河南師範大學 HENAN NORMAL UNIVERSITY

Semileptonic decay of double strangeness heavy flavor baryons

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Outline

1. Introduction

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

3. Numerical analysis of form factors

4. Branching fractions of $\Omega_Q \to \Xi \ell \nu_\ell$

5. Summary

1. Introduction

- The heavy-flavor baryons Ω_c and Ω_b contain two strange quarks and differ from Λ_Q and Ξ_Q.

- Experiments on Ω_c and Ω_b baryon decays are limited.

- Whether the methods used to study Λ_Q and Ξ_Q baryons are also valid for Ω_Q baryons, particularly the light-cone sum rules approach (LCSRs), remains to be investigated.

- The PDG status of Ω_Q baryons is as follows:

Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

Ω_c^0 $\quad I(J^P) = 0(\frac{1}{2}^+)$ Status: ∗∗∗

The quantum numbers have not been measured, but are simply assigned in accord with the quark model, in which the Ω_c^0 is the ssc ground state. No absolute branching fractions have been measured.

Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

Ω_b^- $\quad I(J^P) = 0(\frac{1}{2}^+)$ Status: ∗∗∗

I, *J*, *P* need confirmation.

In the quark model Ω_b^- is ssb ground state. None of its quantum numbers has been measured.

1. Introduction

- Absolute branching fractions are seldom measured (e.g., Ω_c decays are referenced to $\Omega^-\pi^+$).
- Moreover, the lifetime of Ω_c has not been precisely determined.

Ω_c^0 MEAN LIFE

VALUE (10^{-15} s)	EVTS	DOCUMENT ID	TECN	COMMENT
273 ±12 OUR AVERAGE				
243 ±48 ±11	88	ABUDINEN 23	BEL2	$e^+e^- \to \Omega_c^0 + X$, $\Omega_c^0 \to \Omega^-\pi^+$
276.5 ±13.4 ± 4.5		AAIJ 22Y [1,2]	LHCB	$pp \to \Omega_c X$, $\Omega_c \to pK^-K^-\pi^+$
268 ±24 ±10	978	AAIJ 18J [1,3]	LHCB	$\Omega_b \to \Omega_c \mu\nu + X$, $\Omega_c \to pK^-K^-\pi^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
72 ±11 ±11	64	LINK 03C	FOCS	$\Omega^-\pi^+$, $\Xi^-K^-\pi^+\pi^+$
55 $^{+13}_{-11}$ $^{+18}_{-23}$	86	ADAMOVICH 95B	WA89	$\Omega^-\pi^-\pi^+\pi^+$, $\Xi^-K^-\pi^+\pi^+$
86 $^{+27}_{-20}$ ±28	25	FRABETTI 95D	E687	$\Sigma^+K^-K^-\pi^+$

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Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

Ω_c^0 DECAY MODES

No absolute branching fractions have been measured. The following are branching *ratios* relative to $\Omega^-\pi^+$.

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Cabibbo-favored ($S = -3$) decays — relative to $\Omega^-\pi^+$		
Γ_1	$\Omega^-\pi^+$	DEFINED AS 1	
Γ_2	$\Omega^-\pi^+\pi^0$	1.80 ±0.33	
Γ_3	$\Omega^-\rho^+$	>1.3	90%
Γ_4	$\Omega^-\pi^-2\pi^+$	0.31 ±0.05	
Γ_5	$\Omega^-e^+\nu_e$	1.98 ±0.29	
Γ_6	$\Omega^-\mu^+\nu_\mu$	1.94 ±0.21	
Γ_7	$\Xi^0\overline{K}^0$	1.64 ±0.29	
Γ_8	$\Xi^0K^-\pi^+$	1.20 ±0.18	
Γ_9	$\Xi^0\overline{K}^{*0}$, $\overline{K}^{*0} \to K^-\pi^+$	0.68 ±0.16	
Γ_{10}	$\Omega(2012)^-\pi^+$, $\Omega(2012)^- \to \Xi^0K^-$	0.12 ±0.05	
Γ_{11}	$\Xi^-\overline{K}^0\pi^+$	2.12 ±0.28	
Γ_{12}	$\Omega(2012)^-\pi^+$, $\Omega(2012)^- \to \Xi^-\overline{K}^0$	0.12 ±0.06	
Γ_{13}	$\Xi^-K^-2\pi^+$	0.63 ±0.09	
Γ_{14}	$\Xi(1530)^0K^-\pi^+$, $\Xi^{*0} \to \Xi^-\pi^+$	0.21 ±0.06	
Γ_{15}	$\Xi^-\overline{K}^{*0}\pi^+$	0.34 ±0.11	
Γ_{16}	$pK^-K^-\pi^+$	seen	
Γ_{17}	$\Sigma^+K^-K^-\pi^+$	<0.32	90%
Γ_{18}	$\Lambda\overline{K}^0\overline{K}^0$	1.72 ±0.35	
	Singly Cabibbo-suppressed modes — relative to $\Omega^-\pi^+$		
Γ_{19}	$\Xi^-\pi^+$	0.161±0.010	
Γ_{20}	Ω^-K^+	0.061±0.006	
	Doubly Cabibbo-suppressed modes — relative to $\Omega^-\pi^+$		
Γ_{21}	Ξ^-K^+	<0.07	90%

Ω_b^- DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$J/\psi\,\Omega^- \times B(b \to \Omega_b)$	$(1.4^{+0.5}_{-0.4}) \times 10^{-6}$	S=1.6
Γ_2	$pK^-K^- \times B(\overline{b} \to \Omega_b)$	$< 2.3 \times 10^{-9}$	CL=90%
Γ_3	$p\pi^-\pi^- \times B(\overline{b} \to \Omega_b)$	$< 1.5 \times 10^{-8}$	CL=90%
Γ_4	$pK^-\pi^- \times B(\overline{b} \to \Omega_b)$	$< 7 \times 10^{-9}$	CL=90%
Γ_5	$\Omega_c^0\pi^-$	seen	
Γ_6	$\Omega_c^0\pi^-$, $\Omega_c^0 \to pK^-K^-\pi^+$	seen	
Γ_7	$\Xi_c^+K^-\pi^-$	seen	
Γ_8	$\Lambda_c^+K^-K^-$		

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Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_9	$\Lambda_c^+K^-\pi^-$		
Γ_{10}	$\Lambda_c^+\pi^-\pi^-$		

1. Introduction

- Theoretical studies on weak decays of Ω_Q baryon

Heavy quark effective theory (HQET):H.Y. Zheng and B. Tseng. PRD. 53:1457, 1996; M.K. Du and C. Liu. PRD 84:056007,2011; R.L. Singleton. PRD 43:2939, 1991.

Light-front quark model:Z.X. Zhao CPC 42:093101,2018; Y.L. Wang, Y.K. Hsiao, K.L. Wang and C.C. Lih. PRD 111:096013, 2025 (LFQM);Y.K. Hsiao and C.C. Lih. PRD 105:056015,2022(LFQM)

Covariant confined quark model (CCQM):T. Gutsche, M.A. Ivanov, J.G. Korner and V.E. Lyubovitskij. PRD 98:074011, 2018

Constituent quark model (CQM):M. Pervin, W. Roberts and S. Capstick PRC 74, 025205 (2006)

QCD sum rule (QCDSR):Y.J. Shi, J. Zeng EPJC 85 (2025) 712; Z. Neishabouri, K. Azizi and H.R. Moshfegh. PRD 110:014010, 2024.

Light-cone sum rule (LCSR):T.M. Aliev, S. Bilmis and M. Savci. PRD 106:074022, 2022; H.H. Duan, Y.L. Liu and M. Q. Huang. EPJC 81:168, 2021.

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- The weak decay form factors of $\Omega_Q \to \Xi$ are defined by (weak decay V-A current):

$$
\begin{aligned}
&\langle \Omega_Q(P_{\Omega_Q})|j^\nu|\Xi(p)\rangle \\
&= \bar{u}_{\Omega_Q}(p)[f_1(q^2)\gamma^\nu + i\frac{f_2(q^2)}{M_{\Omega_Q}}\sigma^{\nu\mu}q_\mu + \frac{f_3(q^2)}{M_{\Omega_Q}}q^\nu \\
&- (g_1(q^2)\gamma^\nu + i\frac{g_2(q^2)}{M_{\Omega_Q}}\sigma^{\nu\mu}q_\mu + \frac{g_3(q^2)}{M_{\Omega_Q}}q^\nu)\gamma_5]u_\Xi(p).
\end{aligned}
$$

Form factors 1

or

$$
\begin{aligned}
&\langle \Xi(p)|j^\nu|\Omega_Q(P_{\Omega_Q})\rangle \\
&= \bar{u}_\Xi(p)\,[\,f_1(q^2)\gamma^\nu + i\frac{f_2(q^2)}{M_{\Omega_Q}}\sigma^{\nu\mu}q_\mu + \frac{f_3(q^2)}{M_{\Omega_Q}}q^\nu \\
&- (g_1(q^2)\gamma^\nu + i\frac{g_2(q^2)}{M_{\Omega_Q}}\sigma^{\nu\mu}q_\mu + \frac{g_3(q^2)}{M_{\Omega_Q}}q^\nu)\gamma_5\,]\,u_{\Omega_Q}(P_{\Omega_Q})
\end{aligned}
$$

Form factors 2

- The two forms of transition matrix elements above will be utilized differently to contrast the sum rule approaches, and extract the form factors.

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- In the framework of LCSRs, the derivation of form factors starts from the weak decay correlation function, offering two alternative formulations:

$$T^{\nu}(P,q) = i\int d^4x e^{iq\cdot x}\langle 0|T\{j_{\Omega_Q}(x), j^{\nu}(0)\}|\Xi(p)\rangle$$

Correlation function 1

or

$$T^{\nu}(P,q) = i\int d^4x e^{iq\cdot x}\langle 0|T\{j_{\Xi}(x), j^{\nu}(0)\}|\Omega_Q(P_{\Omega_Q})\rangle$$

Correlation function 2

- The formulation of hadronic interpolating currents must also be specified.

$$j_{\Xi}(x) = \epsilon_{ijk}(s^{iT}(x)C\not{z}s^j(x))\gamma_5\not{z}q^k(x)$$
$$j_{\Omega_Q}(x) = \epsilon_{ijk}\left(s^{iT}(x)C\not{z}s^j(x)\right)\gamma_5\not{z}Q^k(x).$$

- And the weak decay V-A currents

$$j_1^{\nu}(x) = \bar{u}(x)\gamma_{\nu}(1-\gamma_5)b(x)$$
$$j_2^{\nu}(x) = \bar{c}(x)\gamma_{\nu}(1-\gamma_5)d(x)$$

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- Based on the definitions established in the preceding section, we calculate the correlation function at both the hadronic and QCD levels.

- At the hadronic level, insertion of a complete set of hadronic states yields:

$$z_\nu T^\nu(p,q) = \frac{f_{\Omega_Q}}{M_{\Omega_Q}^2 - P_{\Omega_Q}^2} 2(z\cdot p)^2 \left\{ f_1 \not{z} - \frac{f_2}{M_{\Omega_Q}} \not{z}\not{q} - g_1 \not{z}\gamma_5 + \frac{g_2}{M_{\Omega_Q}} \not{z}\not{q} \right\} u(p) + \cdots .$$

Correspond to correlation function 1

Or

$$z_\nu T^\nu(p,q) = \frac{f_{\Xi}}{M_{\Xi}^2 - p^2} 2(p\cdot z)^2 \left\{ f_1 \not{z} - \frac{f_2}{M_{\Omega_Q}} \not{z}\not{q} - g_1 \not{z}\gamma_5 + \frac{g_2}{M_{\Omega_Q}} \not{z}\not{q}\gamma_5 \right\} u(P_{\Omega_Q}) + \cdots$$

Correspond to correlation function 2

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- At the QCD level, the operator product expansion is performed through Wick's theorem, yielding:

$$z_\nu T^\nu = \int d^4x \frac{d^4k}{(2\pi)^4} \frac{e^{i(q+k)}}{k^2 - m_Q^2} \gamma_5 \not{z} (\not{k} + m_Q) \not{z} (1-\gamma_5) \langle 0 | s(x) C \not{z} s(x) q(0) | \Xi(p) \rangle$$

LCDAs of Ξ baryon

Or

$$z_\nu T^\nu = \int d^4x \int \frac{d^4k}{(2\pi)^4} \frac{e^{i(p-k)\cdot x}}{k^2 - m_q^2} \gamma_5 \not{z} (\not{k} + m_q) \not{z} (1-\gamma_5) \langle 0 | s(x) C \not{z} s(x) Q(0) | \Omega_Q(P) \rangle.$$

LCDAs of Ω_Q baryon

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- The LCDAs of the Ξ baryon can be decomposed into distinct Lorentz structures through Fierz transformations, including scalar, pseudoscalar, vector, axial-vector and tensor components.

$$4\langle 0|\epsilon^{ijk} s^i_\alpha(a_1 z) s^j_\beta(a_2 z) q^k_\gamma(a_3 z)|\Xi(P)\rangle = \sum_i F_i \Gamma'^{\alpha\beta}_{1i} \left(\Gamma'_{2i}\Xi^\pm\right)_\gamma$$

- F_i (S_i, P_i, V_i, A_i, T_i) denotes the decay constants of the Ξ baryon for different Lorentz-structure interpolating currents.

Twist-3	Twist-4	Twist-5	Twist-6
$V_1(x_i) = 120x_1x_2x_3\phi_3^0$, $A_1(x_i) = 0$, $T_1(x_i) = 120x_1x_2x_3\phi_3'^0$.	$V_2(x_i) = 24x_1x_2\phi_4^0$, $A_2(x_i) = 0$, $V_3(x_i) = 12x_3(x_1 - x_2)\psi_4^0$, $A_3(x_i) = -12x_3(x_1 - x_2)\psi_4^0$, $T_2(x_i) = 24x_1x_2\phi_4'^0$, $T_3(x_i) = 6x_3(1 - x_3)(\xi_4^0 + \xi_4'^0)$, $T_7(x_i) = 6x_3(1 - x_3)(\xi_4'^0 - \xi_4^0)$.	$V_4(x_i) = 3(x_1 - x_3)\psi_5^0$, $A_4(x_i) = 3(x_1 - x_2)\psi_5^0$, $V_5(x_i) = 6x_3\phi_5^0$, $A_5(x_i) = 0$, $T_4(x_i) = -\frac{3}{2}(x_1 + x_2)(\xi_5'^0 + \xi_5^0)$, $T_5(x_i) = 6x_3\phi_5'^0$, $T_8(x_i) = \frac{3}{2}(x_1 + x_2)(\xi_5'^0 - \xi_5^0)$.	$V_6(x_i) = 2\phi_6^0$, $A_6(x_i) = 0$, $T_6(x_i) = 2\phi_6'^0$.

$$\phi_3^0 = \phi_6^0 = f_\Xi,$$
$$\psi_4^0 = \psi_5^0 = \frac{1}{2}(f_\Xi - \lambda_1),$$
$$\phi_4^0 = \phi_5^0 = \frac{1}{2}(f_\Xi + \lambda_1),$$
$$\phi_3'^0 = \phi_6'^0 = -\xi_5^0 = \frac{1}{6}(4\lambda_3 - \lambda_2),$$
$$\phi_4'^0 = \xi_4^0 = \frac{1}{6}(8\lambda_3 - 3\lambda_2),$$
$$\phi_5'^0 = -\xi_5'^0 = \frac{1}{6}\lambda_2,$$
$$\xi_4'^0 = \frac{1}{6}(12\lambda_3 - 5\lambda_2),$$

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- The LCDAs of Ω_Q baryon can be written by:

$$\epsilon_{ijk}\langle 0|q^i_\alpha(t_1 n)q^j_\beta(t_2 n)Q^k_\gamma(0)|\Omega_Q\rangle$$
$$= \frac{1}{8}v_+ f^{(1)}_{\Omega_Q}\Psi^n(t_1,t_2)(\bar{\not n}\gamma_5 C^T)_{\beta\alpha}u_{\Omega_Q\gamma}$$
$$+\frac{1}{4}f^{(2)}_{\Omega_Q}\Psi^{\mathbb{1}}(t_1,t_2)(\gamma_5 C^T)_{\beta\alpha}u_{\Omega_Q\gamma}$$
$$-\frac{1}{8}f^{(2)}_{\Omega_Q}\Psi^{n\bar n}(t_1,t_2)(i\sigma_{n\bar n}\gamma_5 C^T)_{\beta\alpha}u_{\Omega_Q\gamma}$$
$$+\frac{1}{8}\frac{1}{v_+}f^{(1)}_{\Omega_Q}\Psi^{\bar n}(t_1,t_2)(\not n\gamma_5 C^T)_{\beta\alpha}u_{\Omega_Q\gamma}.$$

where

$$n_\mu = \frac{x_\mu}{v\cdot x}, \qquad \bar n_\mu = 2v_\mu - \frac{x_\mu}{v\cdot x}, \qquad \bar v_\mu = \frac{x_\mu}{v\cdot x} - v_\mu.$$

$$\tilde\psi_2(\omega,u) = \omega^2\bar u u\sum_{n=0}^{2}\frac{a_n}{\epsilon_n^4}\frac{C_n^{3/2}(2u-1)}{|C_n^{3/2}|^2}e^{-\omega/\epsilon_n},$$

$$\tilde\psi_3^{\sigma,s}(\omega,u) = \frac{\omega}{2}\sum_{n=0}^{2}\frac{a_n}{\epsilon_n^3}\frac{C_n^{1/2}(2u-1)}{|C_n^{1/2}|^2}e^{-\omega/\epsilon_n},$$

$$\tilde\psi_4(\omega,u) = \sum_{n=0}^{2}\frac{a_n}{\epsilon_n^2}\frac{C_n^{1/2}(2u-1)}{|C_n^{1/2}|^2}e^{-\omega/\epsilon_n}.$$

- Parameters in ψ_i

Twist	a_0	a_1	a_2	ϵ_0[GeV]	ϵ_1[GeV]	ϵ_2[GeV]
2	1	-	$\frac{8A+1}{A+1}$	$\frac{1.3A+1.3}{A+6.9}$	-	$\frac{0.41A+0.06}{A+0.11}$
$3s$	1	-	$\frac{0.17A-0.16}{A-2}$	$\frac{0.56A-1.1}{A-3.22}$	-	$\frac{0.44A-0.43}{A+0.27}$
$3a$	-	1	-	-	$\frac{0.45A-0.63}{A-1.4}$	-
4	1	-	$\frac{-0.10A-0.01}{A+1}$	$\frac{0.62A+0.62}{A+1.62}$	-	$\frac{0.87A+0.07}{A+2.53}$

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- By matching identical Lorentz structures in both hadronic and QCD representations of the correlation function, and applying dispersion relations to subtract contributions from excited states and continuum spectra in the hadronic expression, the form factors can be derived.

eg.

$$\frac{1}{2f_{\Omega_Q}} e^{-M_{\Omega_Q}/M_B^2} f_1(q^2) = -\int_{\alpha_{30}}^{1} \frac{\rho'_{f_{11}}(\alpha_3)}{\alpha_3} d\alpha_3 e^{-s/M_B^2}$$
$$+ \frac{1}{M_B^2}\int_{\alpha_{30}}^{1} \frac{\rho'_{f_{12}}(\alpha_3)}{\alpha_3^2} d\alpha_3 e^{-s/M_B^2} + \frac{\rho'_{f_{12}}(\alpha_{30}) e^{-s_0/M_B^2}}{\alpha_{30}^2 M_\Xi^2 - q^2 + m_Q^2}$$
$$- \frac{1}{2M_B^4}\int_{\alpha_{30}}^{1} \frac{\rho'_{f_{13}}(\alpha_3)}{\alpha_3^3} e^{-s/M_B^2} d\alpha_3 - \frac{1}{2}\frac{\rho'_{f_{13}}(\alpha_{30}) e^{-s_0/M_B^2}}{\alpha_{30} M_B^2(\alpha_{30}^2 M_\Xi^2 - q^2 + m_Q^2)}$$
$$+ \frac{1}{2}\frac{\alpha_{30}^2}{\alpha_{30}^2 M_\Xi^2 - q^2 + m_Q^2}\frac{d}{dx}\frac{\rho'_{f_{13}}(x)}{x(x^2 M_\Xi^2 - q^2 + m_Q^2)}\Big|_{x\to\alpha_{30}} e^{-s_0/M_B^2}$$

$f_1 = g_1$, $f_2 = -g_2$

2. $\Omega_Q \to \Xi$ form factors within light-cone sum rules

- Using the LCDAs of the Ω_Q baryon, we obtain:

$$f_1(q^2) = \left\{ -\int_0^1 du \int_0^{\sigma_0} d\sigma \frac{\rho_{11}(\sigma,u,q^2)}{1-\sigma} e^{(M_\Xi^2 - s)/M^2} + \int_0^1 du \int_0^{\sigma_0} d\sigma \frac{\rho_{12}(\sigma,u,q^2)}{(1-\sigma)^2 M_B^2} e^{(M_\Xi^2 - s)/M_B^2} + \int_0^1 du \frac{\rho_{12}(\sigma_0,u,q^2)\eta(\sigma_0,q^2)}{(1-\sigma_0)^2} e^{(M_\Xi^2 - s)/M_B^2} \right\} \frac{f_{\Omega_Q}}{f_\Xi},$$

Where

Twist-2

Twist-4

$$\rho_{11}(\sigma,u,q^2) = -\sigma(1-\sigma) M_{\Omega_Q} \psi^n(\omega,u),$$
$$\rho_{12}(\sigma,u,q^2) = -(1-\sigma)^2 M_{\Omega_Q} \left(\overline{\psi}^n(\omega,u) - \overline{\psi}^{\overline{n}}(\omega,u) \right)$$

$f_1 = f_2$, $g_1 = g_2 = 0$

3. Numerical analysis of form factors

- The fundamental parameters employed in the form factor calculations, including quark and baryon masses, are adopted from PDG

$$m_u = 2.16 \text{ MeV}, \quad m_c = 1.27 \text{ GeV}, \quad m_b = 4.18 \text{ GeV},$$
$$M_{\Omega_b^-} = 6.0461 \text{ GeV}, \quad M_{\Omega_c} = 2.6952 \text{ GeV},$$

- Additional required parameters include:
(i) the continuum threshold s_0,
(ii) the Borel parameter M_B introduced in the sum rule formalism,
(iii) relevant CKM matrix elements, and
(iv) the Ω_Q baryon lifetime .

3. Numerical analysis of form factors

- The continuum threshold s_0 and Borel parameter M_B serve as adjustable parameters in QCD sum rule calculations.

- However, these parameters must be constrained to ensure minimal contributions from higher-twist LCDAs, excited states, and continuum spectra.

- The region of M_B, must satisfy a stability criteria for form factors at fixed q^2.

- In our numerical analysis, we find that when Ω_Q LCDAs are used, the form factors are one order of magnitude larger than those obtained with Ξ LCDAs. Consequently, the branching ratios of semileptonic decays become two to three orders of magnitude larger than the results derived using Ξ LCDAs and other theoretical works. Therefore, in the following discussion, we focus only on the results obtained with Ξ LCDAs.

3. Numerical analysis of form factors

- In our sum rules, the threshold s_0 and M_B at fixed q^2 within Ξ LCDAs fulfill:

➢ For $\Omega_c \to \Xi$ transitions:
  a) Ground-state contribution ($s < s_0$) > 70% of sum rule
  b) Twist-6 LCDA contribution < 15% of total amplitude

➢ For $\Omega_b \to \Xi$ transitions:
  a) Ground-state contribution ($s < s_0$) > 90% of sum rule
  b) Twist-6 LCDA contribution < 30% of total amplitude

- Therefore, we have:

$$s_0 = \left(M_{\Omega_Q} + \Delta\right)^2 \text{ with } \Delta = (0.5 \pm 0.1)\ \text{GeV}$$

$M_B^2 = (10 \pm 1)\ \text{GeV}^2$ for $\Omega_c^0 \to \Xi^-$ and $M_B^2 = (18 \pm 3)\ \text{GeV}^2$ for $\Omega_b^- \to \Xi^0$

3. Numerical analysis of form factors

- For $\Omega_c^0 \to \Xi^-$: LCSR valid in $0 < q^2 < 1\ \mathrm{GeV}^2$
- For $\Omega_b^- \to \Xi^0$: LCSR valid in $0 < q^2 < 10\ \mathrm{GeV}^2$
- For the whole physical region, we need a fitting formula of form factors:

$$f_i(q^2) = \frac{f_i(0)}{1 - q^2/M^2}\left[1 + a\left(z(q^2) - z(0)\right) + b\left(z^2(q^2) - z^2(0)\right)\right]$$

where

$$z(q^2) = \frac{\sqrt{M^2 - q^2} - \sqrt{M^2 - (M_{\Omega_Q} - M_\Xi)^2}}{\sqrt{M^2 - q^2} + \sqrt{M - (M - M_\Xi)^2}}$$

- Form factors at $q^2 = 0\ \mathrm{GeV}^2$ and fitting parameters

$f_i(q^2)$	$f_i(0)$	a	b
$f_1(q^2)$	$-0.098^{+0.004}_{-0.004}$	$1.934^{+0.240}_{-0.323}$	$-6.473^{+0.985}_{-1.031}$
$f_2(q^2)$	$-0.040^{+0.001}_{-0.002}$	$1.179^{+1.255}_{-1.229}$	$-2.471^{+2.092}_{-2.493}$

3. Numerical analysis of form factors

- The plots of form factors on the whole physical region can be obtained:

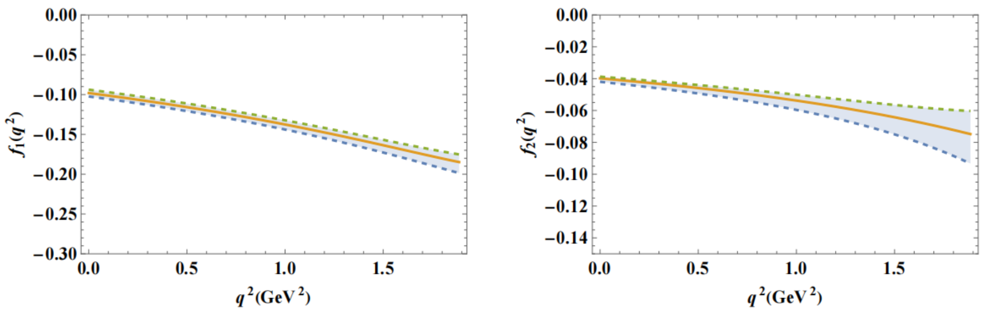

FIG. 1. The dependence of Ω_c^0 transition to Ξ^- form factors $f_i(i = 1, 2)$ with q^2 within Ξ baryon LCDAs.

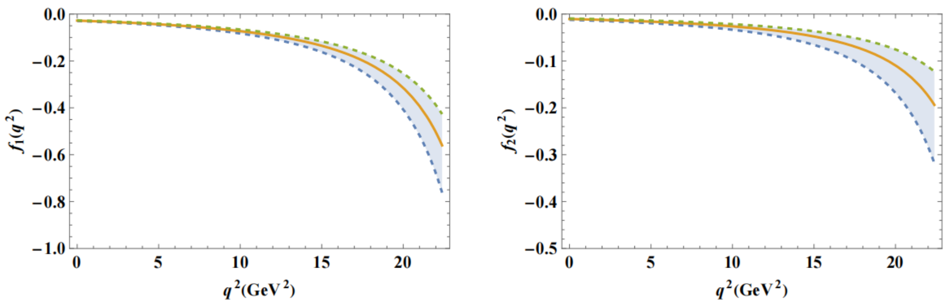

FIG. 2. The dependence of Ω_b^- transition to Ξ^0 form factors $f_i(i = 1, 2)$ with q^2 within Ξ baryon LCDAs.

- Physical region:

$$m_\ell^2 < q^2 < \left(M_{\Omega_Q} - M_\Xi\right)^2$$

- Next, we calculate the branching ratios of the semileptonic decay $\Omega_Q \to \Xi \ell \nu_\ell$ using the form factors across the entire physical region, combined with the helicity amplitudes.

4. Branching fractions of $\Omega_Q \to \Xi \ell \nu_\ell$

- To calculate the branching ratio, we require the differential decay width

$$\frac{d\Gamma}{dq^2} = \frac{d\Gamma_L}{dq^2} + \frac{d\Gamma_T}{dq^2}$$

Where

$$\frac{d\Gamma_L}{dq^2} = \frac{G_F^2 |V_{cd}|^2 q^2 p}{192\pi^3 M_{\Omega_Q}^2}(|H_{\frac{1}{2},0}|^2 + |H_{-\frac{1}{2},0}|^2)$$

$$\frac{d\Gamma_T}{dq^2} = \frac{G_F^2 |V_{cd}|^2 q^2 p}{192\pi^3 M_{\Omega_Q}^2}(|H_{\frac{1}{2},1}|^2 + |H_{-\frac{1}{2},-1}|^2)$$

- Helicity amplitudes:

$$H^V_{\frac{1}{2},0} = -i\frac{\sqrt{Q_-}}{\sqrt{q^2}}[(M_{\Omega_Q} + M_\Xi)f_1 - \frac{q^2}{M_{\Omega_Q}}f_2],$$

$$H^V_{\frac{1}{2},1} = i\sqrt{2Q_-}[-f_1 + \frac{M_{\Omega_Q} + M_\Xi}{M_{\Omega_Q}}f_2],$$

$$H^A_{\frac{1}{2},0} = -i\frac{\sqrt{Q_+}}{\sqrt{q^2}}[(M_{\Omega_Q} - M_\Xi)g_1 + \frac{q^2}{M_{\Omega_Q}}g_2],$$

$$H^A_{\frac{1}{2},1} = i\sqrt{2Q_+}(-g_1 - \frac{M_{\Omega_Q} - M_\Xi}{M_{\Omega_Q}}g_2).$$

$$H^V_{-\lambda,-\lambda_W} = H^V_{\lambda,\lambda_W} \qquad H^A_{-\lambda,-\lambda_W} = -H^A_{\lambda,\lambda_W} \qquad H_{\lambda,\lambda_W} = H^V_{\lambda,\lambda_W} - H^A_{\lambda,\lambda_W}$$

4. Branching fractions of $\Omega_Q \to \Xi \ell \nu_\ell$

- Within the differential decay width, the pictures and decay width of semileptonic decay can be obtained.

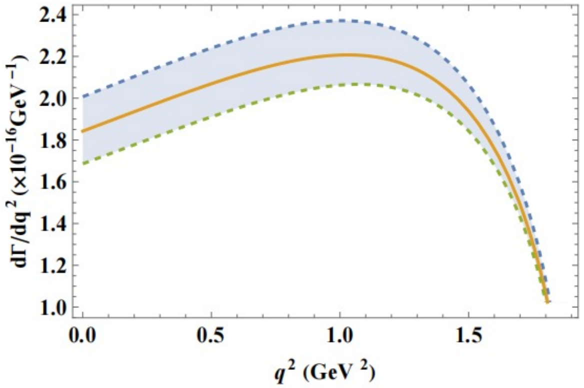

FIG. 3. The differential decay width of $\Omega_c^0 \to \Xi^- \ell^+ \bar{\nu}_\ell$ within Ξ baryon LCDAs.

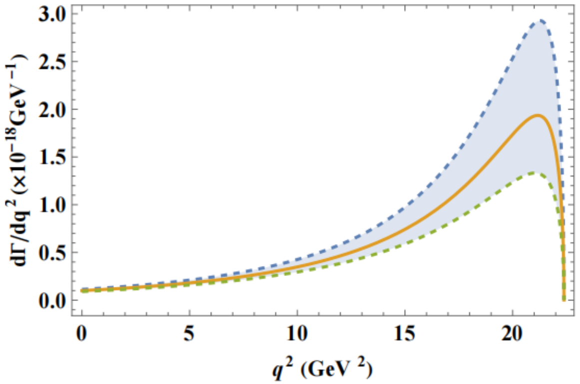

FIG. 4. The differential decay width of $\Omega_b^- \to \Xi^0 \ell^- \nu_\ell$ within Ξ baryon LCDAs.

- Decay width of $\Omega_Q \to \Xi \ell \nu_\ell$

Decay modes	Decay width Γ (GeV)		
	This work	Ref. [13]	Ref. [11]
$\Omega_c^0 \to \Xi^- \ell^+ \bar{\nu}_\ell$	$3.662^{+0.278}_{-0.240} \times 10^{-16}$	$(0.34 \sim 0.65) \times 6.582 \times 10^{-15}$	2.08×10^{-15}
$\Omega_b^- \to \Xi^0 \ell^- \nu_\ell$	$1.451^{+0.544}_{-0.346} \times 10^{-17}$	$(0.82 \sim 1.78) \times 2.514 \times 10^{-18}$	1.18×10^{-17}

[11] Z. X. Zhao. Weak decays of heavy baryons in the light-front approach. Chin. Phys. C, 42:093101,2018.
[13] M. Pervin, W. Roberts and S. Capstick. Semileptonic decays of heavy Omega baryons in a quark model. Phys. Rev. C, 74:025205,2006.

5. Summary

- The $\Omega_Q \to \Xi$ transition form factors are computed within the LCSRs framework
- Both the initial and final baryon LCDAs are analyzed in this work.
- Compared to other theoretical studies, our light-cone sum rule calculations using the final-state light-flavor baryon LCDAs yield consistent results.
- The branching ratios of semileptonic decays for $\Omega_Q \to \Xi$ are calculated using our weak decay form factors and consistent with existing predictions.
- The inconsistent results from Ω_Q baryon LCDAs formulations in LCSRs indicate that theoretical improvements in this area will be required in future studies.

Thank You!