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THE EXPANDING UNIVERSE

"Never believe an experiment until it is checked by theory." Sir Arthur Eddington would add this maxim to rules for the guidance of science.

Theory and experiment must evolve together, he told a group of scientific men at the University of Chicago when he discussed the latest theories of the expanding universe.

Sir Arthur told the story of the expanding universe, making the statement that the galaxies are receding with velocities proportional to their distances from us.

Velocities are determined from the Doppler effect, in this case the shifting of the spectrum lines to the red—the more distant galaxies having the greater shift. Distances are obtained from the period in the luminosity of Cepheid variables by a relationship between this period and their distance. This relationship has been checked for nearer Cepheid variables.

In 1917 Professor Willem De Sitter, of Leiden, brought forward a theory of the expanding universe which required this relationship between distance and velocity, but at that time the supporting evidence was meager; however, since then, a great deal of additional evidence has been accumulated. For galaxies 1,500,000,000 light years distant their velocities of recession are of the order of 15,000 miles per second.

What happens then with galaxies that might be so far distant that their velocity of recession should be greater than the velocity of light? Professors Albert Einstein and Hermann Weyl surmounted this difficulty which would contradict the fundamental basis of relativity by assuming a closed curved space. This spherical space is such that it would take light approximately 6,000,000,000 years to come back to its starting point.

This mathematical curved space must be equivalent to a force of repulsion which force is causing the expansion. According to Newton, gravitational forces of attraction are exerted between objects and these forces also must be taken into account, but their magnitudes are negligible except when the distances between the objects are relatively small.

In the beginning of things, Sir Arthur believes that matter was so distributed that these forces of Newtonian attraction and cosmical repulsion balanced one another, the equilibrium however being unstable. In our own solar system where distances are relatively small the Newtonian attraction has the upper hand, whereas for the galaxies the cosmical repulsion predominates and such types of equilibrium are stable. Why one or the other took precedence it is impossible to say at present.

From astronomical data the total amount of matter in the universe is 10 to the twenty-second power times the mass of the sun, or 10 to the seventy-ninth power protons and electrons. The universe thus consists of 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 particles (one followed by 79 zeros.) Sir Arthur thinks that this figure can be checked from the wave mechanics of an electron.

The wave equation for an electron gives a relation between the size of an electron and the universe, is it not in some way possible to reserve this equation and get a relation which will tell the behavior of the universe in terms of an electron? This relation should somewhere hide the number 10 to the seventy-ninth power, and then would form one of the main pillars of science.

THE REFLECTION OF RADIO WAVES

World-wide efforts to discover whether radio waves escape from the earth and are echoed back to it again from the moon and other distant parts of the solar system will shortly be inaugurated.

Professor E. V. Appleton, of the University of London, who is investigating the radio reflecting layers of the earth's upper atmosphere, plans to enlist the aid of thousands of radio enthusiasts throughout the world, to time echoes of powerful special signals, which it is hoped will pass through the outer layers of the atmosphere into space, and then be reflected from objects or layers within the solar system, as light is reflected from a mirror.

It is easy to tell how far a radio echo has traveled because the speed of radio waves is the same as light, which has been accurately determined. Thus if the moon really does reflect radio echoes back to the earth, radio listeners should catch the echo in a little over two and one half seconds after the signal is shot out into space; for the distance to the moon and back is approximately 480,000 miles, and the radio waves travel with the speed of light, somewhat over 186,000 miles a second. The distance to the moon varies, but the radiation velocity is assumed to be constant. If a "moon echo" of radio signals can be well established, it can probably be used as a research tool in astronomy, to gain better pictures of the moon's somewhat erratic travel path.

The British Broadcasting Company, which holds a government monopoly of all broadcasting in Great Britain, is cooperating with Professor Appleton. The test signals will be sent out by the Empire Transmitter at Daventry, England. A World Radio Research League is being formed to assist in carrying out Professor Appleton's project.

Besides a known radio echo of nearly the time-interval that would be required to get a signal to the moon and back, there are also two other puzzling long-period radio echoes, one of fifteen, the other of thirty seconds. These suggest the existence, somewhere in the solar system, of a reflecting object or layer, at a distance from the earth of approximately 2,800,000 miles, and another at double that distance.

PSITTACOSIS

Ignorance of the danger and deep-rooted love for pets are standing in the way of the conquest of parrot fever. These two obstacles to control of the disease and prevention of future outbreaks were pointed out by Professor K. F. Meyer, of the Hooper Foundation of the University of California, at the meeting of the American College of Physicians in Chicago.

The public does not appreciate the possible danger of contact with birds, particularly birds of unknown origin, Professor Meyer said in discussing the disease, which has been a constant menace since 1929 and which claimed ten victims in Pittsburgh last month.

Facts about parrot fever or psittacosis, little known by the public, were presented by Professor Meyer as follows:

Actual contact with or possession of parrakeets is not necessary to cause the disease. A brief visit in a room with birds or sojourn in a baggage car transporting birds may be followed by disease in persons susceptible to it.

Women are affected by the disease more frequently than men. This is partly because they are either engaged in breeding parrakeets for a livelihood or because as lovers of pets they come more closely in contact with the birds.

Not only parrots and parrakeets are susceptible to psittacosis, and consequently a possible danger, but also the canary, bullfinch, nonpareil, Java sparrow, cockateel, Bengalese, Pekin robin and even the chicken.

Young birds are the chief danger as source of the disease. Mature birds, eight months or older, are much more resistant and are seldom if at all involved in human outbreaks. Over 70 per cent. or nearly three fourths of the human cases in California and elsewhere have been caused by newly acquired shell parrakeets.

The disease may be acquired by direct contact through handling the corpse of a dead bird that died of the disease, by feathers, by excreta, by nasal discharge and through bite wounds. It may also be acquired from virus particles in the air. There is no doubt that the droppings and nasal discharges of the birds, which contain the disease-producing virus, are readily scattered by the flying motions of the birds, which are easily agitated by persons who handle or approach the cage.

The disease belongs to the class of filterable virus diseases. The specific causative agent consists of minute particles of living matter that can only be seen through a microscope and which are known as L.C.L. bodies or *Rickettsia psittaci.*

The disease has a high death rate, one out of every four or five cases ending fatally. Commenting on the difficulty of controlling the disease, in spite of adequate scientific knowledge of it, Professor Meyer said: "The majority of bird breeders, pet-shop owners, lovers of birds and even veterinarians still doubt the existence of of such a disease as psittacosis. Bird breeders and pet-shop owners whose parrakeets have caused sickness and death still declare in 1934 that psittacosis is an imaginary malady and the publicity a hysterical propaganda to injure their business."

OUTBREAKS OF ENCEPHALITIS

BECAUSE of the possible occurrence of encephalitis in other communities during next July, August and September, Dr. David P. Barr, of St. Louis, pointed out salient features of the epidemic occurring in St. Louis last summer for the benefit of physicians from all over the country assembled at the meeting of the American College of Physicians in Chicago.

Dr. Barr explained that these outbreaks, if they occur, may be of similar character and of greater or less severity than the St. Louis epidemic which involved about 1,000 of the population in that area.

One location where the disease will probably not occur next summer is St. Louis, in the opinion of health authorities. Another factor, about which little is known, but which may influence the occurrence of the disease is climate. The summer of 1933 in St. Louis was unusually hot and dry. June was the hottest ever recorded and the rainfall in June, July and August was the lowest in the history of the city. A prolonged drought followed heavy spring rains. Similar climatic conditions prevailed at the time of a similar outbreak of encephalitis in Japan a few years ago. It is not yet known, however, whether there is any but coincidental relation between climate and the appearance of the disease.

The disease is caused by a filterable virus. Blood of patients who recovered from the disease, and to a lesser extent of doctors and nurses who were exposed to it but did not get sick, contain properties that neutralize the effect of the causative virus, according to Dr. Barr.

In the St. Louis outbreak the disease was fatal in one out of five cases, but the death rate was much higher in persons over forty than in those under forty years of age. Most of the deaths were attributable in part to complications, chiefly pneumonia. Kidney disease, high blood pressure and hardening of the arteries when present before the onset of encephalitis seemed to play a rôle in lessening the chances of recovery.

One favorable aspect of the disease as it occurred in St. Louis is that the nervous changes generally following in the wake of encephalitis have not so far appeared in patients who recovered. "It is of especial importance," Dr. Barr said, "that examination of many patients three months after the epidemic showed no new symptoms referable to encephalitis and no evidence of progression of the disease."

THE TREATMENT OF MENTAL DISEASES

METHODS of treating mental and nervous diseases have been completely changed, with benefit to the patient, during the first quarter of the present century, according to a statement made by Dr. Charles Macfie Campbell, professor of psychiatry at Harvard University and director of the Boston Psychopathic Hospital, before the New York Academy of Medicine.

The spirit of this transformation in treatment of mental disease, he continued, was represented by Dr. Thomas W. Salmon, in whose memory Dr. Campbell is giving a series of lectures at the academy.

Understanding of the real forces at the basis of the patient's mental or nervous difficulty, with the view to helpful intervention, has come to be the main interest of the physicians who study and treat mental disease. Before this change in viewpoint, the classification of complicated reactions had been the main interest of psychiatrists.

Dr. Sigmund Freud, Viennese psychiatrist, and Dr. Adolf Meyer, professor of psychiatry at the Johns Hopkins Medical School, furnished the inspiration for the change in psychiatric methods and viewpoint, according to Dr. Campbell.

Dr. Freud contributed psychoanalysis, a method of detailed analysis of the personality. Dr. Meyer emphasized the life history of the patient dealing with concrete situations and described various modes of adaptation of the patient without reducing these ways, of reacting to a situation, to the components on which Dr. Freud laid emphasis.

Dr. Campbell said that "Under the influence of these two schools of thought psychiatry became much more personal and in order to carry out its task looked in every direction for material which would throw light upon the nature of the personality. In this search the greatest contribution was made by the anthropologist and by the genetic psychologist studying the life of the child directly and not through the medium of analysis of the neurotic adult."

INSECT PESTS

GOVERNMENT fighters against insect enemies of crops and orchards are getting set for a tough summer. A summary of surveys conducted during late winter and early spring shows that some of the most troublesome and wide-spread of insect pests have come through the winter with less than the normal percentage of killing, so that they may be expected to be unusually numerous this year.

Grasshoppers have been the cause of the most general apprehension, for they have worked much damage in the drier parts of the northwest during the past two or three years, and the mild winter in that region has had little effect on their eggs. One good has, however, been blown by many ill winds: in parts of South Dakota the severe winter storms, scouring ground with no snow cover, have lifted its top layer and dried out the grasshopper eggs beneath it. In other places, the same blown soil has been deposited so deeply that the buried eggs have no chance to hatch. Nevertheless, there are still plenty of eggs left.

A Western pest, the Mormon cricket, threatens serious damage in parts of Idaho, Wyoming and Montana. Two of its outbreaks are on Indian reservations. In the warmer parts of the Midwest, two serious enemies of grain, chinch bug and Hessian fly, have come through the winter with very low mortality. One of the worst of insect pests in the East, the Japanese beetle, has been protected against extreme cold of the late winter months by a thick blanket of snow on the ground, so that it has escaped the unusual losses which the low temperatures might otherwise have caused.

ITEMS

CLOSING a gap that has existed in the weights of the chemical elements, evidence for the existence of both hydrogen and helium of mass three has been found in Cavendish Laboratory researches at the University of Cambridge, by Dr. P. I. Dee. According to a report in *Nature* these hitherto unfound varieties of helium and hydrogen are created when hearts of double weight hydrogen collide. Here are two new units of matter brought into existence by the smashing of heavy hydrogen particles which only three years ago were themselves undiscovered. Tracks of water vapor left behind after flights of the particles through a cloud chamber showed Dr. Dee that from heavy hydrogen collisions there emerged a proton or heart of an ordinary hydrogen atom and a triple-weight hydrogen atom heart. They recoiled in opposite directions.

A NEW fact about cosmic rays was brought out when Dr. Victor Neher, of the California Institute of Technology, described the results obtained from instruments which recently returned from cruises around various parts of the world aggregating fifty-two thousand miles. The instruments recorded automatically for a period of several months. As the vessels on which they shipped idled in some ports the instruments busily recorded more and more data until they achieved the highest accuracy so far obtained in work of this kind. This accuracy permitted Dr. R. A. Millikan to say with certainty that in these voyages there appeared not only a latitude effect but a longitude effect as well. That is, not only did the cosmic rays show a decrease in intensity as one sails into the equatorial regions, but they also showed a decrease to a lower value in the eastern hemisphere than in the western. This effect can probably be correlated with the magnetic field of the earth, which is strongest in the eastern hemisphere. The new result is, however, so difficult to reconcile with existing interpretations that Drs. Millikan and Neher present it merely as the result of these voyages, leaving it to the future to determine whether it is repeatedly duplicable or not. The experiments were all a part of a program of Dr. Millikan which is supported by a fund of the Carnegie Foundation.

THE possibility of studying explosions under the microscope has been pointed out by Dr. A. Michel-Lévy and Dr. H. Muraour, of Paris. The quantity of explosive used must be very minute, a milligram (.015 grain) or less, and the explosive should preferably be one that leaves a metallic deposit. Nitride of lead was found suitable. From the lead pattern left on the microscope slide, the nature of the explosion can be studied. Using two specks of this substance a short distance apart and exploding one of them, the experimenters found that the second was exploded by the shock and an interference pattern was formed. When the distance apart was large, the second speck was not exploded, but merely burned by the hot gases when they arrived, and no interference pattern was formed. When the experiment was tried in a vacuum, the second particle did not explode even when quite near to the first one. The shock wave is therefore propagated by the air and precedes the expanding hot gases.