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Experimental data on the meson production in $N-N$ interactions at high energies show that quasi-two-body reactions (with excitation of primary nucleons) are a fraction of the inelastic process. For example, at the primary proton momentum of 20 GeV in the reaction with one pion production

$$pp \to np\pi^+$$

30-40% of the observed events correspond to two-body processes when one of the primary nucleons is excited up to the energies of the known isobars $\Delta, N(1470), N(1520)$, $N(1688)$. In the reaction

$$pp \to pp\pi^+\pi^-$$

10-20% of the observed events correspond to two-body processes in which both the nucleons $\Delta^{++}, \Delta^0, \Delta^{++}N(1520)$ are excited.

In a quantum-mechanical sense the probability of appearance of a distinct final state is determined by the square of the corresponding scattering matrix element. In this sense, in order to estimate the contribution of transitions to quasi-two-body states, a transverse cross section is an inconvenient characteristic of the reaction dynamics. Let us consider the reaction $pp \to pp\pi^+\pi^-$. At high energies, even at equal matrix elements of transitions to $pp\pi^+\pi^-$ and $\Delta^{++}N(1520)$ the cross section of the binary reaction is much less than that of the four-body reaction due to the difference between the statistical weights of the final states. The statistical weight of an n-body final state is expressed by /2/:

$$W = \left(\frac{m_N}{3\pi^2 m_\pi^3 M_n}\right)^{n-1} \left(\prod_{k=1}^{n} 2m_k\right) S_n(M_n),$$

where m_π is the pion mass; m_N is the nucleon mass; m_k is the particle mass in the final state; M_n is the effective system mass; $S_n(M_n)$ is the phase volume of the final state /3/.

Normalizing the cross sections of binary reactions (σ_i) to the statistical weights of the final states, we get the square of the respective matrix element of the scattering matrix (H_i^2):

$$H_i^2 = \frac{\sigma_i}{W_2(i)} .$$

Correspondingly the probability of nonresonance transition is equal to:

$$H^2_{nonres} = \frac{\sigma_{nonres}}{W_n} ,$$

where

$$\sigma_{nonres} = \sigma(n) - \sum_i \sigma_i .$$

Now a relative contribution of the quasi-two-body process is characterized by the value $H\ /H$, where $H_n^2 = H^2_{nonres} + H_i^2$; the sum contribution of all quasi-two-body processes equals $(1/H_n^2)\sum_i H_i^2$, respectively.

Figure 1 presents the calculations for the reaction $pp \to np\pi^+$ (1a). As is seen from the figure, the relative probabilities (H_i^2/H_n^2) of transitions to the states $n\Delta^{++}$, $p\Delta^+$ weakly decrease with increasing the energy of primary protons, whereas the relative probabilities of transitions to $pN(1520)$, $pN(1470)$, $pN(1688)$ increase with increasing energy. The lower curve (TOTAL) makes a total contribution of all quasi-two-body transitions. One can see that quasi-two-body transitions dominate (90%) and, probably, do not decrease with increasing energy.

Figure 1b presents the calculations for the reaction $pp \to pp\pi^+\pi^-$. For this reaction the matrix elements of all quasi-two-body transitions do not decrease with increasing energy. The total contribution of all quasi-two-body reactions (TOTAL) sharply increase with increasing the energy of primary protons (90% at 30 GeV).

Thus, the available experimental data on the resonance production cross sections in $N-N$ interactions show that the matrix elements of transitions to quasi-two-body state dominate nonresonance transitions when the number of produced mesons does not exceed 2.

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