$\Lambda(1520, 3/2^-)$ photoproduction reaction via $\gamma N \to K\Lambda(1520)$

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In the present work, we investigate the $\Lambda^*(1520, 3/2^-)$ photoproduction via the $\gamma N \to K\Lambda^*$ reaction. We employ the Rarita-Schwinger formalism for describing the spin-3/2 particle for a relativistic description. Taking into account the effective Lagrangians for the Born diagrams, we construct the invariant amplitudes for the reaction. The model parameters such as the anomalous magnetic moment of Λ^*, κ_{Λ^*} and the off-shell parameter X are tested for their sensitivity. We find that the parameter dependence turns out to be weak in the low–energy region ($E_\gamma \lesssim 3$ GeV). Furthermore, the quark model calculation indicate that κ_{Λ^*} is relatively small and can be ignored. Therefore, we set these two unknown parameters, κ_{Λ^*} and X, to zero for the numerical calculations. The coupling constant $g_{K^*N\Lambda^*}$ is taken to be 0 and ± 11, since the quark model show that $g_{K^*N\Lambda^*}$ is in the same order as $g_{KN\Lambda^*}$. We use the gauge invariant, Lorentz invariant and crossing symmetric four-dimensional form factor. We perform the numerical calculations, which are the total cross section and momentum transfer t–dependence for the $\gamma p \to K^+\Lambda^*$ and $\gamma n \to K^0\Lambda^*$. The results are shown in Fig. 1. We observe that the K^*–exchange is the dominant contribution in the neutron target case. However, the contact term contribution in the proton target prevails over all other kinematical channels. Turning to the helicity dependence which is argued in Refs. [2], though the contribution of the $S_z = \pm 3/2$ is dominant, it is not directly related to the K^*–exchange dominance as indicated in the experimental analysis. We once again confirm that the reaction process of the Λ^* photoproduction is dominated by the contact term contribution. The numerical results are shown in Fig. 2. In the left figure of Fig. 2, K^*–exchange, which brings spin–1 contributes more to the spin–3/2 Λ^* state than that of spin–1/2 and vice versa for pseudoscalar K–exchange in the middle figure. These behavior is quite natural considering spins of the nucleon and the exchanging meson. As for the contact term shown in the left figure, there is larger spin–3/2 contribution than that of spin–1/2. Most of the spin–3/2 contribution was considered comming from K^*-exchange in the experiemntal analysis [2]. However, we verify that significant contribution to spin–3/2 Λ^* state is also comming from the contact term. For more details, one can refer Refs. [3].

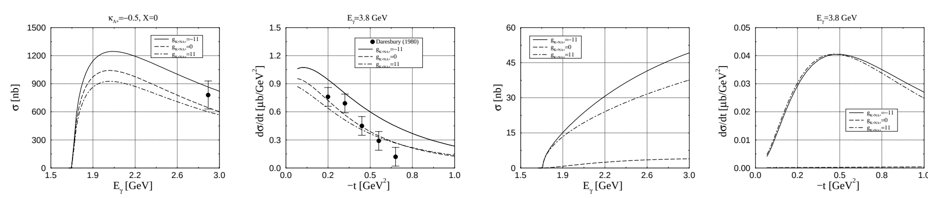

FIG. 1: From the left end: The total cross sections (1st panel) and momentum transfer t–dependence (2nd panel) for the proton target. Those for the neutron one (3rd and 4th, respectively). The experimental data are taken from Ref. [2].

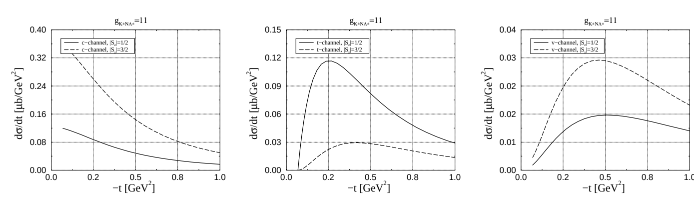

FIG. 2: The t–dependence for the two helicities $S_z = \pm 1/2$ and $S_z = \pm 3/2$ for the c– (left), t–channels (middle) and K^*–exchange (right).

[1] A. Boyarski *et al.*, Phys. Lett. B **34**, 547 (1971).
[2] D. P. Barber *et al.*, Z. Phys. C **7**, 17 (1980).
[3] S. I. Nam, A. Hosaka and H. C. Kim, Genshikaku Kenkyu **49**, 53 (2005).