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a range peculiar to each set, and by various ways it was found possible to prove that each of these sets was associated with one of the four first changes of radium. For instance, one set was found to have a range of 7 centimetres, or rather less than 3 in., and this set was identified with the alpha particles emitted from radium C. Another had a range of 4.8 centimetres, or just under 2 in., and another had a range of 4.2 centimetres; and these two were proved to be due to the emanation and to radium A. As to which was which of these two the experiments had not yet successfully shown, for there were several difficulties in the way. The fourth set had a range of 3.5 centimetres, or a little under an inch and a half; and these were shown to be the alpha particles emitted by the parent radium. When radium had been dissolved and evaporated again all the products had been removed, and the pure radium left. In such circumstances only the short-range alpha particles were emitted, and if an examination was made day by day it was found that the others slowly reappeared. It could be deduced also from the observations that the sets of alpha particles were alike in all other respects except that of speed. From these results it appeared that the radium atom and its successors all ejected an exactly similar alpha particle, giving ground for the belief that the alpha particle itself was an important constituent of these substances, and the suggestion that it might possibly be an important constituent of all substances. An atom consisted of electrons, and so did an army of soldiers; but soldiers were grouped in regiments, and perhaps there were regiments of electrons in the atom of which the alpha particles were examples. Again, it appeared that every radium atom when it broke ejected its alpha particle at identically the same speed. This argument had been used by Mr. Soddy to form the latest illustration of the original atomic theory of Dalton. Experiments had shown that the heavy radium atoms were alike even to this extreme—that when they did break up they ejected particles having identically the same speed; and Mr. Soddy had said that it could hardly have been supposed possible that Dalton's theory could have passed so severe a test.

Experiments had been conducted by Sir William Ramsay and Mr. Soddy on the nature of these alpha particles. It had been suspected that helium was one of the products of radio-activity from its presence in the minerals in which the radio-active substances occur. Their method of procedure was to take a small quantity of radium which had been kept in a dry state for many months, and in which the products had accumulated, to dissolve the same in water, and to take away the gas collected. They then removed from this gas the oxygen and hydrogen which were always present when radium was dissolved. They removed the emanation by passing the residue through liquid air, which liquefied the emanation, but could not liquefy any helium, and examined the remainder by the spectroscope. The remainder proved to consist of pure helium. Further, they took the emanation, which they had removed as explained, and introduced it—it was a very minute quantity—into a very fine tube. On passing the electric spark through this tube the result showed that no helium was present; but three or four days after the sealing up of the tube the spectroscope showed that helium was there, and as the days went by the evidences of its presence became stronger. This experiment was repeated several times by simply leaving the same quantity of radium until a new quantity of emanation had been formed, so that radium was continually producing emanation, and the emanation, together with its successive radio-active substances, was continually producing helium. The alpha particles shot out from radium had not absolutely been proved to be helium in this way; but from his (Professor Bragg's) experiments it appeared that they were identical with the others in nature, and therefore the presumption was that all alpha particles were helium.

THE NATURE OF RADIUM.

Professor Ernest Rutherford, of McGill University, Montreal, whose investigations of radium have gained him a worldwide reputation, has (says The Sydney Daily Telegraph) on his present visit to the land of his birth, New Zealand, been induced to make public some interesting information concerning this new substance. Within the last year or so, he says, a great deal of work has been done in the way of clearing the ground and verifying hypotheses, and it is now plain that radium is matter in process of transformation. Spontaneously, and at a certain fixed and uniform rate, it is slowly disintegrating or breaking down its own atomic system so that already eight different substances—including polonium, the radio-active element discovered by Madame Curie—have been traced in these stages of transition. Radium, the investigators have concluded, must be the product of some other substance, for it gives off its atoms so rapidly that the world's supply would long since have disappeared in the form of inert matter had not some source existed from which it could be replenished. In reference to the theory that uranium is this parent substance, Professor Rutherford was asked whether it would be possible to stimulate the action of uranium—in other words, to encourage the production of radium from it by artificial means—but his reply was in the negative. No known chemical or physical means, he explains, can affect these atomic changes. He suggests that the inference to be drawn from the researches, so far as they have proceeded, is that the heat of the earth—conceivably also that of the sun—may be due to radium. But as he frankly admits that the whole study is still in its infancy, it will be seen that it is far too early yet to speak with any degree of certainty upon the subject. For this reason also he is unable to say definitely whether the hope that cancer may be cured by radium is justified. "The evidence looks promising," he tells us, "but is not conclusive." No doubt, as he says, these experiments will have to extend over a wide area for a long time before they can be regarded as final.

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MR. BREWSTER JONES'S RECITAL.

There was a large audience at the banqueting room of the Town Hall on Tuesday evening, when a recital was given by Mr. Brewster Jones, one of the most promising of Adelaide's young pianists. The task which Mr. Jones set himself was one which would have severely tried the powers of any mature artist, for his programme contained one of the most difficult Beethoven sonatas, a Bach organ prelude and fugue, transcribed by Liszt—the first piece played in Adelaide by Paderewski—groups by Chopin and Schumann, and the familiar "Second Rhapsodie" by Liszt. All these pieces, which occupied nearly an hour and three-quarters in performance, were given from memory, without a slip of consequence—which is in itself no small feat, but what is infinitely of more importance, they were played with uniformly good technique and individual expression that gave ample evidences of the possession of an unusually strong temperament. In a word, the whole recital was a complete success for the young musician, and reflected infinite credit upon his instructor (Mr. Bryceson Treharne). The programme opened with Liszt's transcription of Bach's well-known organ "Prelude and fugue in A minor." In this it was evident that, as far as possible, Paderewsky's "reading" was followed, particularly in the treatment of the prelude, and the remarkably quiet opening of the fugue. Some fine contrasts of tonal effect were obtained in the prelude, and the fugue was given in a generally clear style, with a well-managed climax. Beethoven's great "Sonata Appassionata" followed, and excellent technique was manifested in the opening movement. The "Andante con moto" was presented with much taste and finish, and there was a good deal of self-repression in the final "Allegro," which was neatly and clearly played. Mr. Jones seemed much in sympathy with his Chopin numbers, though there were occasional exaggerations that will doubtless disappear with maturer experience, and much of the beauty of the writings was well brought out. His selection consisted of the "Etude in F major, op. 25, No. 3," the "Nocturne in E major," and "Scherzo in B minor." A well-deserved recall followed this group, and the "Nocturne in C sharp minor" was added. A Schumann group, which included "Des Abends," "Augschwung," "Warum," and the "Tocatta, op. 7," was also interpreted with a good deal of intelligence and genuine musical feeling. The technical difficulties of the latter item were surmounted with great success, and in response to the plaudits of the house Mendelssohn's "Song without words in A minor" was given as a supplementary item. Three writings from the pen of that king of pianists, Liszt, concluded the recital. These were "Au Bord d'une source," the "Etude in D flat," and the "Second rhapsodie." Here, again, the pianist's executive powers were revealed in a most favourable light, and he was heartily cheered as he bowed his acknowledgments for the last time. An excellent Perzina concert grand pianoforte from Mr. Wertheim's warehouse was used.

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EXTENSION LECTURES.

THE LAST ON RADIUM.

MORE WONDERFUL FACTS.

There was another large audience at the Adelaide University on Tuesday evening when Professor Bragg gave his final lecture of the series on radium. He began by saying that certain questions had been addressed to him seeking further explanation on some points in his last lecture. The first related to the fact shown by his experimental curves that the alpha particle produced more effect towards the end of its course than at the beginning. If any misunderstanding had arisen on this point it was because the nature of the collision between an electron of the alpha particle and an electron of the atom passed through had not been made sufficiently clear. The word "collision" had been used in a general sense to cover the results of an encounter between two electrons, but it was probable that they never came into actual contact in the crude and more material sense of the word. Two electrons repelled one another on account of their being similarly charged with electricity. If one moved towards the other with great rapidity it might slip past without repelling it very much, but at a slower speed the force of repulsion would have more time to act. Therefore a fast-moving electron in slipping past an electron in a stationary atom might have less effect in pushing it from its place than one of slower speed. He had also been asked to explain why the alpha particles from the top of a thin radium layer had so much longer range than the particles from the bottom of that layer when the layer was so extremely thin. The answer was that the layer though thin consisted of radium bromide, a very dense material, and that in this short length of heavy substance the alpha particles lost so much way as to rob it of much of its range in the open air. It was at least 10,000 times heavier than air. He had also been asked if the alpha particle itself would not suffer damage in passing through other atoms at rest. The answer to this was "Yes," and formed, indeed, one of his first points for the lecture that evening.

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It was Professor Rutherford who first showed that the alpha particle was positively charged, because when the particles were made to stream across a space before a powerful magnet they were turned slightly to one side in the direction which showed their charge to be positive. It had previously been shown with considerable ease that the beta particles were also turned to one side, their charge being negative. Rutherford's experiment was a very difficult one, because the alpha particles, which were at least a thousand times as heavy as beta particles, were turned aside to a correspondingly less degree. Direct experiments to measure the charge on the alpha particles by simply collecting them and observing the result had been failures until quite recently, and in consequence much discussion and interest had centred about the phenomena attending the charge of the alpha particle. One curious point might be mentioned. The emanation atom, when it broke up, expelled an alpha particle, which, in view of Rutherford's experiment, must be considered to be positively charged, and yet itself was attracted by and deposited on a negatively charged body, such as a metal rod placed in the emanation, showing that the emanation atom was also positively charged. Now when a neutral atom broke up they should expect that if one part was negative, the other would be negative. He had offered an explanation of this point, which had been accepted by Mr. Soddy, and its nature had already been guessed by some of the audience, or they would not have asked the question whether the alpha particle itself did not suffer damage. The point was that any fast-moving atom must become positive at once, because it was sure to have an electron knocked off it in its collisions, and this applied also to the remainder of the emanation atom as it recoiled after its own expulsion of a particle.

Rutherford's experiments on the magnetic deflection, coupled with others on the deflection due to electrical influence, had shown that the velocity of the alpha particle was enormous. Rutherford's estimate was a little less than one-tenth of the velocity of light—say 18,000 miles a second. Others had made it less. Future experiments would no doubt result in greater precision. Nevertheless, the values obtained were in very good agreement with the estimates formed of the energy of the alpha particles, for it had been shown by Curie and Laborde that radium continuously gave out stores of energy which showed themselves as heat in the neighbouring bodies. The alpha particles, in their bombardment of neighbouring objects, raised the temperature of the latter, and considerable quantities of heat were given out in this way if it be remembered that the specimens of radium in existence were very small. To give an idea of the amount of heat involved, it might be mentioned that Curie and Laborde showed that one dram of radium gave out enough heat in every hour to raise an equal quantity of water from freezing point to boiling point. Radium changed very slowly compared with some of its successors, which existed in very minute quantities. If the successors could be had in any quantity the amount of heat emitted would be more astonishing still. A pound of emanation, if it could be obtained, would radiate energy merely by the expulsion of its alpha particles at the rate of between 10,000 and 100,000 horse-power, and keep going for several days. With a pound of radium A the rate would be a thousand times greater, but it would last only a few minutes. It had been found that radium and its products were distributed in minute quantities throughout the majority of materials. Probably they existed in the sun, since helium existed there. It was, in fact, in the sun that helium was first discovered. These considerations had profoundly modified all estimates as to the origin and life of the sun's heat and the origin of the heat of the earth.

Professor Bragg then proceeded to exhibit some curves he had obtained, which showed that a stream of alpha particles in going through a metal plate suffered a loss of range, but were neither altered in number nor in direction. In fact, they had the extraordinary phenomenon that matter in the shape of atoms of helium was passing through other matter without any injury to itself or to the matter passed through, except that of the removal of electrons, which injury, no doubt, was easily and quickly repaired. The alpha particles did not make their way through the pores of the metal nor push the atoms of the metal to one side, but the atoms went through the other atoms without permanent injury to either. In carrying out experiments of this kind he and Mr. Kleeman had used films of various metals and had measured the loss of range which each metal produced. They had apparently stumbled across a very remarkable law for all the metals they had examined, and for all the gases in which they had measured the ranges of the alpha rays—they had found that the loss of range which the alpha particle experienced in going through an atom was proportionate not to the mass of the atom but to its square root. Supposing that the atoms of substance were dislike in form, as had been maintained on other grounds, then the resisting power of an atom depended not upon the number of electrons in it—that was, its mass—but on the number on its edge. Supposing that the loss of range of the alpha particle was due to the expenditure of its energy on breaking off electrons from the atoms passed through, the conclusion would appear to be that the alpha particle never broke electrons from the middle of an atom, but only from the edge. A law of this kind, if it should be proved to be approximately true for all atoms, would be very important indeed. Very few such general laws existed. Nothing but experiment could decide the point, but the experiments already conducted at the University had shown that it was approximately true in the case of some 12 or 15 substances, and experiments on others were to be made. They ranged from hydrogen to platinum in density, and they covered such complex substances as ether and methyl-bromide. This explanation could be little more than conjectured, but he would conclude his lecture with the hope that he might at some future time meet his hearers again, and be able to say that at least some part of thetheory he had tried to construct before their eyes had stood the test of criticism and further experiment.