Table 1 is the results for neutron single-particle energies in ^{40}Ca calculated in various approximation, the calculated results are compared with the available experimental data. We can see that the single-particle energies becomes more negative when the calculation goes beyond the mean field approximation where only the central part of the interaction is included, especially for $1f_{5/2}$, $2p_{1/2}$, $2p_{3/2}$ neutron states, the energy shift is more than 2 MeV compared to the results give by pure Hartree-Fock calculation. Usually the spin-orbit interaction play an attractive role as the residual interaction in the various giant resonances of nuclei, from table 1 we see that the similar results are obtained by the spin-orbit interaction, it gives an attractive contribution to the single-particle energies when the spin-orbit interaction is included in the PVC vertex, the maximum energy shift is about 2.34 MeV. Finally let us discuss the contribution from tensor interaction, for most of the states, the tensor gives an attractive contributions to the single-particle energies, for $1d_{5/2}$, it gives a slightly repulsive contribution to the energy.

Table 2 shows the effective mass in ^{40}Ca within various approximation. The effective mass is about 0.8～0.9 around the Fermi surface within the pure Hartree-Fock calculation, means it just gives the so-called k-mass. When one goes beyond the mean field calculation, one shall consider the energy-dependent mass operator, we see that the calculated e-mass is in the region 1.1 to 1.5 around the Fermi surface, the total effective mass is the product of k-mass and e-mass, finally effective mass around the Fermi surface is about the unit. We conclude that the level density around the Fermi surface is enhanced when we go beyond the mean field calculation.

References

[1] G. Colo, H. Sagawa, P. F. Bortignon, Phys. Rev., C82(2010)064307.
[2] L. G. Cao, G. Colo, H. Sagawa, et. al., Phys. Rev., C80(2009)064304.
[3] T. Lesinski, M. Bender, K. Bennaceur, et al., J. Meyer, Phys. Rev., C76(2007)014312.
[4] G. Colo, L. G. Cao, N. Van Giai, et al., Comp. Phys. Comm., 184(2013)142.

1 - 12 Researchers Explored Roles of Nucleon Resonances in Λ(1520) Photoproduction

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The study of nucleon resonance is an interesting area in hadron physics. As of now, the nucleon resonances around 2.1 GeV are still in confusion. The CQM predicted about two dozens of the nucleon resonances in this region, most of which are in $n=3$ shell. Only a few of them have been observed as shown in PDG with large uncertainties[1]. Hence, more efforts should be paid to figure out the nucleon resonances around 2.1 GeV. Due to the high threshold of Λ(1520) production, about 2 GeV, it is appropriate to enrich our knowledge of nucleon resonances, especially ones with mass larger than 2 GeV. In recent years, excited by the claimed finding of the pentaquark Θ with a mass of about 1.540 GeV, many experiments, such as LEPS/Spring-8[2], CLAS/JLab, have been performed in the Λ(1520) energy region due to the close mass of Λ(1520) and Θ. Though the existence of the pentaquark is doubtful based on later more precise experiments, many experimental data on Λ(1520) photoproduction have been accumulated.

In this work we investigate the Λ(1520) photoproduction within the effective Lagrangian method. The contact term is dominant in the interaction mechanism and K exchanged t-channel are important except at the energy near the threshold. The K^*-exchange t-channel plays an important role in the high energy at 11 GeV, but is negligible at low energy. The contributions of nucleon resonances are determined by the radiative and strong decay amplitudes predicted by the constituent quark model. The results shows that D_{13}(2080) is the most important nucleon resonance in Λ(1520) photoproduction and responsible to the bump structure in the LEPS10 experiment as shown in Fig. 1(left). A nucleon resonance $[N5/2^-]_2$(2080) predicted by CQM with mass about 2100 MeV, which cannot be assigned as N(2200), is also essential to reproduce the experimental data around 2.1 GeV. The contributions from other nucleon resonances are small even negligible.

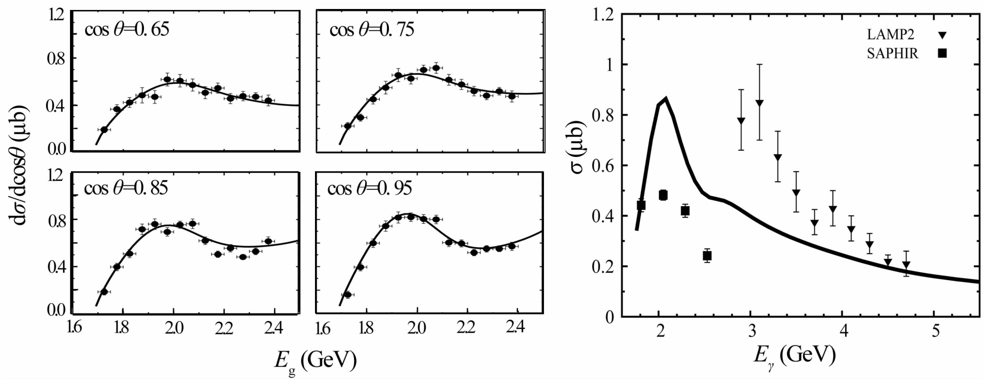

Fig. 1 The differential cross section for the Λ(1520) photoproduction(left). The total cross section for the Λ(1520) pgotoproduction(right).

With the contributions from Born terms and nucleon resonances, the experimental data about differential cross sections can be reproduced while there exists large discrepancy between experimental and theoretical results in polarized asymmetry, which suggests further improvement, such as including the coupled-channel effect, is required. The predictions about the differential cross section at energy 1.75 GeV$<E_\gamma<$ 5.50 GeV are presented in Fig. 1(right), which can be checked by the future experimental data in the CLAS eg3 and g11 runs.

References

[1] K. Nakamura, et al., J. Phys., G37(2010)075021.
[2] H. Kohri, et al., Phys. Rev. Lett.,104(2010)172001.

1 - 13 New Structure around 3250 MeV as D_0^* (2400)N Molecular Hadron

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Very recently the BaBar Collaboration reported a new enhancement structure in the $\Sigma_c^{++}\pi^-\pi^-$ invariant mass spectrum of the $B^-\to\Sigma_c^{++}p\pi^-\pi^-$ decay. Its mass and width are $M=(3245\pm20)$ MeV and $\Gamma=(108\pm6)$ MeV, respectively[1]. We will refer to the new structure by the name $X_c(3250)^0$. In terms of its observed decay channel, we conclude that $X_c(3250)^0$ is an isotriplet with charm number $C=+1$. How to understand this newly observed structure observed in the baryonic B decay becomes an intriguing research topic. In this work, we propose a novel approach to explain the BaBar's observation of $X_c(3250)^0$, where $X_c(3250)^0$ can be naturally explained as a molecular hadron composed of a charmed meson $D_0^*(2400)$ and a nucleon N.

Using the covariant spectator theory, which was proposed and developed to study the wave functions and the form factor of deuteron[2], we calculated the boundary energy and decay width of $X_c(3250)^0$. In Table 1, we give the decay width of $X_c(3250)^0\to nD\pi$ corresponding to several Λ typical values, which does not strongly dependent on Λ. Since the total width of $X_c(3250)^0$ is from its dominant decay $X_c(3250)^0\to nD\pi$, we compare the calculated decay width with the BaBar's data, which shows the total width of $X_c(3250)^0$ under the assignment of the molecular state is comparable with the BaBar's measurement. The study of dominant decay channels of $X_c(3250)^0$ also supports the $nD_0^*(2400)^0$ molecular state explanation to the observed $X_c(3250)^0$.

As an important test of the molecular state assignment to $X_c(3250)^0$, in this work we also predict the existence of the isoscalar partner of $X_c(3250)^0$, which is named as $Y_c(3250)^+$. The result shown in Table 1 indicates that the width of $Y_c(3250)^+$ is also around 100 MeV. The dominant decays of $Y_c(3250)^+$ are