"Uncertainty Principle" Enters Science

Physics

The boundaries of science's delving into the very, very small have been compressed so greatly in the march of the latest theories of physics that scientists have arrived at the limits of their ability to measure accurately.

As complicated as the principle of relativity, as far reaching, some physicists believe, is this new fundamental idea of the universe called the "principle of indeterminacy or uncertainty."

The man responsible for the introduction of this disturbing idea into the flow of scientific thought was present as an inconspicuous individual among the several hundred members of the American Physical Society at its Washington meeting. His name is Prof. W. Heisenberg, and like Einstein, he is a German. This blond, smooth-shaven, reddish-faced young physicist has an almost timid manner as though he were truly unaware of the stir that his theory is sure to make when once philosophers and laymen begin their attempts at its interpretation.

Heisenberg's indetermination principle is destined to revolutionize the ideas of the universe held by scientists and laymen to an even greater extent that Einstein's relativity and the quantnm theories. Crudely stated, the new theory holds that chance rules the physical world. There is an end to the physical domain. Always as man has delved deeper and deeper into the universe's structure he has found finer and more detailed construction. Atoms showed their electrons. But now the bottom has dropped out. There is an end to knowledge not because of lack of endeavor but because of the nature of knowledge itself. Before the infinitesimal is reached, meaning ceases. The scientist has a limit to his curiosity.

Old fashioned physics conceived things as hard and solid and reliable. Measure where a baseball is and how fast it is going and it once was believed that its future position could be predicted. Roughly, that is still true, that is, true enough for practical purposes of every-day life.

But take electrons, the smallest particles of matter, and Heisenberg's uncertainty makes prediction of what they are to do in the future unreliable. In essence, the future cannot be foretold from the past or the present. These weird sounding consequences arise from the contention that a particle may have an exact place or an exact speed, but it can not have both.

To say that the future can no longer be predicted exactly is true if we wish to follow the theoretical physical into the realm of the extremely minute. Even for the most delicate and precise physical measurements that can be made the uncertainty is not enough to be detected. Prof. Heisenberg gives an example to show the order of probability that is involved.

Suppose that a weight of one gram, a thirtieth of an ounce, is thrown a hundred yards, he explains.

The principle of uncertainty says that it would not necessarily fall there. The place of its fall can be computed from the principles of mechanics. Now suppose that it is assumed that in actuality the weight falls three millimeters, about an eight of an inch, from the point (*Turn to next page*)

Universe Given Diminished Size

Astronomy—Physics

Write the number 176 and after it put a row of 18 ciphers. Then you will have the number of miles that you will have to travel if you want to completely encircle the universe and get back where you started.

Vast as this figure appears, it is about a twentieth as large as scientists supposed a few years ago. It is based on a new value of the "radius of curvature of spacetime", as the physicist calls it, that was announced to the meeting of the American Physical Society by Dr. Ludwik Silberstein.

Dr. Silberstein is a mathematical physicist connected with the research laboratory of the Eastman Kodak Company, and is considered as one of the world's leading authorities on these matters, which are closely connected with Einstein's theories.

According to Einstein and his school, space is not infinite. The old idea that one could travel in a straight line forever is wrong, they say. As a matter of fact, there is no such thing as a straight line, and if a person should travel far enough and long enough in what seems to be a straight line, he would eventually find himself back at his starting point.

Yet, they also say, space is unlimited, and this is an illustration of how that may be. If a small insect lived on the surface of the globe, and was unable to leave it, or to perceive anything else off its surface, he could travel indefinitely around it in any direction. He would never come to an end, yet his universe would be limited. Even if endowed with human intelligence, and (*Turn to next page*)

Back to Newton for Quanta

Physics

The idea that light consists of minute particles, or corpuscles, popular centuries ago, but which was abandoned during the seventeenth century, is again seeking scientific recognition. At the meeting of the American Physical Society this idea of the great Sir Isaac Newton was suggested as being true after all.

The corpuscles which compose light, as conceived by Dr. Herbert J. Brennen, Northwestern University physicist, are nothing but the electrons of matter itself. These electrons, say modern theories, form part of the atoms of which matter is made. They are also given off from a hot filament in an electric lamp. They make possible the radio vacuum tube. As cathode rays they are given off in an evacuated tube when high voltage electricity is passed through it. Recently, a General Electric scientist, Dr. W. D. Coolidge, obtained them in large quantities in the open air, outside the generating tube.

But none of these electrons travel as rapidly as light. About 150,000 miles a second is the fastest the cathode rays can be made to travel, but light will traverse 186,000 miles in a second of time. If the electrons from a cathode ray tube could be accelerated to that speed, then a beam of light, and not cathode rays, might emerge.

The wave theory of light, which has held the field without dispute until recent years, states that light consists of waves, in a hypothetical and mysterious medium called the ether. The quantum theory, which physicists have recently (*Turn to next page*)

Universe's Size—*Cont'd*

he or his ancestors had never been able to perceive anything off the globe's surface, he would not be aware of the rest of the world about him.

Our universe, say the relativists, is similarly curved, in some fourth dimension, which the human race has so far been unable to perceive or comprehend. Apparently, we are free to move in any direction we choose, but actually there is at least one direction in which we cannot move, since we cannot comprehend it. If we could, then we could move in that direction.

But even though it cannot be comprehended, the scientist can get some faint glimmering of its existence, and estimate the size of this four-dimensional sphere in which we live. This is what Dr. Silberstein has done.

Using data pertaining to two separate groups of stars, furnished him by the Harvard College Observatory, Dr. Silberstein has made a new estimate of the radius of curvature of the universe, or "spacetime" as it is generally called. This radius is practically the same when calculated from either of the two kinds of stars. It is about a twentieth as large as a previous estimate that he made in 1924, which was based on 18 globular star clusters and the Magellanic Clouds. The latter are clouds of stars seen in the southern hemisphere of the sky. Dr. Harlow Shapley, director of the Harvard College Observatory, is now working out some new material on these objects. Though not finished, it appears that his previous estimate of their distances, which Dr. Silberstein used, was too large. Therefore, and for other weighty reasons, Dr. Silberstein believes that his new determination of the radius is the more accurate.

Science News-Letter, April 27, 1929

Back to Newton—*Cont'd*

tended to accept, states that light consists of bursts of energy, or "quanta", but these are not the same as the corpuscles of Newton, even though they are discrete units, and not a steady series of waves. Another phase of modern physics, the so-called "wave mechanics", suggested by the German physicists Schroedinger and Heisenberg, the latter now in this country, and the French physicist the Duc de Broglie, holds that the electron itself is a wave phenomenon. If this is the case, perhaps the theory proposed by Dr. Brenner may reconcile all of the suggested theories of light.

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A young giraffe is one of the rare and difficult animals to bring to a zoo, and costs about $5,000.

An expedition to Abyssinia hopes to capture specimens of the reticulated giraffe, the largest kind of giraffe in existence.

Uncertainty—*Cont'd*

that mechanics predicts. The probability that it will do so is one time in a number so large that it would be meaningless to write it. Prof. Heisenberg expresses it as E, the base of napierian logarithms, raised to the ten septillion power, that is, E with an exponent consisting of one followed by 25 ciphers.

It is of such bewildering stuff that scientific discussions are made today. In the new idea that uncertainty rules the universe, dreamers and mystics will see the abode of their fancies; the non-existent realm beyond the limits of meaning will soon be populated by ghosts, spirits and mental shadows. This is the price that scientists often pay for progress and it will not worry them, although it may amuse and even excite the lay world.

As reinforcement of Heisenberg's principle, Dr. Arthur E. Ruark of the University of Pittsburgh, told the physicists that there exists a limit of accuracy in the measurement of lengths and he enunciated laws that resemble Heisenberg's ideas of indetermination. The relativity theory provides a limit to the velocity of all things. None can exceed that of light. In the case of length measurements, this provides an automatic accuracy limitation that, paired with the length measurement, makes the uncertainty principle applicable.

Science News-Letter, April 27, 1929

Twenty years ago, New York City lost 4,000 children under five years of age each summer from "cholera infantum", whereas last year only 246 deaths occurred from this cause.

The "black window" is probably the most poisonous spider in orth America, according to an entomologist who has allowed many spiders to attack him.