The Band Spectrum of Zirconium Oxide.—W. A. Wood: Lattice-distortion of Cold-drawn Constantan Wire.—Dr. F. Aughtie: (*a*) A Remote Electrically Recording Accelerometer with Particular Reference to Wheel-impact Measurements; (*b*) A Remote Electrically Recording Load-gauge for Wheel-impact Measurements.—Prof. E. V. Appleton and G. Builder: Wireless Echoes of Short Delay.—Kerr Grant: *Demonstrations*:—A Contrivance for Demonstrating the Law of Errors; a New Type of Surface-tension Meter; and a New Type of Static Electrometer.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at University, Liverpool), at 6.—Prof. I. M. Heilbron: Nature's Variations on the Isoprene Theme.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Presentation of Sixth Report of the Marine Oil Engine Trials Committee.

SOCIETY OF DYERS AND COLOURISTS (at 36 George Street, Manchester), at 7.—C. M. Whittaker: Random Leaves from a Viscose Yarn Dyer's Notebook.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with Institute of Chemistry—South Wales Section) (at Technical College, Cardiff), at 7.30.—Dr. J. H. Quastel: Dyestuffs and Biological Activity.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at St. Enoch Hotel, Glasgow), at 7.30.—Prof. J. C. Philip: The Abstracting of Chemical Literature.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. G. Brown: Modern Pressed Brick Manufacture.

SOUTH LONDON BOTANICAL INSTITUTE (323 Norwood Road), at 8.—J. E. Lousley: Plant Parasites (Lecture).

ROYAL SOCIETY OF MEDICINE (Radiology Section), at 8.30.—Discussion on X-ray Diagnosis of Diseases of the Chest.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. H. Lander: Oil and Petrol from Coal.

ROYAL AERONAUTICAL SOCIETY (Hull and Leeds Branch).—Lt.-Col. W. L. Marsh: Speed in Aviation and what it means.

SATURDAY, NOVEMBER 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Perrett: The Music of Ancient Greece (1): The Enharmonic Genus.

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.—Rev. H. L. Philp: Frustration of Will Acts.—M. F. Lowe: Blood Distribution during Mental Activity.—*Demonstrations*:—A. G. Caws: Perception of Tachistoscopically Exposed Symbols.—R. Westgate: Effect of Affective Stimuli on Muscular Work.

PUBLIC LECTURES.

FRIDAY, NOVEMBER 13.

KING'S COLLEGE, LONDON, at 5.30.—J. Benda: L'exploitation de la Science par la Littérature au 19e Siècle.

BEDSON CLUB (at Armstrong College, Newcastle-upon-Tyne), at 6.30.—Prof. J. Read: Some Researches on Essential Oils.

CHADWICK TRUST LECTURE (at Gateshead Town Hall), at 7.30.—Sir Robert Philip: The Outlook on Tuberculosis—Then and Now.

SATURDAY, NOVEMBER 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30. — M. A. Phillips: Nature at Home.

MONDAY, NOVEMBER 16.

UNIVERSITY, LEEDS, at 5.15.—Prof. J. B. S. Haldane: Evolution in the Light of Genetics.

ROYAL ANTHROPOLOGICAL INSTITUTE (at University College), at 5.30.—J. V. S. Wilkinson: Historians and Painters of the Mughal Court.

UNIVERSITY COLLEGE, at 5.30. — Prof. B. Ohlin: Some Remedies for Unemployment (Newmarch Lectures in Statistics) (1). (Succeeding Lectures on Nov. 17, 18, 19, and 20.)

ROYAL SCHOOL OF MINES, at 8.—Dr. C. J. Smithells: Metallurgy in the Electrical Industry (Armourers' and Brasiers' Company Lectures). (Succeeding Lectures on Nov. 23 and 30.)

TUESDAY, NOVEMBER 17.

UNIVERSITY COLLEGE, at 3.—Dr. W. Stephenson: Clinical Mental Tests.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Unanswered Questions in Astronomy. (Succeeding Lectures on Nov. 18, 19, and 20.)

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Institute of Hygiene, 28 Portland Place, W.1), at 6.30.—J. Fearn: Industrial Russia.

WEDNESDAY, NOVEMBER 18.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. P. Chalmers Watson: The Food of the Citizen.

LONDON SCHOOL OF ECONOMICS, at 6.—Dr. L. J. Comrie: Modern Babbage Machines.

MUSEUM AND ART GALLERY, BELFAST, at 8.—Dr. A. Mahr: Megaliths in Prehistoric Europe, with Special Reference to Irish Evidence.

THURSDAY, NOVEMBER 19.

SCIENCE MUSEUM (South Kensington) (in connexion with Exhibition of Modern Glasses), at 4.45.—A. L. Marden: The Electrical Incandescent Lamp.

FRIDAY, NOVEMBER 20.

UNIVERSITY COLLEGE, DUNDEE, SCIENTIFIC SOCIETY (at Dundee), at 4.30.—Prof. J. Read: An Organic Chemist looks at Australia.

INSTITUTE OF CHEMISTRY, at 8.—Dr. J. V. Eyre: Recent Advances in the Fermentation Industries (Streatfeild Memorial Lecture).

SATURDAY, NOVEMBER 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. St. George Gray: The Romans in the South of England.