Reg. 18th June

UNIVERSITY EXTENSION LECTURES.

The series of University extension lectures will begin this evening with Professor Bragg's course on "Radio-activity." Last year the Prince of Wales Theatre was crowded by those who wished to learn something about a recent discovery which had caused much excitement in the scientific world. During the past twelve months interesting advances have been made by those who are engaged in original research upon the subjects, and the contributions from the Adelaide University are entitled to rank among the most important. In the second volume of the annual report of the Chemical Society for 1905 Mr. Frederick Soddy says:—"The line of work originated by Bragg and Kleeman has been extended and completed, and their methods have been developed into a most powerful engine of research." This is high and well-deserved praise.

In his extension lectures last year Professor Bragg announced that he had been able to show that the alpha particle—an atom of helium ejected by the radium atom—passed through all other atoms which it might happen to meet, and was not turned aside from its course; and, that when evidence of its motion ceased, it was because the particle had been gradually checked through the expenditure of its energy in breaking off fragments from the atoms which it traversed. Professor Rutherford, of McGill University, Montreal, has confirmed these discoveries, and added new and interesting facts. In particular, he has shown that the velocity at which the effects of the particle cease to be observable was far higher than could have been expected—something like half its initial speed, or 9,000 miles a second. Professor Bragg was able to show in his turn that, if this were so, it could be demonstrated from his experiment that the critical speed was the same for all gases. This adds another strong reason for believing that we shall recognise in the chemical elements structures more or less complicated of quantities still more elementary. Professor Rutherford also announced that when the particle ceased to break up the atoms which it encountered it lost all its power to excite phosphorescence, and to act on a photographic plate. Coupled with other recent discoveries regarding the photographic image this new fact seems to forecast the inclusion of photography as a chapter in the theory of radio-activity.

In the Cavendish Laboratory at Cambridge Mr. F. N. Campbell has been making researches concerning the existence of radio-activity in ordinary substances; and he has been guided by the well-known general law that, if one or more of the elements should show some specific property to a high degree, all other elements usually exhibit the same property, though perhaps in a much smaller degree. Expressing himself in terms of the experimental work first done in Adelaide, he demonstrates that various substances—for example, the common metals—emit a radiation which he identifies as a stream of alpha particles. He measures the range of the particle in each case—or, as he terms it, Bragg's constant—and shows that the constant for every metal has its own particular value. It is highly gratifying to know that the work performed in the laboratories of our University is making so powerful an impression on scientific thought. In The Philosophical Magazine for February, 1906, one happens upon such expressions as "Bragg's constant" and "Bragg's law;" and some of the most eminent scientific men in England, Germany, and America freely acknowledge the permanent value of the local Professor's contributions. By his painstaking and untiring efforts Professor Bragg has not only won honour for himself among men who are engaged in original investigation, but he has also done much to enhance the credit of the University which he serves so worthily.

Register 19th June. 1906

RADIO-ACTIVITY.

LECTURE BY PROFESSOR BRAGG.

The great interest taken by South Australians in the discovery of the wonderful radium, added to by the recent finds at Olary, was shown by the large attendance on Monday evening, when Professor Bragg delivered the first of his two lectures on radio-activity during the present session of the University extension addresses. The lecturer said the study of radio-activity was exciting immense interest in all parts of the world. This arose partly from the fact that the new science revealed wonders hitherto unsurpassed, and also because it dealt with a series of phenomena not previously touched by scientific discovery. It was important to understand that point. In the nineteenth century the discoveries of Dalton and the work of all the great chemists and physicists who had followed him had treated in the main with the interactions of atoms and molecules on one another. The very word atom implied that the study of its properties was carried on in relation to it as a whole, and not to its parts. The new science was distinguished from the old in that it dealt with the processes occurring within the atom itself. One illustration of this would serve. In the laboratory of the chemist the thermometer was an all-important instrument; in fact, all chemical processes were largely affected by the temperature at which they were carried on. Temperature implied the existence of heat, which consisted in the energy of the motion of the molecules and atoms among themselves. In the new science of radio-activity temperature was of very small importance, for the motions and properties dealt with were those that occurred within the atoms themselves, and had no relations to their motions among other bodies or to other atoms and molecules round about them. Whether as many great results would flow from the study of radio-activity as proceeded from the study of the atom and the molecules, as exemplified in chemistry and physics, remained to be seen, but there was no doubt that the study was enormously interesting, and gave every promise of leading to knowledge of service to man.

Professor Bragg sketched the principal points in the theory of radio-activity for the benefit of those who had not studied the subject. He recapitulated the description of some discoveries made in the University of Adelaide, an outline of which he gave last year, and mentioned that when he delivered his last lecture on the subject he was not in a position to say much about the impression the Adelaide discoveries had made in the scientific world, but in the year that had elapsed many discoveries in various parts of the world had verified his experiments, so that he might say that the Adelaide University had made material contribution to the world's knowledge of radio-activity. Much new and important work had been done in the past year, and this he proceeded to describe. In the first place Professor Rutherford, who had been working in Montreal, in Canada, had shown that the alpha particle, when it ceased to give evidence of its motion through the air, was still moving at a speed of something like 6,000 miles a second. The range of the alpha particle in the air was the distance it went before its speed fell to the velocity named. The discovery that the remaining velocity of the particle was so great was certainly surprising. What became of it afterwards was a matter of wonderment. Professor Rutherford had written to him that he was at present engaged trying to discover the remaining history of the particle. Professor Rutherford had also carried out a series of experiments, testing and confirming the Adelaide results. That had been done mainly because certain experiments performed by M. Becquerel in Paris had seemed to run counter to them. M. Becquerel had argued from his work that the particle did not gradually lose its speed as it went through matter, as had been supposed by Professor Bragg, and he published his experiments in some of the Continental papers. Professor Rutherford's experiments showed easily the point at which M. Becquerel had erred, and his results were also published in various scientific papers in the early part of the year. The lecturer mentioned that his own replies to M. Becquerel appeared later, as the letters had to travel round the world. Almost immediately after the publication of his first results M. Becquerel himself found out his mistake, and had in his turn also described experiments in which he showed his agreement with the Adelaide results. Professor Rutherford's experiments had also brought out the singular fact that when the alpha particle fell to the velocity named not only did it cease to have electrical effects as Professor Bragg had shown, but it also ceased to be able to affect a photographic plate, or to cause minerals to phosphoresce. A piece of research work had been carried out during the year which dovetailed beautifully with those new results. It had been shown by Sir James Dewar that a photographic plate could be acted upon by light, even at a temperature of 400 Fahr. below zero. All chemical actions had practically ceased at so low a temperature as that, and it was clear therefore that photography was not primarily a chemical effect at all. It was probably electrical. There were certain substances which responded electrically to the stimulus of light. For instance, a large number of bodies discharged negative electricity when ultra-violet light fell upon them. The point was of considerable importance in physiography, for it was generally supposed that mountain tops discharged negative electricity into the air under the effect of brilliant sunshine. These so-called photo-electric effects had also been found by Joly to be in existence at extremely low temperatures, and it was therefore to be inferred that the photographic action was probably one of those photo-electric effects, and not a chemical one at

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THE NEW SCIENCE.

PROFESSOR BRAGG ON RADIO-ACTIVITY.

ADELAIDE UNIVERSITY EXPERIMENTS.

At the University on Monday night, Professor Bragg gave the first of two lectures on radio-activity, with special reference to recent discoveries.

Professor Bragg said the study of radio-activity was exciting immense interest in all parts of the world. This arose in part from the fact that the new science revealed wonders hitherto unsurpassed. Moreover, it dealt with a series of the phenomena never before touched by scientific discovery. It was of some importance to understand clearly this point. In the 19th century, discoveries of Dalton, and the work of all the great chemists and physicists who had followed him, had dealt in the main with the inter-actions of atoms and molecules on one another. The very word atom implied that the study of its properties was carried on in relation to the atom as a whole and not to its parts. The new science was distinguished from the old in that it dealt with the processes occurring within the atom itself. One illustration of this would serve. In the laboratory of the chemist the thermometer was an all-important instrument; in fact all chemical processes were largely affected by the temperature at which they were carried on. Temperature implied the existence of heat, and heat consisted in the energy of the motion of the molecules and atoms amongst themselves. But in the new science of radio-activity temperature was of very small importance, for the motions and properties dealt with were those that occurred within the atoms themselves, and had no relation to their motions amongst other bodies, or to other atoms and molecules round about them. Whether as many great results would flow from the study of radio-activity as proceeded from the study of the atom and the molecule, as exemplified in chemistry and physics, remained to be seen, but there was no doubt that the study was enormously interesting, and gave every promise of leading to knowledge of service to man.

Professor Bragg proceeded to sketch the principal points in the theory of radio-activity, for the information of those who had not studied the subject, and he recapitulated the description of some discoveries made in the University of Adelaide, an outline of which he gave last year. He mentioned that when he gave his last lecture on the subject he was not in a position to say much about the impression the Adelaide discoveries had made in the scientific world, but in the year that had elapsed many discoveries in various parts of the world had verified his experiments, so that he might say the Adelaide University had made a material contribution to the world's knowledge of radio-activity. Much new and important work had been done in the past year, and this he proceeded to discuss. In the first place Professor Rutherford, who had been working in Montreal, in Canada, had shown that the alpha particle, when it ceased to give evidence of its motion through the air, was still moving at a speed something like 6,000 miles a second. The range of the alpha particle in the air was the distance it went before its speed fell to the velocity named. The discovery that the remaining velocity of the particle was so great was certainly very surprising. What became of it afterwards was a matter of wonderment. Professor Rutherford wrote to him in a private letter that he was at present engaged in trying to discover the remaining history of the particle. Professor Rutherford had carried out a series of experiments, which had confirmed the results arrived at in Adelaide. Professor Rutherford had done this mainly because certain experiments had been performed in Paris by M. Becquerel, which seemed to run counter to the conclusions come to at the Adelaide University. M. Becquerel had argued from his experiments that the particle did not gradually lose its speed as it went through matter, as had been supposed by himself (Professor Bragg), and M. Becquerel had published his experiments in some of the Continental journals. Professor Rutherford's experiments, however, showed the point at which M. Becquerel had erred, and his results had also been published in various scientific papers in the early part of the year. Professor Bragg's own reply to M. Becquerel was published later, for the letters had to travel round the world. Almost immediately after the publication of his first result, M. Becquerel himself had found his mistake, and subsequently he described experiments which showed him to be in agreement with the results obtained at Adelaide. Professor Rutherford's experiments had also brought out the singular fact that when the speed of the alpha particles fell to the velocity named, it not only ceased to be capable of electrical effects, as Professor Bragg had shown, but it also ceased to be able to affect a photographic plate or to cause minerals to phosphoresce. A piece of research work had been carried on during the year which dovetailed beautifully with this new result. It had been shown by Sir James Dewar that a photographic plate could be acted upon by light, even at a temperature as low as 400 deg. Fahr., below zero. All chemical actions practically ceased at so low a temperature, and it was clear therefore that the photographic action was not primarily a chemical effect at all, but was probably electrical. There were certain substances which responded electrically to the stimulus of light. For instance, a large number of bodies discharged negative electricity when ultra-violet light fell upon them. The point was of considerable importance in physiography, for it was generally supposed that mountain-tops discharged negative electricity into the air under the effect of brilliant sunshine. These so-called photo-electric effects had also been found by Joly to be in existence at extremely low temperatures, and it was therefore to be inferred that the photographic action was probably one of these photo-electric effects, and not a chemical one at all. This had formed the subject of Joly's address to the Photographic Convention of the United Kingdom during the past year. It would now be seen that Professor Rutherford's discovery of the property of the alpha particle, in so far as it lost this power to affect a photographic plate at the same moment that it lost its electrical power, was in every way consonant with the theory of photography. Probably, therefore, the photographic effect upon a plate exposed in a camera consisted in the unseating of electrons from their proper place, the displacement being capable of being carried on at any temperature. The material so modified would afterwards respond to the chemical action of the developer at ordinary temperatures.

Professor Bragg showed some interesting photographs which had been forwarded to him by Professor Rutherford. These illustrated the radiating power of radium in a very curious way. The process of producing the photographs was as follows:—Metal rods were exposed to the emanations of the radium, and had so become radio-active themselves. When placed upon a photographic plate curious patterns were formed, which depended upon the shape of the rods themselves. The unravelling of these patterns was easily effected by the new theory of the alpha rays, and formed a pleasing confirmation of the correctness of this theory. The lecturer explained that an ordinary incandescent body of the same size would have given no pattern at all upon the plate.

Ad. 27th June 1906

RADIO-ACTIVITY.

PROFESSOR BRAGG'S SECOND LECTURE.

At the University last night Professor Bragg gave his second lecture on "Radio-activity" before a large audience. He explained, in opening, that he proposed to speak of the method by which the life of the radio-active substance was measured. The first important step in this process was the measurement of the number of alpha particles emitted by a given quantity of radium. Professor Rutherford had found that from one gram of radium there would be sent out 60,000,000,000 alpha particles in each second. The number of atoms in one gram of radium was expressed by a figure beginning with a 3 and followed by 21 cyphers. A simple division sum then showed that supposing the ejection of an alpha particle meant the breaking up of one atom of radium one two-thousandth part of a gram of radium would disappear by the end of the year. It was easy to see, therefore, that the life of radium was between 1,000 and 2,000 years. And since uranium had been found to break up at approximately, 1-1,000,000th of the rate of radium, the life of uranium was to be measured by millions of years. Radium had been shown to be the parent of a long series of radio-active substances. The weight of the radium atom itself was about 225 times that of the hydrogen atom, and at each expulsion of an alpha particle this number was diminished by four, since the weight of the particle was equal to four times that of the hydrogen atom. It was very interesting to compare the weights which the various descendants of radium must possess with those of the substances in the chemist's table of atomic weights. It was well known that a periodic law existed amongst the atoms in that if they were arranged in a descending scale of magnitude various properties recurred at regular intervals. To this list the investigation of the properties of the radio-active descendants of radium had added one extremely interesting and new example. After the expulsion of the four alpha particles, the radium atom became a substance whose properties had been chiefly investigated by Mdme. Curie. This substance had been named polonium, after Mdme. Curie's country, Poland. The atomic weight of polonium should be about 209, but at this point in the chemist's table there was a gap, no substance having yet been found to fill it. Polonium, however, not only had the proper weight which it should have if it took the vacant place, but it had also properties which had been

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shown by Marckwald to resemble closely those which chemists would anticipate such substances to have. It was, in fact, the big brother of the sulphur-selinium-tellurium group. The final descendant would have the atomic weight less still. This broke up very like lead, and the constant recurrence of lead in the radium ores made probable the hypothesis that lead itself was the final product of radium. Radium had a life of only a few thousand years, and therefore they must assume that it was continually produced, unless they were to suppose that it was suddenly introduced into the earth a few thousand years ago. It had long been supposed that uranium was the original source from which radium was derived, and further evidence strongly confirmed this view. In all ores in which radium was found there was a proportion of uranium such as bore out this hypothesis. The exact proportion was 0.72 gram of radium to 1 ton of uranium, and this proportion was so universally found that a search for radium practically resolved itself into a search for uranium. The lecturer explained that recent discoveries at Olary and Wallaroo sustained this proportion. With regard to the Olary discovery, he understood that a search was being prosecuted for a body of ore richer in uranium than had hitherto been found, and on the success of this search the value of the discovery, from a commercial point of view, depended. At Wallaroo considerable success had already been reached in the process of purifying the mineral, and he had received from the authorities material which was 200 times as active as uranium. He understood this discovery would form the subject of a communication to be presented at an early date to the Royal Society by Mr. Radcliffe, the original discoverer. The Professor threw upon the screen a diagram which showed the complete history of the radio-active processes, and he drew attention to the marvellous results of a few years' work in this direction. Not very long ago the idea of one substance turning into another would have been scouted, and yet it was now possible to know with accuracy the details of a series of transformations, carried right through from the original substance (uranium) to the final substance of the radium series. That this was lead could hardly, perhaps, be distinctly said at present, but it was probable that in a very little while the matter would be decided. Polonium was found in excessively minute quantities, but a few millegrams could be collected, and this quantity would, if the lead theory were correct, turn into lead in the course of a year or two. The lecturer went on to describe certain curious experiments carried out by himself and Mr. Kleeman, which showed that when the alpha particle broke away an electron from the atom, under many circumstances this electron was extremely likely to slip back into its old place. The laws of it were not yet fully investigated, but a good deal had been done at the University of Adelaide, and more at the Cavendish Laboratory, Cambridge, by Mr. Kleeman, who recently went to Cambridge as the Adelaide research scholar. Mr. Norman Campbell had recently made many attempts at Cambridge to discover radio-activity in other substances than those specially known as radio-active. The experiments were very difficult, and yet they appeared to have been successful, and Mr. Campbell had announced that he had actually measured the range of the alpha particle emitted by lead, silver, tin, and other metals. The range of the alpha particle was shown to be 3.5 centimetres by the original researches carried out at Adelaide, and Mr. Campbell had now shown that the range of the lead particle was about 12 centimetres, and the range of other metals varied from four to five centimetres. Mr. Campbell's work further implied that the rate of change of ordinary materials was perhaps a million times as slow as that of uranium. The discovery that other substances than radium emitted an alpha particle of about the same size as radium strongly confirmed the idea that the particle itself entered as a principal constituent into all atoms. The discovery also tended to show that all atoms were in a continual state of flux. Thus we were gradually drifting away from our ideas of what was permanent in nature. In the last century it was supposed that at least the chemical atom was the final form of stability. Now it was seen that the very atoms themselves were in a state of change, and the recognition of the vast spaces of time occupied in these processes, and the recognition of the enormous stores of energy locked up in the atoms themselves, made it clear that the new science of radio-activity would not only be of immense importance in scientific discovery, but would have a momentous influence on the trend of human thought.