**I. INTRODUCTION**

Searching and explaining the exotic states which may consist of the non $qq$ and $qqq$ configurations, have becoming a very interesting topic in hadron physics. Actually, the structure of baryon is more intriguing than that of the meson. Recently, some charmed baryons have been experimentally identified \[1, 2\], which provide an ideal place to investigate the dynamics of the light quarks in the environment of a heavy quark. For example, the charmed baryon $\Lambda_c^*(2940)$ has aroused intensive studies on its nature.

The charmed baryon $\Lambda_c^*(2940)$ was first announced by the BABAR Collaboration \[3\] by analyzing the $pD^0$ invariant mass spectrum. Later, the Belle Collaboration \[4\] confirmed it as a resonant structure in the final state $\Sigma_c(2555)^{0,++}\pi^\pm \rightarrow \Lambda_c^+\pi^+\pi^-$. The values for the mass and width of the $\Lambda_c^*(2940)$ state were reported by both Collaborations \[3, 4\], which are consistent with each other:

- **BABAR**: $M = 2939.8 \pm 1.3 \pm 1.0$ MeV, 
  $\Gamma = 17.5 \pm 5.2 \pm 5.9$ MeV,
- **Belle**: $M = 2938.0 \pm 1.3^{+2.0}_{-4.0}$ MeV,
  $\Gamma = 13^{+8+27}_{-5-7}$ MeV.

However, the spin-parity of the $\Lambda_c^*(2940)$ state have still not been determined in experiment. Different theoretical groups \[5, 13\] have performed theoretical studies of $\Lambda_c^*(2940)$ by assuming different assignment for its spin-parity $J^P = 1^\pm, 2^\pm, 5^\pm$. For example, by assuming the $\Lambda_c^*(2940)$ as a $pD^{*0}$ molecular state, the spin-parity of $\Lambda_c^*(2940)$ was assigned to be $1^\pm$ in Refs. \[6, 7, 18\]. Besides supposing $\Lambda_c^*(2940)$ to be a hadronic molecular state, the $\Lambda_c^*(2940)$ also is explained as a conventional charmed baryon \[9\] with $J^P = 2^+$ or $J^P = 5^-$. Since the the nature of $\Lambda_c^*(2940)$ is still unclear, more work is needed to determine its real inner structure.

Until now, all experimental observations of $\Lambda_c^*(2940)$ have been from the $e^+e^-$ collision \[3, 4\]. Thus it is interesting to study the production of $\Lambda_c^*(2940)$ in other process. In Refs. \[5, 20\], the production of $\Lambda_c^*(2940)$ by $pp$ annihilation are proposed, while the production of $\Lambda_c^*(2940)$ via $\pi$ meson induced nucleon is discussed in Ref. \[21\]. However, one notice that there is no any relevant informations about the photoproduction of $\Lambda_c^*(2940)$. Thus the studies on the photoproduction of $\Lambda_c^*(2940)$ are highly necessary.

In this work, with an effective Lagrangian approach, the photoproduction of $\Lambda_c^*(2940)$ in the $\gamma n \rightarrow D^-\Lambda_c^*(2940)^+$ process is investigated. Moreover, the feasibility of searching for the charmed $\Lambda_c^*(2940)$ resonance is also discussed. It is shown that modern experiments based on energetic lepton beams of high intensity like the COMPASS experiment at CERN \[22, 23\] could be the promising platform for searching for photoproduction of the charmed baryon $\Lambda_c^*(2940)$ and study of its properties.

This paper is organized as follows. After an Introduction, the formalism and the main ingredients are presented. The numerical results and discussions are given in Sec. III. In Sec. IV, the $\Lambda_c^*(2940)$ production at COMPASS are discussed. Finally, the paper ends with a brief summary.

**II. FORMALISM**

In the present work, an effective Lagrangian approach in terms of hadrons is adopted, which is an important theoretical method in investigating various processes in the resonance region \[8, 21, 24, 29\].

\[\Lambda_c^*(2940)\] photoproduction off the neutron

Xiao-Yun Wang\(^1,2,3\) and Xu-Rong Chen\(^1,3\)

\(^1\)Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China
\(^2\)University of Chinese Academy of Sciences, Beijing 100049, China
\(^3\)Research Center for Hadron and CSR Physics, Institute of Modern Physics of CAS and Lanzhou University, Lanzhou 730000, China

\(^4\)Joint Institute for Nuclear Research, Dubna 141980, Russia

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*xywang@impcas.ac.cn
avg@jinr.ru
A. Feynman diagrams and effective Lagrangian densities

Fig. 1 describes the basic tree level Feynman diagrams for the production of $\Lambda_c^*(2940)$ in $\gamma n \rightarrow D^- \Lambda_c^+$ reaction. These including the $t$-channel with $D^+$ and $D^{*+}$ exchange, $s$-channel with nucleon pole exchange, $u$-channel with $\Lambda_c^*$ exchange and contact term. Fig. 2 is the Feynman diagrams for the $\gamma n \rightarrow D^- D^0 p$ reaction.

In Ref. [6, 7], by assuming the $\Lambda_c^*(2940)$ as a molecular $D^0 p$ state, the spin-parity ($J^P$) quantum number of $\Lambda_c^*(2940)$ was assigned to be $1^+$, while the quantum number $J^P = \frac{3}{2}^-$ is completely excluded because the calculated partial widths are much larger than the experimental width of $\Lambda_c^*(2940)$ state. In this present work, two cases of $\Lambda_c^*(2940)$ with $J^P = \frac{3}{2}^+$ are calculated for a comparison. Thus we take the normally used effective Lagrangians for $\Lambda_c^* N D$, $\Lambda_c^* ND^*$ and $\gamma \Lambda_c^* \Lambda_c^*$ couplings as [3, 21],

$$\mathcal{L}_{ND\Lambda_c^*}^{(\frac{1}{2}^+)} = i g_{\Lambda_c^*ND}^{\perp} \bar{\Lambda}_c^* \gamma^\perp N D + h.c.,$$

$$\mathcal{L}_{ND^*\Lambda_c^*}^{(\frac{1}{2}^+)} = g_{\Lambda_c^*ND^*}^{\perp} \bar{\Lambda}_c^* \gamma^\perp N D^* + h.c.,$$

$$\mathcal{L}_{\gamma\Lambda_c^*\Lambda_c^*}^{(\frac{3}{2}^+)} = -\kappa_{\Lambda_c^*}^{\perp} \bar{\Lambda}_c^* (Q_{\Lambda_c^*} A - \frac{\beta_{\Lambda_c^*}}{2m_{\Lambda_c^*}} g_{\mu\nu} F_{\mu\nu}) \Lambda_c^* + h(\beta)$$

with

$$\Gamma^\perp = \begin{pmatrix} \gamma_5 \\ 1 \end{pmatrix}, \quad \Gamma^\mu = \begin{pmatrix} \gamma^\mu \\ \gamma_5 \gamma^\mu \end{pmatrix}. \quad (4)$$

The $Q_{\Lambda_c^*}$ is the electric charge (in the unite of $e$), while the anomalous magnetic momentum $^1 \kappa_{\Lambda_c^*}^{\perp}$ is 0.38 for the $\Lambda_c^*$ with $J^P = \frac{1}{2}^+$. The anomalous magnetic moment $\kappa_{\Lambda_c^*}^{\perp}$ for $\Lambda_c^*$ with $J^P = \frac{3}{2}^-$ amounts to 0.44 in the SU(3) quark model [31]. We take the coupling constants $g_{\Lambda_c^*ND}^{\perp} = -0.45$, $g_{\Lambda_c^*ND^*}^{\perp} = -0.97$, $g_{\Lambda_c^*ND^*}^{\perp} = 6.64$ and $g_{\Lambda_c^*ND^*}^{\perp} = 3.75$ as used in Refs. [3, 21].

Moreover, the effective Lagrangians for the $\gamma DD$, $\gamma DD^*$ and $\gamma NN$ couplings are

$$\mathcal{L}_{\gamma DD} = i e A_\mu (D^+ \partial^\mu D^- - \partial^\mu D^+ D^-), \quad (5)$$

$$\mathcal{L}_{\gamma DD^*} = g_{\gamma DD^*} \epsilon_{\mu\nu\beta\gamma} (\partial^\nu A^\gamma (\partial^\beta D^\mu) D + h.c.), \quad (6)$$

$$\mathcal{L}_{\gamma NN} = -e \bar{N} (Q_N A - \frac{\kappa_N}{4m_N} \sigma_{\mu\nu} F_{\mu\nu}) N, \quad (7)$$

where $F_{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$ with $A^\mu$, $D$, $D^{*\mu}$ and $N$ are the photon, $D$-meson, $D^{*}$-meson and nucleon fields, respectively. $m_D$ and $m_N$ are the masses of the $D$-meson and nucleon, while $\epsilon_{\mu\nu\beta\gamma}$ is the Levi-Civita tensor. $Q_N$ is the charge of the hadron in the unit of $e = \sqrt{\frac{\alpha}{4\pi}}$ with $\alpha$ being the fine-structure constant. The anomalous magnetic moment $\kappa_N = -1.913$ for the neutron [32].

The coupling constant $g_{\gamma DD^*}$ are determined by the radiative decay widths of $D^*$,

$$\Gamma_{D^*\gamma \rightarrow D^0 \gamma} = \frac{g_{\gamma DD^*}^2 (m_{D^*}^2 - m_{D^0}^2)^2}{32 \pi m_{D^0}^2} |p^\gamma_{D^0}|, \quad (8)$$

where $p^\gamma_{D^0}$ is the three-vector momentum of the $D$ in the $D^*$ meson rest frame. With $m_{D^*} = 2.01$ GeV, $m_D = 1.87$ GeV and $\Gamma_{D^*\gamma \rightarrow D^0 \gamma} = 1.35$ keV, one obtains $g_{\gamma DD^*} = 0.117$ GeV$^{-1}$.

Considering the internal structure of hadrons, a form factor is introduced to describe the possible off-shell effects in the amplitudes. For the exchange baryons, we adopt the following form factors as used in Refs. [33, 34],

$$F_B(q_{ex}^2) = \frac{\Lambda_B^4}{\Lambda_B^4 + (q_{ex}^2 - m_{ex}^2)^2}, \quad (9)$$

while for the $D$ and $D^*$ exchange, we take

$$F_{D/D^*}(q_{ex}^2) = \frac{\Lambda_{D/D^*}^4 - m_{ex}^2}{\Lambda_{D/D^*}^4 - q_{ex}^2}, \quad (10)$$

where $q_{ex}$ and $m_{ex}$ are the four-momenta and the mass of the exchanged hadron, respectively. The values of cutoff parameters $\Lambda_B$ and $\Lambda_{D/D^*}$ will be discussed in the next subsection.

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1 In Ref. [31], the magnetic moment of lighter state $\Lambda_c(2286)$ is predicted to be 0.38. Since this predicted magnetic moment does not depend on mass of $\Lambda_c$ state, it is reasonable to take $\kappa_{\Lambda_c^*}^{\perp} = 0.38$ for the $\Lambda_c^*$ with $J^P = \frac{1}{2}^+$. 

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Breit-Wigner form \[5, 21\]

For the propagators of spin-1/2 baryon, we adopt the Breit-Wigner form \[5, 21\]

\[G_1/2(q_{ex}) = \frac{i}{q_{ex}^2 - M_{\pi}^2 + im_{\pi}1} \]

(11)

where \(m_{\pi}\) is the total decay width of baryon. We take \(\Gamma = 17\) MeV \[1\] for the \(\Lambda_c^+(2940)\) state and \(\Gamma = 0\) for other intermediate baryons.

The propagator for \(D\) exchange is written as

\[G_D(q_{ex}) = \frac{i}{q_{ex}^2 - m_D^2} \]

(12)

For the \(D^*\) exchange, we take the propagator as

\[G_{D^*}(q_{ex}) = i\frac{-g^{\mu\nu} + q^{\mu}q^{\nu}/m_D^2}{q_{ex}^2 - m_{D^*}^2} \]

(13)

where \(\mu\) and \(\nu\) denote the polarization indices of vector meson \(D^*\).

**B. Cross section for the \(\gamma n \to D^-\Lambda_c^+(2940)^+\) reaction**

After the above preparations, the invariant scattering amplitude of \(\gamma(k_1)n(k_2) \to D^-\Lambda_c^+(k_3)\) process as shown in Fig. 1 can be constructed as,

\[-iM_{j}^{1/2} = \bar{u}(k_4, \lambda_{\Lambda_c})A_\gamma^{1/2}(\pm)u(k_2, \lambda_n)\gamma_{\nu}(k_1, \lambda_\gamma), \]

(14)

where \(j\) denotes the s-, t-, u-channel or contact term process that contribute to the total amplitude, while \(\epsilon\) and \(u\) are the photon polarization vector and Dirac spinor, respectively. \(\lambda_{\Lambda_c}, \lambda_n\) and \(\lambda_\gamma\) are the helicities for the \(\Lambda_c^+(2940)\), the neutron, and the photon, respectively.

The reduced \(A_\gamma^{1/2}(\pm)\) amplitudes read as

\[A_\gamma^{1/2}(\pm) = -ie\frac{g_{\Lambda_c D}(\mp)\Gamma^{1}(\pm)(\bar{g}_{n} + m_N)\gamma_{\nu}\slashed{k}_1\slashed{F}_{\gamma}}, \]

\[A_{t,D}^{1/2}(\pm) = -eg_{\Lambda_c D}^{1}(\pm)\frac{(2k_3 - k_1)^{\nu}}{t - m_D^2}\slashed{F}_{D}, \]

\[A_{t,D^*}^{1/2}(\pm) = \frac{g_{\Lambda_c D^*}(\pm)\epsilon_{\mu\nu\rho\beta}k^\rho_{D^*}k^\beta_{D}\Gamma^\mu_{\pm}\slashed{F}_{D^*}}, \]

\[A_{u}^{1/2}(\pm) = -ie\frac{g_{\Lambda_c D}(\pm)\Gamma^{1}(\pm)(\bar{g}_{n} + m_N)\gamma_{\nu}}{u - m_{\Lambda_c}^2}\]

\[\left(Q_{\Lambda_c}^{\pm}(\pm)\frac{\mp}{2m_{\Lambda_c}^2}, \right) \gamma_{\nu}\slashed{k}_1\slashed{F}_{B}, \]

where \(s = q^2 = (k_1 + k_2)^2 \equiv W^2, t = q^2_{D/D^*} = (k_1 - k_3)^2, u = q^2_{\Lambda_c} = (k_2 - k_3)^2\) are the Mandelstam variables.

To restart the gauge invariance, a generalized contact term is introduced as \[35, 36\]

\[A_{\text{cont.}}^{\nu(\pm)} = i\epsilon_{\pm}^{\nu} \Gamma^\pm C_{\gamma}, \]

(19)

with

\[C_{\gamma} = (2k_3 - k_1)^{\nu}\frac{\slashed{F}_{D} - 1}{t - m_{D}^2}(1 - h(1 - \slashed{F}_{B})), \]

\[+ (2k_4 - k_1)^{\nu}\frac{\slashed{F}_{B} - 1}{u - m_{\Lambda_c}^2}(1 - h(1 - \slashed{F}_{D})), \]

(20)

where \(h = 1\) is taken \[52\].

Thus the unpolarized differential cross section for the \(\gamma n \to D^-\Lambda_c^+(2940)^+\) reaction at the center of mass (c.m.) frame is given by

\[
\frac{d\sigma}{d\cos \theta} = \frac{1}{32\pi s} \left| \sum_{\Lambda_c} |M|_c^{2} \right| \left( F_{c} \right)^{2} \]

(21)

where \(\theta\) denotes the angle of the outgoing \(D^-\) meson relative to beam direction in the c.m. frame, while \(\vec{k}_{3,\text{c.m.}}\) and \(\vec{k}_{1,\text{c.m.}}\) are the three-momenta of initial \(\gamma\) and final \(D^-\) meson, respectively.

**C. Differential cross section \(d\sigma^{2}_{\gamma n \to D^{-}D_{0}^{0}p}/dM_{D^{-}D_{0}^{0}}d\Omega\)**

Since the \(\Lambda_c^+(2940)\) have a coupling with \(pD^0\), it is interesting to discuss the \(pD^0\) invariant mass or angle distributions for the Dalitz process \(\gamma n \to D^{-}D_{0}^{0}p\). However, it is difficult to distinguish the two spin-parity assignments of the \(\Lambda_c^+(2940)\) state from those first order differential cross section \[21\]. Thus we shall concentrate only on the second order differential cross section of \(d\sigma^{2}_{\gamma n \to D^{-}D_{0}^{0}p}/dM_{D^{-}D_{0}^{0}}d\Omega\), which may provide useful information for clarifying the spin-parity of \(\Lambda_c^+(2940)\) state.

The second order differential cross section for the \(\gamma n \to D^{-}D_{0}^{0}p\) reaction \[2\] is written as:

\[d\sigma^{2}_{\gamma n \to D^{-}D_{0}^{0}p}/dM_{D^{-}D_{0}^{0}}d\Omega \]

\[\text{2 In some theoretical works, it is indicated that the ground state} \]

\[\]
\[ \frac{d\sigma_{\gamma n\rightarrow D^-\Lambda_c^{++}}}{dM_{pD^0}\,d\Omega} = \frac{m_N^2}{2^{10}\pi^5 \sqrt{3}|p_1\cdot p_2|} \int \sum_{\text{spin}} |M|^2 |p_3^*| d\Omega_3^*, \quad (22) \]

where \( M_{pD^0} \) is the invariant mass of the final \( pD^0 \) system. \( |p_3^*| \) and \( \Omega \) are the three-momentum and solid angle of the final \( D^- \) meson in the center of mass frame of the initial \( \gamma n \) system, while \( |p_3^*| \) and \( \Omega_3^* \) are the three-momentum and solid angle of the outing proton in the final \( pD^0 \) system.

**III. RESULTS**

As shown in the previous section, for the \( \gamma n \rightarrow D^-\Lambda_c^{++} \) process, the \( s \)-channel with nucleon pole exchange, the \( t \)-channel with \( D \) and \( D^* \) exchange as well as the \( u \)-channel with \( \Lambda_c^* \) exchange and contact term are considered.

Since the cutoff parameter \( \Lambda \) related to the form factor is the only free parameter, according to usual practice \( \Lambda = \Lambda_{\gamma n} = \Lambda_D = \Lambda_{D^*} = \Lambda_{\Lambda_c^*} = 3.0 \) GeV in the spirit of minimizing the free parameters. For comparison, the numerical results of the full model with \( \Lambda = 1.5 \) GeV are also presented in Fig. 3, which indicate the cross section with \( \Lambda = 1.5 \) GeV is smaller than that of \( \Lambda = 3.0 \) GeV. Moreover, from fig. 3 one notice that the contribution from the \( t \)-channel with \( D^* \) exchange play dominant role\(^3\) in the \( \gamma n \rightarrow D^-\Lambda_c^{++} \) reaction, while the contribution from the \( D \) exchange is very small. The \( s \)-channel with nucleon pole exchange give a considerable contribution near the threshold. Besides, the contributions from \( u \)-channel with \( \Lambda_c^* \) exchange and contact term are so small that can be negligible. With the comparison, it is found that the \( s \)-channel nucleon pole exchange have more influence on \( \Lambda_c^*(2940) \) with \( J^P = \frac{1}{2}^- \) than that of \( J^P = \frac{3}{2}^+ \).

Fig. 4 present the differential cross section for \( \gamma n \rightarrow D^-\Lambda_c^{++} \) process for the cases of \( \Lambda_c^*(2940) \) with \( J^P = \frac{1}{2}^\pm \). It is noticed that All the curves show strong forward-scattering enhancements, due to the \( D^* \) exchange in the \( t \)-channel dominantly.

Fig. 5 present the differential cross section \( d\sigma_{\gamma n\rightarrow D^-\Lambda_c^{++}}/dM_{pD^0}\,d\Omega \) at the mass \( M_{pD^0} = 2.94 \) GeV for the cases of \( \Lambda_c^*(2940) \) with \( J^P = \frac{1}{2}^\pm \). It is found that the absolute value of the differential cross section \( d\sigma_{\gamma n\rightarrow D^-\Lambda_c^{++}}/dM_{pD^0}\,d\Omega \) for two spin-parity assignments are much different, which can be checked by further experiment.

**IV. \( \Lambda_c^*(2940) \) PRODUCTION AT COMPASS**

The COMPASS experiment at CERN runs since 2002 using positive muon beam of 160 GeV/c (2002-2010) or 200 GeV/c momentum (2011), scattered off solid \( ^6 \)LiD (2002-2004) or NH\(_3\) targets (2006-2011). It covers the range of \( W \) up to 19.4 GeV. The integrated luminosity of

\( \Lambda_c(2286) \) also have a coupling with \( pD^0 \). However, it should be noted that the coupling constant of \( \Lambda_c(2286)ND \) is determined from \( SU(4) \) invariant Lagrangians with a great uncertainty. Besides, the mass of \( \Lambda_c(2286) \) is about 650 MeV smaller than that of \( \Lambda_c^*(2940) \), which means that the effects from \( \Lambda_c(2286) \) state around the \( M_{pD^0} = m_{\Lambda_c^*} \) should be small because of the narrow total decay width of \( \Lambda_c^*(2940) \) state. Thus the \( \Lambda_c(2286) \) is not included in this present calculations.

\(^3\) In this work, as mentioned above, the relevant coupling constants are taken from the Refs. \( \text{[21, 37]} \) by assuming the charmed \( \Lambda_c^*(2940) \) as a molecular state of \( D^0p \). Thus the dominant \( t \)-channel with \( D^* \) exchange contribution can be understood easily since the \( \Lambda_c^*(2940) \) have a strong coupling with the \( D^0p \).
\[ \frac{d\sigma}{d \cos \theta} = \begin{cases} \sigma_1, & \text{for } W = 5 \text{ GeV} \\ \sigma_2, & \text{for } W = 5.5 \text{ GeV} \\ \sigma_3, & \text{for } W = 10 \text{ GeV} \\ \sigma_4, & \text{for } W = 15 \text{ GeV} \end{cases} \]

FIG. 4: (Color online) Differential cross section \( d\sigma/d\cos \theta \) as a function of \( \cos \theta \) for the \( \gamma n \rightarrow D^- \Lambda_c^+ \) reaction at \( W = 5, 5.5, 10, 15 \text{ GeV} \).

\( \gamma N \) interaction multiplied by the general efficiency of the setup, corresponding the period of data taking between 2002 and 2011, can be estimated basing on the number of exclusively produced \( J/\psi \) mesons \([38]\). We calculate it to be of about 10 pb\(^{-1}\).

Basing on the integrated luminosity mentioned above and the calculated \( \Lambda_c^*(2940) \) production cross section value of 0.02 \( \mu \text{b} \) \( (J^P = \frac{1}{2}^+, \Lambda = 3.0 \text{ GeV}, \Gamma_{\Lambda_c^* \rightarrow nD^0} = 0.21 \text{ MeV}) \) we can expect to find in the COMPASS muon data sample collected between 2002 and 2011 up to \( 0.9 \times 10^5 \) \( \Lambda_c^*(2940) \) baryons produced via the reaction \( \gamma n \rightarrow D^- \Lambda_c^+ \). This estimation is done neglecting the nuclear collective effects and assuming the effective amount of neutrons in the target of about 45%. This number can be compared with the COMPASS open charm lepton-production results based on the data collected between 2002 and 2007 \([39]\) where the number of reconstructed \( D^0 \rightarrow K^+\pi^- \) decays (BR=3.88%) exceeded \( 5 \times 10^4 \).

Since the t-channel is dominating, the energy transferred to the produced \( \Lambda_c^*(2940) \) is small and it decays almost at rest with momentum of proton and \( D^0 \)-meson in the centre-of-mass system of 0.42 GeV/c. Such low-momenta particles are almost invisible for the COMPASS tracking system while energetic \( D^- \)-meson can be easily detected. So in spite of impossibility to observe the \( \Lambda_c^*(2940) \) decay directly, its production should manifest itself in the missing mass spectrum.

V. SUMMARY

Within the frame of the effective Lagrangian approach, the photoproduction of charmed \( \Lambda_c^*(2940) \) baryon in the \( \gamma n \rightarrow D^- \Lambda_c^+ \) process via \( s-, t-, u- \)channel and contact term is investigated based on the conditions of the COMPASS experiment.

The numerical results indicate:

(I) The \( t \)-channel with \( D^* \) exchange play dominant role in the \( \gamma n \rightarrow D^- \Lambda_c^+ \) reaction, while the contributions from the \( t \)-channel \( D \) exchange as well the \( u \)-channel \( \Lambda_c^* \) exchange and contact term are very small. The \( s \)-channel with nucleon pole exchange give a considerable contribution at the threshold.

(II) According to our estimations, a sizable number of events related to the \( \Lambda_c^*(2940) \) is already produced at COMPASS facility, which means it is feasible to searching for the charmed \( \Lambda_c^*(2940) \) baryon...
produced via $\gamma n$ interaction. In case of success it would be the first observation of direct production of $\Lambda_c^*(2940)$.

(III) The absolute value of the differential cross section $d\sigma_{\gamma n \rightarrow D^- D^0 p}/dM_{D^0 p} d\Omega$ for the two assignments $J^P = \frac{1}{2}^+$ for the $\Lambda_c^*(2940)$ state are much different. Thus we suggest this observable can be measured in the further COMPASS experiment to clarify the nature of $\Lambda_c^*(2940)$ state.

To sum up, we suggest that this experiment be carried out at COMPASS, which not only helps in testing the above theoretical predictions for the photoproduction of the $\Lambda_c^*(2940)$ state but also provides important information for clarifying the nature of the charmed $\Lambda_c^*(2940)$ baryon. It is worth while pointing out that it is not possible to give a very precision theoretical result for the production of $\Lambda_c^*(2940)$ due to the partial decay width of $\Lambda_c^*(2940)$ is only a theoretical value but not a real width measured by experiment. However, from the experimental point of view, the partial decay width of $\Lambda_c^*(2940)$ is a key factor to determine the spin-parity of $\Lambda_c^*(2940)$. Thus the experiment on measuring the partial decay width of $\Lambda_c^*(2940)$ is also encouraged.

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