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ATOMIC PROCESSES AND THE LAW OF THE CONSERVATION OF ENERGY

IN the forthcoming issue of *Nature*, Professor P. A. M. Dirac, of the University of Cambridge, will ask, "Does the law of the conservation of energy hold in atomic processes?" And lest inventors think they now have good authoritative backing for their perpetual motion machines, let them note that Professor Dirac specifies atomic happenings and not the large-scale every-day world.

Professor Dirac believes that the conservation of energy does not hold in processes involving very high velocities comparable with the speed of light, nor need it hold in happenings involving radiation.

New experimental findings of Dr. Robert S. Shankland, of the University of Chicago, states Professor Dirac, do not agree with previous work and can only be interpreted if the conservation of energy law is given up. He says: "Physics is now faced with the prospect of making drastic changes in its fundamentals; changes involving the giving up of some of its principles which have been most strongly relied upon (the conservation of energy and momentum)."

The important consequence, states Professor Dirac, is that energy and momentum are conserved in atomic processes when the velocity is small compared to light's velocity, just as they are in the large scale world. The whole present quantum theory, therefore, can be retained if so applied. But the newer quantum electrodynamics used to explain radiative processes must go because of the high velocity of radiation quanta.

The new experimental work which inspires Professor Dirac's sweeping statement was performed by Dr. Robert S. Shankland, at the University of Chicago, at the direct suggestion of Professor Arthur H. Compton. It involves shooting gamma rays from radium at scattering material of aluminum, filter paper, beryllium, paraffin and air.

As the gamma rays hit the scattering material, electrons are shot out. The angle of distribution of these electrons and their energy constitute factors in what is known as the "Compton" effect, which won for Professor Compton the Nobel prize in physics in 1927.

From his original experiment Professor Compton went on to develop a theory, explaining the phenomenon, which satisfied the laws of the conservation of energy and momentum. He and other investigators performed, ten years ago, experiments which appeared to substantiate the theory.

But now, Dr. Shankland with newer and more refined equipment, developed in light of experimental advancement in the last ten years, has repeated the experiment and has found contradictory results. It is on this new result that Professor Dirac bases his belief that it is time to throw out the conservation of energy in atomic experiments.

THE "UNCERTAINTY PRINCIPLE"

THE famous "uncertainty principle" of physics was extended to the sciences of biology and psychology by Professor Niels Bohr, Copenhagen Nobelist, in a lecture in London at the Warburg Institute.

According to the uncertainty principle as it applies in physics, it is impossible to tell simultaneously just where a subatomic particle is, and how fast it is going. If you know one of the two facts, the conditions of experiment prevent you from exactly knowing the other. This principle has powerfully shaken the hold of mechanistic determinism, or what has been styled "scientific predestination," on the thinking of physicists.

Professor Bohr called attention to an analogous situation in biology. It has been contended that if you knew all about every atom in a cell you would know all about the cell. But, Professor Bohr pointed out, that facts about the atoms that make up the cell can not be determined without tearing the cell to bits, thereby destroying the very make-up you wanted to find out about. You can not completely analyze life without destroying life.

An analogous "uncertainty principle" also obtains in psychology. Analysis in this science is infinitely more complex than it is in physics. The things in psychology which you may wish to examine are changed by the very act of examination; a picture of a mental situation becomes a different situation when attention is fixed on some part of it.

Racial differences also introduce an uncertainty element into psychology, Professor Bohr claimed. If a Dane or an Englishman gets sufficiently close to the mental culture of a Chinese or a Japanese, he ceases to be really a Dane or an Englishman, so the situation is changed and the attempted analysis is baffled.

Professor Bohr made a strong plea for mutual aid among scientists, regardless of nationality, in winning the common fruits of science, and especially in the conquering of racial prejudices.

THE SYMPATHETIC NERVOUS SYSTEM AND HEART ACTION

SCIENCE'S first step toward an understanding of recently discovered nerve fibers for speeding up heart action, a discovery which may lead to their identification as hitherto unknown sympathetic nerves, was announced recently to the New York Academy of Sciences by Dr. Lucien A. Brouha, of the University of Liége, Belgium.

Discovered at the University of Ghent in 1934 by Jourdan and Nowak, the tiny fibers have remained pretty much of a mystery to science, the only definite fact known about them being their position alongside the vagi nerves which run from the brain to the heart and which serve to retard the cardiac beat.

Even now, Dr. Brouha explained, little is known of their function in the normal body—but in dogs whose

sympathetic nervous system has been removed, these new nerve fibers take its place. Indeed, so successfully do they substitute for the missing nerves that Dr. Brouha finds it absolutely impossible to distinguish a normal dog from one without its sympathetic system.

This finding is in direct contrast to results obtained with cats by Dr. Walter B. Cannon at the Harvard Medical School, for removal of the sympathetic system in these animals made them distinctly apathetic, incapable of exertion to any marked degree.

It was the ability of the new nerves to replace the sympathetic system in dogs that led Dr. Brouha to his conclusions concerning the possible function of the nerves as a substitute for the removed system. In the normal body, he believes, the nerves may aid heart regulation to a very small extent, although he said that in all probability they have additional functions as yet undiscovered by science.

In research leading to these results, Dr. Brouha conducted pioneer tread-mill tests on dogs both before and after removal of the sympathetic system. The experiments were performed in cooperation with Dr. David B. Dill, of the Harvard University Fatigue Laboratory, where Dr. Brouha is carrying on his investigations this year.

Outstanding among his results were that the general behavior of a dog whose sympathetic chains have been removed remains normal, although the heart beat of the animal at rest is slightly less than normal, and that emotional excitement produces the usual definite cardiac acceleration. If the dog takes light exercise, Dr. Brouha found, the cardiac rhythm remains below the normal rate, even during a long experiment in which the total amount of exercise done is considerable. When this exercise becomes more intense, however, the cardiac acceleration occurs in proportion to the intensity of the exercise—exactly as it does in the normal animal. Another important find was that the capacity to stand very intense exercise is not at all diminished three months after the removal operation, that time being necessary for the dog to recover from the effects of the operation.

Experimentally checking the possible influence of a rise in body temperature or muscular metabolism, Dr. Brouha found that they are definitely not responsible for the accelerated heart beat. Nor are adrenalin or sympathin, for with the removal of the sympathetic system, these hormones are not secreted into the blood stream.

This leaves only increased activity of the cardio-accelerator fibers of the vagi nerves to explain heart regulation. The activity of these fibers, Dr. Brouha says, is also accompanied by a reduction in activity of the retarding fibers of the vagi nerves whose functions along these lines are well known.

Testing the sugar and lactic acid content of the blood and the alkaline reserve of sympathectomized dogs, he found them all to vary within normal limits.

THE EFFECTS OF STIMULANTS

THE heart will not be harmed if alcohol or tobacco are used in moderation. The same is true for tea and coffee, according to a statement made by Dr. William H. Robey, emeritus clinical professor of medicine, in a lecture given at the Harvard Medical School.

Even excessive use of these things may not add directly to the dangers and discomforts attending heart trouble, he added. Indirectly, however, such excess can be injurious through its deleterious effect on the general health and the greater work thrown on the heart and circulatory system in consequence.

"If alcohol and tobacco are used to excess, however," Dr. Robey said, "the digestion and often the general health of the individual suffer and those defects throw more work upon the heart and blood vessels. Sufferers from angina pectoris, for example, may have more frequent attacks if they use tobacco. Stomachs which are injured by the undue use of alcohol upset the general health which also in turn throws a strain upon the heart."

Turning to the prevalence of heart disease, Dr. Robey stated that it is the most frequent cause of death in the United States. The increase in heart disease, however, he termed perfectly natural and said that the preeminence of cardiac disease in later life will increase rather than decrease as time progresses. The reasons for this increase, he said, are the following:

"First, children's diseases are better controlled and therefore the mortality during the early years is much less. Hence more individuals by escaping disease and death in childhood advance to middle life when the wear and tear upon the heart and circulation become manifest. If we are successful with our plans for a greater control of heart disease it is not unreasonable to hope that the average duration of life can be considerably raised.

"Secondly, a better understanding of rheumatic fever and allied diseases has lessened the harm done by these conditions and has quickened the attention of physicians to their cardiac dangers.

"Finally, the control of syphilis and gonorrhea has also reduced the heart disease dependent upon those infections. Syphilis insidiously affects the heart and circulation and incapacitates the individual about twenty years after its inception at a time when the activities of the patient should be at their height. Gonorrhea rarely affects the heart but when it does the involvement occurs during the acute stage of the infection and is usually fatal. Boards of health have for several years maintained free laboratory facilities for the early diagnosis of these diseases and physicians are constantly urged to make use of them in order to institute prompt treatment."

Stressing the necessity of early diagnosis and proper care as a preventive of serious heart trouble, Dr. Robey said that if we have certain physical limitations, it is by far the best policy to learn what they are and to live within them.

ELECTRICAL PROSPECTING FOR COAL DEPOSITS

THE same technique of using electrical prospecting methods—often likened to electrical divining rods—which has worked so successfully in discovering oil, gold

and other minerals, is now being used to find deposits of coal in Pennsylvania.

It was stated at the meeting of the American Institute of Mining and Metallurgical Engineers in New York City that the new electrical methods, based on how well a seam of coal conducts electricity, were successful in the Mahanoy fields which have been worked for 70 years.

Most of the coal seams, Dr. Maurice Ewing, A. P. Crary, J. W. Peoples and J. A. Peoples, Jr., describe in their report, were worked near the surface in the past but since the workings were never completely or accurately mapped complete extraction of the coal from older pits was not obtained. In consequence, they point out, virgin bodies of coal, not known, are yet to be found.

The electrical prospecting consists of passing a known electric current between metal stakes driven into the ground at considerable distance apart. How much current will flow between the stakes depends on how well the underlying minerals conduct the current.

Anthracite coal, for example, passed electric current from 10,000 to 2,000,000 times easier than shales and sandstones. In other words, the resistance of the coal to the passage of the electric current is much less by factors of from 10,000 to 2,000,000 times.

"The presence of outcrops of an anthracite seam is indicated at points where electrical resistivity rests show relatively low readings," is the way the technical report reads. Test drilling and strip mining confirmed the findings.

ITEMS

BREAKING all cold-weather records for more than a century, is the characterization given the present winter by Charles D. Reed, of the U. S. Weather Bureau station at Des Moines. Not since white men began to watch thermometers in the heart of the Corn Belt, and jot down the minus quantities they read, has there been a cold spell so severe or so prolonged. Official weather records have been kept in the state only since the winter of 1878–79, but before that, running back into early settlement days 117 years ago, there are recorded temperatures from various parts of the state, and these can be pieced together and compared with present-winter records from the same localities. Mr. Reed has done this, and finds the story the same everywhere: there has never been a winter like this one, since white men kept a history of the weather.

SPEAKING before the meeting of the American Physical Society, meeting in New York City, Drs. M. C. Henderson and M. G. White, of Princeton, described details of the newest atom gun, which will weigh 42 tons. The equipment of the magnetic accelerator type known as the cyclotron because atomic particles are speeded up by being whirled around the apparatus in an ever widening spiral, will generate high speed particles having energies of 11,000,000 volts energy. Such particles are made to strike chemical elements and the collision yields all manner of chemical changes which rival the dreams of the ancient alchemists. A small model at one tenth scale has already been built and tested. The giant apparatus based on such tests should yield a magnetic field strength of from 17,000 to 19,000 gauss. The earth's, for comparison, is only a fraction of one gauss.

BECAUSE there is a doubt about the theory that short radio waves reach the earth from stars in the Milky Way, investigators at the Institute of Technology have erected delicate apparatus in the center of a 10-acre farm near Pasadena to study the origin of the radiation. The research, being conducted by Dr. G. W. Potapenko and D. F. Folland, follows studies made by Dr. Karl G. Janksy, of the Bell Telephone Laboratories on static. No signals as yet have been received. In his experiments, conducted in New Jersey, Dr. Janksy observed three kinds of static, the third of which he speculated originated in the stars in the Milky Way, or reached the earth as the result of secondary radiation. Mr. Folland expressed the opinion that it is probable the short waves, found by Dr. Jansky to be 14.6 meters in length, do not originate in the stars. Dr. Jansky reported that he heard this mysterious hissing when the antenna of his apparatus was directed at the center of the galaxy.

FIELD tests of television will begin in the New York area within eight weeks, states the annual report to the stockholders of the Radio Corporation of America. The field test, emphasizes David Sarnoff, president of RCA, does not mean that regular television service is at hand. Transmission from studios at the top of the Empire State Building will be pioneering tests to estimate and define the possibilities of the system under actual working conditions rather than the refined and controlled laboratory conditions of the past. Problems to be solved during the tests will include: determination of how far transmission can be achieved; with what consistency and regularity can pictures by television be transmitted in the present stage of development, and the possibilities of the television camera for indoor and outdoor pick-up.

WOLF fighters, skilled in warfare against these voracious pack-hunting beasts, are asked for in an emergency wire from Governor John W. Troy, of Alaska, recently received at the Department of the Interior. Because of the severity of the winter, vicious gangs of wolves have been raiding the reindeer herds owned by natives of northern Alaska, threatening to undo the work of years in raising their standard of living and teaching them the ways of civilization. Native hunters have proved unable to cope with the animals, but it is believed that about four hunter leaders, each with a few assistants, could in a swift campaign break up the marauding bands.

PIGS will be better protected against their worst disease, hog cholera, by a new vaccine now under investigation by research workers of the U. S. Department of Agriculture. Crystal violet, a chemical not hitherto used in preparing such vaccines, appears to be the key to its greater effectiveness. In preparing hog cholera vaccines in the past, three other chemicals have been used: glycerin, formalin and phenol or carbolic acid. Vaccines generally are made by adding to blood serum containing the virus of the disease some chemical that will weaken its power to harm, yet not destroy its ability to provoke the formation of disease-preventing "antibodies" in the blood of the animal or person to be protected. Crystal violet appears to be a much more advantageous material to use for this purpose.