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THE EARTH'S MAGNETISM AND COSMIC RAYS

THAT the lop-sided magnetism of the earth is now being used to study the nature of cosmic radiation was indicated in the address of the Abbé Lemaître, of Belgium, before the American Physical Society meeting in Washington.

Father Lemaître read the paper of Professor M. S. Vallarta, of the Massachusetts Institute of Technology, on the "Longitude Effect of Cosmic Radiation." Professor Vallarta, with Father Lemaître, developed the theory of cosmic rays so well supported by scientific evidence which assumes that all the incoming rays are of a particle nature and are charged with electricity.

The earth's magnetic field, Father Lemaître explained, is not perfectly symmetrical about the earth, but acts as if its center were about 186 miles from the ideal center of the earth. The resultant field on the outside, therefore, is a bit off-center too.

Calculations on what the magnetic lop-sided effect should be on cosmic ray intensity at widely separated points about the earth gives almost perfect agreement with experimental measurements, Father Lemaître said. Data taken in places all around the world from zero longitude at Greenwich, England, to the Antipodes on the opposite side of the earth all fall on the new calculated curves.

There is but one set of observational data which does not fit the new theoretical curves. These data were obtained by Professor Robert A. Millikan and Dr. Victor Neher on an automatic instrument placed aboard a ship enroute from Honolulu to Sydney-Melbourne. Other data fit perfectly well, Abbé Lemaître explained. The new report lends additional support to the idea that cosmic rays are particles.

THE TRANSMISSION OF RADIO WAVES

ULTRAVIOLET rays from the sun, combined with the sun's warming visible rays, suffice to explain the daily and seasonal fluctuations of the earth's "radio roof" or ionosphere and hence longer or shorter transmission of radio waves. This is the gist of the address presented before the recent meeting of the American Geophysical Union, by Dr. E. O. Hulburt, of the Naval Research Laboratory at Bellevue, D. C.

From earliest radio days, it has been known to physicists that the radio waves most used strike the lower side of the ionosphere and "bounce back" repeatedly. If it were not for this, they would probably be lost in space.

The ionosphere is a great region of the atmosphere so far out that the now much-publicized stratosphere is only a stone's throw upward by comparison. The lowermost of its two strata, called the "E" layer, is about 60 miles over our heads; the upper, or "F" layer, has an altitude averaging two and a half times that distance. That is the night position of the "F" layer. In the day time it rises higher and higher, until about noon one part of it, the "F_2" layer, is some 200 miles up—less in midwinter, considerably more in midsummer. The sun obviously has a good deal to do with this "humpity" behavior of the "radio roof," making it behave more like the top of a wind-billowing circus-tent than a respectable permanent roof.

Dr. Hulburt's observations and calculations have convinced him that the sun's effect is two-fold. First, the ultraviolet radiation charges the air molecules and other particles that may be present with electricity, causing them to fly apart and thus produce a general expansion. Second, the sun's warming rays have an additional expansive effect. The two together produce the "hump" which always "rides" the ionosphere directly beneath the sun.

Such a vast mountain of even the thinnest air naturally tends to smooth itself out by flowing away in all directions. The stream that flows westward against the earth's rotation is roiled and thrown into invisible waves. The eastward stream flows smoothly and steadily. This picture, Dr. Hulburt said, fits in well with observed radio phenomena. There are one or two radio facts that do not yet fit into the picture, and these challenge geophysicists to attempt further solutions to the problem.

SOUNDING BALLOONS AND WEATHER CONDITIONS

ULTRA-SHORT radio waves, sent by light-weight sets carried by small unmanned sounding balloons, will soon be signaling weather news from far above the clouds. Preparations for flights are now under way at the Blue Hill Meteorological Observatory of Harvard University. Tests of the apparatus have already been made by airplane. Professor Charles F. Brooks, director of the observatory, under whose supervision the research is being conducted, states that the first balloon will be sent aloft within a few weeks.

A report of progress was made before the section of meteorology of the union by Arthur E. Bent, of the Blue Hill Observatory. Equipped with sensitive instruments for the recording of humidity, air pressure and temperature, small balloons will be released to search the upper air. Their readings will be automatically broadcast from the balloon by a small compact radio sender and automatically recorded on graphs at the observatory. The exact location of the balloon, both in altitude and position, can also be determined from these radio signals.

This method of investigation has several advantages over airplane flights for the determination of weather conditions, not only from the point of economy, but also in time saving. Unlike ordinary sounding balloons, those equipped with radio can be used at coastal points where the others usually become lost at sea and are thus of no value. Mr. Bent has succeeded in constructing a complete radio-sending device for a balloon, the simplicity and low cost of which will make its probable loss of no great consequence.

An experimental assembly now being tested weighs a little more than two pounds and is audible up to a distance of 50 miles. A wave-length of five meters will be used. A small 4.5-volt C battery is used for power and works satisfactorily up to more than 20,000 feet. Higher altitudes may require a small heat-generating unit. An eight-foot wire by which the instruments are suspended from the balloon is used as an antenna.

A continuous signal will be broadcast for direction and altitude determination. A break every 60 seconds is used for timing and three other breaks per minute indicate by their spacing the air pressure, temperature and humidity. As recorded in the observatory, the readings are in the form of graphs of these variables.

A radio meteorograph for use on an airplane instead of a balloon was demonstrated by Mr. Bent, assisted by Dr. K. O. Lange, of the Massachusetts Institute of Technology, who designed the instrument for the Blue Hill Observatory. The meteorograph and its radio sender were placed on one side of the lecture hall and the indications were received and automatically recorded on a portable chronograph on the other side of the hall.

A NEW SYSTEM OF RADIO TRANSMISSION

A NEW system of radio transmission and reception which, it is claimed, will wipe out the effects of static, fading and tube noises has been invented by Major Edwin H. Armstrong, professor of electrical engineering at Columbia University. Major Armstrong predicts that the new technique will make ultra-short wave broadcasting practical, solve problems of chain television and make possible the transmission of musical sounds far exceeding, in quality, any possible at present.

Major Armstrong holds the medal of the Institute of Radio Engineers for his invention of radio regeneration and the superhetrodyne and super-regenerative radio circuits.

Secret experiments have been carried on in the tower of the Empire State Building for the last year. That tests were being made was known, but the nature of the work was a closely guarded secret until now.

The fundamental point about the new system is the introduction, into the transmitted wave, of a characteristic which does not exist in the radio waves produced by nature in causing static. The receiving set is so arranged that it will pick up only radio waves having the characteristic properties and discards those from natural sources. "The principle is carried out by the use of a discarded method of modulation of the carrier wave known as frequency modulation," Major Armstrong states. "This method of modulation has been known for over twenty years, but the hitherto unsurmounted difficulties due to distortion and other troubles in both transmitter and receiver have caused its abandonment by all who worked with it." It is possible to transmit from different programs with the system. They can be simultaneously transmitted and received with a single transmitter and receiver.

The radio waves transmitted by the system are of very short wave length and do not make reception possible over great distances as in present broadcasting. A point-to-point nation-wide chain of transmitting stations which would relay the program about the country is the present picture of future development. While the economic investment would be higher, probably, the freedom from the present troubles of static and fading offers much compensation.

A NEW WAR GAS

HAS a new war gas been discovered? Chemists at the meeting of the American Chemical Society in New York City recently were asking themselves this question as they discussed the new chemical reported in the division of organic chemistry. This chemical has a blistering action on the skin comparable with the dreaded war-time mustard gas.

Known by the polysyllabic name pronounced tri-chloro-tri-ethyl-amine, the highly irritating chemical is a new liquid compound reported by Kyle Ward, Jr., chemist of the Experiment Station of the Hercules Powder Company of Wilmington, Del. Containing 25 atoms in its highly complex molecule, the new substance was made synthetically for "raw material," as Mr. Ward described it in an interview, out of which still larger molecules could be made. Whether these still-bigger compounds were in the nature of a new, unannounced explosive, Mr. Ward was unwilling to state.

The intense blistering properties of the new liquid were discovered accidentally, when localized burns appeared on the skin of chemists making it. The liquid is not corrosive in the sense of certain fluorine compounds which can not be made in ordinary glass chemical test-tubes and beakers and must be prepared in paraffin receptacles. Routine chemical laboratory equipment suffices in manufacture of the new gas.

While Mr. Ward was unwilling to speculate on possible military uses of the blister-producing substances chemists recall that mustard gas is also a liquid and that the formula of the new substance is essentially the replacement of the sulfur atom of mustard gas by the element nitrogen.

There will be speculation on the way the new substance might be used in war-time. The most commonly mentioned picture will be that of filling shells with the substance, as with mustard gas, which on explosion will spread the liquid widely in the form of tiny, microscopic droplets in a blister-making "fog." There is at present believed to be no intention to manufacture it with any military use in view.

FIREPROOFING AIRPLANE FABRIC

A NEW technique for "doping" airplane fabric, so successful that gasoline poured on a wing can be burned off without injuring the cloth in any way, was announced at the meetings of the American Chemical Society. Dr. Gordon M. Kline, of the National Bureau of Standards, told of the new "dope" which reduces the danger of fire in aircraft to less than twenty per cent. of its present hazard.

The "dope" is regarded as highly important for military aviation, both airship and airplane, especially on the

great airplane carriers like the *U. S. S. Lexington,* where large numbers of planes are stored below decks.

The new fire-resistant treatment consists of the impregmentation of the cloth fibers with a boric acid-borax mixture and then the coating of this cloth with cellulose acetate instead of cellulose nitrate as now used. Cellulose acetate burns only one fifth as fast as cellulose nitrate, Dr. Kline said. Thus the fire hazard is reduced to 20 per cent., while the fire-resistant treatment of the fibers lowers the danger still more.

At the Bureau of Standards a discarded metal-structured amphibian biplane has been burned up in tests of the new airplane dope. Gasoline was poured over the plane in the most crucial test and then ignited. Flames quickly spread everywhere but, when the gasoline burned itself out, the fabric was as good as new.

Key to the chemical advantage of the new "dope" over that now in use lies in the fact that the new acetate compound needs external supplies of oxygen to make it burn even slowly. The present nitrate "dope" supplies its own oxygen for combustion. Moreover, the acetate "dope" will only ignite at a much higher temperature than the nitrate "dope." The latter has products in it which may burn at the temperature of a hot steam pipe or electric light bulb.

ITEMS

LATE July should see, somewhere in the world, a severe earthquake with its focus, or center of motion, relatively close to the surface of the earth. That is the indication which may be inferred from a report presented before the meeting in Washington, D. C., of the American Geophysical Union, by Professor H. Landsberg, of the Pennsylvania State College. Professor Landsberg did not himself venture an earthquake forecast, but he did show a remarkably close hook-up between deep-focus earthquakes and shallow-focus quakes following three months later, as a rule in some remote part of the world. The Formosa quake of the Easter week-end was a deep-focus disturbance, its center being some 35 kilometers, or 22 miles, beneath the surface of the earth. On the basis of Professor Landsberg's correlations, a destructive shallow-focus earthquake may be expected to occur about a week before the end of July. Professor Landsberg also discovered a correlation between deep- and shallow-focus earthquakes with a much smaller time lag—some three days before and three days after the deep-focus quake.

AT the meeting of the American Chemical Society in New York City Dr. Harry N. Holmes and his co-workers at Oberlin College described new developments in the advance toward the long-sought goal of complete isolation of vitamin A in 100 per cent. purity. While admitting that the goal is not yet attained they reported the production of a fluid 14,000 times as concentrated as standard cod-liver oil. This is a 40 per cent. gain over the previous world's record made in 1931 by Professor P. Karrer, of the University of Zurich, Switzerland. The Swiss concentrate was only 10,000 times as potent as the standard oil.

NEW facts on the structure of vitamin B_1, whose absence from man's diet causes the acute nervous disease beri-beri, were reported to the American Chemical Society by Dr. R. R. Williams, Dr. E. R. Buchman and co-workers of Columbia University. Beri-beri is prevalent among several hundred millions of peoples of the world, especially in the Orient where polished rice is a staple of diet. It produces an inflammation of the nerves, and in acute forms, a painful rigidity of the limbs. Many physicians suspect that certain types of nervous troubles of peoples in occidental countries like the United States and European nations may also be caused by a slight deficiency of vitamin B_1. Some patients appear to obtain relief by taking concentrates of the vitamin obtained from brewer's yeast. Dr. Williams and Dr. Buchman have taken the vitamin apart in their test-tubes, added atoms here and there in the complicated molecules and learned new facts about its composition. Such knowledge is preliminary to the long-sought goal of creating the vitamin synthetically in the laboratory at which time the roundabout method of concentration from yeast can be replaced by the man-made technique. Then one would be able to take pills or capsules of vitamin B_1, just as now it is possible to take vitamin C or vitamin D.

DR. PAUL R. HEYL, of the National Bureau of Standards, announced at the meeting of the American Geophysical Union that the pull of gravity which helps to determine the earth's weight will in a few weeks be more accurately known than ever before. The value as at present determined is represented by the figure 980.087, which differs somewhat from previous measurements. Dr. Heyl, who, with Dr. G. S. Cook, has been working for years on gravity determinations with a specially constructed pendulum, in a deep vault under one of the Bureau of Standards buildings, announced the work "has been practically completed, only a few weeks' work yet remaining."

BY spinning a duralumin rotor in a vacuum, forces are created equal to 1,200,000 times that produced by the gravitational pull of the earth, Dr. E. G. Pickels, of the University of Virginia, reported to the meeting of the American Physical Society. Such an enormous force offers the possibility of being able to pull molecules apart. Centrifugal force 1,200,000 times as great as the force of gravity may be explained by saying that gravity makes an object dropped from a high building fall 16 feet in the first second. If the force of gravity were as large as the fore in Dr. Pickels's ultracentrifuge, a dropped object would fall 19,200,000 feet in the first second, or more than 3,600 miles. Using air pressure of 50 pounds to the square inch to drive the rotor, top speeds of 156,000 revolutions each minute were obtained. At this point the rotor flew apart and the calculated centrifugal force was 1,200,000 times the force of gravity. "Photographs of molecular sedimentation in an observational centrifuge," Dr. Pickels said, "demonstrate the possibilities of the apparatus in molecular weight determinations."