The role of gauged Wess-Zumino-Witten term in kaon photoproduction

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Strangeness production is one of important subjects in hadron and nuclear physics. It is the basis of hyperon interactions and hyper-nuclear physics, where an expansion to the new dimension of strange matter is being explored. Many reactions of producing exotic states including pentaquarks are also associated with strangeness productions. Therefore, the understanding of the production mechanism is indeed a key to discuss the above interesting physics.

Photoproduction of kaon and hyperon is one of the simplest reactions among them and experimental data have been updated till recently [1, 2, 3, 4]. We study Kaon photoproductions associated with the production of the ground state Λ. We investigate the role of K and K^* exchange in the t-channel, which can be tested by the photon asymmetry in comparison with experimental data. We find a significant amount of contribution from the one-loop diagram induced by the gauged Wess-Zumino-Witten term for QCD anomaly [5]. The amplitude of the one-loop diagram renormalizes the K^* exchange amplitude, that is,

$$i\mathcal{M}_{K^*+\mathrm{loop}}(s,t) = \bar{u}(p_\Lambda)[(\mathcal{A}^1_{K^*}(s,t) + \Delta^1_{loop}(s,t))\gamma^\mu \epsilon_{\mu\nu\sigma\rho}\epsilon^\nu_\gamma p^\sigma_\gamma p^\rho_K + (\mathcal{A}^2_{K^*}(s,t) + \Delta^2_{loop}(s,t))1]u(p_N), \qquad (1)$$

where $\mathcal{A}^1_{K^*}(s,t)$ and $\mathcal{A}^2_{K^*}(s,t)$ denote the amplitudes of the K^* exchange at the tree level and, $\Delta^1_{loop}(s,t)$ and $\Delta^2_{loop}(s,t)$ denote the amplitudes of the loop contribution. We have computed the photon asymmetry with those amplitudes and Born terms. The results are shown in Figure 1. As you can see, the positive values of the photon asymmetry is well reproduced by adding the loop contribution. This enable us to use coupling constants which are determined in a microscopic way, unlike the present phenomenological studies where the K^* coupling strength were treated as a free parameter. Having a microscopic description, we hope to extend our study to new physics including exotic hadrons.

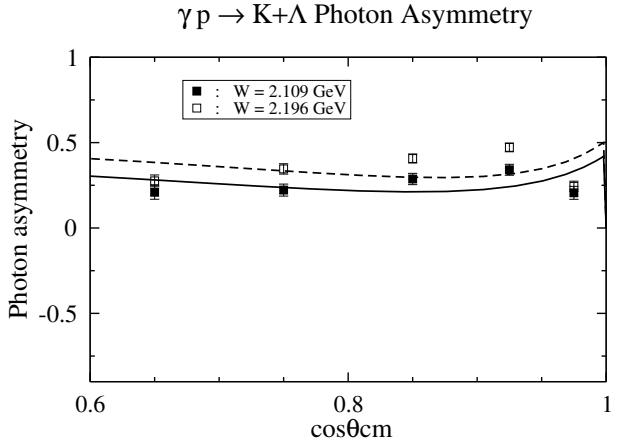

Figure 1: Photon asymmetries as functions of $\cos\theta_{\mathrm{cm}}$. The full results with the WZW term are shown by the solid line ($W = 2.109$ GeV) and dashed line ($W = 2.196$ GeV). The data are taken from LEPS [1].

References

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