A new $N^*(1675)$ resonance in the $\gamma N \to \eta N$ reaction

Ki-Seok Choi[1], Seung-Il Nam[1], Atsushi Hosaka[2] and Hyun-Chul Kim[1]
[1]*Department of Physics and Nuclear physics & Radiation Technology Institute (NuRI)*
Pusan National University, Busan 609-735, Korea
[2]*Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

Recently, GRAAL experiment announced a new nucleon resonance with a seemingly narrow decay width ~ 10 MeV and a mass ~ 1675 MeV in the η-photoproduction [1]. This new nucleon-like resonance, $N^*(1675)$, may be regarded as a non-strange pentaquark because of its narrow decay width, which is assumed to be one of the significant features of the pentaquark baryons. The particularly interesting observation from the GRAAL is that the $N^*(1675)$ is preferably excited on the neutron target. This property can be naturally explained if we assume that $N^*(1675)$ belongs to the antidecuplet. The magnetic coupling of $\gamma N(8) \to N(\overline{10}$ vanishes due to SU(3) Clebsh-Gordan coefficients. It would then be of great interest to analyze the production reaction theoretically.

We use an effective Lagrangian method and compute the Born diagrams as depicted in Fig. 1. There are several unknown parameters; many of them can be determined by fitting the global energy and angular dependence of the eta photoproduction. The most important parameter which is the magnetic coupling of $\gamma N(938) \to N^*(1675)$ is determined so as to reproduce the resonance structure of $N^*(1675)$. Details of the method is found in Ref. [2].

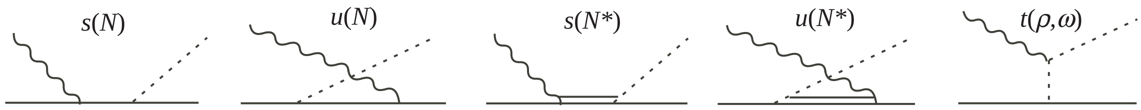

Figure 1: Various Born diagrams for the eta photoproduction.

Here we show the results of our calculation. In the following figures (Figs. 2), we plot the differential cross sections at the scattering angle $\theta = 145$ degree as functions of the total energy of the center-of-mass system E_{CM}. The calculations were done for different magnetic coupling strength μ from zero to some modest value; predictions in the chiral quark model are $\mu_{\gamma nn^*} \simeq 0.2$ and $\mu_{\gamma pp^*} \simeq 0$. Here we assume that the spin and parity of N^* are $J^P = 1/2^+$.

From the figure, it is obvious that the peak of the neutron target at around 1675 MeV can be reproduced when we choose $\mu_{\gamma nn^*} \simeq 0.2$, while for the proton target the cross section is consistently explained by $\mu_{\gamma pp^*} = 0$. It is interesting that the size of the peak in the neutron target is explained by a magnetic coupling consistent with the prediction of the chiral quark soliton model.

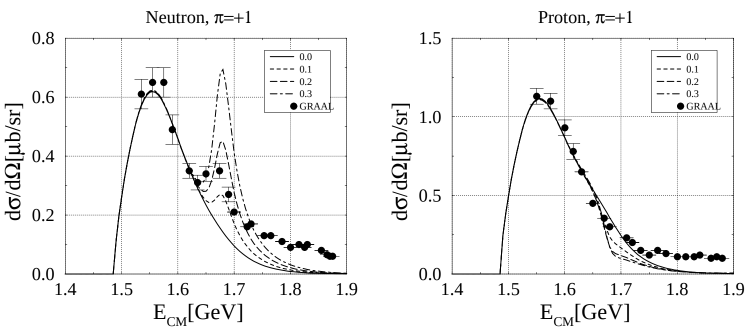

Figure 2: The differential cross sections as functions of the total energy in the center of mass (CM) energy frame for the neutron and proton targets. The four curves are results of using $\mu_{\gamma NN^*} = 0.0,\ 0.1,\ 0.2,\ 0.3$. The experimental data are taken from Ref. [1].

References

[1] V. Kuznetsov [GRAAL Collaboration], [arXiv:hep-ex/0409032].

[2] K. S. Choi, S. i. Nam, A. Hosaka and H. C. Kim, Phys. Lett. B **636**, 253 (2006) [arXiv:hep-ph/0512136].