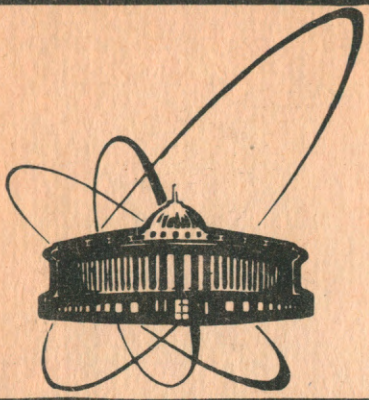

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TARGET RESIDUES FROM THE REACTION OF 3.65 AGeV ^{12}C WITH ^{232}Th AND ^{238}U

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Фрагментация мишеней ^{232}Th и ^{238}U
при взаимодействии с ядрами ^{12}C
при энергии 3,65 АГэВ

Методом гамма-спектроскопии в режиме "off-line" измерены сечения радионуклидов, образованных в реакциях $^{12}C + ^{232}Th$ и $^{12}C + ^{238}U$ при энергии 3,65 АГэВ.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1989

Kozma P., Ilyushchenko V.I., Kliman J. E1-89-482

Target Residues from the Reaction
of 3.65 AGeV ^{12}C with ^{232}Th and ^{238}U

The cross sections for the production of about a hundred different radionuclides from the reaction of 3.65 AGeV ^{12}C with ^{232}Th and ^{238}U were measured by off-line gamma-ray spectroscopy.

The investigation has been performed at the Laboratory of High Energies, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna 1989

In the present paper we report for the first time on the measurements of cross sections of residual nuclei resulting from the interaction of 3.65 AGeV ^{12}C with ^{232}Th and ^{238}U. Previous studies of relativistic heavy ion induced reactions have shown the production, in large amounts, of "heavy" target residues. They range in mass essentially from the target down to very light nuclei. In order to measure cross sections efficiently for this large variety of products, the technique of nondestructive analysis of the target using high-resolution gamma-ray spectroscopy was chosen.

The experiment was performed using the external beam of the Dubna synchrophasotron. The targets were thorium and uranium foils with a thickness of 20-150 mg/cm^2 evaporated on a thin aluminium layer surrounded by 17.5 mg/cm^2 catcher foils. The target stacks were preceded on the upstream side by three 20 mg/cm^2 aluminium foils. The induced ^{24}Na activity in the central Al foil, along with the known cross section /1/ for the $^{27}Al(^{12}C,X)^{24}Na$ reaction of 19.0 mb was used to calculate the beam flux.

Gamma-ray spectroscopic measurements of the radioactivity induced in the targets were performed as described in detail in ref. /2/. Spectra were analysed with computer codes SAMPO /3/ and GSA /4/. Radionuclides were identified on the basis of their gamma-ray energy, half-life, and relative gamma-ray abundance /5/. Recoil losses were measured as negligibly small.

The independent /I/ and cumulative /C^+ - neutron-deficient, C^- - neutron-excessive/ cross sections determined experimentally for individual radionuclides are listed in Table 1.

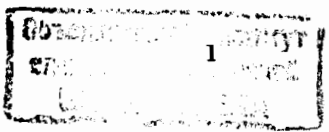

Table 1: Cross sections for the production of radionuclides in the interaction of uranium and thorium with 3.65 AGeV ^{12}C-ions

Nuclide	Type of yield	$\sigma(^{238}U)$ [mb]	$\sigma(^{232}Th)$ [mb]
^{24}Na	C$^-$	60±5	65±7
^{28}Mg	C$^-$	15±2	14±2
^{44}Sc	I	4.7±0.6	4.2±0.5
^{46}Sc	I	10.9±1.3	11.1±1.2
^{48}Sc	I	6.0±0.6	4.9±0.5
^{48}V	C$^+$	3.6±0.4	4.0±0.5
^{52}Mn	I	1.7±0.5	1.5±0.4
^{56}Mn	C$^-$	12.0±3.5	11.8±2.9
^{59}Fe	C$^-$	14.6±2.1	13.3±1.7
^{65}Zn	C$^+$	4.0±0.8	4.0±0.7
^{71}As	C$^+$	5.0±0.9	5.3±1.0
^{72}Zn	C$^-$	5.2±1.3	5.2±0.9
^{72}Ga	C$^-$		7.2±1.4
^{73}Ga	C$^-$	5.6±1.1	
^{74}As	I	8.3±1.4	8.0±1.1
^{75}Se	C$^+$	10.6±2.5	9.5±2.2
^{76}As	I	15.4±3.3	15.2±3.0
^{81}Rb	C$^+$	9.0±1.5	7.8±1.1
^{83}Rb	C$^+$	13.2±1.1	13.5±1.0
^{84}Rb	I	35±5	32±3
^{86}Zr	C$^+$	1.0±0.2	0.9±0.1
^{87}Y	C$^+$	17.3±2.0	20±2
^{88}Zr	C$^+$	9.6±1.5	10±1
^{89}Zr	C$^+$	13±2	13.5±1.7
^{90}Nb	C$^+$	5.4±1.0	4.7±0.8
^{91}Sr	C$^-$	30±5	
^{94}Tc	C$^+$	3.0±0.4	3.2±0.4
^{95}Tc	C$^+$	7.1±1.0	7±1
^{96}Tc	I	6.5±0.9	6.0±0.7
^{96}Nb	I	14.0±0.9	12.5±1.0
^{97}Zr	C$^-$		32±7
^{97}Ru	C$^+$	9.5±1.5	8.3±1.4
^{99}Mo	C$^-$	45±6	
^{100}Rh	C$^+$	7.2±2.1	
^{112}Pd	C$^-$	60±8	55±7

Table 1 (continued)

^{115}Cd		C$^-$	20±3	20±2
^{111}In		C$^+$	9.2±1.0	7.5±1.2
^{121}Te		C$^+$	15.0±1.2	15.0±1.1
^{122}Sb		I	12.8±1.3	13.3±1.4
^{124}Sb		I	8.5±0.8	9.4±0.9
^{124}I		I	6.8±0.7	6.5±0.6
^{125}Sn		C$^-$	6.6±0.5	6.0±0.5
^{126}Sb		C$^-$	4.2±0.4	4.0±0.4
^{126}I		I	10±2	10.0±1.6
^{127}Xe		C$^+$	10.8±2.5	9.9±1.7
^{127}Cs		C$^+$	9.4±1.5	9.5±1.7
^{127}Sb		C$^-$		11.5±1.2
^{128}Sb		C$^-$	7.6±1.5	6.2±0.9
^{129}Sb		C$^-$	7.7±1.6	7.0±1.1
^{128}Ba		C$^+$	4.8±0.7	4.5±0.6
^{129}Cs		C$^+$	17.6±2.0	20±2
^{130}I		I	8.5±0.8	9.4±1.1
^{131}I		C$^-$	22±2	20±2
^{132}Ce		C$^+$	3.2±0.9	3±1
^{133}I		C$^-$	17.4±2.3	15.5±2.1
^{133}Ce		C$^+$	4.5±1.0	4.5±0.9
^{135}Ce		C$^+$	9±1	10±1
^{135}I		C$^-$	12.4±1.9	12.0±1.8
^{136}Cs		I	12.8±1.1	12.0±1.6
^{139}Ce		C$^+$	7.8±0.9	8±1
^{140}Ba		C$^-$		15±1
^{143}Ce		C$^-$	10.3±1.6	10±1
^{145}Eu		C$^+$	9.9±0.7	
^{147}Eu		C$^+$	5.7±0.5	5.2±0.5
^{147}Gd		C$^+$	11±2	10.5±1.2
^{148}Eu		I	3.5±0.5	3.3±0.6
^{149}Gd		C$^+$	9.6±0.8	9.5±0.8
^{151}Tb		C$^+$	15±2	13.9±1.9
^{153}Dy		C$^+$	4.4±1.1	
^{155}Dy		C$^+$	6.5±1.2	6.6±1.3
^{166}Yb	57,5 m	C$^+$ 82	9.5±1.7	9.1±1.5
^{171}Lu	8,3 d	C$^+$ 842,854		10±2
^{173}Hf	23,6 h	C$^+$ 637	15±2	15.4±1.6
^{175}Hf	70 d	C$^+$ 343	20±3	20.4±2.8
^{184}Ir	3,2 h	C$^+$ 264	5.0±1.9	7.4±1.9

Table 1 (continued)

^{189}Ir	13,38м	c^+ 276	11±2	10±2
^{192}Au	4,1г	c^+ 588	10.5±1.4	9.1±1.2
^{201}Pb	9,4г	c^+ 946	3.9±0.5	4.1±0.5
^{203}Pb	52,1г	c^+ 401	4.3±0.7	5.0±0.9
^{203}Bi	11,8г	c^+ 1034	2.0±0.4	1.1±0.2
^{204}Bi	11,2г	c^+ 918	6.8±0.9	5.5±1.0
^{205}Bi	15,3дн	c^+ 1766	10.1±1.5	10.0±1.7
^{206}Po	8,8дн	c^+ 338	4.6±0.6	4.4±0.6
^{233}Pa	27дн	c^- 312	23±3	
^{237}U	6,75дн	c^- 371	185±25	200±30

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