CHARGED-PION PRODUCTION IN PROTON-NUCLEUS COLLISIONS NEAR THRESHOLD

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Measurements of pion production utilizing the QDDM magnetic spectrometer have continued. The emphasis this year has been on angular distribution and excitation function measurements in the near threshold region. The aim of this work is to determine the dependence of the cross sections on momentum transfer q and outgoing pion momentum k_π over a broad region in the q vs k_π plane so that stringent tests of various reaction models can be made.

Table I summarizes the (p,π^+) measurements that have been made. The ^{90}Zr and $^{208}Pb(p,\pi^+)$ results are the first reported[1] measurements of charged-pion production near threshold in proton collisions with heavy nuclei. The angular distributions obtained at 160 MeV are shown in Fig. 1. The ^{10}B and ^{40}Ca results include the first measurements at θ_π = zero degrees. These measurements were made by placing a beam stop inside the spectrograph and determining the integrated beam current from the activity induced in a thin aluminum foil placed behind the target. The extent to which the data can be explained by the one-nucleon model is being investigated using the distorted-wave codes of Keating and Wills[2] and Tsangarides and Wills[3].

Negative pions from the reaction $^{26}Mg(p,\pi^-)^{27}Si$ (g.s.) were observed at 160 MeV bombarding energy. The cross section at θ_π = 25 degrees was about 50 times lower than the theoretical value calculated by Kisslinger and Miller[4] for the Δ^{++} exchange and two-step proton charge exchange mechanisms.

Table 1. Summary of (p,π^+) Reactions Measured with the QDDM Magnetic Spectrograph

Target	Reactions	Final Excitation Energy (MeV)	Tp(lab) (MeV)	θ_π(lab) (Deg)
^6Li	(p,π^+)	0	175	25 → 87
		0.48		25, 45
^{10}B	(p,π^+)	0	152	25
			154	0 → 60
			156	25
			160	0 → 130
			164	25
			166	25 → 155
			175	25
^{12}C	(p,π^+)	0	156	25
			160	25
			166	25, 87, 140
			175	25, 45
		3.08	166	25, 45
			175	25
^{16}O	(p,π^+)	0	166	25 → 155
^{28}Si	(p,π^+)	0	160	25 → 155
		1.27	160	25 → 155
		2.03	160	25 → 155
		3.62	160	25 → 155
^{40}Ca	(p,π^+)	0	148	25 → 155
			152	25
			154	0 → 155
			156	25
			160	10 → 155
			164	25
^{90}Zr	(p,π^+)	0	154	25
			160	25 → 155
			164	25
^{208}Pb	(p,π^+)	0	160	25 → 155
		0.78	160	25, 40, 55
		1.41	156	25
			160	20 → 155
			164	25

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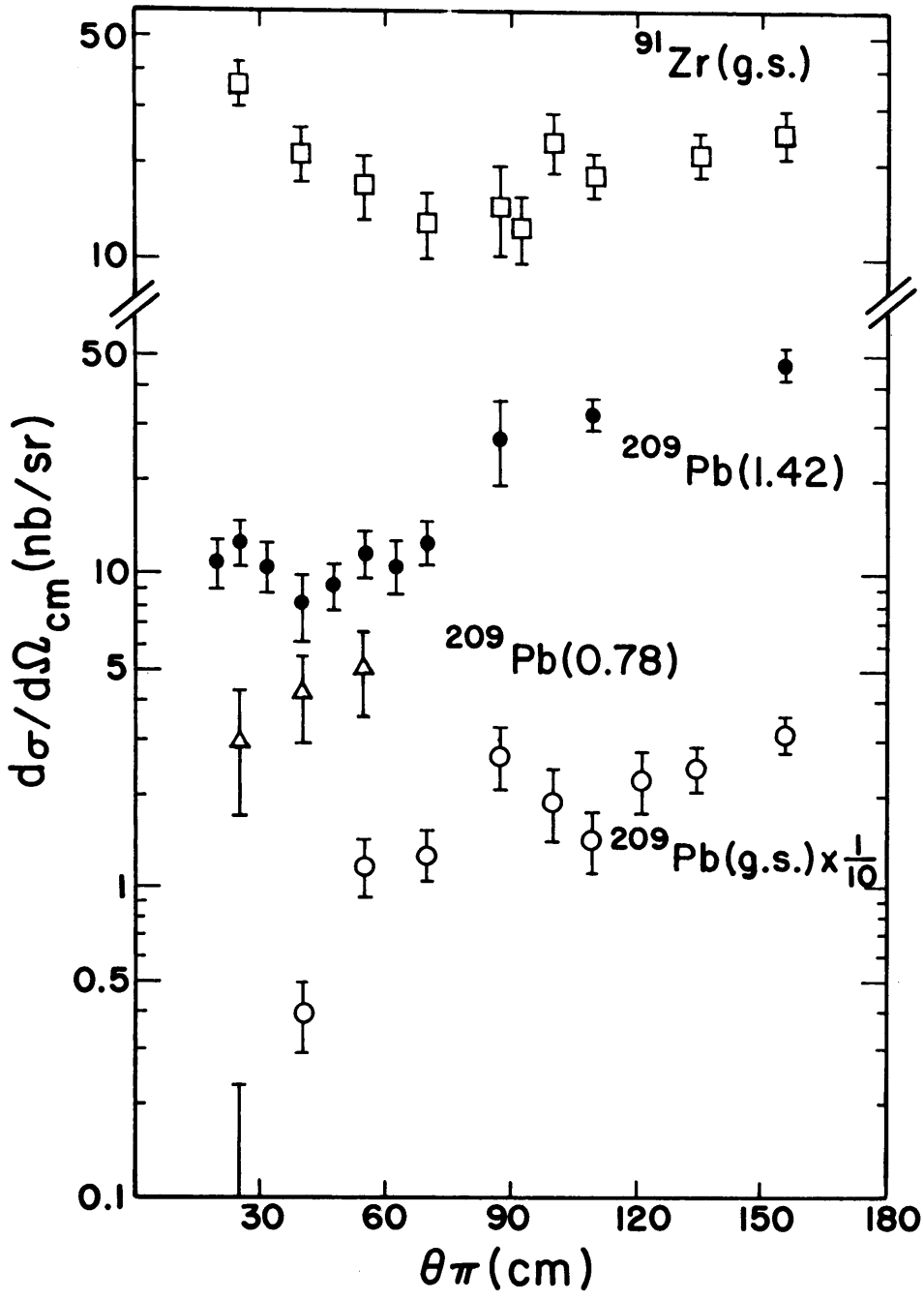

Figure 1

INVESTIGATION OF (p,π^-) REACTIONS NEAR THRESHOLD

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It has been proposed[1] that the total cross section for (p,π^-) reactions should exhibit resonances slightly below threshold, corresponding to direct production of the π^- in bound pionic-atom states. Observation of such resonances would allow investigation of 1S-state properties of pionic atoms that are not possible to study by stopped-pion techniques. The most prominent identified signature of π^- capture on nuclei is correlated two-nucleon emission,[1,2] but observation of the resonance in this channel is made difficult by associated background problems.

We have made initial background measurements of neutron singles counting rates from a thin carbon target, employing a newly-constructed thin-walled scattering chamber in the low intensity area. The results of these measurements suggest that the resonance might be marginally observable above the accidental neutron-neutron coincidence background if a large number of neutron detectors were situated close to the target. Perhaps a more promising approach is to look for neutron-proton coincidences, where background is less of a problem but the branching ratio in π^- capture is smaller. Measurements of the background neutron-neutron and neutron-proton coincidence rates are planned in a further effort to determine the feasibility of this experiment.

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