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

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

J. D'Auria, M. Dombsky and G. Sheffer
Department of Chemistry, Simon Fraser University, Burnaby 2, B.C. Canada

J. Clark
CNC-11, MS 824, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

A. Yavin
Department of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel

The $(p,\pi^{-}xn)$ reaction on Bismuth was studied radiochemically using activation techniques in the energy range of 120-800 MeV. These preliminary results indicate substantial π^{-} production of 1-15 μb per mass number at proton energies of 200-220 MeV. These preliminary results are listed in Table I. The background level for secondary production of ^{211}At was about 1-2 μb, for ^{209}At it was about 0.5-1.0 μb and for

Table I. Preliminary Total Cross Sections for Astatine Production from ^{209}Bi Target

E_p (MeV)	Cross Section (μb)[a] Astatine Isotope 203	204	205	206	207	208	209	210
120	---	---	---	---	0.6±0.2	*	1.3±0.5	---
160	---	---	---	---	4.6±0.9	*	4.2±0.8	---
180	---	---	---	---	10.6±2	*	5.0±1.1	---
180[b]	---	---	---	---	27±10	*	7.4±4	*
200	---	---	---	---	17.4±3.9	---	1.6±0.3	---
210[b]	1.4±0.7	22±4	61±9	37±10	18±3	*	5.8±1	*
214	---	---	---	---	10±3	---	1.0±0.3	---
225[b]	13±4.5	22±4	42±7	20±4	9±1	*	2.0±0.6	*
252[b]	52±8.5	30±18	46±9	32±6	9±2	*	1.4±0.2	*
300[b]	41±18	41±6	35±3	19±2	5.6±0.8	*	1.1±0.1	*
350[b]	30±7	26±7	29±7	24±4	5.5±0.6	*	2.6±0.4	*
400[b]	36±8	14±2	29±3	19±3	3.9±0.4	*	1.2±0.3	*
450[b]	24±4	---	17±2	16±8	2.6±0.4	*	1.0±0.2	*
480[b]	27±4	22±2	21±4	11±2	3.4±0.7	*	1.5±0.2	*
800[b]	*	*	*	*	*	*	*	*

[a]These data were obtained only from residual alpha emissions of At products; secondary contributions have not been subtracted yet.
[b]Data taken at TRIUMF or LAMPF (800 MeV).
*Data at these energies and for these isotopes are still under analysis and will be made available.

^{207}At it was about 0.1-0.5 μb. The At products produced in the (p,π^-xn) reactions at these energies are 3 to 5 neutrons removed from the doubly-coherent residue, ^{210}At. These results are qualitatively in agreement with recent theoretical[1,2] and experimental[2] studies that investigated the energy dependence of the (p,π^-xn) total reaction cross section in terms of a cascade-isobar model[1] or pion knockout model[2].

The preliminary results indicate that the data below 200 MeV are critical since they cover the threshold region. This experiment is approved at TRIUMF (E189) and at LAMPF (E679). The results suggest that a multinucleon process is important in π^- production, as indicated by a strong dependence on the nuclear level density of particle-hole states. In addition, at energies above 200-250 MeV, two nucleon models suggest that coherent production processes are being limited by the increased momentum transfer and that quasifree processes are beginning to dominate.

1) D. Long, M. Sternheim and R. Silbar, "Simplified Intranuclear Cascade Approach to Inclusive (p,π^-xn) Reactions", Phys. Rev. C (in press).

2) J. Clark, P. Haustein, T. Ruth, J. Hudis, A. Caretto, Jr., and W. Gibbs, "Measurements of Inclusive π^- Production with 200 MeV Protons: A Radiochemical Study of the ^{209}Bi(p,π^-)$^{210-xn}$At Reactions," Phys. Rev. C (in press).

A TWO-NUCLEON MODEL FOR THE (p,π) REACTION

J.S. Conte and R.D. Bent
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

M. Dillig
Institute for Theoretical Physics, University of Erlangen-Nurnberg, Erlangen, W. Germany

Work on a two-nucleon model (TNM) computer program for calculating (p,π) cross sections and analyzing powers continued during 1982. The ideas of this model and preliminary results of calculations have been reported previously.[1-3]

The goals of this work are to construct a complete model that includes, to the best of our knowledge, all of the main pieces that are thought to be important in the (p,π) process, and to carry out the calculations without unjustified numerical approximations.

Concentrating on IUCF energies, i.e., from the pion production threshold up to about T_p = 200 MeV, we assume that the dominant piece of the reaction mechanism involves two nucleons, which allows proper momentum sharing and considers the fact that the πN interaction is fairly weak within this energy domain (T_π < 60 MeV). The one-nucleon contribution will be added to the two-nucleon term in the plane-wave limit for the outgoing pion (to avoid double counting). Initial state interactions will be included via a distorted proton wave. Higher order corrections resulting from pion rescattering will be included either in the spirit of DWBA (using a π-nucleus optical potential) or in a simplified isobar-doorway model by including self-energy corrections for the intermediate isobar.

The computer program is written to maximize flexibility with respect to the nuclear structure and reaction mechanism input and to minimize the execution time and core size required. This will allow for a systematic testing of the physics involved in the (p,π) process, which has not been possible so far with other programs of this type now under development,[2,4] where execution times are 3-15 hours (for a ^{12}C(p,π^+)^{13}C