conjunction, and yet the total number being so great, the process might go on for millions of years before all or any considerable part were changed. If, as each atom disintegrated, a ray or rays were suddenly emitted, the facts of radioactivity, as at present known, would be explained.

As each atom breaks up and emits its ray, a new system remains—thorium X. This being also unstable, it in turn breaks up and emits its ray, and there is left the second new system—the emanation. This, in turn, produces in a similar way the excited activity, and so the process goes on to the unnamed fourth and fifth systems, after which "all is at an end, so far as our experimental researches are concerned." The only answer supplied to the question what the final substance may be, is that all the radioactive minerals contain helium, a recently discovered inactive gas. If this is the final product, then we have an evolution, not such as chemists have imagined, from simple elements to complex ones, but the exact converse—helium, the lightest atom except one, formed from the heaviest.

In answer to the question how the change can produce such an enormous amount of energy, comparatively, as is contained in the rays, Mr. Soddy answers that this is our first acquaintance with atomic energy, which occupies the same position for the atom as molecular energy does for the molecule. It has been calculated that the energy in a gram of radium would be enough to keep an incandescent lamp alight for hundreds of years. A few tons, or a few million tons of it would keep the sun going without any outside assistance.

"For the present," concludes the article, "it is sufficient if it has been indicated that the labors of Professor Rutherford have led to the recognition of new forces and new processes. The forces, paradoxical as it sounds, that have been detected and recognized through the measurements of effects almost incredibly small, stand for quantities of energy vastly greater than any that have been before suspected. The processes are so insignificant that the wonder is perhaps that they have ever been brought within the range of the observer and his stop-watch. But over these same processes in the laboratories of nature the stars in the cycles are acting as the time-keepers, possibly—who knows ?—to produce effects which are cosmical in their scope and character."

RADIUM NOTES.

Radium was discovered by a Polish lady, Madame Curie, in carrying on researches in chemistry at Paris. Radium was shown by these experiments to be unlike every other known form of matter in that it produced heat for months together without combustion, without chemical or molecular change of any kind, and without apparent waste or diminution of substance. It maintains its own temperature by some mysterious form of action at somewhat over two degrees Fahrenheit above its surroundings, thus expending without loss of weight or potency an amount of energy represented by the liquefaction of its own weight of ice This is, according to present knowledge, an every hour. inexplicable phenomenon, which would, unless vouched for on such authority, be incredible, because the evolution of heat has always been regarded hitherto as an outlay of energy or force demanding compensation and incapable of sustaining itself without replacement of the original store. Sir William suggests, that in radium right under our hands, if we knew how to grasp it, exists a store of ready-made energy sufficient to give all the world all the light and heat and power that it needs without burning a pound of coal or generating a volt of electricity.

Radium salt has been hitherto noted for its wonderful power of throwing off rays which, when thrown upon a sensitive plate, cause it to glow with phosphorescent light. This property was demonstrated by Professor Crookes at a recnt meeting of the Royal Society, when, though only a few milligrammes of the salt were used, its potency was such that it conveyed its power of exciting phosphorescence to every vessel containing it, as well as to the fingers of the operator. The rays emitted by it, though themselves invisible, make themselves apparent under a microscope when they strike the screen by the inconceivable minute flashes they excite. The effects of radium on the animal economy are decidedly unpleasant, as its contact with the skin produces an open sore if continued for any length of time, and it will act in this way even when carried in a package in the waistcoat pocket. And yet it has been the means of curing that intractable disease, cancer.

Prof. Graham Bell, in a recent interview in Toronto, declares radium to be the most wonderful discovery of the age. Its rays are capable of reflection and refraction, which Roentgen rays are not, so that they may be focussed upon a point and all the advantages derived from Roentgen rays multiplied indefinitely. Sir William Crookes has just succeeded in photographing a room which was absolutely dark by these rays, which are themselves invisible. The possibilities of the uses of the new substance will thus be seen.

Radium looks like common salt, and in the dark is slightly phosphorescent. It is not volatile or dangerous to handle, so that it is conceivable that lanterns may yet be made by the aid of which the operator can look right through a human body. At present Roentgen rays are only produced by the expenditure of a large amount of electrical energy.

Garrett P. Serviss says: "The most striking difference between radioactivity and the X-rays is that the former means the throwing off with immense velocity of actual material particles, while the latter are only waves in the ether, an invisible form of light. To get X-rays we first have to put forth an effort. We must furnish electric energy before the rays will start. But radioactive substances, such as radium and polonium run of themselves, and apparently never rest. They are shooting off incessant streams of particles all the while, in all directions. They do not have to be urged or stimulated, or in any manner excited, in order to perform. They are Gatling guns that run without anybody turning the handle, and without anybody feeding the magazine. A bit of radium is a thing that seems bent on self-destruction. Its atoms and the fragments of its atoms are continually flying off, some of them with a speed as great as 120,000 miles per second. That is to say that a particle of radium which is at this instant under your finger may in two seconds, if there is nothing in the way to stop it, hit the moon ! The recent experiments at Yale and elsewhere show that there is radioactivity all around us. Particles are flying off the surface of water; they are darting from and through the air; they have been detected streaming from the walls of rooms. Wherever a bit of radium is, it not only bombards surrounding space, but it excites everything about it, more or less, to begin throwing. In the light of this new branch of scientific study the whole world seems composed of little demons with slings whose activity is maniacal."

Radium is found in the proportion of about one gram to a ton of pitch-blende. A kilogram (21-5 pounds) of this extraordinary substance would cost \$2,000,000. Not more than a kilogram of this wonderful metal is known to be in existence in a pure form. Radium glows with a pale blue fire, which seems, however, to be mere florescence, the electrons themselves emitting no light as they dash off through space. The luminosity of the salts of radium seem, like their radioactivity, spontaneous. The activity of radium produces various chemical reactions; it transforms oxygen into ozone; it changes white phosphorus to red, it ionizes not only gases but also liquids, such as petroleum and liquid air, and insulating solid bodies, such as paraffin, developing in this latter body a residual conductivity which lasts a long time after the rays have ceased to act.

The flying electrons of radium will whirl through sheet iron with no diminution of speed and photograph an object afterward. A single crystal, says Prof. Pegram of Columbia University, will give out its steady blue light for a million years without cessation, while continuing to hurl forth its electrons into space, and to impart to other substances the property of giving off light. This light is entirely devoid of heat. The electrons will burn your flesh without the usual sensation of flame.