rare and beautiful, together with the instinct of the antiquarian, the bibliophile and the collector. His generous and sympathetic nature endeared him to all who were his fellow-workers, and more than one man has to thank him for scientific opportunity that would otherwise have been denied him.

Lord Crawford's health in his later years was far from good. He once wrote: "It has been my lot to live in close communication with two inseparable hangers-on, the one rheumatism, the other asthma. I found relief by going to sea, provided it was towards the Sunny South. The cold damp of a home winter I have not faced for many years." During these voyages he made important collections of birds, fishes, insects and plants (many of them previously unknown to science), which were presented to the National History Department of the British Museum, or, in the case of live specimens, to the Zoological Society. The story of his last cruise in his yacht, the *Valhalla,* among the little-known islands of the Pacific is told by Mr. M. J. Nicoll in his "Three Voyages of a Naturalist."

During the last four years of his life Lord Crawford was almost a prisoner in his house, Cavendish Square, London, where he occupied a suite of rooms that was maintained at nearly uniform temperature. But his mental activity was unabated, and almost to the last he was closely occupied in preparing a catalogue of a vast number of documents he had gathered together relating to the French Revolution—a collection that includes more than 600 original letters of Napoleon the First.

Lord Crawford joined the Royal Astronomical Society in 1871, and became its president in 1878 and 1879. In recognition of his services to astronomy he was elected a fellow of the Royal Society in 1878. He was a trustee of the British Museum, a Knight of the Thistle, a Knight of Grace of St. John of Jerusalem, a Commander of the Legion of Honour of France and of the Rose of Brazil.

ORIGINS OF HELIUM AND NEON.

AT the meeting of the Chemical Society on Thursday last, February 6, two papers were read which have attracted great public attention. One was by Sir William Ramsay, on the presence of helium in an X-ray tube, and the other, on the presence of neon in hydrogen after the passage of the electric discharge through hydrogen at low pressure, was by Prof. Norman Collie and Mr. H. Patterson. An excellent account of the meeting appeared in *The Morning Post* of February 7, and upon it the subjoined revised report is based. Elsewhere in the present issue will be found a communication from Sir J. J. Thomson describing recent experiments of a somewhat similar character made by him, and his interpretation of them.

In the absence of the president of the Chemical Society, Prof. A. Smithells presided at the meeting of the Chemical Society at Burlington House on February 6. Sir William Ramsay, in his paper on the presence of helium in the gas from the interior of an X-ray tube, reminded the fellows that some years ago he and Mr. Cameron had obtained lithium from copper, though people were mildly incredulous. He had also published a statement to the effect that under the influence of radium emanation silicon gave some carbon dioxide, while with thorium a respectable quantity of carbon dioxide was obtained, the inference being that the element tended to break down to carbon, which in the presence of oxygen became carbon dioxide. When the time came for him to have to return the radium that had been lent to him he had looked about for some other substance with which to continue his experiments. Radium gave helium and niton, or radium emanation, and also heat and α rays. Niton was extraordinarily energetic, more so than any other known substance, so that a cubic centimetre of it gave more than three and a half million times the energy of a cubic centimetre of explosive gas. During the decomposition of the emanation α rays were given off and β rays with even greater velocity. The question to determine was whether it was possible to find signs of chemical transformation through the β rays, a difficult one when it was remembered that only 6 per cent. of the energy of emanation appeared in the form of β rays. He had made the attempt, however, with old X-ray bulbs. In the first instance his method had been to break the bulbs, and on analysing the gases contained in the glass by means of the combustion tube, he had found as the only gases helium, neon, and argon. Last November, instead of breaking the bulbs, he had heated them to three hundred degrees, and collected the gases, finding the spectrum of helium and also a small quantity of neon. As a result of these experiments there was no question that the bulbs contained helium. The problem was what was the source of this helium. It might have been derived from the electrons, or from contact with the kathode or anti-kathode, or from the contact of the kathodic rays with the glass. Last summer he had informed the society that on treating water with radium emanation, instead of getting helium, neon was got, the equation suggesting itself that helium (4) plus oxygen (16) equals neon (20). Thus at Bath, when the waters were charged with radium, great quantities of both neon and helium were produced.

Prof. N. J. Collie and Mr. H. Patterson read their paper on the presence of neon in hydrogen after the passage of the electric discharge through hydrogen at low pressures. Prof. Collie directed attention to the fact that he and Mr. Patterson had done the early portion of the work of their joint paper independently and from different points of view, and that it was only in the later stages of the work, when they had learnt that they were getting the same results independently, that they had collaborated. He described his early experiments, which had been undertaken on fluorspar with the hope of decomposing the fluorine by means of the electric discharge. On testing some fluorspar that Sir William Ramsay had received from Iceland last summer he had found that helium was given off. Further investigation showed that the spar gave off carbon monoxide and other gases, and when the problem had been investigated with one of Sir William Ramsay's ingenious pieces of apparatus it had been determined that on treating the spar neon was produced. Further investigation showed that the same result was obtained by using artificial calcium fluoride, and again by using glass wool, and then again by carrying out the discharge in the bare glass tube. What was the origin of the neon? Had air leaked in through the taps of the apparatus? Was it due to impurities in the hydrogen placed in the tube to con-

duct the current, or to the oxygen used in the later stages to get rid of the hydrogen, or to neon being dissolved in the glass? Prof. Collie described the experiments undertaken to exclude the possibility of there being any such origin for the gas, and also the attempt made with a negative result to see whether the neon could have leaked through the heated glass tube.

At this stage, Mr. Patterson continued the paper, showing the point of view from which he had undertaken the research. He had been interested, he said, in the pure physics of the electron. He described the formulæ on which he had built up a hypothesis, and announced that he had thought it conceivable that by doubling the electrical charge on the hydrogen atom it might be possible to convert this into an α particle, and so into helium. He did not, he said, regard the result of the experiment as proving the hypothesis, but he thought that perhaps his hypothesis provided an explanation.

Prof. Collie then resumed his reading of the paper. He had, he said, criticised Mr. Patterson's method of preparing hydrogen by electrolysis of barium hydrate solution, and to avoid this possibility of error Mr. Patterson had filled his barium hydrate apparatus with pure oxygen, so as to avoid the presence of dissolved air in the barium hydrate solution, but he still obtained neon. Another possibility had then suggested itself. While neon did not enter glass under ordinary conditions, might it not do so under the influence of the X-ray discharge? To make certain on this point the experiment tube was surrounded with another tube containing neon, and about the same result was obtained as before. Several experiments were made with helium in the outer tube; in the inner tube neon was found. Lastly, since sending in his paper the previous week, he had used the outside vessel as a vacuum (a higher than an X-ray vacuum), and still the neon appeared, the quantity thus obtained being comparable with that present in about two cubic centimetres of air. The previous Friday and Saturday he had performed the experiment twice with the experiment tube surrounded by a vacuum. He had then asked himself whether there was anything else he could test. He decided to try whether there was anything in the outer chamber. He let a cubic centimetre of pure oxygen into the outer chamber; having pumped out this oxygen he passed a spark through it, and there was a slight explosion, due to hydrogen. He absorbed the oxygen in the usual way with carbon cooled with liquid air, but there was still some gas left, which he regarded as rather a nuisance. He repeated the process of absorption, but the gas still remained, in relatively large amount. He decided to test it and turned on the coil. The sight he then saw astounded him, for the tube was a blaze of helium, with some neon mixed. He communicated with Mr. Patterson, who repeated the experiment. Mr. Patterson at first found the same. Then he put oxygen into the outer tube, and he found, instead of helium in excess, what appeared to be the neon in excess, the equation being suggested that helium (4) plus oxygen (16) equals neon (20). If the helium had sufficient velocity, when produced in the inner tube, to traverse it, it was quite possible for a new element to be produced. For his own part he was quite satisfied provided neon and helium had been produced from substances in which they were previously not present. There were various possibilities. It might be that the elements of the tube or the electrodes gave neon or helium under the influence of the discharge. This gave them ten or a dozen elements to choose from as the source. Again, there was the chance that the hydrogen was the source or mercury vapour. Or it was possible that they were dealing with a primordial form of matter, the primordial atom which, when produced, had all the energy necessary for forming the universe. By the combination of these "atoms" the atoms of the elements would be formed. Helium, and possibly hydrogen, were present in the hottest stars, and they were present in the experimental tube. Perhaps the electric current was a directed flow of these atoms, and with the phenomena of heat and light the elements came into existence. At any rate one thing seemed certain. The elements could be changed, and they could be changed in a way very different from the way that radium was changed. In its case the process could neither be hastened nor retarded. But the present phenomenon was artificial, and, further, the process was occurring at the other end of the system of the atoms, producing elements of low atomic weight. The old idea of the transmutation of elements had to be altered. We were coming now to know more of subatomic matter, and it had to be realised that—

> The old order changeth, yielding place to new,
> And God fulfils Himself in many ways
> Lest one good custom should corrupt the world.

Prof. Collie then showed two illustrations of the effect of sparking neon, the gas when absolutely pure blazing out into a pillar of perfect flame-red. He added, in conclusion, that he had broken the experiment tube, heated it, and found under the microscope that it was full of bubbles of gas that had been caught in their passage through the tube.

Prof. Smithells, in opening the discussion, said that, without venturing to express any opinion upon the facts or the hypothesis brought forward, it was evident that if the conclusions were substantiated it would be difficult to speak of their importance in language of exaggeration.

Sir William Ramsay expressed his great gratification at other researchers having taken up the investigation. With radium there had been no chance of repetition, but the present experiments on transmutation could be reproduced by anyone with a coil and a battery. He was extremely gratified that the theory of transmutation now no longer rested on his *ipsissima verba*.

Various expressions of opinion by men of science upon the experiments and conclusions described above have been published in the daily papers. Mr. F. Soddy has, we learn from *The Westminster Gazette*, given his views as follows:

The results as regards the apparent formation of helium and neon in vacuum tubes under the influence of the kathode rays have been noticed by previous investigators. A paper published by myself in the Proceedings of the Royal Society, 1908 (p. 94), states that the source of what might be termed the miraculous appearance of helium in a vacuum tube was traced to the power of aluminium electrodes of absorbing these gases during previous use. Baron von Hirsch, of Munich, in 1907 came to this laboratory to investigate a case he had noticed in which he supposed that helium was produced by the kathode ray discharge in a vacuum tube. This we succeeded in completely disproving. These observations show that other workers have investigated the kathode rays in vacuum tubes, and have even thought that helium and other rare gases were produced. It is impossible to say anything about the new experiments of Sir William Ramsay, Prof. Collie, and Mr. Patterson until full publication is available. There is nothing in the paper which leads one to suppose that there is any special new condition to which the production could be ascribed, and, of course, some such condition may account for the results. All that can be said is that other workers have not got helium in experiments which seem to be similar.