of proving their continuous movement in any material. The kinetic or dynamic theory was found useful to explain different phenomena associated with atoms; but, though it seemed right, they must take it on trust yet, because the atoms were in enormously rapid motion. However, they had been able to show it almost directly by means of the cinematograph allied with Brown's microscope. It had been found that the movements of the atom were a fundamental constituent of it, and it followed that if a gas were in motion its speed would be proportional to the friction of the material in which it moved. Similarly the speed would be proportional to the retarding power of any substance. It was a natural thing that, if a sphere were bombarded from all sides, first one part and then another would be hit more often in a given space of time, which would impel it hither and thither. That was what happened with an atom, and its rate of motion depended on the density of the medium. One investigator who examined particles of matter in the ultra microscope found that wherever two collided a strong point of light was noticed, and that light was due to refraction of the beam of light used for the investigation.

The Speed of Helium.

It was true that they could not hope to use a single atom for experiments, but if they could obtain a single particle which moved rapidly and ionized a gas they could apply the discoveries to a general mass. Such a particle was helium, one of the emanations of radium. It had a speed of 10,000 miles a second and ionized gas, and it was used for that purpose in the laboratory. It had been found in the laboratory that the ionization consisted of colliding with various electrons, of which an atom was formed, and releasing them from the mass or merely changing their direction. Electrons were really the atoms of atoms, and in some way they imprisoned electricity, for they were simply electricity. They were quite invisible, but it had been possible to ascertain their size and the amount of electricity in them within minute limits. Photographs of the actual collision of electrons had been obtained, and some were shown during the lecture.

TO-NIGHT'S LECTURE.

There are a few tickets available for Sir Ernest Rutherford's second lecture, which will be given to-night in the Brookman Hall. Early application should be made at the University office.

Reg. 4·9·25

ELDER CONSERVATORIUM.

On Monday, September 10, in the Elder Hall, the University choral class, conducted by Mr. Frederick Ebran, will give its annual concert. The works to be performed are Handel's serenata, "Acis and Yalatea!" and Mendelssohn's "Athalie." For the former the soloists will be Misses Thelma Martin and Elsie Cook, with Messrs. Walter Wood, John Ardill, and Arnold Matters, and for the latter Professor Darnley Naylor, M.A., will act as reader, and Misses Sylvia Thomas, Alice Meigan, Jean Sinclair, and Mabel Siegele will take the solo parts. The boxplan will be opened to-morrow morning at S. Marshall & Sons', Gawler place.

Reg. 7·9·25.

FORESTRY SCHOOL.

TASMANIA OFFENDED.

HOBART, Sunday.

The Attorney-General and Minister for Forestry (Mr. Ogilvie) stated on Saturday that, should it be necessary for him to attend a conference of Attorney-Generals in Melbourne later in the month he would interview the Federal authorities on the subject of the proposed forestry school at Canberra. The Commonwealth forestry adviser (Mr. Lane Poole) said Mr. Ogilvie, recently made a tour at the Commonwealth's expense for the purpose of explaining the proposal for the establishment of the forestry school. He visited all the States, with the exception of Tasmania. "We have had practically no information regarding the proposal," he said. "It is just one more instance of the neglect of Tasmania by the Commonwealth. We are treated like dogs. It is an appalling state of affairs."

Adv. S. 9-25

THE STRUCTURE OF THE ATOM.

AN UNKNOWN WORLD.

In his second lecture last night Sir Ernest Rutherford said, in speaking of the structure of the atom they were dealing with an unknown world. They knew that the nucleus was made up of electrons and protons, but they had no idea how they were held together or arranged, and it might be centuries before they could obtain evidence in detail.

Sir Ernest Rutherford delivered his second lecture on the structure of the atom at the Brookman Building, School of Mines, on Friday evening. Professor Mitchell presided. As at the first address, there was a large attendance, including prominent educationists. The lecturer's remarks were followed with the closest attention, and the solicitude he displayed in making his meaning clear was fully appreciated.

It is universally conceded by Nature students that the possibility exists of all matter being composed of one ultimate substance. The idea is that all matter, if fundamentally the same, must be divided into particles. From an everyday conception of things it is difficult to imagine that water, for instance, is made of the same substance as zinc, or that the basis of molasses is identical with that of leather. Yet practically every physical scientist recognises this fact, and astronomers, medical men, wireless technicians, electricians, engineers, chemists, and all students of the by-products of these sciences, accept it without question. But surrounding the subject is the romance of exploration, and it is natural that the visit and the views of the foremost exponent of the science has aroused more than passing interest in many besides those who have familiarised themselves with the subject.

The Chairman said he had to thank Sir Ernest, on behalf of the students of the Adelaide University, for the extremely inspiring meeting which he had given them that afternoon. He had mentioned incidentally that he had received a cablegram from Cambridge stating how well his experiments were proceeding. (Applause.)

A Wide Subject.

Sir Ernest opened by explaining that his part was to continue the story he had begun on the previous evening on the structure of the atom. His difficulty was to know what to put in and what to leave out, for the subject could not be dealt with in one, ten, or a hundred lectures. He had to boil down the history and development of the subject to its salient facts. Illustrating the minuteness of the atom, he explained that it would take a million people counting for a million years to ascertain the number of atoms in a cubic centimetre. Eighty different elements were discovered by the labors of the chemists. It was thought that though those elements might tend to form molecules, the atoms of the elementary substance could not be changed by any method known to the chemists. They would be here for eternity unchanging and unchargable. To the theory of the immutability of the atom, however, came two shocks—one, radium, and the other the electron. The electron was nearly two thousand times lighter than the lightest atom known. This raised the question whether the electron was not the fundamental unit of which atoms were composed. It was found that electrons could be produced by a variety of methods from almost every substance. Now it was known that the electron was nothing more than an atom of electricity. Electrons possessed the property which could be termed the instability of the atom. Experiments had given very strong evidence that the atom must be a very complete structure, not only of electrons, but also of other things. An enormous force must hold atoms together. Electrons might be units, but they were embedded in a grey intangible sphere of some matter. The negative element of electricity had been found, but the positive had never been discovered. If one wanted to know what was inside the atom the way to ascertain it was to get something that went inside it and then see what would happen when the structure was penetrated. If a thin pencil of alpha rays were pushed through a piece of gold there must be a scattering of the beams. If an atom were composed of electrifying units scattering must occur. The simplest idea to take of the atom was that it consisted of a centre part which was positively charged and surrounded at a distance by negative electrons.

Complicated Arrangements.

Among lantern slides explained by the lecturer one showed the deflecting of alpha particles in a magnetic field. Another illustrated the steps in the spectrums of various metals. Sir Ernest explained that the arrangement of the electrons in an atom was so complicated that there were no definite opinions about it. A further slide showed a few of the orbits which may be occupied by the electron of thehydrogen atom. Another indicated the complicated structure of the radium atom. It was explained that the nucleus of an atom was one eight hundred billionth of a centimetre. The nucleus of the atom had both positive and negative electricity, but the positive in excess. Sir Ernest said they were dealing with the structure of an unknown world. While they had evidence that almost certainly the nucleus was made up of electrons and protons, they had no idea of how they were held together orarranged, and it might be centuries before they could obtain evidence in detail. During the last two years two experimenters believed they had transmitted mercury into gold, but he doubted it, because he did not think Nature worked that way. He had tried to cover a large subject in a general way. The atom was really a great world in itself. They thought they knew something about the outer structure, and they had a vague idea of the inner structure. They could not imagine the complexity of the enormous movements which must be existing within the atomic system. (Applause.)

Professor Chapman, in moving a vote of thanks to the lecturer, said the addresses had been delightful, interesting, and inspiring. Removed as they were from the great centres of scientific research, it was inspiring to hear the pioneer of a new field of knowledge recount the story of his discoveries. They had had unfolded to them a series of discoveries in a new realm of scientific work, a realm of fundamental importance dealing with the constitution of the matter of which everything was made. The work of astronomers left them with a sense of their minuteness, but they might get some consolation from the researches of Sir Ernest, for what Godlike beings they must appear to the ultra-microscopic inhabitants of those electron planets! (Laughter, and applause.)

Professor Kerr Grant seconded the motion, which was carried by acclamation.

Reg. 5·9·25.

STRUCTURE OF THE ATOM.

Experiments in Transmutation

The second lecture on "The structure of the atom" was delivered by Sir Ernest Rutherford in the Brookman hall of the School of Mines on Friday evening. Professor W. Mitchell (Vice-Chancellor of the University), who presided, thanked the lecturer for his interesting address to the University students during the afternoon. He stated that Sir Ernest had received a cablegram from the Cavendish Laboratory, Cambridge, telling him how wonderfully the experiments started by him were progressing.

Sir Ernest Rutherford stated that each little point of his address might well form the subject of a separate lecture, and he had had to condense his matter greatly. Some things he would say were still in doubt, and there might be a different idea about them 10 years hence. As an illustration of the minuteness of atoms, he said that in a cubic centimetre there was a number represented by 50, with 19 noughts after it. Assuming that there were 1,000 million people on earth, each counting 100 a minute, it would take them 1,000 years to count those atoms. That should bring home to the mind the incredible number of atoms in any particle of matter they could see readily. Those atoms were separated by relatively great distances, and did not fill the whole volume, for they were simply like sentinels in a space people could appreciate. How, it would be asked, could they ever hope to know anything about the proper structure of these minute bodies? The labours of the chemist had shown definitely that they could divide all matter into atoms or types of elementary substances, of which there were more than 90. Those substances, while they might combine with one another or with others of the same nature as themselves, could not be changed by any means, it seemed to the chemist; so that they had been classed as the unchanging entities of the universe. Clark-Maxwell had held that they had existed forever, and would exist for eternity. A shock had been given to that idea of the immutability of the atom as a result of two discoveries—those of radium and the electron. It was found that the electron existed as a particle of matter charged with electricity, and it appeared to be 2,000 times lighter than the lightest known atom, hydrogen. That raised the question whether the electron was the fundamental unit of which all atoms were composed. While the chemist had found that there were certain elements, some philosophically minded men had reached a conclusion that each was not a distinct entity, because its property depended on its atomic weight. Certain properties they found to recur in atoms arranged in periodic order. That indicated a common constitution of all. The discovery of the electrified unit seemed to give a foundation stone, because it was found that others could be liberated from atoms. The electron was minutely light, and certain experiments indicated that in a sense it was not material; because they could explain its apparent mass or energy as purely the charge of electricity carried by it.

Search for the Undividable.

An idea then arose that the mass of the electron was inherent in the fact that it was electrified. Now they knew that it was nothing but a piece of electricity. When they studied radio-active substances they not only found the electron ejected at high speed, but convincing evidence as obtained in 1903 that the atom of radium showed peculiar properties because it was undergoing spontaneous radiation. They learned that there were certain striking facts associated with the uranium atom through all its changes. That showed that those atoms which were heaviest did possess a property which could be interpreted as the instability of them. People said, then, that such a characteristic might be true of the heaviest elements, but not of all. New experiments proved the enormous energy emitted by radio-active substances; and the particles ejected gave the strongest evidence that the atom must have an immensely complicated structure, and that it was much more than a place where enormous forces operated. That brought home the tremendous magnitude of the forces which held the atoms together, and the relatively enormous distances of the electrons from each other. The earliest knowledge of the structure of the atom was due to Lord Kelvin, who supposed for purposes of experiment and calculation that it was a sphere in which the electrons were embedded in an intangible material. That theory gave something amenable to mathematical calculation. By means of ingenious calculation and speculation he could show that a model of an atom, considered as a sphere, would have peculiar properties and variations which were observed in all atoms. The great difficulty, then, was that they had proved the existence of a definite unit of negative electricity—the electron—but they could not find a positive unit. People had been hunting for it for 30 years without success; and, in the opinion of the lecturer, would never find it. Though it was hypothetical that positive electricity was something which bound the electrons together, it was believed now that it was just as fundamental as negative.

Theory of Atoms.

If they desired to know what was inside the atom, they must get something which would penetrate it, and such a substance must be followed to watch the effects of its penetration. The modern idea of the atom was a result of an experiment. If alpha particles, which were helium, struck the atoms of a gas, the beam of light which showed its track spread out to an appreciable degree. If the atom were composed of electrified units, such a scattering of the beam of light must occur. It was a striking thing that the alpha particle usually was diverted from its path in a collision, but its speed would indicate small deflection. They found, however, that it was turned round a large angle, and that its path became a hyperbola. The only feasible explanation was that it entered an electrified field; and that was what the lecturer suggested 14 years ago. He then advanced the theory that the atom consisted of a central particle charged with positive electricity, surrounded at a distance by negative. Later experiments showed that that must be the case. Slides were shown to illustrate the deflection of alpha particles when near the nucleus of an atom, the effects of collision, the liberation of hydrogen after a collision with a nitrogen atom, and the capture of the alpha particle. The nucleus should be half the weight of the atom, and the electrons must equal its atomic number. Its chemical properties were dependent on the atomic number. Lantern views of spectra showed the arrangement of lines in a definite order of progression, according to the atomic number. Bauer was able to explain the arrangement of the electrons, but no definite proof of his theory had been obtained yet. He suggested that the electrons might move about in the atom or might remain in one orbit for some time. They were arranged around the nucleus in an order which depended on their number, but the central system controlled their disposition and mass. Their chemical properties, however, were controlled by the outside ring. It had been calculated that the nucleus was one eight-hundred-billionth of a cubic centimetre, and it was a unit of positive electricity.

Transmutation of Metals.

In some of the lighter elements there might be one nucleus within another which would explain isotasy—the name given to describe the characteristic of an element with two or more atomic weights. There were 12 or 13 elements which, when bombarded with alpha particles, threw out atoms of hydrogen. In some cases the nucleus contained both positive and negative electricity, but the former predonderated. The structure of the nucleus was unknown, although they were aware of its constituents. Experiments were in progress to discover a method of transforming elements; and during the past year a German and a Japanese had claimed to have changed mercury into gold; but in such minute quantities that it could not be weighed. One used on the bombardment of the atom of mercury and the other a more drastic method. The lecturer was sceptical about the claims, and did not believe that Nature ever worked in that way, which was to add to the number of electrons in the atom.