FORMATION OF THE $^1S_0$ DIPROTON IN THE REACTION $pp \to \{pp\}_s\pi^0$

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In contrast to very similar (in kinematics) reactions with the final deuteron in the GeV region, the reactions with the diproton, i.e. the proton pair $\{pp\}_s$ in the $^1S_0$ state with small excitation energy $E_{pp} = 0 - 3$ MeV, can give more insight into the short-range NN-dynamics. The reason is that the contribution of non-short-range mechanisms related to excitation of the Δ-isobars is considerably suppressed in intermediate states for the case of diproton formation as compared to the deuteron case due to isospin symmetry and conservation of angular momentum and parity. So, in the reaction $pp \to \{pp\}_s\pi^0$ the intermediate S-wave ΔN state is completely forbidden [2] and higher partial waves are suppressed by centrifugal barrier. Nevertheless, the cross section of the reactions $pp \to \{pp\}_s\pi^0$ [1] recently measured in forward direction for beam energies 0.5 - 2.0 GeV clearly demonstrates the $\Delta(1232)-$isobar peak in the energy spectra. The microscopical model of the reaction $pp \to d\pi^+$ [2] fails to explain the data [1].
We consider two mechanisms of the reaction $pp \to \{pp\}_s\pi^0$. The first one, is the triangle one-pion exchange (OPE) diagram with the subprocesses $\pi^0p \to \pi^0p$ taken on-shell [3]. The second one is the box-diagram with excitation of the $\Delta(1232)$ isobar (Δ-mechanism). The second mechanism, in contrast to the OPE, allows one to take into account only negative parity intermediate states allowed in this reaction by angular momentum and parity conservation and Fermi-statistics of the final pp-pair. Numerical results are performed with different NN-interaction potentials - the RSC, Paris and CD Bonn ones. We show, that in the $\Delta(1232)$ region at beam energies $T_p = 0.6 - 1.3$ GeV, the OPE mechanism reasonable describes the shape of energy dependence of the measured cross section [1] at the diproton cms scattering angle $\theta_{cm} = 0°$, although overestimates its absolute value by factor of 2-3. At $T_p \sim 2$ GeV there is a bump in the measured cross section [1], which is underestimated by the OPE considerably.

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References

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