LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Nuclear Fission of Separated Uranium Isotopes*

Small quantities of the uranium isotopes have been isolated by means of a mass spectrometer similar to several employed by one of us[1] for the measurement of relative abundance of isotopes. In the present apparatus U ions are produced by sending a beam of electrons ($\sim 10^{-4}$ amp.) through a slit in one end of a hollow Nichrome box containing a small piece of solid UBr_4. The box ($1.2\times1.2\times1.8$ cm) was heated to a temperature of several hundred degrees centigrade by a heater wrapped around it. This temperature was sufficient to give a vapor pressure of UBr_4 in the box estimated to be 10^{-2} mm. Positive ions formed by collisions of the electrons with the vapor molecules were drawn out of the box through a slit (13×0.35 mm) in one side. The ions were given an energy of approximately 1000 volts in passing between the box and a slit (also 0.35 mm wide) in a plate 8 mm from the box. The ions traveled in a semi-circular analyzer tube having a radius of 17.8 cm, the entire mass spectrometer tube being mounted between the poles of a large electromagnet.

The U^{238} ions were collected on an insulated Nichrome plate (2×15 mm) and the current was measured with an electrometer tube. The U^{235} ions were collected on a grounded plate also made of Nichrome. The resolution was such that the U^{238} background in the 235 and 241 positions was less than 3 percent of the U^{238} peak height. The resolution was not sufficient to separate U^{234} from U^{235}.

Two separate runs were made. In the first of these, the U^{238} ion current averaged 2×10^{-9} amp. for a period of 10 hours, and in the second 3.4×10^{-9} amp. for 11 hours. This corresponded to U^{238} deposits of 1.7×10^{-7} g and 2.9×10^{-7} g, respectively, provided all the ions stuck. The corresponding U^{235} deposits would be 1/139 of these amounts.

The fission of the separated uranium isotopes has been tested by placing the samples in an ionization chamber connected to a linear amplifier system, and bombarding with neutrons from the Columbia cyclotron which had been slowed down in paraffin.

With high neutron intensities there is always a residual "fission background" in an ionization chamber, presumably due to the presence of very small amounts of uranium or other elements which produce fission. This background sets a lower limit to the amounts of uranium which can be used for fission tests, regardless of the neutron intensity. By careful construction and cleaning this background was reduced to 0.15 ± 0.02 fission/minute, which corresponds to an amount of uranium which would give about 1 alpha-particle per hour.

The results of the tests are shown in the following table. The background has been subtracted.

	Isotope	Fissions/minute
Run 1	U^{238}	0.01 ± 0.04
	U^{235}	0.50 ± 0.05
Run 2	U^{238}	0.00 ± 0.04
	U^{235}	0.81 ± 0.10

The rate of fission per microgram of U^{235} observed above is in good quantitative agreement with the number obtained under the same experimental conditions from unseparated samples of uranium containing the normal percentage of U^{235}. When the ion chamber containing the U^{235} sample was surrounded with Cd to absorb the thermal neutrons, the number of fissions observed was less than 0.1 per minute. The quantity of U^{238} was too small to demonstrate with certainty that it produces fast neutron fissions.

Tests of the backs of the sample strips gave no fissions above background within the limits of error, indicating that the general uranium contamination was probably very small, if any.

These results strongly support the view that U^{235} is the isotope responsible for slow neutron fission, as predicted on theoretical grounds by Bohr and Wheeler.[2] On this basis, the cross section for U^{235} fission by slow neutrons would be about 400 to 500×10^{-24} cm^2. These experiments cannot exclude U^{234} completely, however, for it was also deposited on the U^{235} strips. Since U^{234} is present to only 1 part in 17,000, it is hardly likely that it can be responsible.

These experiments emphasize the importance of uranium isotope separation on a larger scale for the investigation of chain reaction possibilities in uranium.

The UBr_4 used in these experiments was some given to one of us (A. O. N.) several years ago by Professor G. P. Baxter of the Harvard Chemistry Department and was the same material used in the measurement of the uranium isotope abundances.

Alfred O. Nier

Department of Physics,
University of Minnesota,
Minneapolis, Minnesota,

E. T. Booth
J. R. Dunning
A. V. Grosse

Department of Physics,
Columbia University,
New York, New York,
March 3, 1940.

* Publication assisted by the Ernest Kempton Adams Fund for Physical Research of Columbia University.

[1] A. O. Nier, Phys. Rev. **52**, 933 (1937); **53**, 282 (1938); **55**, 150 (1939).

[2] N. Bohr and J. A. Wheeler, Phys. Rev. **56**, 426 and 1065 (1939).