

**EXPERIMENTAL STUDY OF REACTIONS: $p + p \rightleftharpoons \pi^+ + d$
(COMBINED REPORT)**

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(Presented by G. WEBER)

Three independent experiments have been performed on the differential cross-section for the reactions

$$p + p \rightarrow \pi^+ + d; \quad (1)$$

$$\pi^+ + d \rightarrow p + p. \quad (2)$$

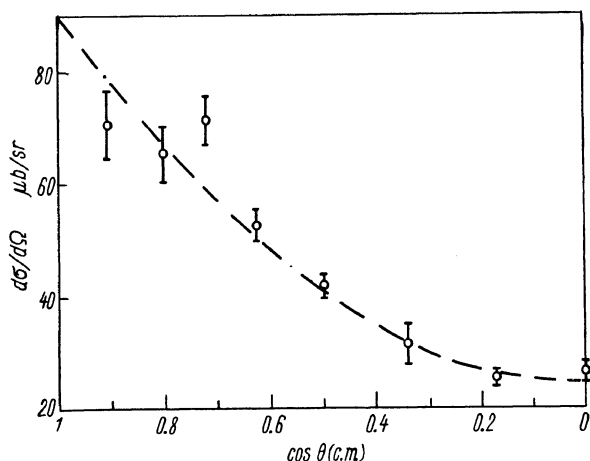


Fig. 1. The differential cross-section for the reaction $pp \rightarrow \pi^+d$ at 990 MeV.

in the energy range 2.3 to 3.1 GeV (center of mass system). All three experiments were performed with scintillation counter telescopes

using conventional techniques. The experimental details are given elsewhere.

One motivation for this series, of investigations was the experiment of Cocconi et al. [1] which, combined with earlier measurements, showed a peak in the differential cross-section near zero degrees as a function of energy near 2.9 GeV (c. m.) which had been interpreted in terms of a one-pion-exchange model by Chahoud et al. [2] and by Yao [3].

The Birmingham group measured the cross-section for reaction (1) at 990 MeV incident proton kinetic energy.

Their measurements are shown in Fig. 1 where the dotted line is a fit to

$$d\sigma/d\Omega = a + b \cos^2 \theta$$

with $a = 25 \pm 2 \mu\text{b}/\text{sr}$ and $b = 65 \pm 5 \mu\text{b}/\text{sr}$ and the total cross-section is found to be $560 \pm \pm 30 \mu\text{b}$.

The Michigan-Stanford group, working at the Cosmotron of the Brookhaven National Laboratory, studied reaction (1) at incident proton laboratory kinetic energies from 1.0 to 2.8 GeV. The differential and total cross-sections are given in Fig. 2 and 3. Some of this data and a description of the apparatus has been published [4].

The CERN group studied reaction (2) at 8 incident laboratory pion momenta from 0.65 to 1.95 GeV/c. Their data are given in Fig. 4;

* Supported by the U. S. Atomic Energy Commission and the U. S. Office of Naval Research.

Fig. 2. Differential cross-sections for the reaction $pp \rightarrow \pi^+d$ in microbarns per steradian (c. m.) plotted vs. $\cos\theta$ of the deuteron (c. m.). T_p is the incident proton kinetic energy. The data from this experiment are shown as circles, where the errors are standard deviations from counting statistics. The zero degree data from reference [4] are indicated by squares.

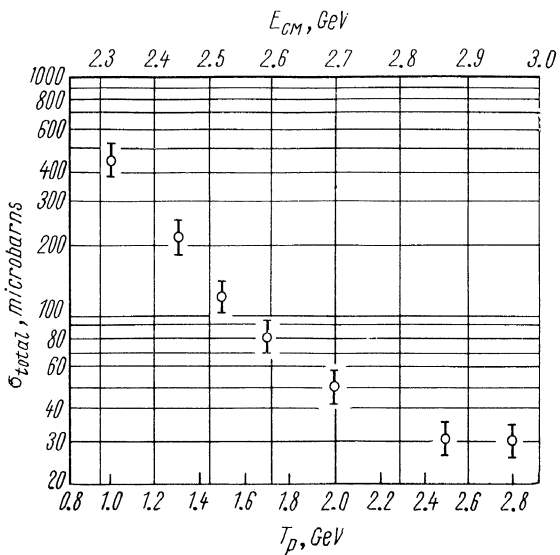
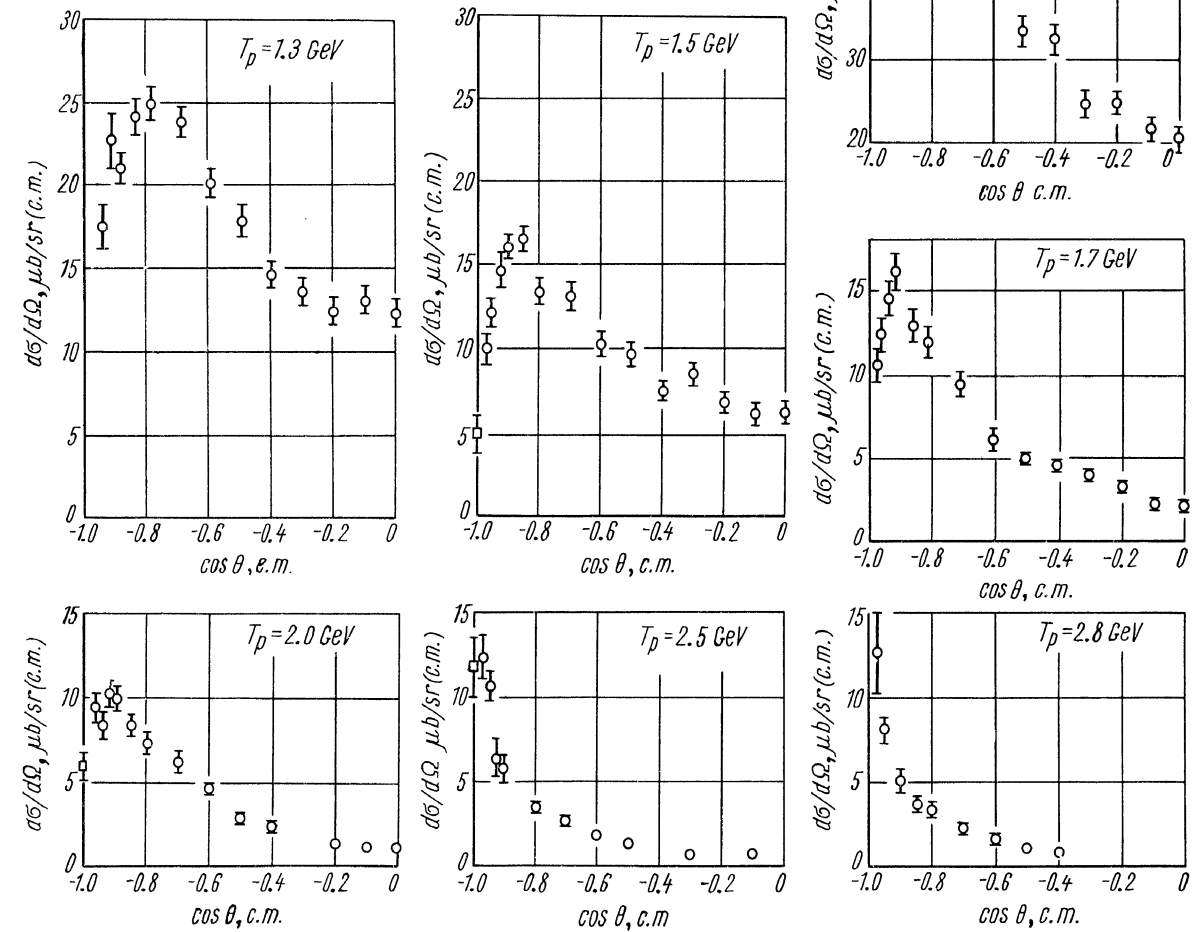


Fig. 3. Total cross-sections for the reaction $pp \rightarrow d\pi^+$ derived from the differential cross-sections measured in this experiment. The error flags include the uncertainty in the shape of the differential cross-section and the 11% uncertainty in the normalization. The abscissa is given as incident proton kinetic energy (bottom) and total c. m. energy (top).

the apparatus description and discussion of the data has been published [5].

The differential and total cross-sections determined by the different groups for reactions (1) and (2) agree with each other within statistical errors using the principle of detailed balance.

The general features displayed by the three experiments are:

1) an angular distribution consisting of s - and p -waves at 2,30 GeV c. m. similar to that observed earlier at lower energy [6].

2) At energies between 2.3 and 2.6 GeV c. m. a minimum is seen at zero degrees, and a maximum between $\cos \theta = 0,8$ and $0,9$

3) Above 2.6 GeV c. m the cross-section is peaked at 0° with a low, flat tail extending to 90° . The total cross-section over the entire range decreases monotonically, in contrast to the prediction of the one-pion-exchange models.

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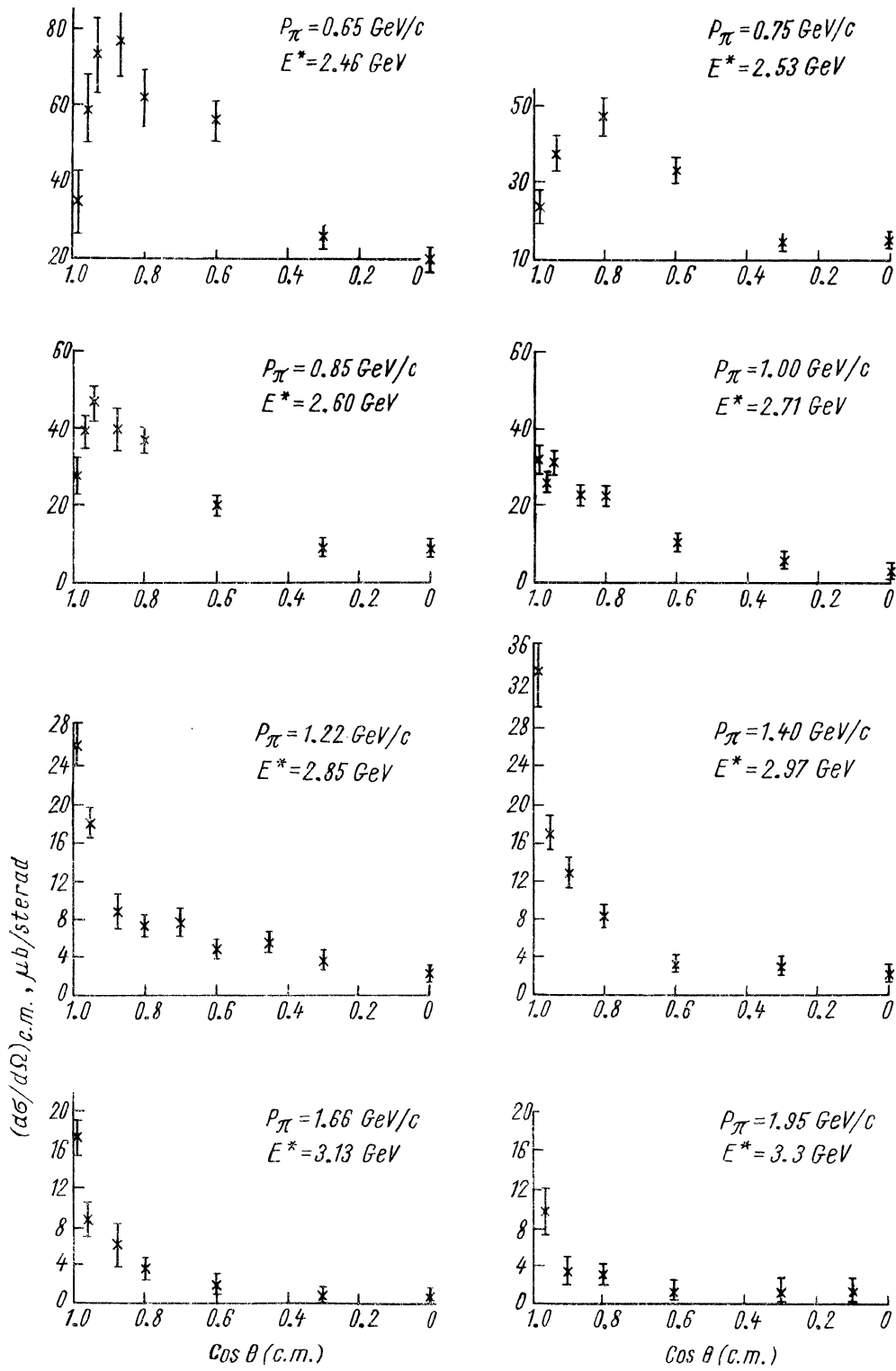


Fig. 4. The differential cross-sections for the reaction $\pi^+ d \rightarrow pp$.