NEUTRAL FINAL STATES IN π^-p INTERACTIONS FROM 500 TO 1300 MeV

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We have measured the total cross-sections and angular distributions for several neutral final states produced in negative pion-proton collisions for incident pion energies from 531 MeV to 1308 MeV. The primary objective of the experiment was to obtain differential cross sections for charge exchange scattering of negative pions, $\pi^-p \to \pi^0 n$; this will be

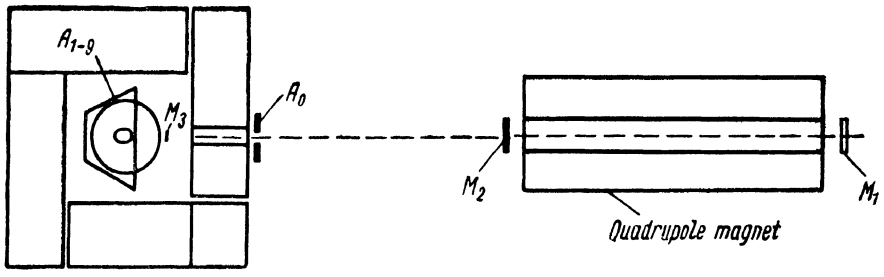

Fig. 1. Experimental arrangement. Six spark chambers form the walls of a cubical box. A_{1-9} are anticounters M_{1-3} are π^- monitor counters.

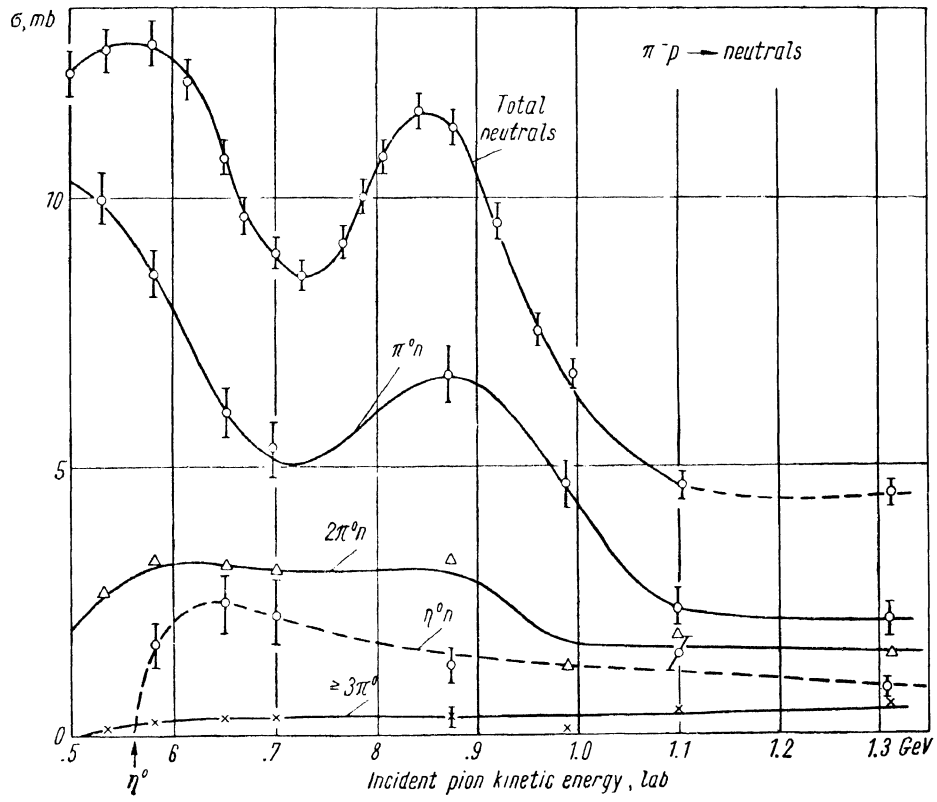

Fig. 2. Total cross-sections for neutral final states in π^-p collisions.

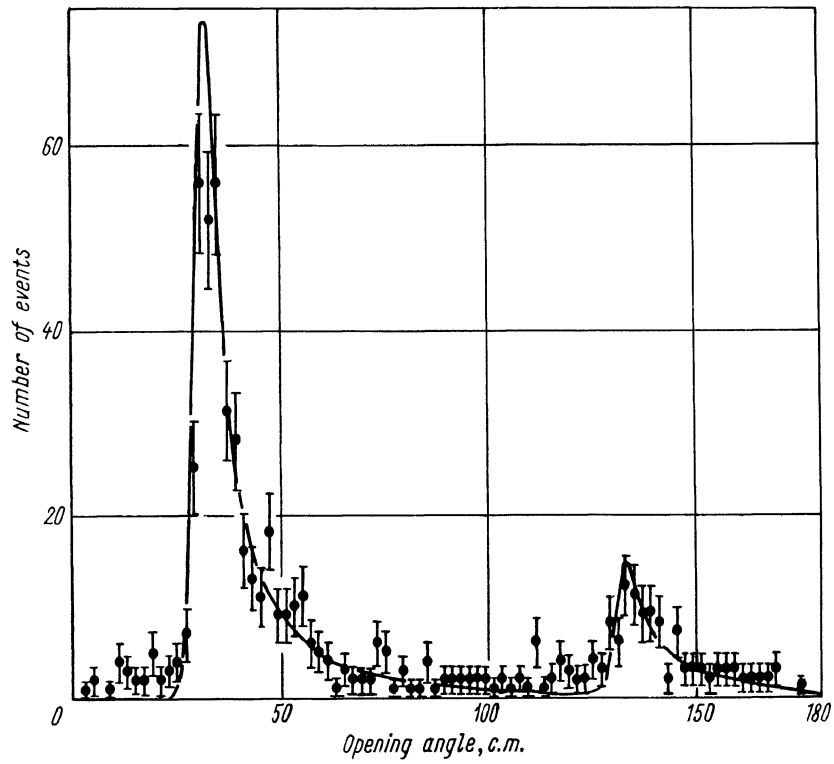

Fig. 3. Opening angle distribution ($\pi^- p$ c. m. system) for 2-shower eventsat 669 at MeV. Target full (empty subtraction not yet made).

reported by Professor Moyer. Analysis of about 15% of the data so far has shown substantial production of eta mesons, $\pi^- p \to \eta^\circ n$, above the threshold of 560 MeV and we separate the decay $\eta^\circ \to 2\gamma$ from $\pi^\circ \to 2\gamma$ by decay kinematics. This paper summarizes the information obtained on eta production and the total cross sections for single and multiple π° production in $\pi^- p$ collisions.

The experimental arrangement, shown in Fig. 1, will be described briefly. A $4\pi^-$ spark chamber array consisted of six steelplate chambers (6.3 radiation lengths thick) surrounding a cubical enclosure 1 meter on a side. An anticounter array selected neutral final states. High energy photons produced showers in the spark chambers. The calculated efficiency for detecting 100 MeV photons is 98%. The requirement of $\geqslant 3$ gaps/shower imposes a minimum photon energy cut off of about 80 MeV. Essentially all of the 1- and 2-shower events correspond to single π° and η° production, 3- and 4-shower events are almost entirely due to $\pi^- p \to 2\pi^\circ n$, and the events with 5 or more showers correspond to $\geqslant 3\pi^\circ$ produced. The 2-shower events are due almost completely to the

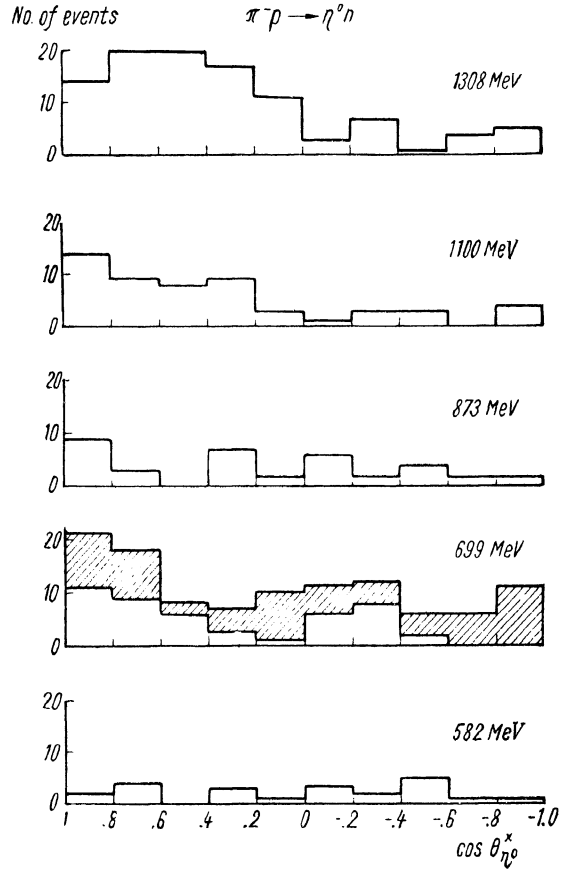

Fig. 4. Angular distributions of eta meson in reactions $\pi^- p \to \eta^0 n$ at various π^- energies.

reactions $\pi^- p \to \pi^\circ n$ and $\pi^- p \to \eta^\circ n$. (Analysis of our data with the top and bottom chambers removed show that 31% of the 3- and 4-shower events would appear as 1- or 2-shower events). The 2-photon opening angle distribution ($\pi^- p$ c. m. system) at 699 MeV is shown in Fig. 3. The solid lines are expected opening angle distributions for $\pi^\circ \to 2\gamma$ ($\theta_{min} = 30.6$ deg) and $\eta^\circ \to 2\gamma$ ($\theta_{min} = 131.6$ deg) with the experimental resolution of $\pm$ 3 deg folded in. The residual background (12%) is assumed to be due to $2\pi^\circ$ events in which only one photon π° converts.

The variation of the $\pi^- p \to \eta^\circ n$ cross-section with π^- kinetic energy is shown in Fig. 2. (A branching ratio $\eta^\circ \to 2\gamma$ of 0.30 was used). The sudden rise above threshold to a peak of about 2.5 mb. near 650 MeV is closely proportional to the c. m. momentum of the η° (solid line) as expected for pure *s*-wave production near threshold. This new inelastic channel is pure isospin $T = 1/2$ state.

The angular distributions of the η° (c. m. system) at several pion energies are shown in Fig. 4. The principal conclusion is that the distributions are consistent with isotropy near threshold, but begin to peak forward at higher energies.

Resolution of the quadratic ambiguity in η° direction becomes difficult near threshold even using shower length as a measure of photon energy. At 699 MeV half of the «good» $\eta^\circ s'$ are ambiguous in eta-direction. If we plot the direction closest to the bisector, we obtain the black squares (Fig. 4). These events do not alter angular distribution significantly. At higher energies the fraction of ambiguous events decreases (20% at 1308 MeV). This work was supported by the U. S. Atomic Energy Commission.