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PAPERS READ BEFORE THE BERKELEY MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

DR. THOMAS H. JOHNSON, assistant director of the Bartol Research Foundation at Swarthmore, Pennsylvania, reported that "it is now possible to say with considerable certainty that the particle part of the cosmic rays accounts for from 90 to 98 per cent. of the total intensity at the top of the atmosphere. It is highly probable, therefore, that by far the greater part of the cosmic radiation consists of positive particles and there is at the most but a few per cent. to be accounted for in some other way, possibly as a gamma radiation." Dr. Johnson bases his contention that cosmic rays are really positively charged particles on the clearing up of the three major objections to the corpuscular theory of the radiation's nature. The former objections, he indicated, were: First, that the particles did not have great enough energies to account for their often remarkable penetration through lead and other dense materials. Theory demanded that the rays (if they were particles) should have energies equal to 10,000 million volts. Most of the cosmic rays observed had only 600 million volts energy. Second, the stopping of the rays as they came through the atmosphere of the earth was much too great. The absorption of cosmic rays, providing they were corpuscular in nature, was 25 times what it ought to be on theory. Third, the amount of absorption as indicated by the range of the atom debris, which the rays knocked out of atoms inside cosmic ray instruments, did not vary with the energy of the incoming radiation. If the theory were correct, the absorption coefficient ought to change with energy. Observations have proved that for great differences of cosmic ray energy the absorption is independent of the energy, or not related to it. The first and second objections, said Dr. Johnson, have been advanced by Professor Robert A. Millikan and his colleagues of the California Institute of Technology. The third is a new mystery advanced by himself. According to Dr. Johnson, all three objections to the particle nature of cosmic rays may be solved if one realizes that the incoming corpuscular rays make direct hits on the nuclei of atoms in the air. These direct impacts cause the "showers" or "bursts" of cosmic rays detected by many observers. He stated that it is probable that every time one of the high-energy primary particle rays hits an atom nucleus it creates 25 secondary rays of the lower energy. The collision would account for the seemingly 25 times too great absorption of the rays and indicate that scientists have only a twenty-five to one chance of detecting the incoming high-speed particle. The secondary rays produced would be the "soft" 600-million-volt rays observed by Carl Anderson and others in the Wilson cloud chamber apparatus. The nucleus impact phenomenon is a chance occurrence. For still more penetrating rays with energies of 100,000 volts a direct hit would produce about 1,700 secondary rays with energies commonly observed—the 600 million volt rays. With all this mixture of secondary radiation present in the instruments it would be a rare, lucky chance indeed which would demonstrate the existence of a really high-energy particle even though a large fraction of incoming radiation is of the positive particle type. "Shower production seems to be able," Dr. Johnson concluded, "to explain away the principal difficulties which have been raised with the corpuscular hypothesis and it is extremely unlikely that any other hypothesis would be able, in such a simple manner, to correlate so many cosmic ray effects. In fact, I think we may say that this hypothesis is now substantially proved, as an explanation of the principal part of cosmic radiation."

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, presented to the American Physical Society his reasons for believing that cosmic rays are mostly photons; that is, that they constitute a phenomenon like ordinary light, heat and x-rays. Experimentally, cosmic ray observations are now in good agreement among the various investigators. It is in the interpretations of the observed data that opinions and theories differ. Dr. Millikan concludes that practically all the electrical disturbance caused in the earth's atmosphere by cosmic rays is due to the passage of positive and negative electrons, most of these particles being born of photons and electrons in the atmosphere. He finds that not more than three or four per cent. of the cosmic ray electrical disturbance, or ionization, found at sea-level is due to electrons that come in from outer space; nevertheless, he believes that these electrons are responsible for the variations in cosmic ray intensities found over the various parts of the earth. The energy of the photons which give rise to most of the atmosphere's ionization is about 130 million volts, although it may be 100 million volts more or less than that. Dr. R. M. Langer, of the California Institute of Technology, suggested that it may be necessary to credit cosmic ray effects to some kind of radiation yet unappreciated in order to obtain an adequate explanation. Perhaps even the newly discovered neutron may play a part.

DESCRIBING recent experiments performed jointly with Dr. L. R. Hafstad, Dr. M. A. Tuve, of the Carnegie Institution of Washington, told of driving deutons, the hearts of atoms of heavy hydrogen, into a gas composed of the same substance. The atomic impacts drove streams of protons (the positive cores of ordinary hydrogen) out of the apparatus with varying ranges of flight. This difference in the length of path which the protons travel does not fit in with atomic theory. Knowing the weights of the atomic particles involved, Dr. Tuve suggested that what is needed to explain the strange phenomena is a neutron of mass two, twice as heavy as the ordinary kind. The reaction which may happen is that two heavy

hydrogen cores—the deutons—combine and then turn into two light hydrogen atoms and one neutron of mass two. The existence of an over-weight neutron would also reconcile some of the differences of opinion about the exact weight of the ordinary neutron. Mixed up in this controversy is the possibility that there exists also a little, or light-weight neutron, called provisionally the neutrino. The neutrino, from the Italian, was suggested some years ago by Professor E. Fermi, who recently made element No. 93. The English version of neutrino would be neutrette. While the existence of the neutrino has not yet been proved, some of its properties have been predicted. A neutrino would be an electrically neutral particle like the neutron, but would weigh only about as much as an electron, that is, 1/1800 the mass of a hydrogen atom. Physicists foresee that like most of the atomic particles the neutrino would spin on some axis (like the earth) as it moves. But they predict also that the spin might be either clockwise or counterclockwise. The neutrino is spinning one way. Its twin, spinning in the reverse direction, has been given the name of anti-neutrino, although it too is yet unfound. The spin of the neutrino and the anti-neutrino would make it possible to account for some of the magnetic properties in atoms.

PLANS are being pushed at the University of California and the Massachusetts Institute of Technology for higher-powered atomic apparatus. Preliminary details were given at the sessions of the American Physical Society, meeting in Berkeley jointly with the association. Immediate and simple changes in the atom-bombarding apparatus of Professor E. O. Lawrence and his colleagues at the University of California will raise its voltage from its present five million rating to twenty million volts. The present equipment, in which particles are speeded up by oscillating electricity and kept inside the apparatus by the influence of an 85-ton magnet, will shortly be quadrupled in diameter. Within a year or two a more powerful machine than the giant ten million volt electrostatic generator of Dr. Robert J. Van de Graaff will be made ready at Round Hill, Massachusetts. About thirty million volts driving force for atom "bullets" is expected from this new machine, which will be built in a steel tank evacuated of all air to create the necessary insulation. Despite its great increase in power over present-day apparatus it will occupy less space than the ten million volt machine now in use which is so large that an airship hangar is its home. The steel tank will be only about ten feet in diameter and twenty-five feet high. A small experimental edition of the vacuum-surrounded generator is now under construction in Cambridge, Massachusetts. A novel feature of the apparatus will be a chain belt made of stainless steel, nickel and porcelain for carrying electric charges up to the large spheres.

DESIROUS of increasing their supply of neutrons, which is already the world's greatest, California experimenters plan to increase neutron emission for atomic investigation some 1,000-fold. Hydrogen will be packed into the chamber of Professor Lawrence. The sides of the chamber will be lined with the metal beryllium, which, when bombarded, will yield immense quantities of the desired neutrons. Since neutrons have just been shown in Italian experiments to be extremely effective agents in producing artificial radioactivity in ordinary stable elements it is hoped that the new technique will make possible new and practically useful reactions of new elements and artificial radioactivity.

OXYGEN in the atomic state has been discovered for the first time in the chromosphere of the sun, by Harold D. Babcock and Horace W. Babcock, of the Mount Wilson Observatory. Their work was reported before the meeting of the Astronomical Society of the Pacific. The presence of oxygen in this portion of the sun was detected by means of a spectrograph, the instrument commonly used for studying light after it has been split into its various component colors, which disclose the chemical elements in the light-source by characteristic bright and dark lines. The oxygen line was found in the green part of the spectrum.

FIRST reports on a way to check the composition of the sun during periods of total eclipses were presented before the Astronomical Society of the Pacific, meeting jointly with the association. Dr. Willi M. Cohn, University of California, and Josef J. Johnson, California Institute of Technology, described experiments on measuring the polarization of sunlight during the total eclipse of the sun on February 14, 1934, which was observed only from Losap Island in the South Seas. Dr. Cohn and Mr. Johnson were two members of a group invited by the Japanese Government to accompany the expedition of that government to Losap Island. "Measurements of the percentage of polarized light received from the various parts of the corona," according to Mr. Johnson, "have an important bearing on the study of the distribution of matter in the solar corona." When the moon interposes itself between the sun and earth so that it casts a shadow and reveals the shining incandescent gas of the corona the light received on earth does not vibrate in its normal helter-skelter fashion at right angles to its line of transmission. More of it vibrates one way than another. This inequality of vibration is partial "plane" polarization. The helter-skelter vibration is called "circular" polarization. Dr. Cohn determined polarization by photographic methods while Mr. Johnson used visual recording.

PRODUCING extreme cold only fifteen hundredths of a degree above absolute zero, the "farthest south" of temperature, Drs. W. F. Giauque and D. P. MacDougall, of the University of California, find that gold remains electrically steadfast under this extreme treatment and does not become less resistant to electricity as do all other metals so far tested. Lead, tin and other metals cooled to near the lower limit of temperature became superconducting, that is, an electrical current would flow nearly unimpeded in a coil for hours. Failure of gold to act in this way is of great interest as there is a possibility that it may become superconducting in the mere fraction of a degree of temperature remaining for cold

to be pushed. The record low achieved so far by Drs. Giauque and MacDougall is a tenth of a degree above absolute zero. This is nearly the world's record cold.

AVIATORS preparing for high altitude flights may in future spend an hour or more in breathing pure oxygen before taking off. Experiments with rats at the University of Southern California show that by such means the animal body can store up oxygen against a time of need. Experiments substantiating this fact were reported by Professor Francis Marsh Baldwin and Harold B. Robertson. White rats, which have physiological responses very similar to man, were made to breathe pure oxygen for twenty-five, forty, seventy, and one hundred and thirty minutes and were subjected to atmospheric conditions comparable to those found at altitudes of from six and one half to eight miles. Seventy minutes of oxygen breathing gave the greatest resistance to subsequent oxygen-want in high altitude conditions. Twenty-five minutes was of considerable value. Forty minutes of oxygen breathing was of less value than either twenty-five or seventy, which is explained as being probably due to a shift in body processes similar to the adjustment a runner makes when he gets his "second wind." Exposure to oxygen for longer than seventy minutes decreased ability to withstand low barometric pressures.

THE latest step in the investigation of whooping cough is the discovery reported by Dr. John J. Miller, Jr., National Research Council fellow at the University of California, that pertussis endoantigen, developed for whooping cough treatment, promises to provide a means of diagnosing this disease rapidly and with certainty. Within the last year whooping cough has been produced in both apes and man by inoculation with pure cultures of the bacillus *Hemophilus pertussis*, clinching the demonstration that this germ causes the disease. Manufactured with the aid of the germ at the University of California by Professor A. P. Krueger, the endoantigen has proved effective in subduing the worst ravages of whooping cough in many cases.

DOUBT was cast upon the common idea that bacteria, or filterable viruses, cause colds or other respiratory diseases such as pharyngitis, laryngitis, bronchitis and even pneumonia. Drs. William J. Kerr and John B. Lagen, of the University of California, after unsuccessful efforts to give colds to men volunteers living under ideal conditions of temperature and humidity, assigned the cause of the common cold, not to infection, but to "the excessive cooling power of the air at certain times, acting upon the body when the skin pores are open through excessive exertion, fatigue or environmental factors themselves, all of which allow heat to dissipate readily through the skin."

DR. JAMES F. RINEHART, of the University of California Medical School, using his own and other experiments, reported that vitamin C deficiency may be an important factor in the cause of rheumatic fever and rheumatoid arthritis. These are illnesses that usually attack undernourished children just when they are growing fastest. Their joints become acutely painful, swollen and reddened, and frequently heart injuries are produced which are a handicap for life. Rheumatic fever usually comes in the spring and attacks the children of the poor in cities. If the proper food containing vitamin C is not eaten, the body seems to be peculiarly susceptible to infection by the hemolytic streptococcus germ, and the combined result is disease. Experiments upon animals uphold this idea and convince Dr. Rinehart that the germ infection alone is not the complete cause. The next step expected is the application of the discovery to the actual prevention and treatment of human cases.

A VAST number of gland secretions capable of influencing the human body in a multitude of ways will be discovered in the future, was predicted by Professor Vincent du Vigneaud, of the George Washington Medical School. Already more than a dozen of these hormones are known. Six have been isolated in pure crystal form and two of them, epinephrine and thyroxine, have been manufactured in the chemical laboratory with entire satisfaction. Like vitamins, only very small amounts of hormones are required to produce large effects. In tearing the hormones apart chemically in hope of discovering their composition, remarkable relationships among substances in the body have been found. For example, the female sex hormone shows relationship to the male sex hormone, to a bile acid, to cholesterol, to ergosterol, to the sunshine vitamin D, to strophanthin (a drug used as a heart tonic), and even to the substance in coal tar which causes certain types of cancer through chronic irritation of the skin.

GREAT BRITAIN, no less than the United States is undertaking an intensive study of her land problems with a view to the best utilization of its relatively limited surface. Dr. L. Dudley Stamp, chairman of the Commission on Land Utilization in Great Britain, told how the task is being begun. Great Britain, with a large industrial population on an area not as large as some of our states in the West, faces a problem exactly opposite that of the United States. The land can not raise a surplus of food; the question is one of raising enough, and increasing acreage and yield-per-acre instead of cutting down. The first step in the British program of land use planning has been to make a minutely detailed survey of the entire island, building a very large-scale map. In this work 22,000 volunteer surveyors have been engaged, and in addition nearly a quarter of a million young people, mostly students, have had some part.

FOOD as well as drink for plants now flows in some of the irrigation ditches watering southern California farms. Instead of spreading nitrogen-containing fertilizer on soil, a little ammonia gas is allowed to mix with the irrigation water. Dr. Dean D. Waynick, of Anaheim, California, has used this method in extensive trials and finds that plants thrive even better on their liquid nitrogen-containing diet than on solid fertilizer.