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COSMIC RAYS

Two of America's leading physicists discussed facts and theories about cosmic rays before the American Association for the Advancement of Science at Atlantic City on December 30.

About most of the experimental facts, they agreed. About the deductions from thousands of experiments performed by scores of investigators ranging the world, they largely disagreed.

Dr. Robert A. Millikan, of the California Institute of Technology, upheld strongly as a fact his conclusion that the cosmic rays that enter the earth's atmosphere are photons, like x-rays and gamma radiation of the same family as light and heat.

Dr. Arthur H. Compton, of the University of Chicago, found "no way of reconciling the data with the hypothesis that any considerable portion of the cosmic rays consists of photons." He concludes that cosmic rays come from outer space as high-speed electrified particles, either negatively charged electrons or positively charged protons.

As to what causes the discharging of the sensitive electrical instruments used in detecting the effects of cosmic radiation, Drs. Compton and Millikan agree. Very energetic electrified particles produce the effect, but whereas Dr. Compton considers them the original rays, Dr. Millikan advanced evidence that they are secondary radiation produced in the earth's air by photons smashing into the hearts of air atoms.

To account for the very penetrating radiations that Dr. Millikan and others have observed in the depths of lakes, Dr. Compton countered with the suggestion that electron cosmic rays produce photons in the earth's atmosphere just as electrons striking an x-ray tube target produce x-rays.

His argument fell in line with experimental evidence for a new process of ionization presented to the same session by Dr. Gordon Locher, a national research fellow at the Bartol Research Foundation, near Philadelphia. According to Dr. Locher x-rays are produced in the gas of a detecting chamber by the passage through of swiftly moving particles like electrons.

Reporting the results of airplane flights this past summer in the United States, Canada and Peru, at altitudes up to twenty-one thousand feet, Dr. Millikan explained that a new type, very sensitive, recording electroscope showed differences in cosmic ray readings at high altitudes that may possibly be explained by a new cause, a modification of the earth's electrical field connected with some secondary influence of sunlight. Changes in the earth's negative electric field such as occur between day and night would change the resistance to the inflow of the secondary negative particles generated by the cosmic rays. But the rays that get down to sea-level are so hard that the earth's electrical field does not affect them. This fits in with a lack of latitude variation in cosmic-ray readings made at sea-level by Dr. Millikan and others recently and in past years.

Dr. Compton and his associates in a world-wide survey during the past eighteen months found large variations with latitude in cosmic ray intensities at sea-level and on the tops of high mountains. This he attributes to the effect of the magnetic field of the earth, since the earth's magnetism would theoretically keep electrified-particle cosmic rays from reaching the equatorial regions where the Compton experiments show cosmic rays to be less.

As to the energies of cosmic rays, there is difference of opinion. Dr. Millikan cited the experiments of his colleague, Dr. Carl D. Anderson, to show that observed cosmic ray energies lie largely below five hundred million volts and that less than a tenth reach the billion volt range.

Dr. Compton advanced an energy of seven billion volts for the electron cosmic rays that are so feeble as not to reach the equator, and he set thirty billion as the figure for a more penetrating component of high-speed electrified particles. Dr. Compton holds that the high energy portion is not affected by the earth's magnetic field.

As to the way in which cosmic-ray effects vary with increase in height over the earth's surface, there is little difference in the experimental results, but both Dr. Millikan and Dr. Compton see the experiments bolstering up their theories.

The question of the origin of the cosmic rays, a moot question upon which there is little experimental evidence except the fact that they come from outer space, was left for future meetings.—WATSON DAVIS.

MEASUREMENT OF UNITS OF HEREDITY

THE unit of heredity known as the gene, that controls physical characteristics and passes them on from generation to generation in man and other living things, has been measured. Its largest size is one quintillionth of a cubic centimeter. This is just about the volume that fifteen protein molecules, one of the largest of the organic chemical aggregations, could crowd into.

This determination of the size limits of the bearers of heredity, announced at Atlantic City to the American Association for the Advancement of Science by Drs. John W. Gowen and E. H. Gay, of the Rockefeller Institute for Medical Research, is considered an important fundamental step in the development of biology.

Genes are the units within the chromosomes which determine the development of physical characteristics when, through the union of male and female germ cells, a new individual is created. Chromosomes can be seen readily with the microscope, but the single gene is probably too small to be seen by the eye even when aided by the most powerful optical means. The gene is as important to biology as molecules, atoms or electrons are to the physical sciences.

"We postulate the existence of the gene because of the properties it gives to aggregates of other matter," Drs. Gowen and Gay explained. "Size is a fundamental structural characteristic. The measurement of size, even though it may be crude, has, if we may judge by our sister sciences, always led to further progress."

The Rockefeller investigators based their discovery of the gene's size upon the discovery made several years ago that x-rays will smash into genes and change the bodily characteristics that they transmit. They used the drosophila fruit flies that have been experimented upon to contribute so much to the new knowledge of heredity obtained since the turn of the century. Pure x-rays specially produced were used to bring about the changes in genes that are known as mutations. Thousands of flies were used in the experiments. The magnitude of the average gene was found by dividing the amount of chromatin, or material in the chromosome, by the number of genes estimated by the mutations observed.

The total number of genes in any one cell was shown to be not less than fourteen thousand three hundred eighty. This corresponded to a largest gene size expressed numerically in cubic centimeters as one tenth visualize this extremely small volume, one quintillionth multiplied by itself eighteen times. In attempting to of a cubic centimeter, it may be helpful to remember that a centimeter is a little more than a third of an inch.

These gene size determinations check approximately with those reported several months ago by Professor Oswald Blackwood, of the University of Pittsburgh.—WATSON DAVIS.

KING TUT'S PURPLE GOLD

BEAUTIFUL purple surface films on golden sequins found in the tomb of Tut-Ankh-Amen have been proved to be due to the presence of iron in the gold, by Professor R. W. Wood, of the Johns Hopkins University. Professor Wood reported on his examination of these ancient ornaments before the American Association for the Advancement of Science.

The sequins have been the subject of much discussion ever since they were first discovered. Some investigators have claimed that the Egyptians knew an art for coloring gold surface purple, while others have believed that the purple sheen was a kind of patina due to the great age of the ornaments. Professor Wood, using the methods of a physicist, has shown the color to be due merely to the presence of iron in gold which has been first hammered and then heated. He even made duplicates of the sequins by hammering out a gold-iron alloy into thin flakes and heating the latter over a flame. One of his modern purple-gold sequins has been sent to the Cairo Museum, to be displayed along with the originals.

A modern beauty aid helped in the solution of the riddle of the purple film. Professor Wood found he could remove the film by coating the gold ornaments with celluloid varnish such as is used in fingernail polish, and then peeling off the varnish, leaving the underlying gold of a bright yellow color. There was no sign of the film on the peeled-off varnish layer, but the film could be made to reappear by redepositing gold on the side to which the film was attached by vaporizing gold in a vacuum. Then the purple could again be seen by reflected light. The problem in physical optics presented by this phenomenon is still under examination.

Subjected to spectroscopic examination, the stripped-off film proved to be principally iron, probably an iron oxide. Professor Wood then suspended one of the sequins from which the purple film had been removed between the poles of a strong electromagnet. It was attracted toward one of the poles, demonstrating the presence of iron in the gold.

Etching the surface of the gold with acid showed a very marked crystalline structure, such as is found only when rolled or hammered sheet gold is subsequently heated to nearly a red heat. Microscopic examination showed on the surface numerous small globules of gold standing out in high relief, conclusive evidence that the sequins had been heated to a high temperature after having been hammered into shape. It was after having learned these facts that Professor Wood took gold and iron and duplicated the product of the "lost art" of the ancient Egyptian court jewelers.

The microscopic globules Professor Wood believes to be due to melting of the gold out of a gold-orpiment mixture experimentally tried by the Egyptian artist. Orpiment is a bright yellow arsenic-sulphur compound known to the Egyptians and used by them in tomb wall decorations. Lumps of it were found in Tut-Ankh-Amen's tomb, some of which Professor Wood received from the Cairo authorities.

Melting gold with this orpiment, and rolling the resulting bead out into a plate, Professor Wood heated it over a flame and obtained gold globules exactly like those on the sequins. He also hammered out small nuggets of California gold, which had been in his family since '49, and on heating the resulting plates he again obtained the globules. No purple film appeared, however, for the California gold is free from iron.

MOTION PICTURES OF THE GROWTH OF NERVE FIBERS

MOTION pictures demonstrating how nerve fibers grow through living tissue, and how they repair themselves when injured, were shown before the meeting of the American Association for the Advancement of Science by Professor Carl C. Speidel, of the University of Virginia. Professor Speidel was the winner of the Association's $1,000 prize at the midwinter meeting at New Orleans last year, and the report he rendered constituted a summary of his work up to that time and of advances made since then.

As pictured and explained by Professor Speidel, nerve growth is pioneered by what are known as "growth cones" on the ends of the nerve fibers. These are thickenings of the tips, which probe their way through the tissues, constantly sending out and retracting tiny processes from their surfaces, like finger-tips feeling their way. As the nerve progresses, special cells develop

along its course. They hug its sides closely, though they take no part in its actual growth process, nor in its function as a nerve. These are known as the "sheath cells." Finally, as the nerve becomes more mature, it develops around itself a layer of fatty material called the "myelin sheath."

All these developments were shown in the motion pictures. In life, the growth process is rather slow, but by taking only one picture in two seconds and then projecting them at normal movie speed of sixteen to the second, the apparent rate of growth was speeded up 32 times. Another portion of the film was taken at the rate of one frame in eight seconds, giving them a speeding-up effect on the screen of 128 times the natural rate.

Growth after injury, as well as normal growth, was studied. It has long been a disputed point whether a severed nerve grew together again or started afresh from the cut end nearest the central nervous system. Evidence apparently supporting both views has been produced in the past. Professor Speidel's studies showed that where the two cut ends apparently grew together again, there was an anastomosis, or anatomical detour, connecting them by another path. A cut end really quite separated from the central nervous system degenerates and disappears and a new nerve fiber grows out to replace it.

Professor Speidel's first studies were conducted by watching the growth of nerve fibers in the transparent tissues of a frog tadpole's tail. During the past year he has also been studying nerve fiber growth in salamanders, which are rather remote zoological cousins of the frogs. He finds that the growth processes in this order of animals are essentially the same as those he observed in the tadpole tails.

GROWTH OF PLANTS STIMULATED BY X-RAYS

X-RAYS can cause plants to grow faster, blossom earlier, form more chlorophyll, and in general speed up their life processes. But if they get too much of a dose of the rays, they become cripples. This in brief summary is what Professor Charles A. Shull, of the University of Chicago, has found in experiments which he reported at Atlantic City before the meeting of the American Society of Plant Physiologists.

Professor Shull exposed corn, wheat, oats and sunflowers to x-rays for periods of from one to five minutes, inclusive, under screens to take out the harmful parts of the x-ray spectrum, and also for ten minutes without the benefit of screening. He compared the growth of these plants with "control" plants that were not x-rayed at all.

All the rayed plants except the ten-minute lot apparently were stimulated by the treatment. In some cases they became juicier, or more succulent, as well as larger. In corn a considerable increase of the green food-making substance, chlorophyll, was noted, running from 20 to 60 per cent. above the controls. X-rayed seeds carried on their respiratory processes with greater energy, the data indicating from 30 to 50 per cent. increase.

The three-minute treatment seemed to be most beneficial especially in the case of the sunflowers. Pots of the young plants ranged side by side mark off a curve with the graduated heights of their tops: good at one minute, best at three, not so good at five, and disastrous for the ten-minute treatment without a screen. The plants were in bud at about the same time, but the three-minute group blossomed first.

The condition of the ten-minute group indicated emphatically the effects of too much of a good thing. It was badly burned, and pocked all over the leaves, as though with a mosaic disease. The leaves were irregularly lopsided, an effect not observed at all in the plants given shorter rayings under screens.

ITEMS

THE earth and the moon were born out of the parent spiral nebula that fathered not only the sun but all the other stars of the Milky Way, is the suggestion of Dr. Harlow Shapley, of Harvard College Observatory, made at the meeting of the American Association for the Advancement of Science. This theory makes the moon, planets and sun all the same age, the progeny of a "secondary swirl or eddy of the parental spiral nebula out of which the local galaxy or Milky Way may be supposed to have generated." The conventional theory is that the earth and planets were born when a passing star pulled matter out of the sun, and some have theorized that the moon was cleaved off the earth at an even later time.

THE planetary nebulae, globes of glowing gas that can be seen in various parts of the sky, are not the light airy things they seem. According to Dr. Adrian van Maanen, of the Mount Wilson Observatory, who reported to the American Astronomical Society, the nuclei of these structures are something like 250 times as massive as the sun, and about a fifth its diameter. This has been found from studies of the motions of these bodies, from which their distances have been determined.

ULTRA-VIOLET rays change the viscosity, or "thickness," of protoplasm by causing it to let go of calcium which it contains. This conclusion is indicated by experiments reported before the American Society of Zoologists by Professor L. V. Heilbrunn and Kathryn Daugherty, of the University of Pennsylvania. They exposed one species of amoeba to the action of ultra-violet radiation. Afterwards they whirled the animals in a centrifuge, which enabled them to measure the changes in their protoplasmic viscosity. They found that the interior protoplasm had been made more viscous, while the originally fairly stiff outer protoplasm had become more fluid. They knew from previous experiments that ultra-violet raying causes a loss of calcium from protoplasm. The changes in the amoebae they ascribed to a release of calcium from the originally stiff, calcium-rich outer layer, which calcium then diffused into the inner mass of protoplasm, originally fluid, causing it to become more viscous.