

Solid Matter May be Waves

Physics

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 Telephone Laboratories in New York by Dr. C. J. Davisson, in collaboration with his colleague, Dr. L. H. Germer. An extended account of the researches is given by Dr. Davisson 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. As the physicist expresses it, "The angle of reflection is equal to the angle of incidence."

At first glance, says Dr. Davisson, 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 sur-

face 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.

"There is a certain small probability, or at least there might seem to be, that the electron will strike into an atom in or near the surface of the metal, be swung about comet-wise, and sent flying out of the metal without loss of energy. The direction taken by such an electron as it leaves the metal should be a matter of private treaty between the electron and the individual atom. One does not see how the neighboring atoms could have any voice in the matter. And yet we find that the high-speed scattered electrons have a preference for moving off in the direction of regular reflection, a direction which is related to the plane of the surface. Three atoms at least are required to fix this plane, so that the direction taken by the electron is deter- (Turn to next page)

Bible Sites Located

Archaeology

No less than 1,312 of the places that made Bible history in ancient Palestine have been accurately located by archaeologists, according to Dr. George S. Duncan, professor of Egyptology and Assyriology at American University in Washington.

Picks and spades wielded by scientists are unearthing so much important evidence about the Bible that it is like a new book, Dr. Duncan pointed out.

"Hebrew architecture was deeply influenced by Egypt," he stated. "Solomon's temple and its utensils were modeled after Egyptian patterns. Temples on the Nile contain altars, tables with bread, and arks with cherubim, all recalling the Bible descriptions."

"Archaeology shows that the first chapters in Genesis are old traditions originating in Babylonia. The Hebrews monotheized them and spiritualized them and made them the vehicles of most important religious truths. It is a great mistake to make the chapters standard for scientific knowledge. The Bible is a religious book, not a scientific treatise."

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New Theory in Sociology

Sociology

Sociologists who moralize on poverty, bad housing, and delinquency are not dealing with reality at all, according to Prof. Robert R. Kern, professor of sociology at George Washington, who has concluded that the first step toward solving the problems of the universe is to solve the problems of the individual person.

"Making people over, so that they get rid of foolish fears and other inefficient behavior is a real task for sociologists," he states. "How a human being will behave can be predicted and his behavior can be altered by understanding and applying principles of physiology."

Prof. Kern, in cooperation with his students, has conducted over 1,000 experiments in predicting and reorganizing behavior. The students use themselves as subjects of the experiments and by understanding their own bodily mechanisms they are better equipped to understand why other people and large groups of people act as they do.

Emotions are inefficient as guides in

the opinion of this sociologist, who believes that social problems should be attacked from a realistic physiological point of view.

"A man may have developed a dislike for milk because of some highly emotional and disagreeable experience with it," he explains. "Now, milk is wholesome, and if he were to get sick he might be seriously handicapped by his unreasonable aversion for it. Yet, the very sight of it produces a physical disgust that is so real that it must be taken seriously."

"The first problem is to help him trace the mechanism of the neural hook-up that has been established in his body. He sees how the sight of a bottle of milk sets up the same old nervous mechanism, carrying a current over the same nerve route, effecting the same visceral muscles, and producing the sensation of nausea. Then, he tries to direct and re-route the nerve current by substituting for the old emotion an unemotional attitude of thinking how the milk will be good for him." (Turn to next page)

Solid Matter May Be Waves—*Continued*

mined, not by one but by three atoms, at least.

"One may say without qualification that in terms of atoms and electrons and their interaction as we have been accustomed to picture them the regular reflection of electrons from a metal surface is quite incomprehensible.

"Of course, if electrons were waves there would be no difficulty. We think we understand the regular reflection of light and of X-rays—and we should understand the reflection of electrons as well if electrons were only waves instead of particles. This observation, though true, does not seem a particularly valuable one. It is rather as if one were to see a rabbit climbing a tree, and were to say: 'Well, that is rather a strange thing for a rabbit to be doing, but, after all, there is really nothing to get excited about. Cats climb trees—so that, if the rabbit were only a cat, we would understand its behavior perfectly.' Of course, the explanation might be that what we took to be a rabbit was not a rabbit at all, but was actually a cat. Is it possible that we are mistaken about electrons? Is it possi-

ble that we have been wrong all this time in supposing that they are particles, and that actually they are waves? Well, I do not need to enumerate the many reasons we have for believing—I may say for knowing—that electrons are actually particles."

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," he says. "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 cannot explain. The so-called Schrödinger wave mechanics, based on an idea suggested by a French physicist, L. de Broglie, 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 photoelectric 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."

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New Theory in Sociology—*Continued*

Explaining the theory of brain physiology on which his experiments are based Prof. Kern says:

"First there are the conducting neural cells which conduct nerve currents from sense organs and sensory points to the primary, or sensory, brain cells. These primary brain cells are the final points at which human beings may influence sense experiences. Then there are secondary, or interpretative brain cells which are the final points at which we may influence the memory or imaginative experiences. Then there are conducting cells which conduct nerve currents from one group of secondary brain cells to another. And there are also conducting cells which serve to conduct nerve currents to motor cells which in turn forward the current over systems of cells which distribute the current to the muscles.

"There are two types of hook-up between these brain cells. One is an original response, following a prescribed circuit, such as the fear response of a baby at a loud noise.

"The other type of circuit is over built up hook-ups. Our experiments indicate that these hook-ups may be built over the secondary brain cells

but never between primary brain cells. By building new hook-ups among the brain cells which function as interpretative cells we can not only modify our experiences but also our conduct. The new paths that are established for the nerve current control the impressions that are permitted to come to the primary brain cells."

Prof. Kern's experiments in a realistic sociology have been conducted over a period of six years, and they indicate that behavior can be modified along predetermined lines, he concludes.

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Consumption of gasoline increased in all but two states last year.

More than half the narcissus bulbs produced in the United States last year came from Florida.

Success in raising the bob-white quail in captivity is reported from the Virginia state game farm.

There are usually two bear cubs to a litter, though occasionally one or three occur.

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