# Analysis of the Vertexes $\Sigma_Q\Xi_Q^*K^*$ and $\Xi_Q'\Sigma_Q^*K^*$ within Light-Cone QCD Sum Rules *

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*We parameterize the vertexes $\Sigma_Q\Xi_Q^*K^*$ and $\Xi_Q'\Sigma_Q^*K^*$ with three tensor structures due to Lorentz invariance, and calculate the corresponding three coupling constants within light-cone QCD sum rules. We then obtain their numerical values taking into account all the uncertainties of the relevant parameters.*

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Since the first observation of the $\frac{3}{2}^+$ baryons $\Omega_c^*$ in the radiative decay $\Omega_c^* \to \Omega_c\gamma$ in 2006,[1] there has been more and more interest in new heavy baryon states theoretically and experimentally. On the theoretical side, these new baryons which contain a heavy quark and two light quarks are especially interesting for studying the dynamics of light quarks in the presence of a heavy quark and also serve as an excellent ground for testing predictions of the constituent quark models and heavy quark symmetry. On the experimental side, the large hadron collider (LHC) will provide us with more and more excited charm and bottom baryon states and attract a lot of study interest.

Recently, many coupling constants of these new baryons with mesons have been studied using light-cone sum rules.[2−5] In Refs. [2,3], we study the strong coupling constants in the vertexes $\Omega_Q^*\Omega_Q\phi$, $\Xi_Q^*\Xi_Q'V$ and $\Sigma_Q^*\Sigma_QV$ within the light-cone (QCD) sum rules using the Ioffe-type interpolating currents of the baryons. In Refs. [4,5] the vertexes $\Xi_Q\Xi_Q\pi$, $\Sigma_Q\Lambda_Q\pi$ are studied with the light-cone QCD sum rules using more general interpolating currents of the baryons. In this Letter, we analyze the vertexes $\Sigma_Q\Xi_Q^*K^*$ and $\Xi_Q'\Sigma_Q^*K^*$ within this method, and calculate the corresponding coupling constants and the uncertainties. Once the reasonable values of the coupling constants in these vertexes are known, we can use them to do the phenomenological analysis and understand better the dynamics of the heavy baryon interactions with light vector mesons.

Following Refs. [2,3] we parameterize the vertexes $\Sigma_Q\Xi_Q^*K^*$ and $\Xi_Q'\Sigma_Q^*K^*$ with three tensor structures due to Lorentz invariance and introduce three strong coupling constants $g_1, g_2$ and $g_3$,[6]

$$\begin{aligned}&\langle B_Q(p+q)|B_Q'^*(p)K^*(q)\rangle\\ &=\overline{U}(p+q)[g_1(q_\mu \not{\epsilon} - \epsilon_\mu \not{q})\gamma_5 + g_2(P\cdot\epsilon q_\mu - P\cdot q\epsilon_\mu)\gamma_5\\ &\quad + g_3(q\cdot\epsilon q_\mu - q^2\epsilon_\mu)\gamma_5]U^\mu(p),\end{aligned} \tag{1}$$

where the $U(p)$ and $U_\mu(p+q)$ are the Dirac spinors of the heavy baryons $B_Q$ and $B_Q'^*$ respectively, the $\epsilon_\mu$ is the polarization of the meson $K^*(892)$, and $P=(2p+q)/q$.

We write down the two-point correlation function $\Pi_{1\mu}(p,q)$ for the vertexes $\Sigma_Q\Xi_Q^*K^*$,

$$\Pi_{1\mu}(p,q) = i\int d^4x e^{-ip\cdot x}\langle 0|T\{J_1(0)\bar{J}_{1\mu}(x)\}|K^*(q)\rangle, \tag{2}$$

$$\Pi_{2\mu}(p,q) = i\int d^4x e^{-ip\cdot x}\langle 0|T\{J_2(0)\bar{J}_{2\mu}(x)\}|K^*(q)\rangle. \tag{3}$$

We will specify the interpolating currents of the heavy spin-1/2 and 3/2 baryons. The general form of the interpolating currents of these baryons has been discussed in Ref. [7]. The Ioffe currents were used in Refs. [2,3] for the study of vertex $\Omega_Q^*\Omega_Q\phi$, $\Xi_Q^*\Xi_Q'V$, and reasonable results were obtained. For simplicity, we use these interpolating currents of the baryons in this study.

$$\begin{aligned}J_1(x) &= \epsilon_{abc}q_a^T(x)C\gamma_\mu q_b'(x)\gamma_5\gamma^\mu Q_c(x),\\ J_{1\mu}(x) &= \epsilon_{abc}q_a^T(x)C\gamma_\mu s_b(x)Q_c(x),\end{aligned} \tag{4}$$

$$\begin{aligned}J_2(x) &= \epsilon_{abc}q_a^T(x)C\gamma_\mu s_b(x)\gamma_5\gamma^\mu Q_c(x),\\ J_{2\mu}(x) &= \epsilon_{abc}q_a^T(x)C\gamma_\mu q_b'(x)Q_c(x),\end{aligned} \tag{5}$$

where $Q = c, b$ and $q, q' = u, d$, the $a, b, c$ are color indexes, the Ioffe-type heavy baryon currents $J_1(x)$, $J_{1\mu}(x)$ interpolate the baryons $\Sigma_Q$, $\Xi_Q^*$, and the currents $J_2(x)$, $J_{2\mu}(x)$ interpolate the baryons $\Xi_Q'$, $\Sigma_Q^*$ respectively. The external vector meson $K^*(890)$ has the four momentum $q_\mu$ with $q^2 = M_{K^*}^2$.

Based on quark-hadron duality,[8,9] we can insert a complete set of intermediate hadronic states with the same quantum numbers as the current operators $J_i(x)$ and $J_{i\mu}(x)$ into the correlation function $\Pi_{i\mu}(p,q)$ to obtain the hadronic representations, where $i=1,2$. After isolating the ground state contribution from the pole terms of the baryons $B_Q$ and $B_Q'^*$, we get the

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following result,

$$\begin{aligned}\Pi_{i\mu}(p,q) &= \Big\{\langle 0|J_i(0)|B_Q(p+q)\rangle\langle B_Q(p+q)\\ &\cdot|B_Q^{'*}(p)K^*(q)\rangle\langle B_Q^{'*}(p)|\bar{J}_{i\mu}(0)|0\rangle\Big\}\\ &\cdot\Big\{[M_{B_Q}^2-(q+p)^2][M_{B_{Q'*}}^2-p^2]\Big\}^{-1}+\cdots\\ &=\frac{\lambda_{B_Q}\lambda_{B_Q'^*}}{[M_{B_Q}^2-(q+p)^2][M_{B_{Q'*}}^2-p^2]}\\ &\cdot\Big\{g_1[M_{B_Q}+M_{B_Q'^*}]\not\epsilon\not p\gamma_5 q_\mu\\ &-g_1[M_{B_Q}+M_{B_Q'^*}]\not q\not p\gamma_5\epsilon_\mu\\ &+g_2\not q\not p\gamma_5 p\cdot\epsilon q_\mu-\frac{g_2}{2}\not q\not p\gamma_5 q^2\epsilon_\mu\\ &-g_3\not q\not p\gamma_5 q^2\epsilon_\mu+\cdots\Big\}+\cdots,\end{aligned}\tag{6}$$

where

$$\begin{aligned}&\langle 0|J_i(0)|B_Q(p)\rangle=\lambda_{B_Q}U(p,s),\\ &\langle 0|J_{i\mu}(0)|B_Q^{'*}(p)\rangle=\lambda_{B_Q'^*}U_\mu(p,s),\\ &\sum_s U(p,s)\overline{U}(p,s)=\not p+M_{B_Q},\\ &\sum_s U_\mu(p,s)\overline{U}_\nu(p,s)=-(\not p+M_{B_Q'^*})\\ &\cdot\Big(g_{\mu\nu}-\frac{\gamma_\mu\gamma_\nu}{3}-\frac{2p_\mu p_\nu}{3M_{B_Q'^*}^2}+\frac{p_\mu\gamma_\nu-p_\nu\gamma_\mu}{3M_{B_Q'^*}}\Big).\end{aligned}\tag{7}$$

In general, the current $J_\mu(x)$ couples not only to the spin-parity $J^P=\frac{3}{2}^+$ states, but also to the spin-parity $J^P=\frac{1}{2}^-$ states. For a generic $\frac{1}{2}^-$ baryon state $\tilde{B}_Q$, $\langle 0|J_\mu(0)|\tilde{B}_Q(p)\rangle=\lambda(\gamma_\mu-\frac{4p_\mu}{M})U(p,s)$, where $\lambda$ is the pole residue, $M$ is the mass, and the spinor $U(p,s)$ satisfies the usual Dirac equation $(\not p-M)U(p,s)=0$. However, if we choose the tensor structure $\not\epsilon\not p\gamma_5 q_\mu, \not q\not p\gamma_5 p\cdot\epsilon q_\mu, \not q\not p\gamma_5\epsilon_\mu$, the baryon state $\widetilde{B}_Q$ has no contamination.[2,3]

Now, we briefly outline the operator product expansion for the correlation function $\Pi_{i\mu}(p,q)$ in perturbative QCD theory. The calculations are performed in the large space-like momentum regions $(q+p)^2\ll 0$ and $p^2\ll 0$, which correspond to the small light-cone distance $x^2\approx 0$ required by the validity of the operator product expansion approach. We write down the "full" propagator of a massive quark in the presence of the quark and gluon condensates,[8,9]

$$\begin{aligned}&[iS(x,0)]_{ab}\\ &=\frac{i\delta_{ab}\not x}{2\pi^2x^4}-\frac{m_q\delta_{ab}}{4\pi^2x^2}-\frac{\delta_{ab}}{12}\langle\bar{q}q\rangle(1+\frac{m_0^2}{16}x^2)\\ &+\frac{im_q\delta_{ab}}{48}\langle\bar{q}q\rangle\not x(1+\frac{m_0^2}{24}x^2)-\frac{ig_s}{16\pi^2x^2}\\ &\cdot\int_0^1 dvG_{ab}^{\mu\nu}(vx)[(1-v)\not x\sigma_{\mu\nu}+v\sigma_{\mu\nu}\not x]+\cdots,\end{aligned}$$

$$\begin{aligned}&[iS_Q(x,0)]_{ab}\\ &=\frac{i}{(2\pi)^4}\int d^4k e^{ik\cdot x}\Big\{\frac{\delta_{ab}}{\not k-m_Q}-\frac{g_sG_{ab}^{\mu\nu}}{4}\\ &\cdot\frac{\sigma_{\mu\nu}(\not k+m_Q)+(\not k+m_Q)\sigma_{\mu\nu}}{(k^2-m_Q^2)^2}+\frac{\pi^2}{3}\\ &\cdot\Big\langle\frac{\alpha_sGG}{\pi}\Big\rangle\delta_{ab}m_Q\frac{k^2+m_Q\not k}{(k^2-m_Q^2)^4}+\cdots\Big\},\end{aligned}\tag{8}$$

where $\langle\bar{q}g_s\sigma Gq\rangle=m_0^2\langle\bar{q}q\rangle$, $m_0^2=(0.8\pm0.2)\text{GeV}^2$ and $\langle\frac{\alpha_sGG}{\pi}\rangle=\langle\frac{\alpha_sG_{\mu\nu}G^{\mu\nu}}{\pi}\rangle$. Then, we contract the quark fields in the correlation function $\Pi_{i\mu}(p,q)$ with the Wick theorem and obtain the result:

$$\begin{aligned}&\Pi_{1\mu}(p,q)(\Sigma_c^+\Xi_c^{*0}K^{*+})=\Pi_{1\mu}(\Sigma_c^0\Xi_c^{*0}k^{*0})\\ &=\frac{1}{2}\Pi_{1\mu}(p,q)(\Sigma_c^{++}\Xi_c^{*+}K^{*+})\\ &=\frac{1}{2}\Pi_{1\mu}(p,q)(\Sigma_c^{+}\Xi_c^{*+}K^{*+})\\ &=i\epsilon_{abc}\epsilon_{a'b'c'}\int d^4x e^{-ip\cdot x}\gamma_5\gamma^\nu[iS_Q(0,x)]_{cc'}\\ &\cdot\text{Tr}[\gamma_\nu[iS(0,x)]_{bb'}\gamma_\mu C\langle 0|q_a(0)\bar{s}_{a'}(x)|K^*\rangle^TC]\\ &=i\epsilon_{abc}\epsilon_{a'b'c'}\int d^4x e^{-ip\cdot x}\gamma_5\gamma^\nu[iS_Q(0,x)]_{cc'}\\ &\cdot\text{Tr}[\gamma_\nu\langle 0|q_b(0)\bar{s}_{b'}(x)|K^*\rangle\gamma_\mu C[iS(0,x)]_{aa'}^TC].\end{aligned}\tag{9}$$

With a simple replacement in the quark content, we can obtain the correlation function in the bottom channel. With the replacement of $\Sigma_Q\to\Xi_Q',\Xi_Q^*\to\Sigma_Q^*$ in $\Pi_{1\mu}$, we can obtain the correlation function $\Pi_{2\mu}(p,q)$.

Performing Fierz re-ordering to extract contributions from the two-particle and three-particle vector meson light-cone distribution amplitudes respectively, then substituting the full $q$ and $Q$ quark propagators into the correlation functions in Eq. (9) and completing the integral in the coordinate space, finally integrating over the variable $k$, we can obtain the correlation functions $\Pi_{i\mu}$ at the level of quark-gluon degrees of freedom. In the calculation, the two-particle and three-particle vector meson light-cone distribution amplitudes have been used.[10–14] The parameters in the light-cone distribution amplitudes are scale dependent and are estimated with the QCD sum rules,[13,14] where the energy scale $\mu$ is chosen to be $\mu=1\,\text{GeV}$.

Taking double Borel transform with respect to the variables $Q_1^2=-p^2$ and $Q_2^2=-(p+q)^2$ respectively, then subtracting the contributions from the high resonances and continuum states by introducing the threshold parameter $s_0$ (i.e. $M^{2n}\to\frac{1}{\Gamma[n]}\int_0^{s_0}dss^{n-1}e^{-s/M^2}$), finally we can obtain 12 sum rules for the strong coupling constants $g_1,g_2$ and $G_3=-(M_{B_Q}+M_{B_Q'}^*)g_1-M_{K^*}^2(\frac{g_2}{2}+g_3)$ respectively. With $c\to b$, we can reach the bottom part for these two

vertexes, and the other remaining coupling constants are easily obtained by Eq. (9).

The masses of the established baryons are taken from the particle data group $M_{K^*} = 0.892\,\text{GeV}$, $M_{\Sigma_c^{++}} = 2.45402\,\text{GeV}$, $M_{\Sigma_c^{+}} = 2.4529\,\text{GeV}$, $M_{\Sigma_c^{0}} = 2.45376\,\text{GeV}$, $M_{\Sigma_b^{+}} = 5.8078\,\text{GeV}$, $M_{\Sigma_b^{-}} = 5.8152\,\text{GeV}$, $M_{\Sigma_c^{*++}} = 2.5184\,\text{GeV}$, $M_{\Sigma_c^{*+}} = 2.5175\,\text{GeV}$, $M_{\Sigma_c^{*0}} = 2.5180\,\text{GeV}$, $M_{\Sigma_b^{*+}} = 5.8290\,\text{GeV}$, $M_{\Sigma_b^{*-}} = 5.8364\,\text{GeV}$, $M_{\Xi_c^{*}} = 2.6459\,\text{GeV}$, $M_{\Xi_c^{\prime+}} = 2.5756\,\text{GeV}$, $M_{\Xi_c^{\prime0}} = 2.5779\,\text{GeV}$. In calculation, we neglect the small isospin splitting in the heavy baryon multiplet. Because the bottom baryon states $\Xi_b^*$ and $\Xi_b^\prime$ have not been observed yet we take their masses from QCD sum rules, $M_{\Xi_b^*} = 5.98\,\text{GeV}$ and $M_{\Xi_b^\prime} = 5.95\,\text{GeV}$ given in Refs. [2,3],

$$\Pi_{\mu\nu}(p) = i\int d^4x e^{ip\cdot x}\langle 0|T\{J_\mu(x)\bar{J}_\nu(0)\}|0\rangle,$$
$$\Pi(p) = i\int d^4x e^{ip\cdot x}\langle 0|T\{J(x)\bar{J}(0)\}|0\rangle. \qquad (10)$$

The values of the pole residues are $\lambda_{\Sigma_c} = (4.5 \pm 0.9)\times 10^{-2}\,\text{GeV}^3$, $\lambda_{\Sigma_b} = (6.5 \pm 1.2)\times 10^{-2}\,\text{GeV}^3$, $\lambda_{\Sigma_c^*} = (2.7 \pm 0.5)\times 10^{-2}\,\text{GeV}^3$, $\lambda_{\Sigma_b^*} = (3.8 \pm 0.7)\times 10^{-2}\,\text{GeV}^3$, $\lambda_{\Xi_c^*} = (3.1 \pm 0.5)\times 10^{-2}\,\text{GeV}^3$, $\lambda_{\Xi_b^*} = (4.5\pm0.8)\times10^{-2}\,\text{GeV}^3$, $\lambda_{\Xi_c^\prime} = (5.3\pm1.0)\times10^{-2}\,\text{GeV}^3$, $\lambda_{\Xi_b^\prime} = (7.5\pm1.5)\times10^{-2}\,\text{GeV}^3$, which are also from the QCD sum rules.[2,3]

The QCD input parameters are taken to be the standard values $m_u = m_d = (5.6 \pm 1.6)\,\text{MeV}$, $m_s = (140 \pm 10)\,\text{MeV}$, $m_c = (1.35 \pm 0.10)\,\text{GeV}$, $m_b = (4.7 \pm 0.1)\,\text{GeV}$ (The $Q$ quark masses appearing in the perturbative terms are usually taken to be the pole masses in QCD sum rules, while the choice of the $m_Q$ in the leading-order coefficients of the higher-dimensional terms is arbitary.[15] The $\overline{MS}$ mass $m_c(m_c^2)$ relates to the pole mass $\hat{m}_c$ by the relation $m_c(m_c^2) = \hat{m}_c[1 + \frac{C_F\alpha_s(m_c^2)}{\pi} + \cdots]^{-1}$. We take approximately $m_c(m_c^2) \approx \hat{m}_c$ without the $\alpha_s$ corrections for consistency. The value listed in the Particle Data Group is $m_c(m_c^2) = 1.27^{+0.07}_{-0.11}\,\text{GeV}$.[16] It is reasonable to take $\hat{m}_c = m_c(1\text{GeV}^2) = (1.35 \pm 0.10)\,\text{GeV}$. For the $b$ quark, the $\overline{MS}$ mass $m_b(m_b^2) = 4.20^{+0.17}_{-0.07}\,\text{GeV}$,[16] the gap between the energy scale $\mu = 4.2\,\text{GeV}$ and $1\,\text{GeV}$ is rather large and the approximation $\hat{m}_b \approx m_b(m_b^2) \approx m_b(1\,\text{GeV}^2)$ seems rather crude. It would possibly be better to understand the heavy quark masses $m_c$ and $m_b$ at the energy scale $\mu^2 = 1\,\text{GeV}^2$ simply as the effective quark masses, or just the mass parameter. Here $\langle\bar{q}q\rangle = -(0.24 \pm 0.01\,\text{GeV})^3$, $\langle\bar{q}g_s\sigma Gq\rangle = m_0^2\langle\bar{q}q\rangle$, $m_0^2 = (0.8 \pm 0.2)\,\text{GeV}^2$, and $\langle\frac{\alpha_s GG}{\pi}\rangle = (0.33\ \text{GeV})^4$ at the energy scale $\mu = 1\,\text{GeV}$.[8,9,17] The parameters which determine the $K^*$ vector meson light-cone distribution amplitudes are $f_{K^*} = (0.220 \pm 0.005)\,\text{GeV}$, $f_{K^*}^\perp = (0.185 \pm 0.010)\,\text{GeV}$, $a_1^\parallel = 0.03 \pm 0.02$, $a_1^\perp = 0.04 \pm 0.03$, $a_2^\parallel = 0.11 \pm 0.09$, $a_2^\perp = 0.10 \pm 0.08$, $\zeta_3^\parallel = 0.023 \pm 0.008$, $\lambda_3^\parallel = -0.008 \pm 0.004$, $\lambda_3^\perp = -0.025 \pm 0.020$, $\widetilde{\lambda}_3^\parallel = 0.035 \pm 0.015$, $\omega_3^\parallel = 0.10 \pm 0.04$, $\omega_3^\perp = 0.3\pm0.1$, $\widetilde{\omega}_3^\parallel = -0.07\pm0.03$, $\kappa_3^\parallel = 0.000\pm0.001$, $\kappa_3^\perp = 0.003\pm0.003$, $\zeta_4 = 0.15\pm0.10$, $\zeta_4^T = 0.10\pm0.05$, and $\widetilde{\zeta}_4^T = -0.10 \pm 0.05$.

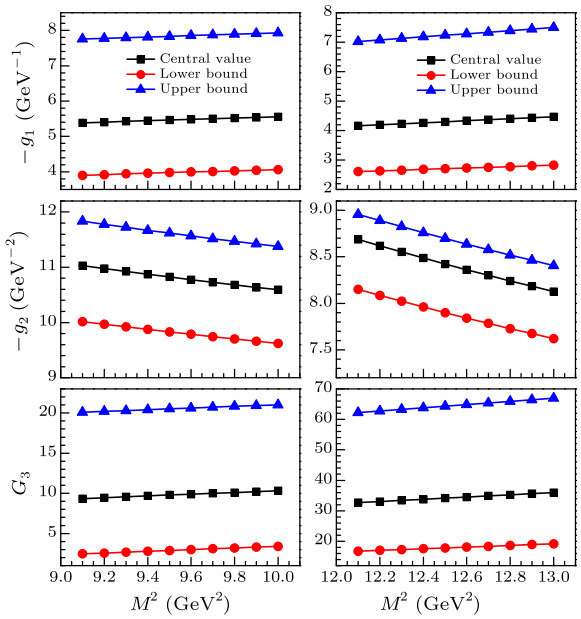


**Fig. 1.** The strong coupling constants $g_1$, $g_2$ and G3 with variation of the Borel parameter $M^2$ in the vertexes $\Sigma_Q\Xi_Q^*K^*$. The left three and the right three correspond to the charm and bottom channels respectively.

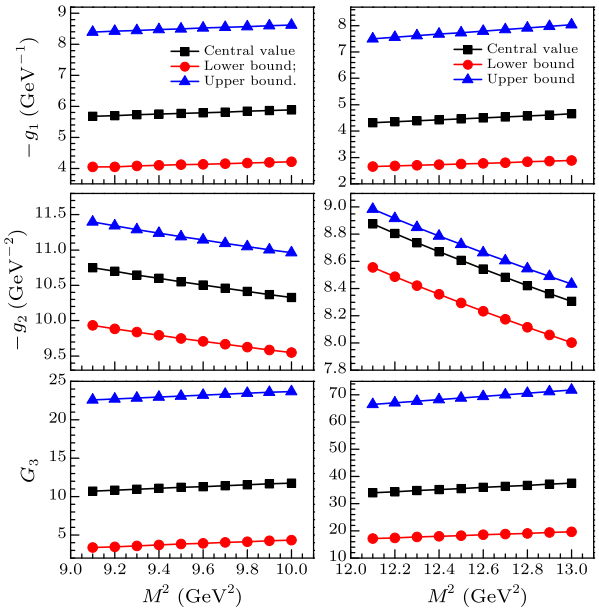


**Fig. 2.** The strong coupling constants $g_1$, $g_2$ and G3 with variation of the Borel parameter $M^2$ in the vertexes $\Xi_Q^\prime\Sigma_Q^*K^*$. The left three and the right three correspond to the charm and bottom channels respectively.

The threshold parameters are taken as $s_0 = (11.2\pm 1.0)\,\text{GeV}^2$ in the charm channels and $s_0 = (44.9 \pm 1.0)\,\text{GeV}^2$ in the bottom channels for the vertexes

$\Sigma_Q\Xi_Q^*K^*$, and $s_0 = (12.0 \pm 1.0)\,\mathrm{GeV}^2$ in the charm channels and $s_0 = (47.0 \pm 1.0)\,\mathrm{GeV}^2$ in the bottom channels for the vertexes $\Xi_Q'\Sigma_Q^*K^*$. The Borel parameters are $M^2 = (9.0 - 10.0)\,\mathrm{GeV}^2$ in the charm channels and $M^2 = (12.0 - 13.0)\,\mathrm{GeV}^2$ for both vertexes. We observe that the values of the strong coupling constants $g_1$, $g_2$ and $G_3$ are insensitive to threshold parameters $s_0$ and show their variation with respect to Borel parameters $M^2$ in Figs. 1 and 2.

The main uncertainties come from the six parameters $\lambda_{B_Q}$, $\lambda_{B_Q^*}$ and $m_Q$. The variation of those parameters can lead to relatively large changes to the numerical values, refining those parameters are of great importance. Although there are many parameters in the light-cone distributions amplitudes,[13,14] the uncertainties coming from those parameters are relatively small.

Taking into account all the uncertainties of the relevant parameters, finally we obtain the numerical results of the strong coupling constants $g_1$, $g_2$ and $G_3$, which are shown in Figs. 1 and 2,

$$\begin{aligned} -g_1 &= 5.40^{+2.32}_{-1.45}\,\mathrm{GeV}^{-1}, \\ -g_2 &= 11.05^{+0.75}_{-0.96}\,\mathrm{GeV}^{-2}, \\ G_3 &= 9.24^{+13.16}_{-6.79}, \end{aligned} \tag{11}$$

and

$$\begin{aligned} -g_1 &= 4.19^{+2.93}_{-1.59}\,\mathrm{GeV}^{-1}, \\ -g_2 &= 8.80^{+0.34}_{-0.60}\,\mathrm{GeV}^{-2}, \\ G_3 &= 32.2^{+31.4}_{-16.0}, \end{aligned} \tag{12}$$

in the charm and bottom channels for the vertexes $\Sigma_Q\Xi_Q^*K^*$ respectively, and

$$\begin{aligned} -g_1 &= 5.62^{+2.70}_{-1.58}\,\mathrm{GeV}^{-1}, \\ -g_2 &= 10.74^{+0.71}_{-0.74}\,\mathrm{GeV}^{-2}, \\ G_3 &= 10.7^{+11.9}_{-7.7}, \end{aligned} \tag{13}$$

and

$$\begin{aligned} -g_1 &= 4.30^{+2.64}_{-1.72}\,\mathrm{GeV}^{-1}, \\ -g_2 &= 8.84^{+0.12}_{-0.34}\,\mathrm{GeV}^{-2}, \\ G_3 &= 33.7^{+31.8}_{-17.4}. \end{aligned} \tag{14}$$

in the charm and bottom channels for the vertexes $\Xi_Q'\Sigma_Q^*K^*$ respectively. We calculate the uncertainties $\delta$ with the formula $\delta \approx \sqrt{[f(\bar{x}_i \pm \Delta x_i) - f(\bar{x}_i)]^2}$ as in Refs. [2,3], where $f$ denotes strong coupling constants $g_1$, $g_2$, and $G_3$, and $x_i$ denotes the relevant parameters $m_Q$, $\lambda_{B_Q}$, $\lambda_{B_Q'^*}$, $\langle\bar{q}q\rangle, \cdots$. From Figs. 1 and 2, we can see the large errors of $G_3$ compared to $g_2$, which is due to the fact that the sum rules in $G_3$ involve one more $M^2$ factor and one less $u_0$ factor, thereby a small error in $g_2$ will produce an error of approximately $M^2/u_0$ times in the corresponding sum rules of $G_3$.

In summary, we have parameterized the vertexes $\Sigma_Q\Xi_Q^*K^*$, $\Xi_Q'\Sigma_Q^*K^*$ with three tensor structures due to Lorentz invariance, and analyzed the corresponding strong coupling constants with the light-cone QCD sum rules. Expressions about the coupling constants in the light-cone sum rules are presented. I hope that these numerical values will be found in future particle experiments. The strong coupling constants in these vertexes are the basic parameters for describing the interactions among the heavy baryon states, we hope to use them to perform phenomenological analysis and understand better heavy baryons interactions with light vector mesons.

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