

ALCHEMY, LONG SCOFFED AT, TURNS OUT TO BE TRUE

THE legend of the philosopher's stone that turned base metals to gold at its touch is so ancient that its origin cannot be traced. Always there seems to have been in the human mind the idea that one kind of metal was not fundamentally different from another; that lead, gold, and silver were all so closely related as to make the changing of one into the other just a trick that might be discovered by much experimenting.

Within the last ten years this idea, which persisted all through the Middle Ages, and, apparently, existed long before, has taken especial hold of men's minds. Every once in a while we read of a business man, or even a great scientist, who has been deceived by some one who claimed he could make gold or silver. Occasionally an item in the paper tells of the death of some one killed by fumes or by the explosion of a retort while experimenting in search for chemically made gold.

The odd thing is that after solemn men of weight in the world of learning have been for generations showing us what fools or knaves the alchemists were, modern science takes a sharp turn and shows that they were in their fundamental contention probably quite right. But—and this is a large but—they were wrong in thinking that the process by which one metal may turn into another can be hastened any more than it can be retarded. Science does not say that it would not be possible to do either of these things, but it does say most emphatically that the secret is still a long way off, and that the process that would turn lead to gold, or vice versa, would incidentally enable us to do so many other things that civilization would be changed upside down, and the mere gold that might be produced would sink into laughable insignificance.

A generation or two ago the world was just beginning to make scientific discoveries, and naturally had come to the conclusion that it knew pretty nearly all there was to be known. But to-day the transmutation of one element into another is an accomplished scientific fact. It is proved that certain elements are perpetually changing into certain other elements, and it is more than suspected that what is known to be true of a few elements is true of all. These discoveries came about, of course, through radium. Every idea that is topsy-turvy has come about through the discovery of radium. We might have gone on for another century quite content with the old idea of the nature of matter if that baffling and contradictory thing had not been found one fateful day by the Curies.

Columbia University recently bestowed

upon Ernest Rutherford of Manchester University, England, the Barnard Medal for his researches in radio-activity. It is a high honor, and it marks Mr. Rutherford as one of the great men of the day; but scientists feel no honor could be enough for the man who opened the way for such amazing results as have recently been secured. Rutherford and Frederick Soddy of Glasgow University led the way and Sir William Ramsay followed. Rutherford and Soddy worked together at McGill University in Montreal. They made radium give up some of its secrets, and then Ramsay made it give up more.

So far radium has been found to change one part of itself at will into three different elements. Another part of itself has been traced through no less than seven different changes, while one of the by-products of the experiment gives the suspicion that copper sulphate, too, which has always been held a perfectly well-behaved element, will change into something else if it gets a chance.

Most of us think of the world as made up of many different things, and we do not trace connections between the various phenomena that go on about us. For instance, the burning of a candle and the rusting of a piece of metal seem to the average person very distinct processes. The chemist sees a close connection between them. In each process there is the main fact that oxygen enters into new chemical combinations. To the savage the falling of an apple or the rising of the tide would seem to have no connection, but any person of ordinary education to-day knows that both are the result of the law of gravitation. Now, science has gone a step further and has discovered a most intimate connection between elements which seem to be totally different.

Since experiments have proved that elements believed to be totally different can change one into the other, and since these elements are quite common and ordinary, though they have been found to behave in this strange way, there is no reason to believe that they are exceptional. Uranium changes into radium; part of radium becomes a gaseous body which in no time at all will turn back again into a solid, and then go on changing from one thing to another, tending toward something that is very probably just common lead, though this last has not been proved. Moreover, radium under different circumstances turns into different things. If this is not transmutation, what is? Science is on the verge of an epoch-making discovery that may utterly revolutionize not only our ideas of chemistry, but, perhaps, of astronomy and geology, too, and, what is more important, may put

Transmutation of Metals, the Principle of the Philosopher's Stone, Accomplished in the Twentieth Century.

in the hand of man the power to harness nature as was never dreamed of before, and change civilization to a fairy tale.

Hitherto chemists have dealt with atoms as architects have dealt with bricks. Bricks have been built up into different forms, and produced widely different results, but they were always bricks. Nobody ever got back of that fact. What would be the surprise of a builder if he suddenly discovered that a brick would pull a wagon or keep him warm, or go off with a bang like gunpowder? His surprise would be no greater than that of the chemist when he discovered that atoms of matter of their own accord were prepared to do things quite as startling.

"Science," says Prof. Soddy in his interpretation of radium, "has broken fundamentally new ground, and has delved with distinct step further down into the foundations of knowledge." Into the foundations, he says. Science has been building up and spreading out, but now it has dug deeper and is getting near the bed rock of things.

Radium is an ordinary looking affair, differing in no respect, so far as the eye can see, from any one of the ordinary common elements known to everybody. It closely resembles barium and other well-behaved elements that have never done anything startling. Uranium, too, has been known for a hundred years or more and never was considered extraordinary, nor was thorium, the product which has become of commercial value in the manufacture of Welsbach gas mantles. But uranium and thorium, as well as radium, have been discovered to possess the curious quality that is known as radio activity, that is, they give out rays invisible to the naked eye but capable of passing where light cannot pass. And from this discovery science has passed on to still stranger things. The properties of thorium that made it radio active have nothing to do with its value as a gas mantle, but they can easily be detected. Take a photographic plate, wrap it in light proof paper; then take a Welsbach mantle, scrape off the cotton, lay it on the photographic plate with the light proof paper wrapped between as carefully as you wish, and lay the whole thing away (in a dark drawer if you choose) for about a fortnight. At the end of that

time you will find that the Welsbach burner has photographed itself on the plate through the light proof paper. This is because thorium is radio active, in a far less degree than radium, but still quite enough to be highly interesting.

Radio activity was discovered by M. Henri Becquerel in 1896, the year after Prof. Roentgen discovered the X-ray. It came about by an accident. He had been experimenting in the sunlight with uranium and a photographic plate. The sun failed, and he put things away in a dark drawer for several days. When the sun came out again and he went for his plate he discovered that the uranium had made a photograph of itself in the dark. Thus, by accident, although it was an accident which must soon have happened, the key was given to a mighty secret of nature.

A few years later M. and Mme. Curie were able to isolate the element radium from a piece of pitchblende.

Now comes the transmutation part of the wonder. Everybody knows that radium is giving out energy at a tremendous rate. It gives out three hundred times as much as the same weight of burning coal. Nothing in nature can work like this and not show it—one does not have to be a scientist to suspect that. And radium, it seems, does show it very rapidly, though of course not so rapidly that it did not take a great deal of experimenting to find the secret. Radium turns itself into atoms that are thrown off at incredible rapidity (10,000 miles a second) and a gaseous body known as the radium emanation. Just as burning coal turns into smoke and ashes, so radium, quite of its own accord, turns into the alpha particles and the emanation. Nothing can stop it, nothing can hasten it.

Radium changes so fast that Prof. Soddy says if the whole world had been made of radium still there has been enough time, as geologists have proved, since the world took something like its present form for all the radium to disappear. So there began the search for the parent of radium, which turns out as far back as scientists have got, to be uranium. Uranium is changing, too; far more rapidly than the minerals that are not radio active, but the process is nothing like as rapid as that of radium.

If radium would change altogether in 2,500 years, a piece of uranium the same size would require 7,500,000,000 years to change altogether. If lead, copper, gold, and silver are changing, which seems likely, they are certainly not doing so at the rapid rate of uranium, and you can add to this 7,500,000,000 about any number of others that you like. We used to think of these things as unchanging, and when we get into the billions of years they might as well be so far as we are concerned at present; but the changes of radium have been calculated in a very narrow space, and science has determined what they are. It may be possible to determine the same thing for other elements, and of course in the far distant future the dream of the old alchemists may come true and we may be able to transmute one into the other at will.

The singular fact about all this experimenting has been that radium does not always give the same product. If the conditions under which the experiment is carried on differ radium seems willing and able to turn into different things. The Alpha particles were identified with the element helium, discovered some ten or twelve years ago and known for its absolute refusal to respond to experiment or to unite chemically with anything else. As its name indicates it was an element known to exist in the sun long before its presence was suspected on earth. Sir William Ramsay has made experiments and has discovered that when the radium was immersed in water the result was not helium but another totally distinct element called neon, which has the same property as helium of refusing to unite with other elements.

It was sufficiently startling to discover that radium could give helium and neon at will, but the amazing results were not at an end. Some copper sulphate was put in the water and, behold, the result was neither helium nor neon, but argon, a third gas of the same lazy family as helium. In other words, radium seems able to change at will into different elements, all quite distinct.

A fourth remarkable discovery was made in connection with this series of experiments. In the vessel in which the

experiment with the copper sulphate had been made there was found to be a small but distinct quantity of lithium. Now, lithium was not to be found in the water, in the air, in the radium emanation, in the glass or in the copper to begin with. The conclusion was that in connection with the radium the copper sulphate itself had been changed into lithium, seeming quite unrelated to it. This experiment has been repeated in vessels of different kinds, and while it is not absolutely certain, the chances are that a common, everyday thing like copper can turn into another common, everyday thing like lithium, with which it has no apparent relation. This is the alchemy of the Twentieth Century.

The changes of the radium emanation are startling in the extreme. The emanation is a true gas, derived from a substance that is changing rapidly as compared with other substances, but still as we count time very slowly. The emanation, on the other hand, changes in hardly any time at all. If it would take a thousand or twelve hundred years for a quantity of radium to change, it takes less than four days for a similar quantity of the emanation to change back again into a solid. After this product, there follow seven changes, all into solids, and all made in different lengths of time.

One would suppose, if there was order in nature, that there would be some relation between the periods of change, but there is none at all. Radium A changes in a few minutes. Radium D changes in about seventeen years. Some changes are accompanied by a very violent disintegration of atoms, and it would be reasonable to suppose that these would be the quick changes; but there is no connection between violence and the length of time required for a change. And so it goes.

With all this mystery and topsy-turvy-ness it is easy to see how poor a chance the alchemists have of ever reaching a simple method of making gold. Probably in the course of trillions and trillions of years something is turning to gold. But what? And even if the substance was discovered and the change could be chemically made the energy that would be given off in bringing it about would be sufficient to run the world's business for it for many a year. The value of the discovery would not lie in the gold produced.

Just here comes the wonder that opens before the world with this discovery of the energy that is stored in a harmless looking substance like radium. Presumably there is equal energy and

greater, in every ordinary substance about us, if we could get it out. The axles of carriage wheels could run the vehicle faster than any automobile, the iron in the grate could give out heat and to spare, without a particle of coal. Only this is their secret and they show no disposition to give it up.

When Professor Soddy delivered his lectures on the wonders of radium he ventured to let his imagination take a long flight backward and forward. When a man has for a long time tithed anise and cummin in the laboratory one would think he might well be permitted a flight through the empyrean, but many of his brother scientists scolded him soundly for it. To the lay mind, however, the fascination of radium is the marvelous visions it brings up of what man might do had he the power to control the vast forces that lie quietly and hitherto unsuspected on every side.

"A race," says Professor Soddy in his "Interpretation of Radium," "that could transmute matter would have little need to earn its bread by the sweat of its brow. If we can judge from what our engineers accomplish with their comparatively restricted supplies of energy, such a race could transform a desert continent, thaw the frozen poles and make the whole world one smiling garden of Eden. Possibly they could explore the outer realms of space, emigrating to more favorable worlds as the superfluous emigrate to more favorable continents."

What is more, Prof. Soddy lets himself see, in the old legend of the philosopher's stone, in the story of the fall of man, in ancient symbol of matter, the tall-deavouring serpent with the motto, "The whole is one," a suggestion that this mighty secret was once actually in the possession of man. He finds in all this an echo from an infinitely remote past in which men struggled along the road of learning as we are struggling to-day and conquered nature as we have not yet dreamed of doing until some fearful mistake turned back the hands of time and made man not the master but the terrified slave of nature.

A long flight, certainly, but made by a man who has worked harder in the new science of radio-activity than any one except his colleague, Mr. Rutherford. It shows how powerful a hold the mysteries of radium take upon the mind. It shows what dreams are made possible by the idea of the transmutation of matter. To the chemist of the Middle Ages, as to the dupe or the impostor of to-day, it has brought only a vision of wealth, but to the scientist it means the material salvation of the race.