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Interaction of ^{197}Au with 300 GeV protons: Cross sections and recoil properties in the A ∿ 130 mass region.*

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Cross sections and thick-target recoil properties of 8 products in the A ∿ 130 mass region from the interaction of ^{197}Au with 300 GeV protons have been determined. The results have been compared with similar data obtained at 11.5 GeV. Within the limits of error the results are the same at both energies.

NUCLEAR REACTIONS Measured σ, 2W(F+B), F/B of 8 I, Cs, and Ba nuclides from 300 GeV proton bombardment of ^{197}Au.

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The recent availability of 300 GeV protons at the Fermi National Accelerator Laboratory (FNAL) has led to a number of studies of their interaction with complex nuclei. Comparative measurements of a variety of cross sections have been performed at 300 and 10-30 GeV on vanadium[1], cobalt[1], silver[2,3], and uranium[4,5]. The recoil properties of selected products formed in the interaction of 300 and 10-30 GeV protons with uranium[4-6] and gold[6] have been determined. It appears that for the lighter targets, including silver, the cross sections are essentially independent of energy. On the other hand the cross sections of products from uranium tend to be lower at 300 than at 11.5 GeV, the difference becoming as large as 30% for certain nuclides[5]. Relatively little difference has been found in the recoil properties although both ranges and forward-to-backward ratios (F/B) tend to be somewhat lower at 300 GeV.

We report here the results of cross-section and recoil measurements on products in the A $\sim$ 130 mass region from the interaction of ^{197}Au with 300 GeV protons. We have recently published the results of similar experiments at 11.5 GeV[7] thereby permitting a comparison to be made.

Four irradiations with 300 GeV protons were performed in the Neutrino Hall at FNAL. Target stacks consisting of a 20 μm gold foil and 20 μm aluminum catcher and monitor foils were irradiated for approximately 10 hour periods. The bombardments were discontinuous and corrections were applied for these discontinuities as well as for variations in beam intensity. Iodine, cesium, and barium were radiochemically separated and γ-ray spectrometry was performed with a calibrated Ge(Li) detector. Except for the irradiations the procedure was identical to that employed at 11.5 GeV and our earlier study[7] may be consulted for relevant details.

The results are summarized in Table I. The cross sections are based on a value of 8.6 mb for that of the $^{27}Al(p,3pn)$ monitor reaction[8]. The listed uncertainties are based on the agreement between the indicated number of replicate determinations. Additional systematic uncertainties are $\sim$ 10%. The experimental recoil ranges, denoted by 2W(F+B), have been corrected by 3% for the effect of scattering at the target-catcher interface[9]. The uncertainties in these values as well as those in the F/B ratios are based on the agreement between replicate determinations. These data are free of any additional systematic errors.

Table I also includes the ratios of the cross sections and recoil properties determined at 300 GeV to those measured at 11.5 GeV[7]. The quoted uncertainties in these ratios are based on the random errors of the results obtained at each energy. Systematic errors cancel out in the ratios because all measurements were made on the same γ-rays with the same equipment. The various ratios are in most cases equal to unity within the limits of error. The weighted average values of the ratios were calculated using the reciprocals of the variances as the weighting factors. The results are: $\langle\sigma_{300}/\sigma_{11.5}\rangle = 0.96\pm0.05$, $\langle 2W(F+B)_{300}/2W(F+B)_{11.5}\rangle = 1.01\pm0.11$, and $\langle F/B_{300}/F/B_{11.5}\rangle = 0.93\pm0.10$. The cross sections and F/B values thus appear to be marginally smaller at 300 than at 11.5 GeV although the difference is within the experimental uncertainty.

The results may be compared with those previously reported[5] for products in the A $\sim$ 130 mass region from uranium at 300 and 11.5 GeV. For this target the weighted average values for the nuclides listed in Table I are $\langle\sigma_{300}/\sigma_{11.5}\rangle = 0.83\pm0.12$, $\langle 2W(F+B)_{300}/2W(F+B)_{11.5}\rangle = 0.96\pm0.06$, and $\langle F/B_{300}/F/B_{11.5}\rangle = 0.99\pm0.05$. It thus appears that the cross section ratios for the products of interest are somewhat higher for gold than for uranium. In this respect the results for gold are closer to those obtained for the lighter targets[1-3]. On the other hand, the recoil properties of these particular pro-

ducts are essentially independent of energy for both targets.

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References

1. S. Katcoff, S. B. Kaufman, E. P. Steinberg, M. W. Weisfield, and B. D. Wilkins, Phys. Rev. Lett. 30, 1221 (1973).
2. G. English, Y. W. Yu, and N. T. Porile, Phys. Rev. Lett. 31, 244 (1973).
3. G. English, Y. W. Yu, and N. T. Porile, Phys. Rev. C10, 2281 (1974).
4. S. K. Chang and N. Sugarman, Phys. Rev. C9, 1138 (1974).
5. Y. W. Yu and N. T. Porile, Phys. Rev. C10, 167 (1974).
6. S. B. Kaufman and M. W. Weisfield, to be published.
7. Y. W. Yu and N. T. Porile, submitted to Phys. Rev. C.
8. M. W. Weisfield, private communication.
9. N. Sugarman, M. Munzel, J. A. Panontin, K. Wielgoz, M. V. Ramanaiah, G. Lange, and E. Lopez-Menchero, Phys. Rev. 143, 952 (1966).

Table I. Cross sections and recoil properties of products from the interaction of ^{197}Au with 300 GeV protons and their ratios to 11.5 GeV values.

Nuclide	Mode of formation	σ(mb)	$\frac{\sigma_{300}}{\sigma_{11.5}}$	2W(F+B) (mg/cm^2)	$\frac{2W(F+B)_{300}}{2W(F+B)_{11.5}}$	F/B	$\frac{F/B_{300}}{F/B_{11.5}}$
^{123}I	C	6.7±0.4(2)[a]	0.90±0.10	1.86±0.38	1.07±0.24	1.75±0.03	0.90±0.02
^{124}I	I	0.26±0.03(3)	1.00±0.22	3.30±0.21	1.15±0.22	1.47±0.35	0.86±0.24
^{126}I	I	0.066±0.012(3)	1.00±0.18				
^{131}I	C	0.0019±0.0008(2)	1.36±0.69				
^{129}Cs	C	7.9±0.2(2)	0.92±0.10	2.05±0.24	1.34±0.21	2.25±0.10	1.28±0.14
^{132}Cs	I	0.05±0.02(2)	1.61±0.83				
^{128}Ba	C	6.2±0.1(4)	0.98±0.05	1.79±0.12	0.93±0.11	2.10±0.24	1.01±0.15
^{131}Ba	C	8.3±0.7(4)	0.94±0.08	1.63±0.12	0.98±0.08	1.87±0.25	0.86±0.10

a. Number of replicate determinations