

Letters to the Editor

PROTON-PROTON SCATTERING IN THE 1D_2 STATE AT 616 Mev

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PRODUCTION of π mesons in p-p collisions, which proceeds rather intensively beginning with proton energies of ~ 400 Mev, complicates substantially the character of the elastic scattering. The connection between elastic and inelastic scattering is analyzed with the aid of the unitarity of the S matrix. In the region of proton energies of ~ 600 Mev, the initial 1D_2 state of the two protons plays an essential role.

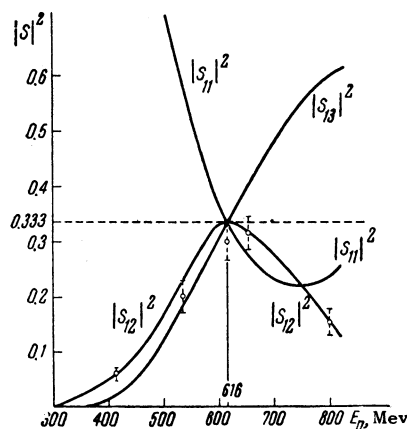
If we consider only processes with the production of a single π meson, and also neglect d-states of the π meson, then the following processes can go through the 1D_2 state: (1) elastic p-p scattering; (2) the transition ${}^1D_2 \rightarrow ({}^3S_1p)_2$ in the reaction $p+p \rightarrow d + \pi^+$; (3) the transition ${}^1D_2 \rightarrow ({}^3S_1p)_2$ in the reaction $p+p \rightarrow n+p + \pi^+$; (4) the transition ${}^1D_2 \rightarrow ({}^3P_2s)_2$ in the reaction $p+p \rightarrow \pi^0 + p+p$.

The probability of emission of π^0 meson in an s state is rather low, since process (4) is negligible in the energy region considered. Then the S matrix for the initial 1D_2 state ($T = 1$; $J = 2$; $\Pi = +$) can be written

$$S = \begin{pmatrix} S_{11} & iS_{12} & iS_{13} \\ -iS_{12} & S_{22} & S_{23} \\ -iS_{13} & S_{23} & S_{33} \end{pmatrix},$$

where the suffix 1 denotes the p-p system, 2 the (π^+d) system, and 3 the (π^+np) system.

The values of $|S_{12}|^2$ and $|S_{13}|^2$ can be determined using the results of references 1 and 2 and also of reference 3. For the energy $E_p = 654$ Mev we obtain $|S_{12}|^2 = 0.31$ and $|S_{13}|^2 = 0.41$. Then, using one of the unitarity conditions $|S_{11}|^2 + |S_{12}|^2$



Dependence of the squares of S-matrix elements on proton energy. \circ - results of reference 1.

+ $|S_{13}|^2 = 1$, we find $|S_{11}|^2 = 0.28$. In the figure we show the data for a wide range of E_p , from 400 to 800 Mev. It can be seen from the graph that all three curves have the tendency to go through the same point at a proton energy of $E_p = 616$ Mev, which has the feature that the total energy of two colliding protons⁴ in the center-of-mass system is equal to the resonance energy for meson-nucleon scattering, when account is taken of the π -meson rest mass.

If we assume that this, in fact, occurs, then the remaining two unitarity relations give

$$|S_{22}|^2 = |S_{33}|^2; \quad |S_{22}|^2 + |S_{23}|^2 = 2/3.$$

These results can be used in carrying out phase-shift analyses of p-p scattering and scattering π^+ mesons on deuterons.

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²Akimov, Savchenko and Soroko, J. Exptl. Theoret. Phys. **35**, 89 (1958), (this issue, p. 69).

³S. Mandelstam, Proc. Roy. Soc. **A244**, 491 (1958).

⁴Meshcheriakov, Neganov, Soroko and Vzorov, Dokl. Akad. Nauk SSSR **99**, 959 (1954).

Translated by G. E. Brown

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