adjacent parts of the rings would have different angular velocities. It was found, also, that the external boundary of the outer ring apparently joined the inner bright ring at a point on its northern edge, while the crape ring was almost twice as wide in the northern as in the southern part. This imperfect symmetry of the outer ring and crape ring with the inner bright ring, suggests that they do not all rotate in one plane. The different divisions of the ring would thus cast shadows upon each other, the amount of shadow depending upon the inclination.

The colour of the crape ring is described as bluish, and the shadow of the globe on the rings was curved, with the convexity towards the planet. Encke's division was very feeble and uncertain during the observations. It is pointed out that future observations of the spots may throw further light upon the rotation and constitution of the rings.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

LAST Saturday being St. Andrew's Day, the Anniversary Meeting of the Royal Society was held in their apartments at Burlington House. The auditors of the Treasurer's accounts having read their report, the Secretary read the list of Fellows elected and deceased since the last Anniversary.

The qualifications of the new Fellows were given in NATURE of May 9 (vol. 52, p. 31). Since the last Anniversary Meeting, the Society has lost nineteen Fellows and seven Foreign Members, viz. :—

Bisset Hawkins, December 7, 1894, aged 98.
Pafnutij Tchebitchef, December 8, 1894, aged 73.
Arthur Cayley, January 26, 1895, aged 73.
Sir James Cockle, January 27, 1895, aged 76.
Rev. Thomas Penyngton Kirkman, February, 1895, aged 88.
John Whitaker Hulke, February 19, 1895, aged 64.
Henry Austin Bruce, Lord Aberdare, February 25, 1895, aged 80.
Sir William Scovell Savory, March 4, 1895, aged 69.
Sir Henry Creswicke Rawlinson, March 5, 1895, aged 84.
Albert William Beetham, March 11, 1895, aged 95.
James Dwight Dana, April 15, 1895, aged 82.
Carl Ludwig, April 24, 1895, aged 78.
Roundell Palmer, Earl of Selborne, May 4, 1895, aged 83.
Henry John Carter, May 4, 1895, aged 82.
Sir George Buchanan, May 5, 1895, aged 64.
Franz Ernst Neumann, May 23, 1895, aged 97.
Valentine Ball, June 15, 1895, aged 52.
William Crawford Williamson, June 23, 1895, aged 78.
Right Hon. Thomas Henry Huxley, June 29, 1895, aged 70.
Henri Ernest Baillon, July 19, 1895, aged 67.
Charles Cardale Babington, July 22, 1895, aged 86.
Sir John Tomes, July 29, 1895, aged 80.
John Syer Bristowe, August 20, 1895, aged 68.
Sven Ludwig Lovén, September 3, 1895, aged 86.
Louis Pasteur, September 28, 1895, aged 73.
George Edward Dobson, November 26, 1895, aged 47.

Lord Kelvin, the President, then delivered the Anniversary Address as follows :—

In Cayley we have lost one of the makers of mathematics, a poet in the true sense of the word, who made real for the world the ideas which his ever fertile imagination created for himself. He was the Senior Wrangler of my freshman's year at Cambridge, and I well remember to this day the admiration and awe with which, before the end of my first term just fifty-four years ago, I had learned to regard his mathematical powers. When a little later I attained to the honour of knowing him personally, the awe was evaporated by the sunshine of his genial kindness; the admiration has remained unabated to this day, and his friendship has been one of the valued possessions of my life. While we mourn his departure from among us we know with gratitude that he has left an imperishable monument of his life's work in the grand edition of his mathematical writings which the University Press of Cambridge gives to the world. The interesting and genuinely appreciative obituary notice of Arthur Cayley, contributed by our colleague, Prof. Forsyth, to the *Proceedings* of the Royal Society for the present year, has been reprinted as a preface to the eighth volume of his "Collected Mathematical Papers," which was published last August, rather more than half of it having been passed through the press by the author with notes and references, and the remainder simply reprinted from the original publications. Matter for two more such volumes remains to be reprinted.

At the good old age of ninety-seven the veteran Franz Ernst Neumann has left us. He has been one of the most profound and fertile of all the workers in mathematical physics of the nineteenth century. I remember with gratitude the admirable and suggestive theorem[1] on electromagnetic induction which I learned in 1848, from a first paper on the subject which he had communicated to the Berlin Academy of Sciences, and which, translated into French, was published in the April number of that year of Liouville's *Journal des Mathématiques*. That first paper and others which followed it on the same subject, and his papers on the physical theory of light and on elasticity, are grand and permanently valuable contributions to science.

The death of Huxley, one of my predecessors in the Presidential chair of the Royal Society, takes from us a man who can ill be spared. During the fifty years since he sailed from England, as assistant-surgeon on board H.M.S. *Rattlesnake*, bound for a surveying expedition in the southern seas, he had been a resolute and untiring searcher after truth, and an enthusiastically devoted teacher of what he learned from others and what he discovered by his own work in biological science. His first contribution to science was a short note communicated, while he was still a student in the Charing Cross Hospital, to the *Medical Times and Gazette*, describing a structure in the root-sheath of hair, which has since borne the name of Huxley's layer. It was followed by papers on the blood corpuscles of the *Amphioxus lanceolatus* and on the anatomy and affinities of the family of *Medusæ*, for the British Association and the Royal Society; and several other articles on various biological subjects, all describing some of the work of the leisure left him by his medical duties during his four years' cruise on board the *Rattlesnake*, which were sent home by him to England, and published during his absence. It is to be hoped that the long series, thus so well begun, of papers describing skilful and laborious research by which knowledge was increased in every department of biology, will be given to the world in collected form as soon as possible. Even those purely scientific papers contain ample evidence that Huxley's mind did not rest with the mere recording of results discovered by observation and experiment: in them, and in the nine volumes of collected essays which he has left us, we find everywhere traces of acute and profound philosophic thought. When he introduced the word agnostic to describe his own feeling with reference to the origin and continuance of life, he confessed himself to be in the presence of mysteries on which science had not been strong enough to enlighten us; and he chose the word wisely and well. It is a word which, even though negative in character, may be helpful to all philosophers and theologians. If religion means strenuousness in doing right and trying to do right, who has earned the title of a religious man better than Huxley?

Another name literally of world-wide fame, Louis Pasteur, stands next to the end of our list of losses. Before he entered on his grand biological work, Pasteur made a discovery of first-rate importance in physics and chemistry—the formation of crystals, visibly right-handed and left-handed, from a solution of racemate of soda and ammonia; and the extraction of ordinary tartaric acid and of a kind of tartaric acid not previously known, from solutions obtained by picking out the crystals separately and redissolving: the new kind of tartaric acid having the property of producing the opposite rotatory effect on the plane of polarisation of light to that produced by ordinary tartaric acid From 1848 to 1857 he was chiefly occupied with researches related to the subject of that great discovery, as may be seen from the titles of the first twenty-two of his papers in the Royal Society Catalogue. His work of those nine years led up from Biot's fundamental discovery of the dioptric helicoidal property of liquids and vapours, to the enrichment of chemistry by the annexation of a new province called stereochemistry, splendidly and fruitfully developed twenty years later by Le Bel and Van 't Hoff. Near the end of 1857 his twenty-third paper appeared, three pages, in the *Comptes rendus*, "Sur la Fermentation appelée lactique." It shows that he had then entered on the

[1] Quoted in "Mathematical and Physical Papers" (Sir William Thomson), p. 92, vol. i.

line of research to which he devoted the rest of his life, and by which he conferred untold benefits on humanity and the lower animals. As I had occasion to remark in my Presidential Address of last year, Helmholtz had in his earliest work proved almost to a certainty "that the actual presence of a living creature—vibrio, as he called it, bacterium as we more commonly call it now—is necessary for either fermentation or putrefaction." Pasteur gave complete demonstration of that conclusion, and early expanded it to vast and previously undreamt of extensions of its application. The first great practical application of his views was made by Lister about 1863-65, then my colleague in the University of Glasgow, now recommended by your Council as my successor to the Presidency of the Royal Society. From Pasteur's discoveries he was led to work out the principles of his antiseptic surgery, the practice of which he commenced in the Glasgow Royal Infirmary in the summer of 1865.

Having been led to trace microbes as the origin not only of fermentation and putrefaction, but of a vast array of destructive blights happening to plants and animals—vines, silkworms, birds, cattle, and mankind—Pasteur was forced to take up the question, as of supreme practical importance, "Whence came these microbes, and what are their antecedents?" From warmth and moisture, as we see by turning up a stone in a field, I was told forty years ago by an Arran farmer well versed in the popular literature of the day. We are sometimes told the same thing in scientific journals of 1895 under the more learned disguise perhaps of abiogenesis, or the fortuitous concourse of atoms, not tested by the calculus of probabilities. Without wasting words to prove theoretically that, while stones falling together may, as we all believe they have actually done, make a solar system with a habitable planet or planets, they cannot make a man, or a microbe, or an organic cell with its property of heredity, Pasteur set about practically to trace the antecedents of every microbe he met with, and he found for it in every case a living thing, whether in the air, or in water, or in earth. During nearly all the latter part of his life and to the end Pasteur devoted himself to biological research, and to vigorous practical realisation of its benefits for the world.

Turning now to the business of the Royal Society since our last Anniversary Meeting, I am glad to be able to report that excellent progress has been made with the "Catalogue of Scientific Papers." Vol. xi. of the Catalogue, under authors' names, completing the alphabet, is on the eve of issue, and the supplementary volume is far advanced.

The movement which led to the inception of the Catalogue dates back forty years—to the first meeting of the British Association in Glasgow, when Prof. Henry, of Washington, communicated a proposal for the publication of a catalogue of philosophical memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of co-operation on the part of the Smithsonian Institution.

The proposal was referred to a committee consisting of Mr. Cayley, Mr. Grant, and Mr. Gabriel Stokes. The year after, at the Cheltenham meeting, this committee propounded a scheme for a Catalogue, embracing the mathematical and physical sciences, to include both authors' names and subjects. Besides, Transactions and Proceedings of Societies, journals, ephemerides, volumes of observations, and other collections not coming under these heads were to be indexed.

This scheme came before the Royal Society in March 1857, in consequence of a request made by General Sabine at the instance of the British Association. Considerable discussion took place, and eventually it was decided to prepare a *manuscript* Catalogue of periodical works in the Royal Society's library, to include all the sciences, the question of printing being deferred; and to do the work at the Society's sole charge. Subsequently it was resolved to extend the Catalogue to works in other libraries not included in that of the Royal Society.

In 1864 it was decided to offer the Catalogue to Government for publication, and in 1866 the printing of the first series of the Catalogue, covering the period from 1800 to 1863, was commenced by the Stationery Office. The sixth and last volume of the series was published in 1872. Two additional volumes, covering the period 1863-1873, were published in 1879. The Treasury then declined to continue the publication of the Catalogue, which, however, was undertaken by the Society, assisted by a sum of £1000 voted by Parliament towards the charges of publication of the decade 1873-1883. The unexpended portion of this grant was invested in a policy, under which £1000 will become available for the purposes of the Catalogue in October, 1899.

So far back as June, 1864, it was resolved by the Council that the Catalogue according to authors should be followed by the immediate publication of an Index according to subjects. Such an Index Rerum was constantly under consideration, and many plans for its preparation have been discussed. The work at last took practical shape in 1893, when our Fellow Mr. Ludwig Mond most generously presented a sum of £2000 to the Society, in aid of the work of preparing the Catalogue and the Subject Index. Out of this liberal donation there remains unexpended a sum of £1,500. A special staff was organised, by whom more than 140,000 slips have now been mounted and arranged in boxes, and of these over 46,000 have already been provisionally prepared for press. Since the last Anniversary, the department has to some extent been reorganised by the Committee, women being now employed in the Index Rerum Department, and Miss Chambers having been entrusted with full control over the whole. The total number of women employed in the two departments including junior copyists is now twelve.

It has, however, long been felt that the continuation of such a work was almost beyond the resources of the Royal Society, and therefore about two years ago a committee was appointed to take into consideration a suggestion that the preparation of complete indexes to scientific publications should be effected by international co-operation.

This very important subject has continued to engage the attention of the Council during the past year; and the suggestion of international co-operation having been recommended to Her Majesty's Government for favourable consideration, official invitations have been issued to an International Conference to be held in London in July next.

Meanwhile others have been equally aware of the great importance attaching to the indexing of literature, and only in September last an International Institute of Bibliography was established by Royal Decree in Brussels.

Two gentlemen in that city, MM. Otlet and La Fontaine, have, during the past half dozen years, devoted themselves to the study of modern methods of bibliographic classification, specially with reference to sociology, and their work has been supported by the Belgian Government. They were led to adopt the decimal system devised by Melvil Dewey, which is popular with American librarians, and having made a careful study of its application, have become so impressed with its value that they have developed an extraordinarily comprehensive scheme applicable to literature generally.

An invitation to attend a conference in Brussels at the beginning of September last was received by the Royal Society early in August, too late unfortunately to permit of a representative being present.

At the conference held there on September 2 to 4, a number of resolutions to establish an International Institute of Bibliography as a development of the work begun by the above-mentioned gentlemen, were arrived at, and by a Royal Decree of September 12, 1895, such an office was established.

Your senior Secretary had an opportunity, when in Brussels recently, of visiting the office which has been established, and of seeing the skill and zeal with which the preliminary preparations have been made to carry the work into execution.

All must admire the energy and enterprise which has thus been displayed in Belgium. At the same time, the magnitude of the work and the importance of the interests involved are such that it appears most desirable that the action which the Royal Society has already taken for an International Conference should be persevered in, so that decisions may be arrived at which may ensure, if possible, complete success. The enterprise is one in which we, in consequence of our long connection with such work, are most deeply interested; it is also one which may well become of exceeding value to science generally. But it is impossible to overrate the difficulties connected with it; and to avoid unnecessary complications in the future it is essential that very many questions—especially the division of the subject matter in the various branches of science and the nomenclature to be used—be taken into consideration by competent bodies and settled by general agreement.

In my last Anniversary Address I mentioned that the Library Committee, in view of the great accumulation of the stock of *Philosophical Transactions*, were taking measures to make the memoirs composing the volumes separately available to the public, which, while facilitating the sale, would increase their

utility. I have now the pleasure to announce that arrangements have been made with Messrs. Dulau and Co. to carry out this suggestion, and that Messrs. Dulau have, at their own expense, issued a very useful alphabetical list of all the papers in the *Philosophical Transactions*, from the year 1800 to the present time, any of which may now be separately purchased by the public.

The great and increasing success of our annual soirées has led the House and Soirée Committee to recommend to the Council that in addition to the two conversaziones held in May and June, some informal receptions for the Fellows should also be occasionally held. This suggestion was readily adopted by the Council, and the first of these receptions was held last month.

The Water Research Committee have continued the labours which they commenced in conjunction with the London County Council four years ago, and although the County Council no longer contributes to the expenses, the Committee have been able to carry on the researches, partly by means of an assignment from the Government grant, and partly by a grant from the fund established in 1891, by his Excellency Dr. Gunning. A Report, of 200 pages, by Prof. Marshall Ward, forming the Fourth Report to the Committee, was presented to the Council of the Royal Society last March, and has been published in the *Proceedings*. This Report treats on the biology of *Bacillus ramosus* (Fraenkel), a schizomycete of the River Thames.

With respect to the Gunning Fund which I have just now mentioned, the Committee appointed by the Council to consider and report upon the best terms for carrying out the trust, made the following recommendations, which, with Dr. Gunning's approval, were adopted by the Council :—

"(1) That the Fund should not be applied in the form of a prize, medal, or reward, but should be devoted to the furtherance of knowledge in some special direction.

"(2) That, by preference, the interest accruing from the Fund during every three years be applied for the promotion of Physical Science and of Biology alternately.

"(3) That aid should, by preference, thus be given in Physical Science and Biology respectively, either to investigations or operations which require to be repeated from time to time, or to the development of some specified continued line of research."

The Council, while adhering to the policy of retrenchment touched upon in my last address, have had to recognise the fact that the Society was, at that time, already committed to a large amount of publication, a great bulk of printed matter being almost ready for issue. This accumulation has been rapidly worked off during the past session, with the result that the Council, notwithstanding that every effort has been made to limit the amount of fresh publication, have issued in the mathematical and physical section of the *Philosophical Transactions* no less than thirty-one papers, and in the biological section twenty-one. The two sections together contain in all 2259 pages of letterpress and sixty-one plates. Of the *Proceedings*, fourteen numbers have been issued, containing 1356 pages.

While determined not to depart from the policy of avoiding all unnecessary expenditure on publication, the Council felt that with only the funds hitherto at its disposal it could not effect the requisite diminution of expenditure without diminishing the efficiency of the Royal Society in promoting the augmentation of natural knowledge, which is the reason for its existence. An application to the Treasury for additional funds was therefore made by a resolution of Council adopted at its meeting of June 20 last. I am happy to say that a favourable answer has been received, and a grant of £1000 a year has been given by the Treasury to the Royal Society on the purpose of aiding in the adequate publication of scientific matter, whether in the *Transactions* or *Proceedings* of the Society or through other channels and in other ways.

At a meeting of the Council on October 17 it was resolved to send to the Institute of France the following address on the occasion of the centenary of its foundation; and it was agreed to authorise the President and Treasurer to represent the Royal Society at the commemoration to be held in Paris from October 23 to 26 :—

"The President and Council of the Royal Society of London offer to the Institut de France their most cordial congratulations on the auspicious occasion of the centenary of its existence, which it is now about to celebrate.

"The President and Council are well aware that various ancient Academies flourished in France long before the official foundation of the Institut as a means of recording discoveries and promoting arts and sciences, and that much of that great advance in human knowledge which took place during the 17th and 18th centuries was due to the labours of members of the French Academy of Science.

"The foundation of the Institut, however, comprising as it does five Academies, each with its own special sphere of action, but all united as one harmonious whole, constantly investigating the laws of nature and the developments of art, constitutes an era in the history of civilisation.

"It would be an endless task to attempt to enumerate the branches of human knowledge which during the past century have benefited by the labours of the Institut. It is a body of which not only France but the whole of the civilised world may be justly proud.

"It is sad to think, that just at the moment of a commemoration which would otherwise have been celebrated with unalloyed pleasure, Science has to mourn the loss of one of her most distinguished votaries. The single-minded and devoted labours of Pasteur, and their beneficial results to man and the domestic animals, are recognised throughout the whole world with the highest gratitude and admiration. The Royal Society assures the members of the Institut of its hearty sympathy in the sad loss that they and humanity at large have sustained.

"That the Institut may long continue to exist and prosper, and that each succeeding century may witness an ample harvest from its labours, is the heartfelt wish of the President and Council of the Royal Society.

(Signed) "KELVIN,
"*Pres. R.S.*"

I had the honour of presenting this address to the President of the Institute of France in person. For myself and other Fellows of the Royal Society who were present along with me I may be allowed to say that we were much gratified with the friendly and fraternal reception accorded to us, as colleagues and fellow labourers in the work of the Institute.

I am sorry to say that we are now losing the service, as Assistant-Secretary, of Mr. Herbert Rix, who, after seventeen years of faithful work for the Royal Society, retires from this post, as he finds the necessarily increased anxiety and burden of the office to be too great a strain upon his health. We all feel grateful to him for the manner in which he has discharged his duties from the time he first entered the service of the Royal Society; and I am sure the Fellows generally will agree with the Council in being pleased that we have been able to arrange to still have Mr. Rix to help us in our work, in the less arduous post of Secretary to the Government Grant Committee.

A very important scientific event of the past year, resulting from work initiated by the Royal Society a quarter of a century ago, is the completion of the "Report of the *Challenger* Expedition," in fifty large royal quarto volumes containing 29,500 pages, and illustrated by over 3000 lithographic plates, copper-plates, charts, maps, and diagrams. I may remind you that H.M.S. *Challenger* was fitted out by the Government in 1872, on the recommendation of the Royal Society, and was absent for nearly four years on an exploration of the Great Ocean Basins. The publication of the numerous observations, which have enriched almost every branch of science, was at first carried on under the direction of Sir C. Wyville Thomson, and subsequently by Mr. John Murray.

I have been myself much struck with the extreme beauty of many of the plates contained in these volumes; and, though no expert in the subject, I may be allowed to say that I believe nothing more admirable has been hitherto given to the world in the way of illustration and representation of biological subjects. Of the maps, I may confidently say that they are models of careful, accurate, and elaborate work. Two volumes of the Report deal with the narrative of the voyage, three volumes with the physics and chemistry of the ocean, one volume with deap-sea deposits and geology, two volumes with botany, forty volumes with marine zoology, and two volumes are devoted to a summary of the scientific results.

How highly the work of the *Challenger* expedition is appreciated by those best qualified to judge of the merits of its results is illustrated by the following words, spoken by Milne-Edwards at a meeting of the International Congress of Zoology, held last September in Leiden :—L'expédition du *Challenger* a porté des fruits merveilleux. Ceux qui l'ont organisé, ceux qui y ont pris part, et dont quelques-uns ne sont plus ici pour

recueillir le prix de leurs efforts, ceux qui en ont étudié les résultats, ont rendu des services dont nous leur sommes profondément reconnaissants. Le monument scientifique ainsi élevé par les savants anglais constitue un titre de gloire dont une nation a le droit d'être fière."

The contributors to this gigantic Report are, for the most part, natives of the United Kingdom and the British Colonies, but the scientific men of nearly every civilised State are represented among the authors. The British and foreign contributors are seventy-six in number, and many scientific men whose names do not appear on the title-pages of the special memoirs have taken part in the physical and chemical researches performed in connection with the work of the expedition. Among the contributors we find the names of Alexander Agassiz, Ernst Haeckel, P. G. Tait, G. O. Sars, F. E. Schulze, T. H. Huxley, Rudolph Bergh, A. v. Kölliker, A. Renard, W. K. Brooks, N. N. Polejeff, Th. Studer, A. A. W. Hubrecht, W. Dittmar, Sir William Turner, A. Günther. Before the end of the present meeting I shall have the pleasure of presenting to Mr. Murray one of the Royal medals, which has been awarded to him by the Council of the Royal Society, to mark their appreciation of his editorship of this great work, and of his own scientific contributions to it.

In my Presidential Address of last year I took occasion to refer to Lord Rayleigh's discovery that the gas which remains when oxygen, vapour of water, and carbonic acid are removed from common air, is denser than nitrogen extracted from chemical compounds; and I was then able to tell you of the consequent discovery that our atmosphere contains a fifth constituent which is denser than nitrogen. This discovery had been thoroughly established by Rayleigh, in association with Ramsay, who had joined him in the work; but no details had then been published. They had succeeded in isolating the new constituent by extracting all the four previously known constituents (oxygen, nitrogen, aqueous vapour, carbonic acid) from air, and they were energetically at work with a view to discovering its properties. I concluded my last year's Address by expressing the hope that their work would give us, "before the next Anniversary Meeting of the Royal Society, much knowledge of the properties, both physical and chemical, of the hitherto unknown and still anonymous fifth constituent of our atmosphere." That hope, as you all know, has been splendidly fulfilled. They early discovered a name for it, Argon, because exhaustive chemical investigation gave them no evidence of its chemical combination with any other known element. They found its density to be very high, 20 (that of oxygen being called 16), and the ratio of its specific heats $1\frac{2}{3}$. Olzewski, experimenting on a specimen sent to him by Ramsay, succeeded in liquefying it, and found its critical pressure to be 50·6 atmospheres, and its critical temperature $-121°$. These results were communicated in a joint paper by Rayleigh and Ramsay to the Royal Society at a memorable meeting, held in the theatre of the University of London, because our ordinary meeting-room was not large enough to contain all who wished to hear it. It will be gratifying to Fellows of the Royal Society to know that the Smithsonian Institution of Washington gave to Lord Rayleigh and Prof. William Ramsay the first Hodgkins' prize for their "Memoir on Argon: a New Constituent of the Atmosphere." This memoir had been communicated to Washington before the end of December 1894.

Since the dates of those first communications much work has been done by various observers on the spectrum analysis of argon. In a communication by Rayleigh to the recent meeting of the British Association, we find a very accurate determination of its refractive index and its viscosity. Ramsay, in trying for clues to compounds of argon, had his attention called by Mr. Miers (of the British Museum) to a paper by Hillebrande, telling that cleveite (a rare Norwegian mineral which consists chiefly of uranate of lead) gives out 2 per cent. of gas, supposed to be nitrogen, when warmed with weak sulphuric acid. Ramsay, thinking the so-called nitrogen might turn out to be argon, experimented on the mineral. He found that the gas evolved, by heating it in sulphuric acid, contained a trace of nitrogen, which he removed by the Cavendish process of sparking with oxygen in presence of alkaline liquor. The residue was proved by the spectrum test to contain argon, but to contain also another gas, not argon, showing itself by a brilliant yellow line. This line was identified by Crookes as the "helium line," discovered thirty years ago by Lockyer, who, finding it to have been not discovered in the spectrum of any terrestrial substance spectroscopically examined up to that time, attributed it to a substance in the sun's atmosphere, which he called helium. Thus, a substance, discovered thirty years ago in the sun's atmosphere, and accordingly named from the sun, has been found in a terrestrial mineral by Ramsay, in his quest after argon. Having got helium into his laboratory, he found its density to be less than 3·9 (ultimately reduced to 2), and, therefore, less than one-fifth (about one-tenth) of that of argon. He sent a specimen to Olzewski, who found (NATURE, October 3, 1895) that the treatment by which he had succeeded in liquefying hydrogen—namely, compressing with a pressure of 140 atmospheres, cooling to the temperature of liquid air boiling at low pressure, and then expanding suddenly, showed no signs of liquefying helium.

Considering the uncertainty as to the density of the gas in which helium was identified, and the multiplicity of spectrums found for it by various experimenters, Lockyer, who experimented on some eighty minerals, and found the yellow line of helium in sixteen of them, thinks it most probable that it is not a single gas that is extracted either from cleveite or the other minerals, but a mixture of gases of which helium is one; and this view was supported by Runge and Paschen in their admirable spectroscopic analysis of argon and helium, communicated to the British Association ("British Association Report," Section A, September 18, 1895) at its recent meeting at Ipswich. It seems too early to feel sure that the helium found by Ramsay in the gas from cleveite, if perfectly purified of nitrogen and other known gases, is a single gas, or is a mixture or combination of several. Before another Anniversary Meeting of the Royal Society, it is probable that we shall have certain knowledge, without any doubt, as to this question. Meantime, at our present Anniversary, we may be satisfied to feel that if there are several new gases, of which one, at least, has density less than a quarter of that of oxygen, the discovery will be several times as interesting as if the helium now discovered proves to be only one gas.

COPLEY MEDAL.

Dr. Karl Weierstrass, For. Mem. R.S.

Dr. Karl Weierstrass is distinguished for his investigations in pure mathematics, extending over a period of fifty years. He is one of the great pure mathematicians of the century.

Among his researches, dealing with many branches of the science in which his work is of significant effect, may be specially mentioned:—

(i.) His investigations in pure algebra, particularly in relation to functions of real variables, to the considerations of convergence and divergence of series and products, and to the theory of bilinear and quadratic forms.

(ii.) His contributions to the general theory of functions of complex variables. This subject he has developed from its foundations, and has re-established it on a new basis, so that much of it is his creation. The extensions which he has made to this theory have of themselves proved sufficient to secure for him the distinction of an acknowledged master.

(iii.) His work in the theory of periodic functions. In particular, the advances made by him in the theory of Abelian transcendents, mark the chief algebraical development since the time of Abel and Jacobi, and they have stimulated others to further developments. Also the valuable advances made by him in the theory of elliptic functions have been fruitful and suggestive as the starting-points for researches by a number of distinguished mathematicians.

(iv.) His work in the calculus of variations, the best known published part of which relates to the theory of minimal surfaces.

Not least remarkable among his claims to originality is the method of proof which he has introduced in his investigations; he has associated a vigour and a strictness with the minutest details of his proofs that have not merely led to the sound establishment of propositions, but have indicated limitations and have suggested new ideas.

ROYAL MEDAL.

Dr. John Murray.

To Dr. John Murray one of the Royal Medals is awarded for his energetic and successful editorship of the Report of the *Challenger* Expedition, and for his own large contributions to the work of the expedition and to the scientific papers embodied in the Report. In this matter Dr. Murray's labours are recognised universally as having been of extreme value to zoological science. His own contributions to the elucidation of the material brought home by the *Challenger* have been of great

importance and originality. His researches on the deep sea deposits, and his general discussion of the oceanographic results of the expedition, are recognised as being of first-rate quality.

Dr. John Murray has already received the "Prix Cuvier" of the French Académie des Sciences, and it is right that the corresponding body in this country should take the first opportunity available to it, after the completion of the *Challenger* Reports, to express its appreciation of their value.

ROYAL MEDAL.

Prof. James Alfred Ewing, F.R.S.

A Royal Medal is conferred on Prof. J. A. Ewing for his investigations on magnetic induction in iron and other metals.

The magnetic properties of iron and steel when subjected to magnetising forces of different intensities, under various conditions of temperature and mechanical stress, have been studied by many physicists both in this country and abroad. In a series of papers which have appeared at intervals during the last fourteen years, Prof. Ewing has put on record a remarkable collection of experimental facts connected with these complicated subjects. In some of his results and methods he was anticipated by others, but apart from the wide extent of his investigations, he has displayed great sagacity and originality both in his more fundamental researches, and in the directions in which he has developed his work.

Having studied the behaviour of iron when subject to magnetic forces which vary in a cycle, he applied the same process to nickel, proving that, as in the case of iron, the susceptibility is constant for small forces, but that the range of force over which this law holds good is much larger for nickel than for iron.

Prof. Ewing has also investigated the behaviour of iron and steel of various qualities, of manganese steel, of cobalt and nickel, when placed in very strong magnetic fields, the intensity of which was raised to the splendid magnitude of 46,000 C.G.S. units in the air around the metal bar under observation. He thus showed experimentally, in corroboration and extension of Joule's primary discovery, that the intensity of magnetisation approaches asymptotically towards a limiting value, which it very nearly reaches before the magnetising force attains a comparatively small magnitude, and at which it remains constant while the magnetising force is increased without limit.

Not content with investigations such as these, Prof. Ewing has made an important advance in our knowledge of the probable constitution of magnetic substances. He constructed a model of such bodies by placing a number of small magnets near to each other so that each is free to rotate in a horizontal plane. These magnets, when disturbed, settled down into groups of more or less stable equilibrium, which are gradually broken up under the influence of increasing magnetic forces. This model suggests the novel and most important conclusion that the act of magnetisation is accompanied by the re-arrangement of similar groups of magnetic molecules. So closely does it reproduce the behaviour of iron, that it is possible not only to imitate the more prominent phenomena, to copy the curve of magnetisation, and the loops produced by cyclic forces, but also to detect minor details which were for long overlooked in iron itself.

Throughout these theoretical researches Prof. Ewing has paid attention to their practical applications. The well-known phenomenon which he has named "hysteresis" plays an important part in the action of transformers. He has, on this account, invented two instruments by which the magnetic properties of samples of iron can be readily tested.

Prof. Ewing's researches on magnetic induction are described in a series of memoirs published in the *Transactions* of the Royal Society, and in a number of shorter papers which appeared chiefly in the *Roy. Soc. Proc.* and the "Reports of the British Association." He ranks as one of the principal authorities on a subject of great theoretical and practical importance. He has thrown light upon the theory, and has facilitated its application to industry.

DAVY MEDAL.

Prof. William Ramsay, F.R.S.

Prof. Ramsay's earlier researches were in the department of organic chemistry. Nearly twenty years ago he was carrying on researches on picoline and its derivatives, which were published in the *Phil. Mag.* for 1887 and 1888, and on quinine and its decomposition products, the results of which were published in the *Chem. Soc. Trans.* for 1878 and 1879.

Prof. Ramsay's later researches have been more devoted to subjects in the borderland dividing chemistry and physics. In 1879 and 1881, he published in the *Chem. Soc. Trans.* four papers on molecular volumes, and between the years 1880 and 1892 he communicated to the Royal Society eight papers on the critical state and properties of liquids, two being published in the *Proceedings*, and six in the *Phil. Trans.* In 1893 he published the results of researches on molecular surface energy in the *Phil. Mag.*, the *Chem. Soc. Trans.*, and the *Proc. Roy. Soc.* In 1893 he communicated to the *Phil. Mag.* a very important paper on the expansion of rarefied gases.

But the researches on which the award of the Davy Medal to Prof. Ramsay is chiefly founded are, firstly, those which he has carried on, in conjunction with Lord Rayleigh, in the investigation of the properties of argon, and in the discovery of improved and rapid methods of getting it from the atmosphere; and, secondly, his discovery in certain rare minerals of a new elementary gas which appears to be identical with the hitherto hypothetical solar element, to which Mr. Lockyer many years ago gave the name of "helium." The spectrum of this terrestrial gas was seen at first as an extremely narrow and sharp line of a brilliant yellow colour, close to, and slightly more refrangible than, the sodium lines D_1 and D_2, and having a wave-length near to 5876, this, according to recent determinations, being the wave-length of the solar line of helium, or, as it is usually designated, D_3. Shortly after its discovery, Prof. Runge, of Hanover, announced that the yellow line of Ramsay's gas was double, consisting of a strong component having a wave-length of 5875·88, and a faint component having a wave-length of 5876·21. As no observer had seen the solar line, D_3, double doubt was thrown on the first assumption that Prof. Ramsay had actually isolated a solar element hitherto unknown on the earth. Within the last few weeks, however, Dr. Huggins, in England, and Prof. Hale, in America, have detected the presence of a faint luminous companion of D_3 in the spectrum of the chromosphere, and as these solar lines have the same wave-lengths as those of the corresponding terrestrial lines, the doubts at first raised have been set at rest. The body giving rise to the solar line D_3, and Prof. Ramsay's new gas from cleveite, uraninite, bröggerite, monazite, and many other rare minerals, is now admitted by chemists, physicists, and astronomers to be the same substance—helium.

The conferring of the Davy Medal on Prof. Ramsay is a crowning act of recognition of his work on argon and helium, which has already been recognised as worthy of honour by scientific societies in other countries. For his discoveries on these gases he has already been awarded the Foreign Membership of the Société Philosophique de Genève, and of the Leyden Philosophical Society. He has had the Barnard Medal of the Columbia College awarded to him by the American Academy of Sciences, and within the last few weeks he has been elected a Foreign Correspondent of the French Académie des Sciences.

Five years have now passed since you elected me to be your President. Living at a distance of 400 miles from London, I felt that it could not be possible for me to accept the honour when the possibility of its being offered to me was first suggested. I accepted, with much misgiving as to my ability to perform the duty which would fall upon me; and now, after having been re-elected four times, I feel that if the interests of the Society have not suffered under my Presidency, it is chiefly because they have been so faithfully and unintermittently cared for and worked for by the other officers, the Treasurer and the Secretaries, who have left nothing undone that could be done to promote the welfare of the Royal Society. For their unfailing kindness to myself I can only offer my heartfelt thanks. I soon found that what I looked forward to with apprehension—the Council meetings, and as many of the ordinary meetings as I could attend, during my University session in Glasgow—were the reverse of fatiguing; and I am only sorry that I have been so many times obliged to forego the pleasure of performing that part of my Presidential duty. I look back otherwise with unmixed pleasure to all the meetings at which I have presided, and my sole regret now is—I cannot disguise it, and it is a very keen regret—that these five years are passed, and that to-day I cease to be your President. I thank you all, my colleagues of the Royal Society, for electing me five times to be your President, for

forgiving me all my short-comings, and for the inestimable benefit which you have conferred on me by giving me your friendship.

In the evening a large number of the Fellows and their guests dined together at the Hôtel Métropole. Among those present being M. Marey, who attended officially as President of the Paris Academy of Sciences.

DR. DUBOIS' "MISSING LINK."

THE opening scientific meeting of the session of the Royal Dublin Society, on November 20, was of especial interest, owing to the presence of Dr. Eugene Dubois, who exhibited the famous remains which he discovered in Java. The chair was taken by Prof. W. J. Sollas, F.R.S. Dr. Dubois read a paper "On *Pithecanthropus erectus*: a transitional form between Man and the Apes," which will very shortly be published by the Society, and which was illustrated by a number of lantern slides made in Dublin for this lecture. He said that when he was invited by Prof. Cunningham to read a paper before the Royal Dublin Society, he did not for a moment hesitate to comply, as he was anxious to get as much criticism as possible. By order of the Dutch Indian Government he conducted, from 1890 to 1895, explorations of a fossil vertebrate fauna, of which some remains had been discovered many years ago by Junghuhn and others. These vertebrate remains, which were found abundantly at Trinil on the southern slope of the low Kendeng Hills, were obtained from beds of cemented volcanic tuff, consisting of clay, sand and consolidated lapilli, which were rearranged by fluviatile action. The whole formation attains a maximum thickness of over 350 metres. In these strata the Bengawan River has cut its channel 12 to 15 metres in depth. These beds lie unconformably upon beds of marine marl, sand and limestone, which have recently been determined by Prof. Martin to be of Pliocene age. In August 1891, Dr. Dubois came upon a very rich layer of fossil bones, in which the remains in question were found; this occurred in the lapilli deposit, or fine gravel, about five inches above a bed of coarse gravel, which rests on a black clay. The layer of bones lies a little below the dry-season level of the river. The river-bank was excavated with such care that the position of each specimen was accurately known. In September a wisdom tooth was discovered, and a month later the skull-cap was found about one metre distant, and at precisely the same level. The work was interrupted by the rainy season, but was renewed in May 1892; the left femur was found in August, at distance of about 15 metres from the calvaria, and in October a second molar, at a distance of 3 metres from where the skull-cap was found, and in a direction towards the place where the femur had been dug out. Among the associated animals may be mentioned large numbers of Stegodon, specimens of hippopotamus (Hexaprotodon), hyæna, several species of deer, Bubulus, a gigantic pangolin three times as large as the existing Javan form, &c. The four remains were all in the same state of fossilisation as the animal remains, the weight of the femur being nearly three times that of a recent femur. Doubt had been expressed whether the four remains belonged to the same individual; Dr. Dubois himself had no doubt on this point, as he had often found bones from the self-same skeleton, and even fragments of a single bone, at similar distances apart; never had he found a complete skeleton. He had good reasons for believing that the animals perished in volcanic catastrophes, and their corpses were brought down a large Pliocene river, so that before the bones were finally deposited and buried they must have been separated by the rotting of the flesh; and there are evidences of crocodiles having preyed upon the carcases.

The femur is so human-like that nearly all anatomists did not hesitate to declare it to be human; but up to the present no human remains had been found in the Lower Pleistocene, the oldest only reach down to about the middle of that period. Nobody had the slightest doubt that the bone must have belonged to a form with an erect posture. Only Virchow repeatedly maintained, even after seeing it, that it belonged to an ape, probably Hylobates, because it has, in his opinion, a straight, shaft such as never occurs in man; but the audience could easily see that the shaft of the fossil was by no means straight, and Dr. Dubois demonstrated some features which he had never seen in human femora, but which he believed to be simian characters.

For normal human proportions the capacity of the cranium was too small for the femur; but microcephalic skulls of the class which may be regarded as atavistic can be even relatively smaller, while the height of the body is more than that of Pithecanthropus, as computed from the length of the femur. Such was the case of the microcephalic idiot, Joe, described by Prof. Cunningham. The length of the Java cranium is 185 mm., its breadth 130 mm. The same dimensions in an average female chimpanzee's skull are 132 and 91, and those of a Hylobates 95 and 69. The internal capacity he estimated at 1000 cubic centimetres. The largest skulls of the anthropoid apes average about 500 c.c. Normal human skulls are known of an equal or even less size than the Java cranium; but these small skulls are always associated with a small body. The chances are enormously against this being the skull of an idiot, and no microcephalic skull shows such a flattening of the parietal region. The orbital part of the skull is quite different from that of man, but the inclination of the nuchal plane is far more human than simian. From the genus Hylobates he could only find a difference in size and in the downward slope of the occiput; the resemblance between the two was most striking if the former was enlarged two diameters.

A divergence of opinion also prevailed as to whether the teeth were human or simian; they were larger than human teeth, and the cusps showed a relative development which was characteristically simian.

From the whole geological and anatomical investigation it followed that in each of the four specimens they had evidence of a form intermediate and transitional between man and anthropoid apes. The problem was as to the exact position of this creature in the tree of genealogical descent.

Dr. D. J. Cunningham, Hon. Secretary of the Society, believed the specimens to be of supreme importance. Discussing Dr. Dubois' memoir at a previous meeting of the Royal Dublin Society, he had expressed the view that the cranium was distinctly human, and he still held that an unbiassed study of the published description and figures could lead to no other conclusion. Now, however, when he was brought face to face with the actual specimen, he failed to see in it any decided and leading human feature, except its capacity of 1000 c.c. He agreed with Dr. Dubois in considering that it most resembled the cranium of Hylobates, although he was of opinion that Dr. Dubois slightly exaggerated the relative height and quality of the cranial arch in Hylobates. In this respect he considered that, if fairly tested, the fossil cranium would be found to be superior to any known ape. Certainly the cranial arch was vastly superior to that of a gorilla, chimpanzee, or orang, and he believed also that it was relatively fuller and loftier than the most highly-arched Hylobates cranium. Dr. Dubois placed some stress upon the inclination of the nuchal area of the occipital bone, and thought that in this there was a human characteristic; but he (Dr. Cunningham) thought that this region of the cranium was extremely ape-like, and, further, he did not altogether consider that the means which Dr. Dubois had taken to determine the degree of this inclination were calculated to yield absolutely trustworthy results.

With regard to the femur, he had nothing to add to what he had previously said on this subject. It was a human bone, and while he fully appreciated the distinctive points alluded to by Dr. Dubois, he thought that Dr. Dubois had not made sufficient allowance for the variation to which this bone was liable. It was, to say the least of it, strange that a thigh-bone of such undoubted antiquity should exhibit none of those characteristics which we were in the habit of associating with prehistoric femora, as well as with the femora of rude and savage races of the present day. It showed no signs which would indicate that the individual to whom it belonged was in the habit of assuming the squatting attitude.

In so far as the two molar teeth were concerned, he still held that the features which they exhibited were more human than simian, although it could not be denied that they also exhibited some very decided ape-like characters.

The question as to the place which should be assigned to the fossil form on the genealogical tree was a most interesting one. On this point he differed entirely from Dr. Dubois. Dr. Dubois placed Pithecanthropus below the point of devarication of the anthropoid apes from the human line. Dr. Cunningham, on the other hand, placed it on the human line, a short distance above the point at which the anthropoid branch is given off. In urging this view, he stated that he could not believe that an ape-form with a cranial capacity of 1000 could be the progenitor of the man-like apes, the largest of which had a capacity of only 500.