reactions will show a difference in energy due to the different zero point energies of NaOD and NaOH. The former having the smaller zero point energy, the barrier will be lower, when NaOD is formed. Formation of NaOD would therefore be preferred. An estimate of the effect of zero point energy makes it possible to assume that this is sufficient to account for the ratio of the two reaction rates actually found.

Obviously the difference in the 'leakage' of the particles H and D would also lead to a preference of the observed reaction.

We wish to express our thanks to Prof. Polanyi for valuable discussions.

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[1] *J. Amer. Chem. Soc.*, **56**, 492, Feb. 1934.
[2] Cremer and Polanyi, *Z. phys. Chem.*, B, **19**, 443, 1932.
[3] Horiuti and Polanyi, NATURE, **132**, 819, Nov. 25, 1933.
[4] This has also been independently recognised by H. Eyring, *Proc. Nat. Acad. Sci.*, **19**, 78; 1933.

Production of Induced Radioactivity by High Velocity Protons

CURIE and Joliot[1] have reported that a number of new radioactive isotopes can be produced by the bombardment of various elements with α-particles, these isotopes emitting positive electrons. In particular, they showed that boron when bombarded by α-particles was transformed to the isotope N^{13}, radionitrogen, this isotope having a half life of 14 minutes. They suggested that the isotope might be produced by the bombardment of carbon with heavy hydrogen, the product, N^{14}, disintegrating with the emission of a neutron to radio-nitrogen.

We have bombarded a target of Acheson graphite with *protons* of 600 k.v. energy and have used a Geiger counter to search for any radiations produced after the bombardment ceased. After bombardment for 15 minutes with a current of about 10 microamperes of protons, the target was removed from the apparatus and placed against the Geiger counter. We then observed about 200 counts per minute, being about forty times the natural effect. The number of counts decayed exponentially with time, having a half life of $10{\cdot}5 \pm 0{\cdot}5$ minutes.

We then carried out an experiment similar to that performed by Becquerel, in which the source was placed on one side of a 9 mm. thick lead plate with the counter on the opposite side, the whole being placed in a magnetic field, so that any electron emitted could only reach the counter by applying a field of appropriate sign and magnitude. We found that when the field was such that positive electrons could reach the counter, the number of counts increased by a factor of 3; when the field was in the reverse direction no definite increase was observed. We conclude, therefore, that the radiations consist in part at least of positive particles.

We have also taken about 250 Wilson chamber photographs in a field of 2,000 gauss, placing the activated source against the outside of the chamber wall, which was about 3 mm. thick. Under these conditions, we observed only two electrons of positive curvature which could possibly have come from the source, these electrons having energies of the order of 500 k.v. We observed, on the other hand, 48 tracks of Compton electrons starting in the gas, having energies ranging from 100 k.v. to 500 k.v., suggesting the emission of γ-rays of energy between 500 k.v. and 1 million volts. These γ-rays may result from the annihilation of the positive electrons, presumably in the glass wall of the chamber. The deflection experiments, whilst not at present precise, tend to confirm that few of the positive electrons would have sufficient energy to penetrate the glass walls. Further experiments will, therefore, be carried out with the source inside the chamber.*

The observations suggest that the unstable isotope N^{13} is produced by the addition of a proton to C^{12}. The difference between the half life observed and that reported by Curie and Joliot may be due to the formation of N^{13} in a different excited state.

No marked increase in the number of counts was observed when a mixed beam of heavy hydrogen ions and protons was substituted for the proton beam.

We are very much indebted to Dr. K. T. Bainbridge, who supplied the Geiger counter with which the observations were made.

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* February 27. Experiments carried out with a counter having a mica window of small stopping power gave a great increase in the number of counts owing to the positive electrons now entering the counter. The absorption curve of the positive electrons is similar to that of negative electrons of 800 k.v. energy.

[1] *Comptes rendus*, **198**, 254; 1934.

A Perturbation in the Spectrum of Se II

WHEN the analysis of the spectrum of Se II has been completed, it is observed that the quartet

$$
\begin{aligned}
& & & \nu\ \text{(int.)} \\
4p\ {}^4S_{1\frac{1}{2}} & - 5s\ {}^4P_{1/2} & = & \ 95270\ (10) \\
& - 5s\ {}^4P_{1\frac{1}{2}} & = & \ 96753\ (10) \\
& - 5s\ {}^4P_{2\frac{1}{2}} & = & \ 98676\ \ (4)
\end{aligned}
$$

due to the fundamental transition $4p \rightarrow 5s$ exhibits abnormal relative intensities of its components. The intensity ratio of these lines, according to Burger and Dorgelo's rule, should be 2 : 4 : 6, the line $S_{1\frac{1}{2}} - P_{2\frac{1}{2}}$ being thus the brightest and the most easily excitable of the group, whereas in Se II, it is extremely faint under all the variety of experimental conditions of excitation in which the group has been photographed. The corresponding quartets in other similar spectra, hitherto known, do not show this anomalous feature.

In Se II this must obviously be a perturbation in intensity arising from the mutual interaction of adjacent spectral terms; for our analysis has revealed a clear interpenetration of the levels due to the $5s$ and $4d$ configurations, while in the lighter elements there is a somewhat large separation between these two groups of energy states.

Excepting this intensity anomaly, the other characteristics of Se II are found to be generally analogous to those of As I or S II. Full details of this scheme will be published shortly.

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