MEASUREMENT OF THE TOTAL (p,π) CROSS SECTIONS THROUGH RESIDUAL ACTIVITY

D.L. Friesel, P.P. Singh, and T.E. Ward
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

A. Doron, A. Yavin, and G. Aszuelo
Tel Aviv University, Tel Aviv, Israel

J. D'Auria, G. Sheffer, and P. Jackson
Simon Fraser University, B.C., Canada

The residual activity measurement of pion production near threshold has centered on the $^{209}Bi(p,\pi^0)^{210}Po$ reaction with additional efforts at observing the (p,π^+) and (p,π^-) reactions. Radiochemical procedures for the separation of Bi, Po and At activities have been developed. Monoisotopic bismuth is ideal for a standard measurement of the total (p,π) cross section for a number of reasons. These are: a) bismuth lacks spectroscopic impurities of higher Z elements (of those higher in Z only Th and U are "stable") and b) the reaction products $^{210}At(\pi^-)$, $^{210}Po(\pi^0)$ and $^{210}Bi(\pi^+)$ are easily separated radiochemically and identified spectroscopically by alpha or gamma-ray counting. Initially we studied Po production from targets of various thicknesses (5, 25, 600 mg/cm^2) at proton energies of 125, 147 and 160 MeV and found substantial secondary isotope production, in particular from the (α,xn) reaction from thick targets.

Our results of neutral pion production from protons on bismuth near threshold at IUCF are shown in Fig. 1. The excitation function was obtained from measurements with proton energies in the range of 60-160 MeV. These results compare well with those obtained earlier by Shaw and Daly[1] in the 65-125 MeV range including one data point above pion threshold at 150 MeV. The uncertainty in our measurement is estimated to be about 30%. Thick target (≈ 100 mg/cm^2) measurements of the ^{210}Po yields by Daly and Shaw[1] required a substantial reduction (≈ 50%) due to secondary reactions in order to obtain the net $(p,\gamma+\pi^0)$ contribution. In our measurements we used thin 3-15 mg/cm^2 targets, thus substantially reducing the secondary contributions to less than 0.3 μb near pion threshold.

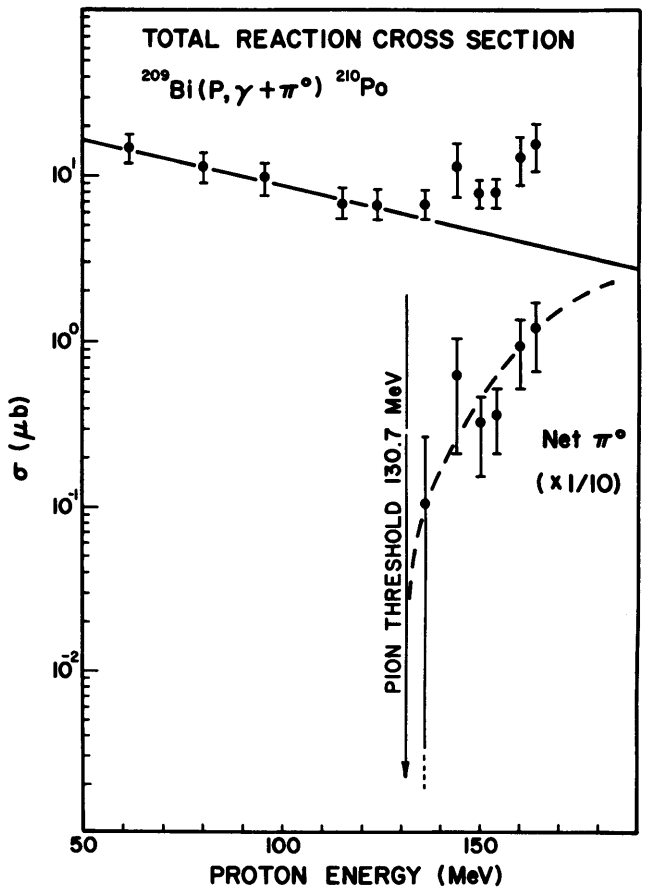

Figure 1. Net neutral pion production from protons on ^{209}Bi at intermediate energies. Below threshold the experimental points represent the proton radiative capture cross section. The net pion cross section with an uncertainty of about 20% was obtained by subtracting the extrapolated (p,γ) contribution.

In Fig. 2 are shown the combined results of this study performed at IUCF and TRIUMF. At IUCF three

new measurements between 160-200 MeV have been made and await further counting and analyses. Our studies at TRIUMF have covered a much larger energy range (183-480 MeV), including several overlapping energies with IUCF. In Fig. 2 are plotted the cross section ratios for the production of ^{210}Po, ^{208}Po and ^{206}Po normalized to ^{206}Po. The relative errors in these measurements are about 15%, whereas in those cases where tracer studies and γ-ray analysis were performed the absolute cross sections were determined to be about 30%. Interesting features of the total reaction cross section leading to ^{210}Po are the threshold neutral pion effect (threshold energy of 130.7 MeV) and the gradual increase above ∿ 300 MeV. Clearly one does not observe similar effects in the (p,xn) channels.

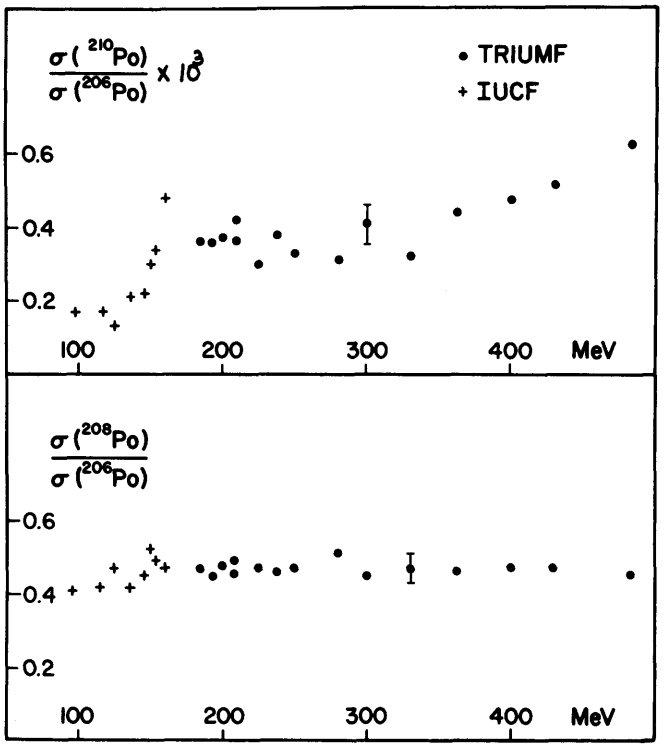

Figure 2. Total reaction cross section ratios for the production of ^{206}Po, ^{208}Po and ^{210}Po normalized to ^{206}Po.

A series of runs are scheduled at TRIUMF between the energies of 183-480 MeV for March 1980 in order to complete this phase of the experiment. A manuscript of these studies is presently in preparation.

1) P.J. Daly and P.F.D. Shaw, Nucl. Phys. 56, 322 (1964).