LETTERS TO THE EDITORS

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The Helium-3 Problem of the Atmosphere

IN a communication in the *Zeitschrift für Naturforschung* of August 2, 1950, we have reported our attempts to prove the presence of tritium (H_3) in the atmosphere. The free atmospheric hydrogen, which is found in the air in a concentration of 5×10^{-7} , was burned with copper oxide out of the helium-neon fraction of an air-liquefaction plant. The water was electrolysed down to one-fortieth of its volume in order to enrich the tritium twenty times. The tritium-containing hydrogen of the enriched water was used to make ethane, the activity of which could easily be examined. According to our measurements, about one mole of elementary tritium is present in the whole dry atmosphere of the earth, or one atom of tritium in 10 cm^3 of air. Evidently this tritium has been produced by nuclear fission in the upper layers of the atmosphere, and did not take part in the atmospheric water circulation, but has remained elementary hydrogen.

Now it is possible to compare the amount of helium-3 found in the earth's atmosphere with that produced in the course of the earth's history by tritium, which has a half-life of 12 years, breaking down to helium-3. For this purpose it is necessary to have a precise total balance for the tritium. We have, indeed, determined the amount of tritium in the free hydrogen of dry air; but it is to be expected that a much higher amount of tritium will take part in the water circulation of the atmosphere. On one hand this amount can be estimated from kinetic relations and the distribution of the cosmic radiation intensity; on the other hand, the measurements of Willard F. Libby (Chicago) and A. V. Grosse (Temple University), published in *Time* of September 25, 1950, give the concentration of tritium in rain water as 10^{-18} , from which follows the interesting result that there is an enrichment of about 10,000 in atmospheric hydrogen compared with rain water.

If the intensity of the cosmic radiation has always been the same as now, and taking 3.6×10^9 years for the age of the earth, there should be 2×10^7 atoms of helium-3 in 1 cm^3 of air under normal conditions, if only the tritium in the free hydrogen of the dry atmosphere is taken into account. In fact, there are 1.5×10^8 atoms of helium-3 in 1 cm^3 of air. It is obvious that this estimated concentration of helium-3 is only one-eighth of that really found.

However, the cosmic radiation may have produced primarily as much helium-3 as tritium; furthermore, a large part of the tritium has certainly come into the water circulation. With an assumed mean annual rainfall of 18 cm., averaged over the whole earth, and a concentration of tritium of 10^{-18} , as measured by Libby and Grosse, the estimated figure for the concentration of helium-3 should rise to about 5×10^8 atoms/ cm^3 . In this case most of the helium-3 must have left the earth.

By measuring the concentration of tritium in several samples of C_2D_6 prepared from heavy water, we hope to get a fairly accurate value for the tritium content of the whole earth, which would form a

necessary base for discussing the problem of the loss of helium-3 from the atmosphere.

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Alpha-Particle Scintillations in Organic Compounds

THE papers¹⁻⁷ previously published on organic luminescent materials do not enable a direct and reliable comparison of their conversion efficiencies (conversion of incident radiation energy into light energy) to be made. This is so because different types of photomultipliers have been used and not all the compounds have been investigated with similar radiation. Further, the results reported are not consistent. Most of the materials previously used have been re-investigated in this laboratory under the same conditions in each case and their efficiencies as scintillation counters assessed. The effective use of a fluorescent material depends on the spectral response of the photomultiplier and on the wavelength of the light emitted when a scintillation takes place. The results presented are therefore of additional interest, as RCA 931 type photomultipliers were used to obtain the major part of the information available in the literature, whereas the results given here were obtained with an EMI 5311 photomultiplier which has a different response. In addition, materials not so far reported on have been investigated.

Results obtained with α -particles seem to provide the most satisfactory basis of comparison. Integral bias curves have been obtained using α -particles (6.04 and 8.72 MeV.) from thorium C and C'. This procedure has the further advantage that thin crystals with an area of one or two square millimetres are adequate. The crystals chosen were as thin as possible, consistent with stopping all the α -particles. In this way, the β - and γ -ray background was kept to a minimum. Results were considered reliable only if the integral bias curve showed two α -particle groups indicating complete stoppage of the lower group, which could therefore be used for comparing the performances of the compounds.

To ensure that measurements of this type shall be reliable, it is necessary to pay particular attention to the purity of the samples⁸. As only a few small crystals were required, it was possible to obtain a good deal of purification by recrystallization from

Integral bias curves for organic phosphorus using α -particles from thorium C and C': (1) anthracene; (2) naphthalene; (3) chrysene; (4) 1,4 diphenyl butadiene; (5) 2,2' dinaphthyl; (6) stilbene