We take pleasure in recording our indebtedness to Professor Urey and his colleagues, Professors Zanetti and La Mer, for the deuterium gas used in most of these experiments. Our first observations were made with a sample of heavy water presented to us more than a year ago by the late Dr. Washburn. To our colleagues O. Dahl and C. F. Brown, and Dr. J. A. Fleming, Acting Director of this Department, we record our grateful thanks for their assistance and support.

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The Relation of the Positron Energy Spectrum to the Decay Constant and to the Energy of the Bombarding Protons

We have reported[1] approximate energy distributions of the positrons emitted by various substances activated by proton or deuton bombardment. A typical photograph is reproduced in Fig. 1. To find whether a relation exists

FIG. 1. Magnetic field 800 gauss. Disintegration positrons from carbon target after bombardment by 900,000 electron-volt deutons.

between the maximum energy of the bombarding particles and the energies of the disintegration positrons we have studied numerous samples of carbon bombarded by protons at peak voltages of 900,000 and 700,000, supplied us by Dr. Lauritsen and Mr. Crane. The results of cloud chamber measurements on these samples are shown in Figs. 2 and 3, in which the number of tracks in two overlapping sets of 200,000 volt intervals is plotted against energy in electron-volts. The existence of a definite energy limit to the positron spectrum is not established, but we may infer something as to the relative limits in the above two cases by ignoring the small tail and extrapolating to

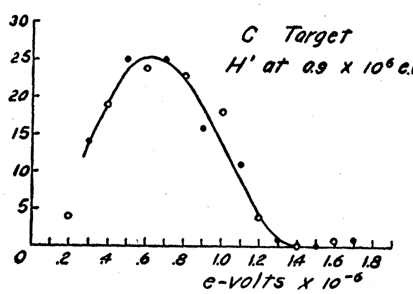

FIG. 2.

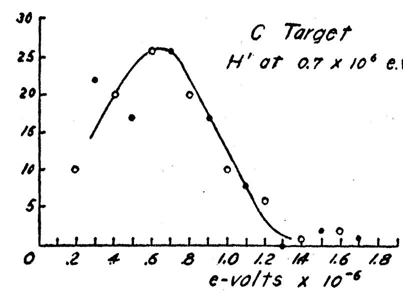

FIG. 3.

the energy axis the declining portions, and comparing intercepts. We find in this way about 1.3×10^6 e.v. for both curves and conclude that the disintegration energy within experimental uncertainties is not a function of the energy of the bombarding particles. As a further check on this conclusion we compared the mean energy of the disintegration positrons from the above targets activated at the two different voltages, with results as shown in Table I, which gives the data obtained from two independent measurements on the same sets of photographs,

TABLE I.

Maximum energy of bombarding proton	Mean positron energy	Number of tracks	
0.7×10^6 e.v.	0.64×10^6 e.v.	157	First meas.
.9	.69	103	
.7	.67	95	Second meas.
.9	.70	93	

the second measurement representing a more critical choice of only the sharpest tracks. Whereas the difference in energy of the protons was 200,000 e.v., the difference in mean positron energy was, for the two sets of measurements, only 50,000 and 30,000 e.v., respectively.

As we have previously stated[1] there exists a rough connection between the energies of the disintegration positrons and the disintegration probability. That the upper limits of the β-ray spectra of natural radioactive bodies and the disintegration probabilities are related by a quite definite law, which in its general character is similar to the Geiger-Nuttall law for the α-disintegrations, has been pointed out by Sargent.[2] For convenience we

[1] Neddermeyer and Anderson, Phys. Rev. **45**, 498 (1934).

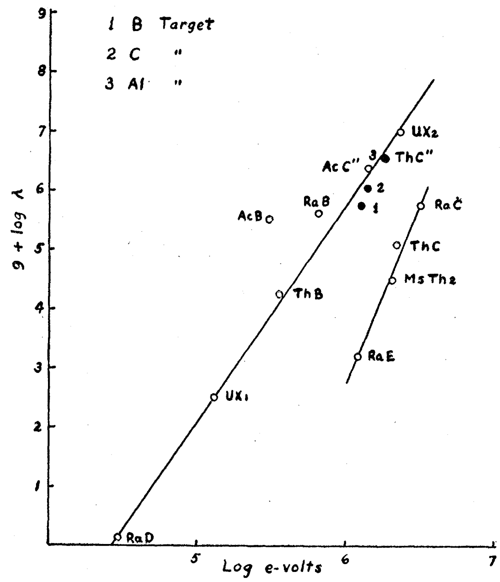

FIG. 4.

have reproduced his results in Fig. 4, where log λ(sec.$^{-1}$) is plotted against log energy in e.v. of the upper limit of the β-spectrum. It is seen that the elements fall into two main groups, each fitting rather closely a straight line. Ac B definitely does not fit but suggests the presence of a third group as Sargent states. Using the data of Crane and Lauritsen[3] for the half-lives of B (20 min.) and C (10.3 min.) activated by deutons, and of Henderson, Livingston and Lawrence[4] for the half-life of Al (3 min.) activated by deutons, and our own data on the energies (taking the intercepts, found as discussed above, to be very rough values for the upper limits of energy), we have found these three cases of positron disintegration to fit rather closely one of the curves on Sargent's diagram. It is a remarkable fact that C^{11}, N^{13}, and the as yet unidentified active product obtained from the Al target fall so close to the curve drawn for the natural radioactive bodies, considering the great difference in atomic number and in the type of disintegration (positron as compared with negatron) between these two classes of radioactive substances.

It is interesting to note that potassium, which is known to emit β-particles, does not lie on either of the above curves. Our measurements of the energies of the β-particles from potassium showed numerous cases in which the negatrons (no positrons were here observed) had energies exceeding 700,000 e.v., greater in order of magnitude than the energies to be expected on the above relation using 4.4×10^{16} minutes as the half-life of potassium. The radioactive potassium nucleus, therefore, in view of its disintegration energy, in comparison with other known negatron or positron emitters, is abnormally stable.

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[2] Sargent, Proc. Roy. Soc. **A139**, 659 (1933).
[3] Crane and Lauritsen, Phys. Rev. **45**, 430 (1934).
[4] Henderson, Livingston and Lawrence, Phys. Rev. **45**, 428 (1934).

Infrared Absorption by Rochelle Salt Crystals

Optical tests were made of the theory that the change at 23°C in the very great dielectric constant of Rochelle salt crystals is due to a change in the polarizability of the molecules of the water of crystallization. Such a change in polarizability should result in a shift in the absorption bands due to the water of crystallization which appear in the near infrared.

Since the transmissibility of the crystal is very low in this region of the spectrum, it was necessary to prepare thin slabs of the substance for the tests. It was found feasible to prepare crystal plates ranging from one-quarter to one-half of a millimeter. These plates were made by first polishing a properly oriented cut and then scraping out a depression about one millimeter deep into the thick crystal plate. After the depression was polished, the crystal was cut parallel to the face so that the resulting plate was thick around the edges but contained a thin window in its central portion. Plates were made in this way for each of the principal crystallographic directions.

In making the tests a Hilger infrared spectrometer was used. The light source was a Nernst glower, and the crystal was so arranged that it could be inserted or withdrawn from the light beam at will. Since continuous passage of light through the crystal produced a gradual rise in temperature, a shutter was used to control the beam of light. The temperature of the crystal was indicated by a thermocouple pressed against its surface. Readings of light transmission were taken after a small definite rise in temperature had taken place.

Measurements were also taken using polarized light. With the light travelling along the *b* direction it was found that the absorption maxima are considerably more pronounced when the electric vector is in the *a* direction. However the wave-lengths at which they occur appear to be practically the same in all cases and their displacement with temperature remains unaltered. These absorption maxima were found at 1.55, 2.15 and 3.05 microns when the temperature of the crystal was 27°C. When the temperature was lowered to 18°C they were uniformly displaced by about 0.1 micron toward shorter wave-lengths. The former temperature is above and the latter is below the critical temperature of 23°C at which the substance loses its high dielectric and piezoelectric property. Any shift due to a change in polarizability of the molecules of

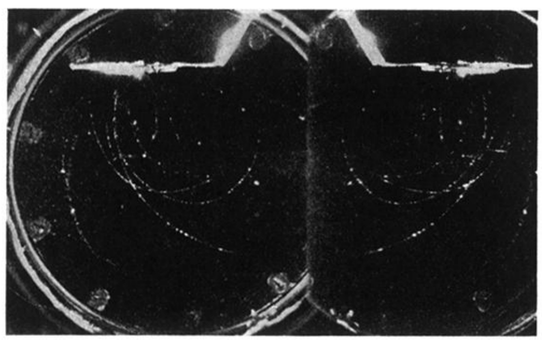

FIG. 1. Magnetic field 800 gauss. Disintegration positrons from carbon target after bombardment by 900,000 electron-volt deutons.