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ELECTRONS AND WAVE MATTER

So-called "solid" matter—the bricks of our homes, the sidewalks we walk on, in fact, even the tissues of our own bodies, may consist ultimately of waves, or vibrations. Such is one of the startling conclusions that might be drawn from experiments at the Bell Laboratories by Dr. C. J. Davisson, in collaboration with his colleague Dr. L. H. Germer. An extended account of the researches will be given by Dr. Davisson in an article to appear shortly in the *Journal* of the Franklin Institute.

The experiments indicate that electrons—one of the important parts of the atoms of matter—may really be waves, and not the infinitesimally tiny particles that previous scientists have supposed them. What Dr. Davisson and his associate have done is to study the way that a beam of electrons, given off from a glowing electric light filament, is reflected from a crystal of nickel. They found that the electrons were reflected in the same way that light waves would be reflected. That is, if the beam hit the face of the crystal at an angle of 45 degrees, for example, it left at the same angle. "The angle of reflection being equal to the angle of incidence."

At first glance, says Dr. Davisson in his forthcoming article, this might not seem inconsistent with the theory that the electrons are actual particles. But the electrons are supposed to be so small that some 25 million million would make a row an inch long. The size of the atoms is about a hundred thousand times as great, for only about 250 million of them are required to fill an inch. Furthermore, the distance between the adjacent atoms, in the nickel crystal, is something like 250,000 times the diameter of an electron.

"The difficulty of picturing the regular reflection of particles as small as electrons from a surface made up of bodies as large as atoms is at once evident," says Dr. Davisson. "If we were to fire a load of birdshot against a pyramid of cannon balls, we should not expect to find a little cloud of shot moving off in the direction of the regular reflection from the face of the pyramid. A surface made up of cannon balls is much too coarse-grained to serve as a regular reflector for particles as small as birdshot.

"The analogy is not such a good one, really, for we do not think of electrons rebounding from the surface of an atom in the way that shot rebound from a cannon ball. We have been accustomed to think of the atom as rather like the solar system—a massive nuclear sun surrounded by planetary electrons moving in closed orbits. On this view the electron which strikes into a metal surface is like a comet plunging into a region rather densely packed with solar systems."

Dr. Davisson points out that if the electrons were waves, their behavior would be perfectly understandable, for X-rays, which are supposed to be waves, are likewise reflected from a crystal in the same way. Another experiment brings out the similarity to X-rays in an even more striking way.

"We direct a stream of electrons against a target of ordinary nickel—a target made up of many small crystals instead of one large one—and we never under any circumstances find any indication of regular reflection. Electrons are not regularly reflected from a target of ordinary polycrystalline nickel.

"It seems curious that electrons should be reflected only from a crystal-face—and then we remember that this is true also of X-rays. X-rays may be regularly reflected from the face of a crystal, but not from a polycrystalline mirror. The difference between light and X-rays in this respect is due, as we know, to a difference in order of wave-lengths. The lengths of light waves are great compared to the distance between atoms in solids while the X-ray wave-lengths are comparable with these distances."

Since scientists also have good reason for supposing that the electrons are particles, there is a conflict of ideas that he can not explain. The so-called Schroedinger wave mechanics, named after its German inventor, has suggested that electrons are either made up of, or accompanied by, a system of waves and this, he thinks, may help explain the difficulty.

"Are electrons waves?" he asks. "The easiest way of answering this question is to ask another. Are X-rays waves? If X-rays are waves, then so also are electrons. But we are no longer so certain as we used to be that X-rays are waves. The Compton effect and the photo-electric effect are most simply described by supposing that there is some sense in which X-rays are particles. It is all rather paradoxical and confusing. We must believe not only that there is a certain sense in which rabbits are cats, but there is also a certain sense in which cats are rabbits."

PHOTOGRAPHS OF STELLAR SPECTRA

Gigantic stars that could engulf the whole solar system are transported from their far distances of hundreds of trillions of miles and set beside our own sun as a result of the latest researches of astronomy.

Spectral messages are received by a combination of the world's largest stellar spectrograph and the world's largest telescope, the 100-inch on Mt. Wilson, Calif. They are interpreted by Professor Henry Norris Russell, of Princeton University, who worked with Dr. Walter S. Adams, director of the Mt. Wilson Observatory.

The powerful spectrograph, just put in commission, gave stellar spectra photographs almost as detailed as the standard spectra of the sun, the earth's nearest star. Hundreds of lines in these fingerprints of the stars were revealed for the first time. These spectrum lines allow the astronomer to analyze the stuff of stars, take their temperature and probe their atmosphere.

"For the giant red stars, such as Antares and Betelgeuse, the total quantity of material above a square mile of the visible surface is apparently about a hundred time as great as in the sun," Professor Russell sai

"Procyon, a dwarf star only a little brighter and probably no larger than the sun, has an atmosphere comparable with the sun's in extent."

The lines of the new photographs tell the proportion of excited atoms loaded with energy and thus determine the temperatures, which range from 3,000 to 10,000 degrees Centigrade for the stars studied.

THE GREEN SUNSET RAY

INTENDING voyagers to Europe during the next few months should carefully watch the setting sun, and they may be able to see the "green ray." This is the brilliant green coloration that the sun assumes just before its last narrow sliver disappears behind the horizon. A really satisfactory sight of it is rather rare, said Professor R. W. Wood, professor of experimental physics at the Johns Hopkins University. On thirty crossings of the Atlantic he has looked for it every time there was a clear sky and no haze or clouds near the horizon at sunset, but has only seen it three or four times. Only once, he said, was it really striking. At that time it appeared a brilliant emerald green, about the color of a railroad signal.

The cause of the green ray is generally supposed to be that the rays of light are bent as if by a prism when they pass through the atmosphere of the earth. This enables us to see the sun for a short time after it is below the line of the horizon. As the red and orange rays are bent least, they disappear first behind the horizon. This leaves the green, blue and violet rays still visible. Blue and violet affect the eye much less strongly than green, and so the green color predominates.

Dr. Wood accepts this theory of the origin of the ray, but proposes a new theory to explain why it is not always seen at sunset. At the time that he saw the ray so well, the air and ocean were at approximately the same temperature. Through the rest of the voyage, when it was not seen, the ocean was much warmer than the air. He thinks that when the water is warm and the air cool, the layer of warm air right in contact with the sea would cause the light rays of all colors to be bent less, and so the sun would set abnormally early. When the air is warmer than the water, the curvature of all the rays would be increased, and so the atmospheric dispersion that causes the ray would have a longer time to act.

THE MEASUREMENT OF ULTRA-VIOLET RAYS

RADIO amplification now is to be of service in the field of medicine. Professor Ernst A. Pohle, roentgenologist of the University of Michigan, in collaboration with Walter S. Huxford, of the physics department, has designed a measuring device for ultra-violet rays, independent of other radiation which comes from quartz lamp or other light source.

In recent years ultra-violet light has come to be recognized as a cure for rickets and possibly for other diseases, but there has been no accurate means of measuring the quantity with which the patient is treated.

Up to the present time the photo-electric cell, one means of measurement, has required precision apparatus too complicated for the average physician to handle. Professor Pohle and his associate have designed one that is simple and dependable. In it a radio amplifier is used to magnify an extremely small electric current so that it can be read on an ordinary switchboard galvanometer. The current comes from a photo-electric cell, which turns light into electricity.

Only ultra-violet rays between certain definite wave-lengths are believed to have any beneficial effect upon the patient, so it was necessary to develop apparatus which would measure only light of that wave-length, disregarding both longer and shorter waves. For this purpose the metal cadmium has been utilized by Dr. Pohle and Mr. Huxford because it is most sensitive to the waves long enough to affect the skin. The glass which they use in their cell cuts off longer light waves.

Dr. Pohle and Professor Ralph A. Sawyer have also succeeded in calibrating the photo-electric cell in absolute units. This makes any recorded dose reproducible.

A RADISH-CABBAGE HYBRID

A CROSS between a radish and a cabbage, considered to be about the most difficult feat in plant breeding so far on record, has been made by Dr. George D. Karpechenko at the botanical institute at Detskoje Selo, in Russia. The Russian botanist's work is reported by Professor William Seifriz, of the University of Pennsylvania, who recently visited a number of scientific laboratories and experiment stations in the Soviet union.

Although the new plant has no economic significance at present, its development is of much interest to plant breeders because of the remoteness of the relationship between the two parents. The great bulk of our hybrids, both plant and animal, are between varieties of the same species, or even between strains or races of the same variety. Hybrids between two species within the same genus are usually hailed as out of the ordinary; the crossing of the lime and the kumquat to produce the limquat was such a hybrid. There are, however, certain crosses between species that are very common, such as the mule.

But the hybridization of radish and cabbage means that two quite distinct genera have been combined to produce something entirely new under the sun. The more remotely related the parents, the more difficult the cross is to make; and in this instance the parents are believed to be more distantly related than any plants from which successful hybrid offspring has yet been secured.

A MAGNETIC SENSE

AT the sessions of the Congress of American Physicians and Surgeons, in Washington, Dr. Frederick Tilney, professor of neurology at Columbia University, mentioned experiments now in progress on a hitherto undiscovered animal sense, the power that allows the homing pigeon to find its loft, the migrating bird its far distant summer home, the animal its burrow. This sense may prove to be magnetic. The retina of the eye was suggested by Dr. Tilney as the organ of the body in which the sense resides.

Mere men have long marveled at the abilities of animals to find their way home through strange surroundings. Aviators need compasses and intricate instruments to navigate as efficiently as the birds of the air. Such phenomena as these gave impetus to Dr. Tilney's researches.

One clue in the search that is now under way is the fact that animals are greatly disturbed by any change of direction of their surroundings. Mice that are taught to run intricate mazes, a feat that is not dependent upon ordinary senses of sight and smell for instance, are completely baffled when the mazes are moved and oriented geographically in a different direction. They have to learn the mazes all over again.

Dr. Tilney was careful to point out that as yet his researches are in a preliminary stage. Both his own laboratories and those of the department of psychology at Columbia University are at work. If this magnetic sense is confirmed by his experiments, it will be the ninth sense. Five senses, sight, hearing, touch, taste and smell, which are the result of contact of the nervous system to environment, are familiar to every one. Then there are what Dr. Tilney called the skeletal sense and the visceral sense, both of which reside in the body itself. As the eighth, Dr. Tilney lists what he calls the hurt or pain sense, which is protective instead of guiding like the others.

THE ETHNOLOGY OF ST. LAWRENCE ISLAND

THE belief that ancient men bridging the gap between Asia and America may have left clues to their identity and their manners near Bering Strait is taking Henry B. Collins, Jr., ethnologist of the U. S. National Museum, to St. Lawrence Island, which lies just south of Bering Strait. Mr. Collins left for Seattle on May 4. He will be the first scientist to excavate in the island, though Eskimos living there have dug up a number of very old ivory harpoons and ornaments used by their forerunners. Mr. Collins will spend most of the summer locating ancient Eskimo villages and digging where excavation seems most likely to reveal traces of early inhabitants.

St. Lawrence Island would be rather south of the direct line of travel across Bering Strait. But some of the prehistoric men who found their way across the short cut between Asia and America, thousands of years ago, may have wandered to the island or stopped off there. At any rate, it is known that men have inhabited the island for many centuries.

St. Lawrence Island is about 100 miles long, but it is now inhabited by only a small group of Eskimos. Prior to 1880, the population was much larger, but in that disastrous year the Eskimos drank a good deal of bad whiskey and neglected to hunt and store up a food supply. When winter came, hundreds died from famine, and the island never regained its former importance.

Mr. Collins plans to spend some time in conducting excavations along the mainland of Alaska just south of the Arctic Circle and in making studies of the physical type of the natives.

ITEMS

M. SCHELENZ, of the Carlsruhe Museum, writing in *Naturforscher*, states that museum specimens of fish can be prepared in such a way as to be as bright and interesting and attractive as the mounted animals or birds. One side of a freshly killed fish is cleaned of its coat of mucus. The specimen is embedded in modelling clay, leaving the cleaned side projecting, melted paraffin is poured over it, forming a solid block and impregnating the fish with the wax. The paraffined fish is next removed, leaving an exact mould of itself in the clay. Into this mould fine plaster-of-paris is poured and allowed to harden. The clay is then dissolved and the plaster cast of the fish remains, with every detail of skin and scale and fin. White plaster models, "aged" for some weeks, are then coated successively with shellac and with silver or gold leaf. Finally, life colors and markings of the fish are painted by hand, and the model is given a protecting coat of varnish.

AS a result of his investigations of the common magpie, E. R. Kalmbach, biologist of the division of food habits research, states that the magpie eats more insects than any other member of the crow family and must also be credited with the destruction of a number of small rodents. These virtues, however, are counterbalanced by destruction of poultry and beneficial wild birds and their eggs. The magpie likewise preys on sick and injured cattle and has proved a nuisance and a hindrance in anti-coyote campaigns by stealing bait and tripping the traps. Poisoning is the cheapest and most effective method of destroying the magpie.

THE country around the town of Geestemuende, in Hanover, has recently suffered from an outbreak of vipers. These snakes are troublesomely poisonous, though their bites are not often fatal. The farmers' best snake-alarms were their hens, which invariably set up a clatter when a viper appeared. A number of cases were reported of battles between a snake on one side and a flock of hens on the other, in which the reptiles were invariably pecked to death.

To be eligible for the presidency of the French republic a man must be the father of at least seven children, is one of the provisions of a bill proposed by M. Jean Rameau, with the idea of increasing the dwindling population of France. A Frenchman who aspires to be a cabinet minister would have to have at least six children, according to the proposed law. If he had only five in his family, he could rise no higher than the senate. With four he might aspire to the Chamber of Deputies. To be mayor of a French town a man would have to have two children, and even a town councilor would be required to have one child, as one of his qualifications for office. The author of the plan, relying upon the aspirations of his countrymen for political careers, estimates that such a law would increase the French population by 10,000,000 in ten years.