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REACTIONS OF U238 WITH CYCLOTRON PRODUCED NITROGEN IONS

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REACTIONS OF  $U^{238}$  WITH CYCLOTRON PRODUCED

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## NITROGEN IONS

By

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The acceleration of  $N^{14}$  (+6) ions with the Berkeley Crocker Laboratory 60-inch cyclotron has made it possible to study nuclear reactions of these ions with  $U^{238}$ .

The following transmutation products have been observed:

$^{99}Zr^{247(?)}$ ,  $^{99}Zr^{246}$ ,  $^{99}Zr^{244}$ ,  $^{99}Zr^{246}$ ,  $^{99}Zr^{247(?)}$ ,  $^{99}Zr^{248}$ ,  $^{99}Zr^{243}$ , and other berkelium isotopes not yet identified. The identification of the elements was definitely established by their carrying on lanthanum fluoride precipitates and by their order of elution from a Dowex-50 ion exchange column.

The observed nuclear properties of these nuclides are summarized in Table I.

Table I  
Nuclides Produced by U<sup>238</sup> Plus N<sup>14</sup> Ions

Nuclide	Half-life	Radiation	Alpha energy (Mev)	Remarks
<sup>99</sup> 247(?)	7.3 min	EC(?) <sub>p</sub>	7.35	
<sup>99</sup> 246	minutes	EC		Observed only through growth of its 1.5-day <sup>Cf</sup> 246 daughter
<sup>Cf</sup> 244	45 min	α, EC(?)	7.15	
<sup>Cf</sup> 246	35.7 hr	α	6.75	
<sup>Cf</sup> 247(?)	~2.7 hr	EC		
<sup>Cf</sup> 248	225 day	α	6.26	
<sup>Bk</sup> 243	4.6 hr	EC, α	6.72 (30%) 6.55 (53%) 6.20 (17%)	
<sup>Bk</sup> 245	days	EC		Observed K x-rays; probably unresolved mixture of <sup>Bk</sup> 245 and <sup>Bk</sup> 246

The nuclides <sup>Cf</sup>244, <sup>Cf</sup>246, <sup>Cf</sup>248, <sup>Bk</sup>243, and <sup>Bk</sup>245 have previously been observed in this laboratory.<sup>2,3</sup>

The yields of the transcurium nuclides were low even though bombardment currents of 0.1 microampere of N<sup>14</sup> (+6) ions of energy greater than 100 Mev were available. In three separate experiments a total of 40 alpha-emitting atoms of the 7.3-minute isotope of element 99 were observed to decay in the ion exchange column fraction immediately preceding californium, namely the aka-holmium position. Thus, the element identification is certain though the mass number can only be inferred on the basis of nuclear systematics. By observation of the

abundant fission product activity it was found that almost all of the nuclear reactions of nitrogen ions with  $U^{238}$  resulted in fission much as in the case of carbon ion bombardment of the same nucleus.

It is a pleasure to acknowledge the continued help and encouragement of Professor Joseph G. Hamilton, Director of the Crocker Laboratory. Our grateful thanks are extended to William B. Jones and the members of the 60-inch cyclotron operating crew for their cooperation in making the many bombardments necessary for this work. Special thanks are due to Dr. Gregory Choppin for his valuable assistance with some of the chemical separations. It is a privilege to acknowledge that this work was accomplished with the always helpful guidance of Professor Glenn T. Seaborg. The continued interest and encouragement of Professor Ernest O. Lawrence is gratefully acknowledged.

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<sup>1</sup>Rossi, Jones, Hollander, and Hamilton, Phys. Rev. (this issue).

<sup>2</sup>Hollander, Perlman, and Seaborg, Revs. Modern Phys. 25, 469 (1953).

<sup>3</sup>E. K. Hulet, Ph. D. Thesis, University of California Radiation Laboratory Unclassified Report UCRL- 2283 (July 1953).