Hadronic interaction of η and η' mesons with nucleons

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The production of η and η' mesons in elementary proton-proton collisions has been investigated at the synchrotrons CELSIUS, COSY and SATURNE. The high quality proton beam with low emittance and small momentum spread permits to study the creation of these mesons very close to the kinematical threshold, where – due to the rapid growth of the phase space volume – the total cross section increases by orders of magnitude over a few MeV range of the excess energy.
The experimental data allows to establish that the dependence of the total cross section on the excess energy is predominantly determined by the final state interaction among the produced particles. In case of the $pp \to pp\eta$ reaction the achieved precision permits to distinguish the effect of the η-nucleon interaction from the overwhelming influence of the nucleon-nucleon distortion. Moreover, by the comparison of the η and η' production one can deduce the relative strength of the η-nucleon and η'-nucleon interactions.
A modification of the phase space occupation due to the ηpp interaction is evidently seen in the high statistics exclusive measurements of the $pp \to pp\eta$ reaction recently performed at the COSY-11 facility at COSY.
Because of the high momentum transfer involved, the production probes the short range (≈ 0.3 fm) of the nucleon-nucleon interaction. At such small distances residual color forces may play a significant role. The relevance of hadronic and quark degrees of freedom will be briefly reported. In case of the production of η and η' mesons via the proton-proton collision the dominance of the ${}^3P_0 \to Ss$ transition is expected up to an excess energy of about 40 MeV and 100 MeV, respectively. This crucially simplifies the study of the $meson - nucleon - nucleon$ interaction and of the primary production mechanism. The latter manifests itself in practice in the magnitude of the total cross section only. Especially interesting is the relative magnitude of the total cross section for the different isospin channels. For the η production in proton-proton and proton-neutron collisions the ratio of the total cross sections implies that the yield of η in the isosinglet nucleons configuration exceeds the one in the isospin triplet state by more than an order of magnitude.
The presentation will comprise the description of the experimental method utilized at the COSY-11 facility. The world available data will be interpreted with the emphasize of the elaborated [1,2,3] and new results [4] of the COSY-11 collaboration in view of the production mechanism, structure of the mesons, and the meson-nucleon interaction. The η and η' production in both the proton-proton interaction and the quasi free scattering of nucleons inside a deuteron will be considered.

References

[1] COSY-11: J. Smyrski et al., Phys. Lett. **B 474** (2000) 182.
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[3] COSY-11: P. Moskal et al., Phys. Rev. Lett. **80** (1998) 3202.
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