

Photon-fusion reactions from chiral dynamics with vector fields

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Photon-fusion reactions $\gamma\gamma \rightarrow PP$ (with $PP = \pi^0\pi^0, \pi^-\pi^+, K^0\bar{K}^0, K^+K^-, \eta\eta$ and $\pi^0\eta$) play an important role in our understanding of non-perturbative QCD. As a systematic approach chiral perturbation theory (χ PT) is applied to describe these reactions at low energies [1]. An extension of χ PT to the resonance region can be achieved by recently proposed novel scheme [2], which implements constraints from micro-causality and coupled-channel unitarity.

The cross sections of fusion processes are very sensitive to hadronic final-state interactions. Therefore, a crucial input is a proper description of the Goldstone boson scattering. This study has been performed in [3] within the novel unitarization scheme. The scalar resonances $f_0(980)$ and $\eta(980)$ are dynamically generated from coupled-channel $PP \leftrightarrow PP$ interactions. An important ingredient of these calculations is the chiral Lagrangian supplemented with light vector-meson degrees of freedom. The latter plays a crucial role in the hadrogenesis conjecture [4].

In the case of photo-fusion reactions, the chiral Lagrangian has five unknown parameters [5]. They parameterize the strength of interaction terms involving two vector meson fields. These parameters are fitted to $\gamma\gamma \rightarrow \pi^0\pi^0, \pi^-\pi^+, \pi^0\eta$ data and to the decay $\eta \rightarrow \pi^0\gamma\gamma$, which is linked to $\gamma\gamma \rightarrow \pi^0\eta$ by crossing symmetry. For the decay amplitude we use the tree-level result, while for the reaction amplitudes we use the full rescattering formalism outlined in [2]. The results are depicted in Figs. 1 and 2.

The photon-fusion cross sections for the two-pion final states are in good agreement with the existing experimental data from threshold up to about 0.9 GeV. The $a_0(980)$

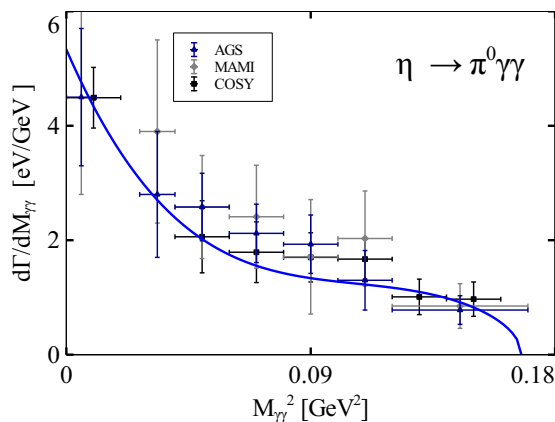


Figure 1: The single-differential invariant-mass distribution of the decay $\eta \rightarrow \pi^0\gamma\gamma$.

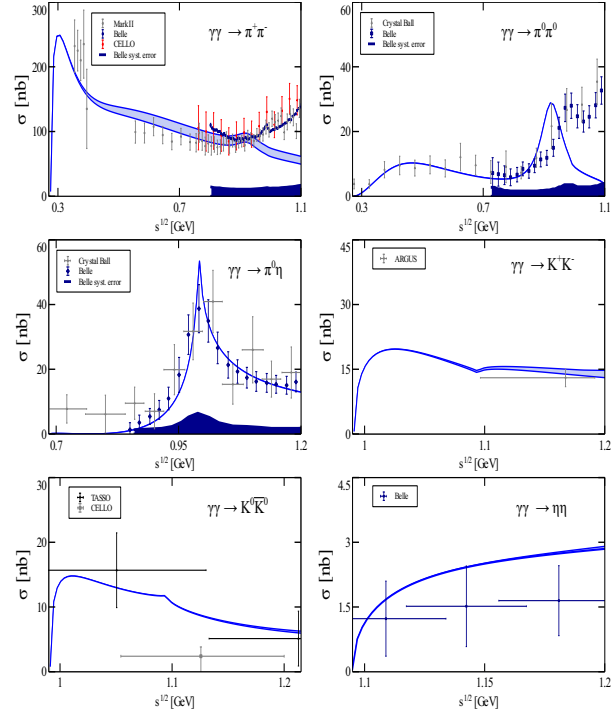


Figure 2: Total cross sections for the reactions $\gamma\gamma \rightarrow \pi^+\pi^-, \pi^0\pi^0, \pi^0\eta, K^+K^-, K^0\bar{K}^0$ and $\eta\eta$.

meson in the $\pi^0\eta$ channel is dynamically generated and an accurate reproduction of the $\gamma\gamma \rightarrow \pi^0\eta$ data is achieved up to 1.2 GeV. Based on our parameter sets we predict the $\gamma\gamma \rightarrow K^0\bar{K}^0, K^+K^-, \eta\eta$ cross sections (see Fig. 2).

References

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