Absorption Curve of 31-Second $_{8}\mathrm{O}^{19}$ Beta-Rays and Cross Section for Production by Thermal Neutrons*

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THE absorption of 31-second $_{8}\mathrm{O}^{19}$ beta-rays has been measured by irradiating ordinary distilled water in the Argonne pile. The beta-rays were counted on a Duraluminum-walled Geiger counter. Aluminum absorbers up to 0.875 gram per cm^2 were used, and one point was taken with a 1.84 gram per cm^2 Pb absorber. (See the attached graph, Fig. 1.) From the absorption curve the range can be estimated as ~1.4 grams per cm^2 Al which corresponds to 3 Mev beta-rays. A further check on the energy is obtained by comparing the mass absorption coefficient of the $_{8}\mathrm{O}^{19}$ beta-rays with that from $_{13}\mathrm{Al}^{28}$ and $_{19}\mathrm{K}^{42}$ beta-rays which we measured on the same geometry. For 31 sec. $_{8}\mathrm{O}^{19}$ beta-rays, we got $u = 2.56$ cm^2 per gram Al. For 2.4 min $_{13}\mathrm{Al}^{28}$ beta-rays, we got $u = 2.5$ cm^2 per gram Al, and a cloud-chamber measurement[1] of the energy of these beta-rays gave 3.4 Mev. For 12.4 hr. $_{19}\mathrm{K}^{42}$ beta-rays, we got $u = 2.56$ cm^2 per gram Al, and a cloud-chamber measurement[2] of the energy of these beta-rays gave 3.5 Mev.

From the range and absorption coefficient data, it would seem reasonable to conclude that the energy of the $_{8}\mathrm{O}^{19}$ beta-rays is about 3.3 Mev. Gamma-rays also accompany the 31-sec. activity, as shown by the point on the absorption curve taken with the Pb absorber.

In addition to the 31-sec. beta-rays, we observed a half-life of ~4 minutes, probably caused by an impurity in the water. The saturation value of the ~4-minute activity was ~25 percent of the 31-sec. activity.

John Marshall[3] has measured the thermal neutron activation cross section[4] of $_{8}\mathrm{O}^{18}$ assuming that $_{8}\mathrm{O}^{19}$ beta-rays had the same absorption coefficient as UX_{II} beta-rays. On the same geometry that we used to measure the absorption coefficient of $_{8}\mathrm{O}^{19}$ beta-rays, we obtained $\mu = 4.88$ cm^2 per gram for UX_{II} beta-rays. Hence, Marshall's value of 3.5×10^{-4} barn[5] for the thermal neutron activation cross section of $_{8}\mathrm{O}^{18}$ is high because he assumed $_{8}\mathrm{O}^{19}$ beta-rays to be less penetrating than they actually are. A correction was made as follows: Counter wall used in Marshall's measurements was 0.050 gram per cm^2 Al, thickness of water layer used was 3 mm or 0.3 gram per cm^2. One-half of the water layer was the effective self-absorption thickness. Hence, the beta-ray absorption correction factor

$$\exp^{-(4.88-2.56)(0.050+0.150)} = \exp^{-0.464} = 0.63$$

reduces the activation cross section of $_{8}\mathrm{O}^{18}$ to 2.2×10^{-4} barn and the activation cross section for the normal oxygen atom is 4.4×10^{-7} barn. (The abundance of $_{8}\mathrm{O}^{18}$ in normal oxygen is 0.20 percent.)

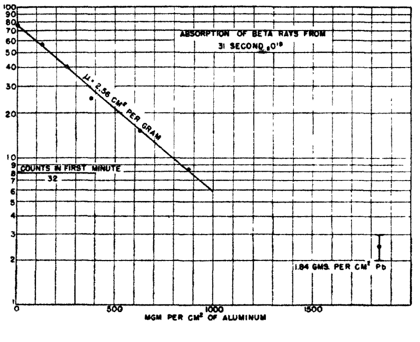

FIG. 1. Absorption of β-rays from O^{19}.

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[1] J. M. Cork, J. R. Richardson, and F. N. D. Kurie, Phys. Rev. **49**, 208 (1936).

[2] F. N. D. Kurie, J. R. Richardson, and H. C. Paxton, Phys. Rev. **49**, 368 (1936).

[3] To be published in the Manhattan Project Technical Series.

[4] A survey of all thermal neutron activation cross sections measured at the Argonne Laboratory will be published shortly in *The Physical Review*.

[5] A barn equals 10^{-24} cm^2.

Proposal of a Method for the Separation of He^3 from He^4

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THE isotope He^3 is present in helium according to Alvarez and Cornog in a concentration 10^{-7} to 10^{-8}. In a discussion with Earl Long about the problem of how to separate this rare He isotope from the bulk of He^4, it occurred to the present author that the superfluid state of liquid helium may offer an opportunity to carry out a separation process.

In London's theory the occurrence of superfluidity is explained as a quality acquired at very low temperatures by an atomic species obeying the Bose-Einstein statistic. He^4 having no spin is supposed to follow this statistic; but for He^3, which has odd nuclear spin, the rules of the Fermi statistic are valid and, correspondingly, no superfluid state is expected to occur for this isotope. Therefore, a great enrichment of He^3 in liquid He may be achieved by letting the bulk of He^4 run out of a container on account of its superfluidity, while He^3 is expected to remain in the residue.

If such an experiment should prove to be successful, it would not only have the practical value of producing a supply of He^3 to be used for experiments in nuclear physics, but would at the same time offer direct evidence in favor of London's theory.

The drawback of the proposed experiment is the fact that greater quantities of liquid helium (about 10 liters) are needed to carry it out. Since such amounts are usually not available, this proposal is published to bring it to the attention of those laboratories in which the special equipment for the production of greater quantities of liquid He is available.