SCIENCE

VOL. 84 FRIDAY, OCTOBER 30, 1936 No. 2183

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

TWO-DIMENSIONAL GASES, LIQUIDS AND SOLIDS[1]

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WE live in a world of three dimensions. We measure objects by their length, breadth and thickness. The position of a point can be described by three coordinates, x, y and z. We can not escape from the inside of a spherical surface except by passing through it, but if we are standing in a circle on a surface we escape from it by stepping over it.

It is amusing to try to imagine a fourth dimension. We can reason that if we could travel into it, we could escape from the inside of a sphere without going through its surface.

In the special theory of relativity, Einstein has given us reasons for looking upon time as a kind of imaginary fourth dimension which differs from any of the ordinary dimensions of space much as the number one differs from the imaginary number $\sqrt{-1}$.

In the general theory of relativity, there are suggestions that the effect of gravitation is to warp four-dimensional space-time in a fifth dimension, very much as we have to warp a map of Europe to make it fit onto a globe representing the earth.

Poincaré in an interesting book, "Science and Hypothesis," attempted in 1903 to trace the probable development of science on the earth if it had happened that the earth's atmosphere, like that of Venus, had been perpetually cloudy. Without ability to observe the stars and sun, mankind would have persisted for long in a belief that the earth is flat. If a pioneer among scientists had made the statement that the surface of the earth has no edge or boundary but yet has a limited area, he would have been disbelieved; for these two statements seem contradictory to those who believe in a flat earth. The difficulty disappears, however, if it is recognized that the surface of the earth is bent into a spherical surface by being warped in a third dimension.

[1] Address delivered at the Mark Hopkins Centenary, Williams College, October 10, 1936.