Energy Dependence of the Primary Production Amplitude for the $pp \to pp\eta'$ Reaction

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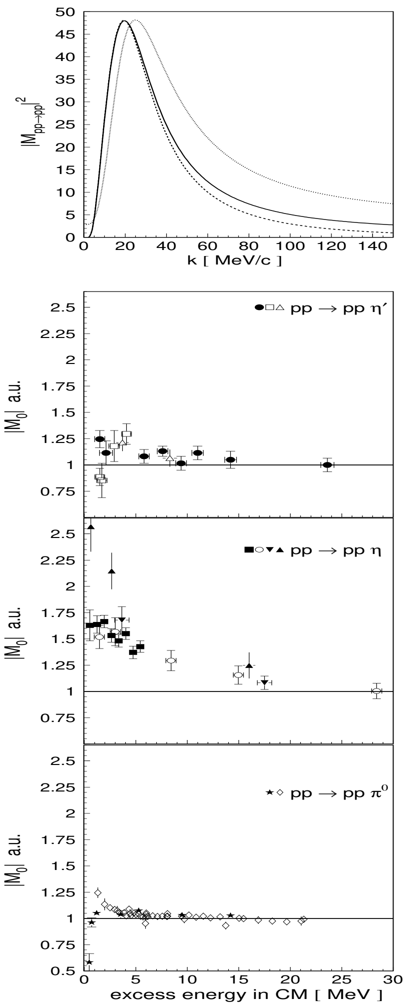
New data on η and η' meson production in the $pp \to ppX$ reaction, obtained recently at the COSY–11 facility [1], encouraged us to continue [2] the phenomenological investigations on the energy dependence of the primary production amplitude. The modulus $|M_0|$ of the primary production amplitude was calculated [2] under the assumptions that this quantity is independent of the incoming proton beam energy, and that there is no meson–proton final state interaction.



a)

b)

Figure 1: a) Square of the proton–proton scattering amplitude from Ref. [3] (solid), [6] (dashed), and [5] (dotted). b) Quantity $|M_0|$ extracted from the experimental data (see references in [1]).

In the derivation of $|M_0|$ the enhancement from the proton–proton FSI, $|M_{pp\to pp}|^2$, was calculated as an inverse of the squared Jost function, with the Coulomb interaction taken into account (see solid line in Fig. 1a) [3]. Obtained values for the quantity $|M_0|$ for π^0, η and η' production are shown in the lower, middle and upper part of Figure 1b, respectively. The shown values are normalized to unity at the point of highest excess energy, for each meson separately. If the assumptions in the derivation of $|M_0|$ were fulfilled the obtained values would be constant as depicted by the solid lines. It can be seen, however, that in the case of the η meson, $|M_0|$ grows with decreasing excess energy. The observed deviation from unity is too large to be assigned to the actual variation of the primary production amplitude. The calculations of Moalem et al. [4] show that in the discussed energy range the primary production amplitude may grow by a few per cent only. Therefore, the observed behavior of $|M_0|$ may be assigned to an attractive η–proton interaction. In the data for the π^0 production, apart from the two lowest points one can notice a tiny growth of $|M_0|$ when the excess energy decreases from Q = 20 MeV to Q = 2 MeV. This is much smaller than in the η meson case. Notice, that also the S–wave π–proton interaction is much weaker than the η–proton one. Similarly, neglecting the two lowest points for the η' meson, one observes about 20 % increase of $|M_0|$ when approaching the threshold. This might indicate an attractive η'–proton interaction. We must be careful, however, since the behaviour of $|M_0|$ depends on the prescription used for the proton–proton scattering amplitude, and as can be seen in Figure 1a there exist models, which differ significantly. Therefore as a next step we would like to check the sensitivity of $|M_0|$ to the used prescription.

References:

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