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# STUDIES OF PROPERTIES OF THE $\eta'$ MESON
# AT THE COSY–11 FACILITY

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We shortly discuss results on the isospin dependence of the $\eta'$ production cross section in nucleon-nucleon collisions, results of comparative analysis of the invariant mass distributions for the $pp \to pp\eta'$ and $pp \to pp\eta$ reactions, and we present the value of the total width of the $\eta'$ meson as derived directly from the mass distribution measured with the mass resolution of 0.3 MeV/c$^2$.

*Keywords*: near threshold $\eta'$ meson production; total width

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The COSY–11 detector permits to determine momentum vectors of outgoing nucleons and the four-momentum of unregistered meson is reconstructed via the missing mass technique. The detector was described in many publications and therefore for detailed information the interested reader is referred e.g. to articles [1–3].

The upper limit of the total cross section for quasi-free $pn \to pn\eta'$ reaction has been determined in the excess energy range near the kinematic threshold [4, 5]. The measurement has been carried out using a proton beam and a deuteron cluster target. The energy dependence of the upper limit of the cross section is extracted with a fixed proton beam momentum of $p_{beam} = 3.35$ GeV/c and exploiting the Fermi momenta of nucleons inside the deuteron [3]. The data cover a range of centre-of-mass excess energies from 0 to 24 MeV. The experimentally determined upper limit of the ratio $R_{\eta'} = \frac{\sigma(pn \to pn\eta')}{\sigma(pp \to pp\eta')}$, which is smaller than the ratio for the $\eta$ meson [6], excludes the excitation of the $S_{11}(1535)$ resonance as a dominant production mechanism of the $\eta'$ meson in nucleon-nucleon collisions [7]. At the same time, the determined upper limits of $R_{\eta'}$ go in the direction of what one would expect in the glue production and production via mesonic currents [8, 9]. For quantitative

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tests of these mechanisms an order of magnitude larger statistics and a larger energy range would be required. This can be reached with the WASA-at-COSY facility [10]. The detailed description of the data evaluation as well as theoretical motivation one can find in Ref. [4–6, 11]

The COSY-11 collaboration measured also the $pp \rightarrow pp\eta$ and $pp \rightarrow pp\eta'$ reactions in order to perform comparative studies of the interactions within the proton-proton-meson system [3]. The experiment results in differential distributions of squared invariant proton-proton ($s_{pp}$) and proton-$\eta'$ ($s_{p\eta'}$) masses, as well as in angular distributions and the total cross section at an excess energy of 16.4 MeV [12, 13]. The differential distributions $s_{pp}$ and $s_{p\eta'}$ are compared to theoretical predictions [14, 15] and to the analogous spectra determined for the $pp \rightarrow pp\eta$ reaction [16]. The comparison of the results for the $\eta$ and $\eta'$ meson production rather excludes the hypothesis that the enhancement observed in the invariant mass distributions is due to the meson-proton interaction. Further, the shapes of the distributions do not favour any of the postulated theoretical models.

The reaction $pp \rightarrow pp\eta'$ measured at five different beam momenta was used for the determination of the total width of the $\eta'$ meson, which was directly derived from the mass distributions [17, 18]. Based on the $\eta'$ meson mass spectra reconstructed for 2300 events with the experimental resolution of 0.3 MeV/c$^2$ the total width of the $\eta'$ meson was determined to be $\Gamma_{\eta'} = 0.226 \pm 0.017(\text{stat.}) \pm 0.014(\text{syst.})$ MeV/c$^2$, which is the most precise measurement until now.

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