1 - 12 $K^{*0}\Lambda$ Photoproduction off a Neutron*

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In recent years, the strange meson photoproductions are widely investigated in both experiment and theory. The $\gamma n \to K^{*0}\Lambda$ reaction attracts special attention because of its absence of the contact term, which is usually dominant in a photoproduction process[1−6]. The interaction mechanism includes the s channel with nucleon and its resonances, t channels with K and κ exchanges, and the u channel with hyperon (Λ, Σ and Σ^*). The t-channel K^* exchange vanishes also because of the neutral charge of final K^*. Usually, the contribution from the s channel with the nucleon pole is very small and negligible, and the u-channel contribution is important only at backward angles[2,3]. Hence, the $\gamma n \to K^{*0}\Lambda$ reaction is a very ideal channel to investigate the nucleon resonances and the t-channel K and κ exchanges.

Thanks to the experimental data released from the facilities such as CLAS [7], the $K^*\Lambda$ photoproduction off a proton was widely investigated theoretically[8−11]. However, because of a lack of experimental data, study of the $K^{*0}\Lambda$ photoproduction off a neutron is scarce except for some predictions[8, 10, 11]. Recently, the CLAS Collaboration reported preliminary experimental data for the $\gamma n \to K^{*0}\Lambda$ reaction[12]. In Refs. [8, 11], the contribution from the nucleon resonance was suggested to be small and the κ exchange is also suppressed. The CLAS data provide an opportunity to do a preliminary check of these opinions. And if they are right, the K exchange becomes dominant at this interaction, which is helpful for clarifying the role of the t-channel contribution in the $\gamma n \to K^{*0}\Lambda$ reaction.

In this work, within an effective Lagrangian approach, we analyze the $\gamma n \to K^{*0}\Lambda$ reaction based on the preliminary CLAS data. In Ref. [9] the Regge model is found essential to reproduce the experimental data of the charged K^* photoproduction. So, in this work, both the Regge model and the Feynman model will be applied to treat the t-channel contribution. The differential cross sections $d\sigma/d\cos\theta$ obtained in the two schemes are illustrated in Fig.1.

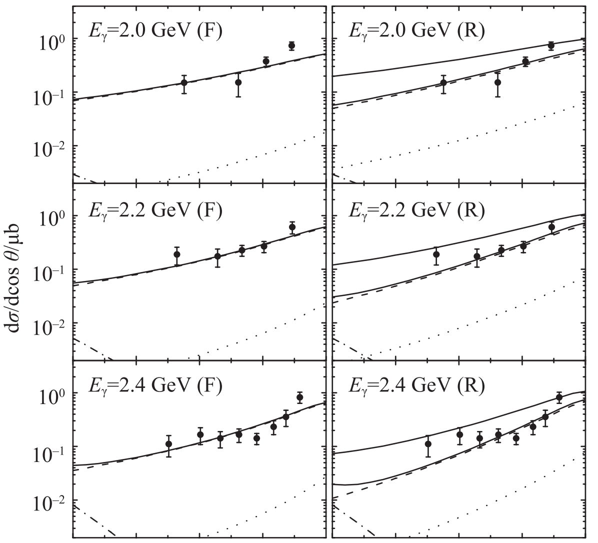

Fig. 1 The differential cross section for the $K^{*0}\Lambda$ photoproduction from the neutron. The marks (F) and (R) are for the Feynman model and the Regge model, respectively. The full, dashed, dotted, and dash-dotted lines are for the full model, K exchange, κ exchange, and u channel.

Both results are acceptable considering that only one parameter is fitted in the current work. The difference between the best-fitted χ^2 for the two schemes are small with values of 1.99 and 1.68 for the Feynman and the Regge models, respectively. The slope of curve in the full model for the Regge model is steeper than that for the Feynman model, which results in the Regge model working better at forward angles while the Feynman model is better at medium angles ($\cos\theta$ around 0) . One can find that the K exchange is dominant at energies $E_\gamma = 2.0{\sim}2.4$

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GeV. The κ exchange contribution is much smaller than the contribution from the K exchange and almost has no effect on the differential cross sections in the full model. The s channel contribution is negligible as the other photoproduction process. The u channel works at backward angles and leads to a small increase of the differential cross section.

The preliminary CLAS data are helpful to understand the interaction mechanism of the $K^{*0}\Lambda$ photoproduction, such as confirming the dominance of the K exchange and the smallness of nucleon resonance contribution. The precise data at energies around 2 GeV and data at high energies, especially at backward angles will be helpful to clarify the roles of nucleon resonances and the Regge model, respectively.

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1 - 13 Understanding Spin Parities of $P_c(4450)$ and $Y(4274)$ in Hadronic Molecular State Picture*

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The hadronic molecular state picture is one of the most popular interpretations of the exotic state in market[1]. It has been widely applied to explain a series of experimentally observed exotic states, which can not be assigned in conventional quark model but is close to the threshold of two hadrons. In the literature, people often focus on the bound state from S-wave interaction and assume P-wave bound state should be difficult to form from hadron-hadron interaction and to observe in experiment. For example, the Y(4274) and the Y(4140) are related to the S-wave $D_s\bar{D}_{s0}(2317)$ and $D_s^{*+}D_s^{*-}$ states, respectively[2,3]. There also exist predictions of hidden-charmed pentaquark from S-wave anticharmed meson and charmed baryon interactions[4,5]. The recent observation of the $P_c(4450)$ and $P_c(4380)$ at LHCb confirmed the existence of the hidden-charmed pentaquark[6]. Surprisingly, different from the predictions in Refs. [4, 5] the hidden-charmed pentaquarks $P_c(4380)$ and $P_c(4450)$ carry opposite parities. Hence, it is difficult to explain both states as hadronic molecular states from the relevant S-wave anticharmed meson and the charmed baryon interactions, *i.e.*, $\bar{D}\Sigma_c^*$, $\bar{D}^*\Sigma_c$, and $\bar{D}^*\Sigma_c^*$ interactions. Such challenge also happens in the case of the Y(4274). The spin parity 1^{++} determined at LHCb[7,8] conflicts with the previous S-wave $D_s\bar{D}_{s0}(2317)$ molecular state interpretation[2,3], which suggests P-wave interaction should be also introduced in this case. In this work we will study the $P_c(4450)$ and Y(4274) in a quasipotential Bethe-Saltpeter equation with a partial wave decomposition on spin parity J^P.

In this work, the $P_c(4450)$ and $P_c(4380)$ are taken as a $5/2^+$ (P- and F-waves) state and a $3/2^-$ (S- and D-waves) state from the $\bar{D}^*\Sigma_c$ interaction, respectively. In the molecular state picture, these states are produced from a generating channel $\bar{D}^*\Sigma_c$, with pseudoscalar (π, η), vector (ρ, ω) and scalar (σ) meson exchanges. These two pentaquarks were observed in the $J/\psi p$ invariant mass spectrum, so we choose it as observation channel. The poles of these two states at $|1-V(z)G(z)|=0$ and the corresponding $J/\psi p$ invariant mass spectrum of $\Lambda_b^0 \to J/\psi K^- p$ decay are presented in Fig. 1.

A pole at $4\,447\pm4i$ MeV is found in $5/2^+$-wave $\bar{D}^*\Sigma_c$ interaction. Correspondingly, a narrow peak appears in the $J/\psi p$ mass spectrum near the $\bar{D}^*\Sigma_c$ threshold. The small binding energy and width of this state is due to the relatively weak interaction in P and F waves. Obviously, this state can be identified as the experimentally observed