and 4 mm in hydrogen. To each collision a spread in scattering angle was attributed. This was equal to the angle subtended at the point of impact by a sphere 8 mm in diameter. This makes some allowance for the fact that around the source there was a hemispherical wall of platinum 0.5 cm thick, used to keep x-rays from the chamber, and thus produces some scattering.

The number of points at which the neutron-proton collisions occurred was found to be very nearly proportional to the inverse square of the distance.

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The Enhancement of Cosmic-Ray Nuclear Bursts by the Presence of Subsidiary Material

It has been pointed out[1, 2] that cloud-chamber photographs of showers of rays strongly suggest that a shower contains radiation which has the power of creating another shower. Hence it should be possible for the radiation accompanying a shower formed in one body to produce a shower in another body. An experiment to show this phenomenon has been performed. As the first body the water contained in a tank 126 cm in diameter and 150 cm high was employed. Seventy-five centimeters below the tank was placed the second body: a spherical ionization chamber of cast steel of 2.5 cm wall thickness and 14.2 liters capacity, filled with nitrogen to a pressure of 12.5 atmospheres. The number of bursts of ionization greater than 0.45×10^6 ions occurring in the chamber was measured for different thicknesses of water. As the depth of the water was increased, the number of bursts first increased, so that at a thickness of 79 cm of water, the number was about 20 percent greater than at zero thickness. At still greater depths of water, the number of bursts decreased, until, at 136 cm, approximately as many bursts were observed as at zero thickness. This is represented by the center curve of Fig. 1. Some observations were also taken with a slightly higher sensitivity in which bursts greater than 0.35×10^6 ions were measured. The increase between zero and 41 cm of water for these bursts is shown in the upper curve of the figure.

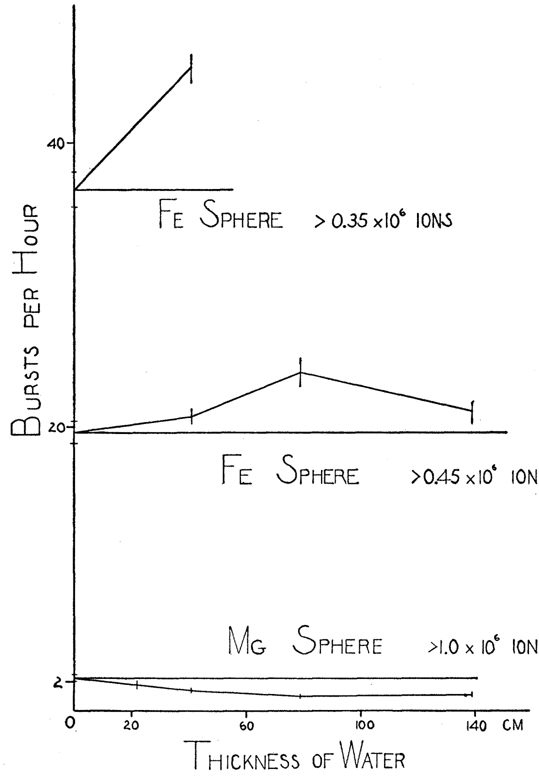

Fig. 1. The rate of occurrence of bursts of ionization in chambers placed below different thicknesses of water. The vertical lines at the observed points represent the standard deviation in the rate computed from the square root of the number of bursts observed.

At first glance, the simplest interpretation of these data would seem to be that the additional bursts observed when water was present were bursts of ionizing rays originating in the water and passing through the walls of the ionization chamber despite the large intervening thickness of water and iron. However, when an ionization chamber with one centimeter magnesium walls was substituted for the steel one, the number of bursts decreased uniformly as the depth of the water was increased. These data are shown in the lower curve in the figure. The magnesium chamber had a volume of fifty liters and was filled with nitrogen to a pressure of 14.5 atmospheres. In order to compare its results with those obtained with the steel chamber, bursts of a somewhat larger size should be considered. The size of burst in the magnesium sphere comparable to 0.45×10^6 ions in the steel chamber is 0.78×10^6 ions if we suppose the ionization per centimeter of path should be the same, and 1.84×10^6 ions if the ionization per unit volume should be the same in the two cases. A value between these two, *viz.*, 1.0×10^6 ions, has been chosen for the purposes of this comparison.

The uniform decrease in the number of bursts observed with the magnesium chamber obviously represents the absorption of the primary burst-producing rays. It is of the order of magnitude to be expected from the variation with altitude of the number of bursts in this chamber.[3] There is no evidence of the three or four bursts per hour coming from the water whose occurrence the data taken with the steel chamber seem to indicate. Thus we must conclude that the additional bursts in the steel chamber originate in its walls, but are occasioned by the presence of the water. The eventual decrease in the number of bursts with increasing thickness of water represents here also the absorption of the primary burst-producing rays.

The initial increase in burst frequency must be produced by some kind of radiation coming from the water. That this radiation is accompanied by a shower of ionizing rays is evidenced by the following experiment. Three Geiger-Müller counters, each of area 109 square centimeters, were placed below the water tank and above the steel sphere in such positions that they would only be simultaneously discharged by at least three ionizing rays. The simultaneous discharges of these three counters were made to light a small lamp which made a trace on the same photographic paper on which was recorded the occurrence of the bursts of ionization. Thus the simultaneous occurrence of a burst and the discharges of the three counters could be recognized. With 41 cm of water in the tank, observations were taken for a period of 10.8 hours. During this time 69 simultaneous discharges of the counters occurred, and 19 of these were coincident with the occurrence of a burst of ionization greater than 0.35×10^6 ions in the steel chamber. Thus the radiation from the water which will produce bursts in the steel chamber walls is accompanied by a shower of ionizing particles.

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The Liquid State

In the consideration of the application of the third law of thermodynamics to the undercooled liquid state,[1] the writer was impressed by the analogy which holds between the electrons in a metal and the molecules in a liquid. The entropy of a liquid involves a term which depends upon the possibility of the molecules being arranged in different configurations of the same energy. These configurations are in resonance with one another, and the state of the liquid is to be described as a combination of various configurations. The statistics which apply to the molecule are, of course, not the same as for the electron, and the problem of writing the wave functions is even more difficult than in the case of the electron in the metal.

Herzfeld and Mayer[2] have recently discussed the melting of crystals. They consider the impossibility of superheating a crystal to be a unique phenomenon. It is, of course, but the explanation of this behavior is not difficult. The melting point must depend upon the equilibrium between the solid and liquid states, and is, therefore, a measure of the multiplicity of configurations per molecule in the liquid state which correspond to the single configuration in the crystal. Naturally, the entropy of fusion is the greater the more complex the molecule. Superheating does not occur because the heat of activation for fusion is small, presumably no greater than the heat of fusion. In other words, the two states are not separated by a high potential barrier. The situation is quite different with respect to a transition point. Here, for transformation from one crystal form to another, a heat of activation essentially equal to the heat of vaporization is required. If the two crystal forms are brought into intimate contact, the heat of activation is reduced and superheating no longer occurs.

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