

PHYSICS

Behavior of Electron Is Not Predictable

Physicist Explains Theory That the Law of Cause and Effect Does Not Apply to Motion of Single Particles

HOW SCIENCE is losing faith in the law of cause and effect was explained in an address at the University of Wisconsin by Prof. P. W. Bridgman of Harvard University.

New experimental facts in the last few years, Prof. Bridgman said, have made us less certain as to the thoroughgoing uniformity of nature or the predictability of future events. When we refine our measurements beyond a certain point we enter a new domain of small things not before accessible, full of the most capricious irregularities. The new domain is that in which the motions of single electrons or atoms are concerned.

"Let us imagine the simplest large-scale situation, a billiard ball rolling without friction or other interference

on a table-top. Let us imagine the table-top marked with lines a foot apart," Prof. Bridgman continued. "Then we all know that if we observe the ball to be at the zero mark when the second hand of our watch points to zero, and to be at the one-foot mark when the second hand points to one second, when the second hand points to two seconds we shall find the ball at the two-foot mark. . . .

"But experiment shows that if we were dealing with an electron instead of a billiard ball the experiment would entirely fail At two seconds we might sometimes find it at seven feet and sometimes at five feet, . . . and indeed sometimes at two feet, like the billiard ball."

Prof. Bridgman went on to discuss the question of whether there could ever be any practical effects arising from such small-scale uncertainties. An example of this sort of thing is known to every physicist in an apparatus so constructed that the effect of the entrance of a single electron into the sensitive part of the apparatus is amplified with vacuum tubes so as give a crack of sound in a loud speaker or start or stop a piece of machinery.

"We may," he continued, "romance about the future religion of a superstitious race by imagining in the inmost shrine of their temple a speck of radioactive salt in process of disintegration, and attached to this a train of vacuum tube amplifiers, which shall ever and anon flood the temple with light, or beat a tom-tom, or perhaps sacrifice a victim."

The disintegration of such an atom, Prof. Bridgman said, is the sort of thing that experiment and theory both show is essentially unpredictable.

"A rather good argument might be made for this sort of thing," he went on, "and it really appeals to the imagination in many ways, for we have here the possibility of a spectacular projection into the realm of ordinary sense of the eternally inscrutable foundations of our physical world

"I gather the impression that at the present time a number of biologists are prepared to admit that not infrequently the adjustment of a single cell may be so delicate as to be thrown out of balance and a reaction started by the entrance of a single free electron or light corpuscle into the cell. In such cases the behavior of the cell must be admitted to be unpredictable."

The notion of cause is not so simple as it seems. Suppose that one had a heavy weight attached to a support by a string; then he will find that whenever he cuts the string the weight falls. This would lead to the assertion that the cause of the falling of the weight was the cutting of the string.

"For instance," Prof. Bridgman concluded, "if I could by some heroic means remove the earth, then we are all convinced that the weight would no longer fall when the string is cut, and so we could justify the contention that the true cause of the falling of the weight was not the cutting of the string but the presence of the earth."

Prof. Bridgman's address is reported in full in *Science*.

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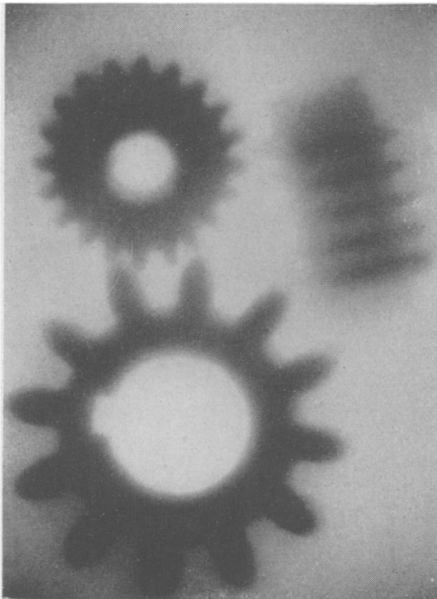
METEOROLOGY

Britain Has Few Natural Fogs

THE prevalent belief that England is a land of perpetual fog has been disproved by the National Physical Laboratory at Teddington, which reports that investigations carried out to determine the water in fogs for the Atmospheric Pollution Research Committee were much hampered in the early stages by the infrequency of the opportunities for work to be carried out on natural fogs. Apparatus for producing an artificial fog had to be constructed, a small chamber being equipped with an air-circulating apparatus supplied with steam from a generator outside.

How the formation of fog depends on the presence of solid particles in the air is shown by the fact that after the fog had been produced continuously for from ten to fifteen minutes it thinned, owing to lack of nuclei for the formation of the droplets. However, if a little smoke, obtained from smouldering sacking placed near the intake of the circulating system, was added it was possible to produce continuously dense fog, although the smoke alone, in the absence of the steam supply, was hardly visible.

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THROUGH FOUR INCHES OF IRON
By the aid of a powerful 800,000-volt X-ray apparatus. This photograph was made in only 30 seconds, although even the most powerful of tubes in commercial use would require several hours of exposure. The images are not clear because this new tube is not intended for photography but for therapeutic use by the Memorial Hospital in New York City.