and electrons (the space charge) will be displaced in the direction of their deflection. The electron field at the cathode will no longer partially neutralize the ion field symmetrically as in Fig. 1A but will have a greater neutralizing effect in the direction of their displacement, because of the larger electron displacement, as shown in Fig. 1B. Thus, surprisingly enough, while each of the component fields is shifted to the right, the peak of the net field is shifted to the left, thus accounting for the observed motion of the spot.

If the magnetic field intensity is increased greatly in magnitude, the electron and ion fields will be separated to the point of resolution, and then further displacement of the electron space charge would not influence the position of the net field maximum which would then be solely a function of the ion space charge. The displacement of the latter, small though it is, now solely determines the motion of the cathode spot (see Fig. 1C). This theory thus demands that the spot motion should reverse its direction as the magnetic field is greatly increased. This reversal has, indeed, been observed.[2]

Random motion will be superimposed on those described above because of irregularities in the cathode shape which will cause variations in the net field.

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Activities Induced by Pile Neutron Bombardment of Samarium*

MARK G. INGHRAM, RICHARD J. HAYDEN, AND DAVID C. HESS, JR.
Argonne National Laboratory, Chicago, Illinois
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A SAMPLE of Sm_2O_3 was given a long neutron bombardment in the Hanford pile. By mass spectrographic analysis[1] active masses were observed at mass numbers 145, 151, 152, 154, 155, 156, 161, 167, 169, and 176. The interpretation of these active masses is given in Table I. Parentheses are placed about those half-lives which are tentative.

The assignment of samarium to certain of these active masses was made because samarium emits ions of form Sm^+ and SmO^+ from the heated oxide. The assignment of europium to other active masses was made because europium emits only as the metal. The 169 activity could conceivably have been caused by samarium, gadolinium, erbium, or ytterbium. Since no line was observed as mass 153 the possibility of samarium was ruled out. Gadolinium, which emits mostly as GdO^+, could have caused the line as could erbium or ytterbium emitting as Er^+ and Yb^+. However, since gadolinium was a known impurity in the samarium sample and no erbium or ytterbium impurities could be detected, it was concluded that the 169 mass line

TABLE I.

Mass No.	Ion	Active isotope	Half-life
145	$Sm^{145}+$	Sm^{145}	>72 days
151	$Sm^{151}+$	Sm^{151}	(~20 years)
152	$Eu^{152}+$	Eu^{152}	(~ 5 years)
154	$Eu^{154}+$	Eu^{154}	(~ 5 years)
155	$Eu^{155}+$	Eu^{155}	2–3 years
156	$Eu^{156}+$	Eu^{156}	15.4 days
161	$Sm^{145}O+$	Sm^{145}	>72 days
167	$Sm^{151}O+$	Sm^{151}	(~20 years)
169	$Gd^{153}O+$	Gd^{153}	>72 days
176	$Tb^{160}O+$	Tb^{160}	72 days

was caused by a gadolinium isotope of mass 153. The mass observed at 176 was caused by 72-day terbium[2] emitting at TbO^+.

The Sm^{145} was formed by (n,γ) reaction on Sm^{144}. It probably decays by K-capture or positron emission to 61^{145}. Since the ratio of blackening at 145 and 161 positions is that characteristic of samarium, the half-life of the 61^{145} cannot be of the same order of magnitude as the half-life of Sm^{145}. The half-lives of Sm^{145} and Gd^{153} were shown to be greater than 72 days by comparison with the decay of 72-day Tb^{160}. The Sm^{151} has previously been observed only in fission.[3] It decays with a half-life of roughly 20 years to Eu^{151}. The europium activities at masses 152 and 154 were formed by (n,γ) reactions on impurities of europium in the samarium sample. In addition an appreciable part of the 154 observed was formed by the reaction

$$Sm^{152} \xrightarrow{(n,\gamma)} Sm^{153} \xrightarrow{\beta,\ T_{\frac{1}{2}}=47\text{ hr.}} Eu^{153} \xrightarrow{(n,\gamma)} Eu^{154}.$$

The 2–3 year Eu^{155} was formed by the reaction

$$Sm^{154} \xrightarrow{(n,\gamma)} Sm^{155} \xrightarrow{\beta,\ T_{\frac{1}{2}}=21\text{ min.}} Eu^{155}.$$

It has previously been observed only in fission.[2] The 15.4-day Eu^{156} had also been observed only in fission. Here it was formed by (n,γ) reaction on the Eu^{155}. The cross section for this reaction was calculated to be roughly $14{,}000\times10^{-24}$ cm^2. This is the first example of the determination of an absorbing cross section for a radioactive isotope by means of the mass spectrometer. The half-life of the europium activity at the 156 position on the plate was shown to be 15.4 days by the following method. The active plate was placed successively against various parts of a larger photographic plate for times calculated to give equal intensity at the 156 position if the half-life were 15.4 days. Four exposures were taken for successive times of 5 days, 6.4 days, 9.2 days, and 15.8 days. The lines at masses 152, 154, and 155 became denser with successive exposure, but the intensity of the 156 lines remained constant thus verifying that the half-life of the Eu^{156} was actually 15.4 days. The half-lives of the Sm^{145}, Gd^{153}, and Tb^{160} were determined by a similar method.

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