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π^--PROTON INTERACTIONS AT 4.5 BEV

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The interaction with protons of 4.5-Bev negative pions from the Bevatron is being studied by use of a hydrogen-filled diffusion cloud chamber.[1] The mesons were produced by circulating protons of 5.7 and 6.2 Bev striking targets of carbon or uranium. π^- mesons emitted in the forward direction from the target underwent momentum analysis by deflections of 17.6° in the magnetic field of the Bevatron and 10.8° in an external analyzing magnet. A 4-foot-long steel collimator with a 5-inch-wide gap was inserted between the Bevatron and the analyzing magnet. The mesons passing through the collimator then entered the cloud chamber, which contained hydrogen at 36 atmospheres and operated in a pulsed magnetic field of 21,500 gauss. Preliminary measurements show a momentum spectrum for several runs extending from about 4 Bev/c to about 5.25 Bev/c. As the cloud chamber was about 60 feet from the target, the μ^- contamination is thought to be small.

To date, 95 π^--proton interactions producing charged outgoing particles have been observed. These include the following types:

Eighteen events are elastic π^--proton scatters. The angular distribution fits that expected for diffraction scattering from an opaque or semitransparent sphere[2] of radius 8×10^{-14} cm. Two of the events fell outside the central maximum. The diffraction peak showed that five small-angle scatters of less than 3° (lab.) should have occurred. Observation of these is quite difficult and only one was detected. Adding the four inferred small-angle scatters gives a total of 22 elastic scatters.

Forty-six events were inelastic, with two outgoing prongs. This corresponds to the production of one or more additional mesons. Three of these events are known from observed decays to involve the production of heavy unstable particles. These particles are one θ^0, one Λ^0, and one positive unstable particle that is not a π meson. The positive prong associated with the Λ^0 production appeared, from its momentum and relative ionization, to be a K meson.

Twenty-nine events have four outgoing prongs. These correspond to the production of two or more additional mesons. In one of these events one of the prongs decays in flight and has been identified as a K^+ meson.

Two events have six prongs. In neither of these does transverse momentum balance. One event has an electron (presumably from a π^0 decay) as one prong, so only two additional charged mesons are produced in this collision. It thus involves the production of three or more mesons. The other six-prong event involves the production of five or more mesons in the single π^--proton interaction.

Methyl alcohol, which was the condensable vapor in the cloud chamber, constituted about 0.1% of the gas molecules at the beam level. Carbon or oxygen stars should be recognizable as such because of the total positive charge of the event of + 5 or + 7, the lower momentum and higher ionization of the prongs, or the recoil blob usually associated with the star. One such event was observed.

The results are summarized in Table I.

Table I

Relative frequency of various π^--proton interactions at 4.5 Bev giving charged particles.

Type of interaction	% of events
Elastic (diffraction)	20
Elastic (nondiffraction)	2
2-prong inelastic	47
4-prong	29
6-prong	2

These 95 interactions occurred in 87,000 meson traversals of 25 cm through the accepted volume in the cloud chamber. Insensitive regions in the chamber at times reduced the effective length somewhat. The average hydrogen pressure was 526 psi gauge and the temperature at the beam level was -40° C, so that the hydrogen density was 3.9 mg/cm^3. Including the four small-angle elastic scatters inferred from the diffraction pattern, we find a total cross section of 19.7 ± 3.4 millibarns for π^--proton collisions resulting in charged outgoing particles. The standard error includes both statistical uncertainties and estimated uncertainties of the effective path length. All the cloud chamber pictures were scanned twice.

The film was scanned by Mr. John B. Elliot, Mr. Arthur A. Kemalyan, Jr., and Mr. Joseph H. Wenzel.

Further analysis of the data and additional runs are planned.

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1. Elliot, Maenchen, Moulthrop, Oswald, Powell, and Wright, Rev. Sci. Inst. in press.

2. Eisberg, Fowler, Lea, Shephard, Shutt, Thorndike, and Whittemore, Phys. Rev. 97, 797 (1955).