respectively, at the proper times to give the moving electrons maximum acceleration. The end of the last line was grounded through a resistance to prevent "floating" while the ground wires were attached to the grounded side of the condenser. By means of the above arrangement with a spark gap distance between the spheres corresponding to 300,000 volts we have obtained electrons with energies of 1.3×10^6 volts, i.e., each transmission line effectively adds 260,000 volts to the energy of the electrons or 86 percent of the spark gap voltage. In view of these first results we believe that with an extension of this method in which a larger number of transmission lines are used it may be possible to secure electron energies of many times that already obtained. However, it should not be overlooked that the potential surge or wave produced by a spark in air has a finite slope and that the total effective surge impedance of the lines decreases with increasing number of lines so that for the present condenser spark gap system the number of lines cannot be advantageously increased beyond a certain limit. Yet on the other hand the potential increases at reflection at the end of each line. Also some recent measurements made by Mr. J. W. Flowers in this laboratory indicate that potential surges many times steeper than those produced by an ordinary spark in air can be obtained.

It is a pleasure to record our indebtedness to Dr. L. B. Snoddy for many helpful discussions and to the Virginia Academy of Sciences for a grant that made possible the construction of the Van de Graaff generator.

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The Mass of the Neutron from the Nuclear Reaction $H^2+H^2\rightarrow He^3+n^1$

In recent experiments by Oliphant, Harteck and Rutherford,[1] and by Dee,[2] compounds containing H^2 were bombarded with deutons of energies up to 0.1 m.e.v. In addition to two groups of charged particles, neutrons were observed in large numbers. This neutron emission was best accounted for by assuming the process

$$H^2+H^2\rightarrow He^3+n^1. \quad (1)$$

The He^3 was not detected; however momentum considerations based upon the measured neutron energy lead to an expected range for the He^3 particles of only 5 mm, a range too short to be observable in these experiments.

One notes that the mass-energy relation of Eq. (1) may be used for a determination of the mass of the neutron. Thus:

$$n^1=2H^2-He^3+T(H^2)-T(He^3)-T(n^1). \quad (2)$$

The mass of He^3 has been obtained[1, 3] from the reaction

$$Li^6+H^1\rightarrow He^3+He^4. \quad (3)$$

Hence, if we assume the validity of process (1), the measurement of the mass of He^3 from (3), the absence of gamma-ray emission in both (1) and (3), and an accurate measurement of the neutron kinetic energy, reaction (1) yields an accurate value for the mass of the neutron.

However, Oliphant, Harteck and Rutherford obtained two different values of the He^3 nuclear mass;

(a) $He^3=3.0155$ if the Li^6 nuclear mass equals 6.0129 ±0.0003 as obtained by Bainbridge,[4]

(b) $He^3=3.0167$ if the Li^6 nuclear mass equals 6.0141[5] as obtained from the data[6] of the reaction

$$Li^6+H^2\rightarrow 2He^4. \quad (4)$$

The maximum neutron energy was measured by Oliphant, Harteck and Rutherford, and by Dee as about 2 m.e.v. From momentum considerations, neglecting the impulse of H^2, the kinetic energy He^3 equals 0.7 m.e.v. The mass of H^2 is 2.0131; its kinetic energy is 0.1 m.e.v. The mass of the neutron is, therefore,

(a) 1.0079 if Bainbridge's Li^6 is used,

(b) 1.0067 if the Li^6 is taken from (4).

The emission of gamma-radiation from lithium bombarded by protons has been observed.[7] If this is associated with (3), the mass of He^3 may be lowered and that of the neutron raised. No study of gamma-ray emission for (1) has yet been reported.

The purpose of this letter is not to stress the specific values of the neutron mass above, but to point to the likelihood that reaction (1) may lead to a reliable value of the neutron mass.

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May 17, 1934.

[1] Oliphant, Harteck, and Rutherford, Nature **133**, 413 (1934): Proc. Roy. Soc. **A144**, 692 (1934).
[2] Dee, Nature **133**, 564 (1934).
[3] Wu and Uhlenbeck, Phys. Rev. **45**, 553 (1934).
[4] Bainbridge, Phys. Rev. **44**, 56 (1933).
[5] The probable error is not given by *O*, *K*, *R*, but we estimate it from their data to be about ±0.0002 m.u.; hence we retain both values of the mass of He^3 in the calculation.
[6] Oliphant, Kinsey, Rutherford, Proc. Roy. Soc. **A141**, 722 (1933).
[7] R. v. Traubenberg, Eckardt, and Gebauer, Naturwiss. **21**, 694 (1933); Crane and Lauritsen, Phys. Rev. **45**, 63 (1934).