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Strong decay properties of low-lying excited singly heavy baryons

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Contents

Background

1S、1P 、1D-wave（$\lambda-$mode）charmed baryons.

	J^P (nL)	Experimental values [3]	RQM [223]	NQM [224]	NQM [225]	NQM [309]
Λ_c	$1/2^+$ $(1S)$	2286.46 ± 0.14	2286	2268	2285	2286
Ξ_c	$1/2^+$ $(1S)$	$2467.94^{+0.17}_{-0.20}$	2476	2466	–	2470
Σ_c	$1/2^+$ $(1S)$	2452.9 ± 0.4	2443	2455	2460	2456
Σ_c^*	$3/2^+$ $(1S)$	2517.5 ± 2.3	2519	2519	2523	2515
Ξ_c'	$1/2^+$ $(1S)$	2578.4 ± 0.5	2579	2594	–	2579
Ξ_c^*	$3/2^+$ $(1S)$	$2645.56^{+0.24}_{-0.30}$	2649	2649	–	2649
Ω_c	$1/2^+$ $(1S)$	2695.2 ± 1.7	2698	2718	2731	–
Ω_c^*	$3/2^+$ $(1S)$	2765.9 ± 2.0	2768	2776	2779	–
Λ_c	$1/2^-$ $(1P)$	$\Lambda_c(2595) = 2592.25 \pm 0.28$	2598	2625	2628	2614
Λ_c	$3/2^-$ $(1P)$	$\Lambda_c(2625) = 2628.11 \pm 0.19$	2627	2636	2630	2639
Ξ_c	$1/2^-$ $(1P)$	$\Xi_c(2790) = 2792.4 \pm 0.5$	2792	2773	–	2793
Ξ_c	$3/2^-$ $(1P)$	$\Xi_c(2815) = 2816.74^{+0.20}_{-0.23}$	2819	2783	–	2820
Σ_c	$1/2^-$ $(1P)$	–	2713	2748	2802	2702
Σ_c	$1/2^-$ $(1P)$	$\Sigma_c(2800) = 2792^{+14}_{-5}$	2799	2768	2826	2765
Σ_c	$3/2^-$ $(1P)$		2773	2763	2807	2785
Σ_c	$3/2^-$ $(1P)$		2798	2776	2837	2798
Σ_c	$5/2^-$ $(1P)$		2789	2790	2839	2790
Ξ_c'	$1/2^-$ $(1P)$	–	2854	2855	–	2839
Ξ_c'	$1/2^-$ $(1P)$	$\Xi_c(2923) = 2923.04 \pm 0.35$ [304]	2936	–	–	2900
Ξ_c'	$3/2^-$ $(1P)$	$\Xi_c(2939) = 2938.55 \pm 0.30$ [304]	2912	2866	–	2921
Ξ_c'	$3/2^-$ $(1P)$	$\Xi_c(2965) = 2964.88 \pm 0.33$ [304]	2935	–	–	2932
Ξ_c'	$5/2^-$ $(1P)$	–	2929	2895	–	2927
Ω_c	$1/2^-$ $(1P)$	–	2966	2977	3030	–
Ω_c	$1/2^-$ $(1P)$	$\Omega_c(3000) = 3000.41 \pm 0.22$	3055	2990	3048	–
Ω_c	$3/2^-$ $(1P)$	$\Omega_c(3050) = 3050.20 \pm 0.13$	3029	2986	3033	–
Ω_c	$3/2^-$ $(1P)$	$\Omega_c(3066) = 3065.46 \pm 0.28$	3054	2994	3056	–
Ω_c	$5/2^-$ $(1P)$	$\Omega_c(3090) = 3090.0 \pm 0.5$	3051	3014	3057	–

Rept.Prog.Phys. 86 (2023) 2, 026201

Background

1D-wave ($\lambda-$mode) bottom baryons.

	J^P (nL)	Experimental values [3]	RQM [223]	NQM [224]	NQM [225]
Λ_b	$3/2^+$ $(1D)$	$\Lambda_b(6152) = 6152.51 \pm 0.37$ [216]	6190	6181	6211
Λ_b	$5/2^+$ $(1D)$	$\Lambda_b(6146) = 6146.17 \pm 0.43$ [216]	6196	6183	6212
Ξ_b	$3/2^+$ $(1D)$	$\Xi_b(6327) = 6327.28^{+0.34}_{-0.33}$ [221]	6366	–	–
Ξ_b	$5/2^+$ $(1D)$	$\Xi_b(6333) = 6332.69^{+0.28}_{-0.29}$ [221]	6373	6300	–
Σ_b	$1/2^+$ $(1D)$	–	6311	–	6395
Σ_b	$3/2^+$ $(1D)$	–	6285	–	6393
Σ_b	$3/2^+$ $(1D)$	–	6326	–	–
Σ_b	$5/2^+$ $(1D)$	–	6270	6325	6397
Σ_b	$5/2^+$ $(1D)$	–	6284	6328	6402
Σ_b	$7/2^+$ $(1D)$	–	6260	6333	–
Ξ_b'	$1/2^+$ $(1D)$	–	6447	–	–
Ξ_b'	$3/2^+$ $(1D)$	–	6431	–	–
Ξ_b'	$3/2^+$ $(1D)$	–	6459	–	–
Ξ_b'	$5/2^+$ $(1D)$	–	6420	6393	–
Ξ_b'	$5/2^+$ $(1D)$	–	6432	–	–
Ξ_b'	$7/2^+$ $(1D)$	–	6414	6395	–
Ω_b	$1/2^+$ $(1D)$	–	6540	–	6561
Ω_b	$3/2^+$ $(1D)$	–	6530	–	6559
Ω_b	$3/2^+$ $(1D)$	–	6549	–	–
Ω_b	$5/2^+$ $(1D)$	–	6520	6492	6561
Ω_b	$5/2^+$ $(1D)$	–	6529	6494	6566
Ω_b	$7/2^+$ $(1D)$	–	6517	6497	–

Rept.Prog.Phys. 86 (2023) 2, 026201

Background

Belle： reported $\Sigma_c(2800)$ in 2005.

Observation of an isotriplet of excited charmed baryons decaying to Lambda+(c) pi #1

Belle Collaboration • R. Mizuk (Moscow, ITEP) et al. (Dec, 2004)

Published in: *Phys.Rev.Lett.* 94 (2005) 122002 • e-Print: hep-ex/0412069 [hep-ex]

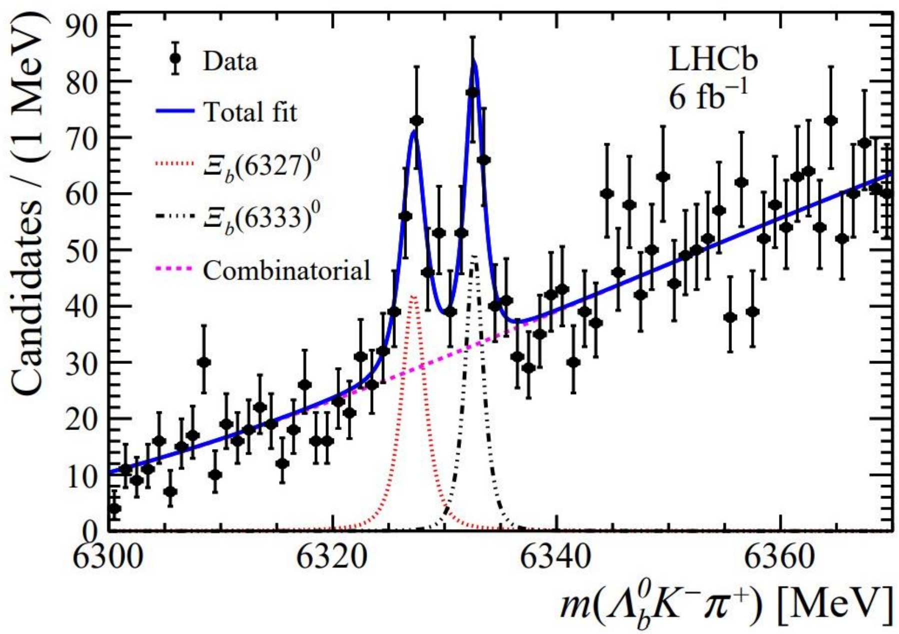
State	Yield $/10^3$	ΔM, MeV$/c^2$	Γ, MeV
$\Sigma_c(2800)^0$	$2.24^{+0.79\,+1.03}_{-0.55\,-0.50}$	$515.4^{+3.2\,+2.1}_{-3.1\,-6.0}$	$61^{+18\,+22}_{-13\,-13}$
$\Sigma_c(2800)^+$	$1.54^{+1.05\,+1.40}_{-0.57\,-0.88}$	$505.4^{+5.8\,+12.4}_{-4.6\,-\ 2.0}$	$62^{+37\,+52}_{-23\,-38}$
$\Sigma_c(2800)^{++}$	$2.81^{+0.82\,+0.71}_{-0.60\,-0.49}$	$514.5^{+3.4\,+2.8}_{-3.1\,-4.9}$	$75^{+18\,+12}_{-13\,-11}$

assignments:
- **Conventional baryon——1P λ-mode Σ_c**
- **Bound state——DN**

Phys.Rev.Lett. 94 (2005) 122002

Background

LHCb: $\Xi_b(6327)^0$ and $\Xi_b(6333)^0$



In 2021, LHCb collaboration reported two narrow resonances, $\Xi_b(6327)^0$ and $\Xi_b(6333)^0$, in the $\Lambda_b^0 K^- \pi^+$ mass spectrum.

Critical issue: How can we identify them?

- Narrow
- Preliminarily assigned as λ-mode 1D Ξ_b with $J^P = 3/2^+, 5/2^+$.

- Mass:

M($\Xi_b(6327)^0$)=$6327.38^{+0.23}_{-0.21}$ ± 0.08 ± 0.24 MeV

M($\Xi_b(6333)^0$)=$6332.69^{+0.17}_{-0.18}$ ± 0.02 ± 0.22 MeV

- Width:

Γ ($\Xi_b(6327)^0$= $\mathbf{0.93^{+0.74}_{-0.60}}$MeV

Γ ($\Xi_b(6333)^0$= $\mathbf{0.25^{+0.58}_{-0.25}}$MeV

- Decay:

$\Xi_b(6327)^0 \to \Sigma_b^+ K^-$

$\Xi_b(6333)^0 \to \Sigma_b^{*+} K^-$

Phys.Rev.Lett. 128 (2022) 16, 162001

Theory

◆ **Strong decays of the low-lying excited Σ_c and $\Xi_b^{(\prime)}$ are systematically studied with quark pair creation model .**

Survey → **Study** → **Explain** → **Predict**

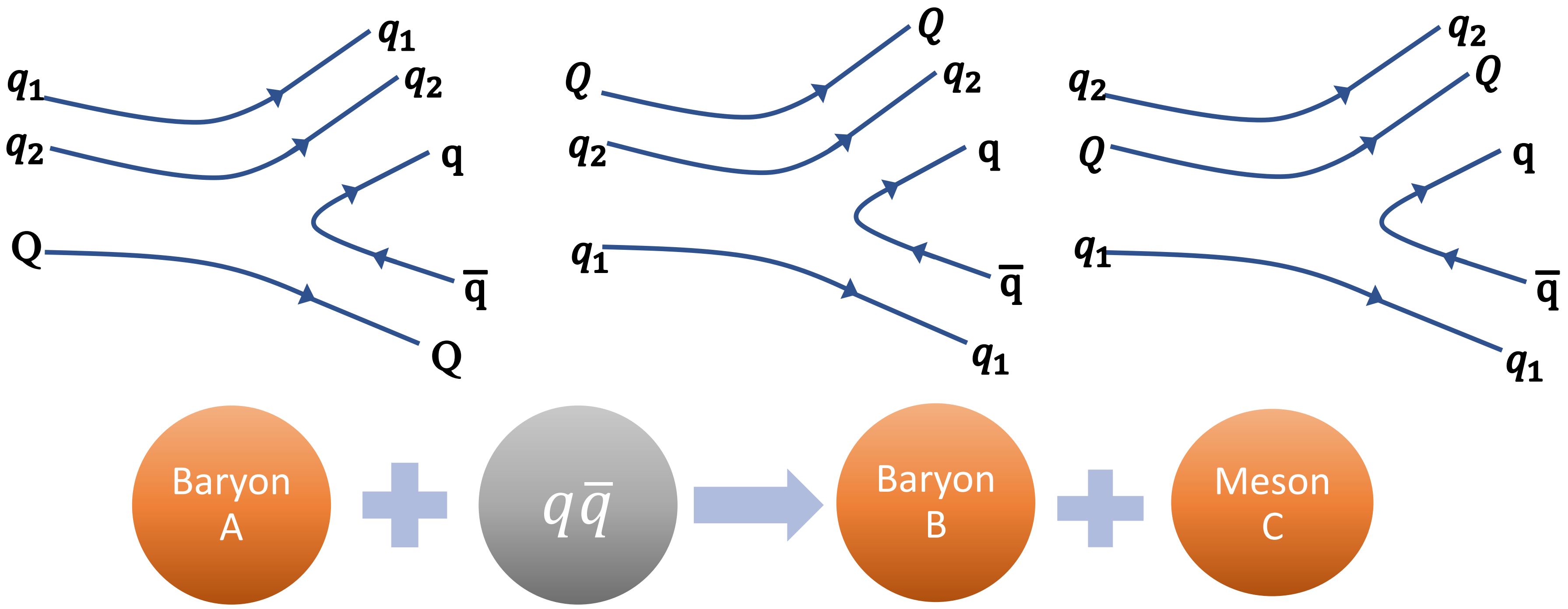
Mass spectrum | **Strong decay** | **Quantum number** | **Missing states**

Mass predictions + Strong decay properties → Candidates

Theory

◆QPC Model （ $^3P_0$ model ）：

- Strong decays take place via the creation of $q\bar{q}$ pair from the vacuum with quantum number $\mathbf{0^{++}}$.
- For baryon decays, one quark of the **initial baryon A** regroups with the created antiquark $\bar{q}$ to form **a meson C**, and the other two quarks regroup with the created quark q to form a daughter **baryon B**.



Theory

◆ QPC Model （ $^3P_0$ model ）：

$$H_{q\bar{q}} = \gamma \sum_q 2m_q \int d^3x \overline{\psi_q}\psi_q$$

In the nonrelativistic limit, the transition operator under the QPC model is given by

$$T = -3\gamma \sum_m \langle 1m\, 1-m|00\rangle \int d^3\boldsymbol{p}_4 d^3\boldsymbol{p}_5\, \delta^3(\boldsymbol{p}_4+\boldsymbol{p}_5) \times \mathcal{Y}_1^m\left(\frac{\boldsymbol{p}_4-\boldsymbol{p}_5}{2}\right)\chi_{1-m}^{45}\phi_0^{45}\omega_0^{45}a_{4i}^\dagger(\boldsymbol{p}_4)b_{5j}^\dagger(\boldsymbol{p}_5)$$

Fitted by experiments, determined as 6.95

$$\langle BC|T|A\rangle = \delta^3(\boldsymbol{P}_A - \boldsymbol{P}_B - \boldsymbol{P}_C)\mathcal{M}^{M_{J_A}M_{J_B}M_{J_C}}$$

The partial decay amplitude in the center of mass frame can be obtained：

$$\mathcal{M}^{M_{J_A}M_{J_B}M_{J_C}}(A \to B + C) = \gamma\sqrt{8E_AE_BE_C}\prod_{A,B,C}\left\langle \chi_{S_BM_{S_B}}^{124}\chi_{S_CM_{S_C}}^{35}\middle|\chi_{S_AM_{S_A}}^{123}\chi_{1-m}^{45}\right\rangle$$

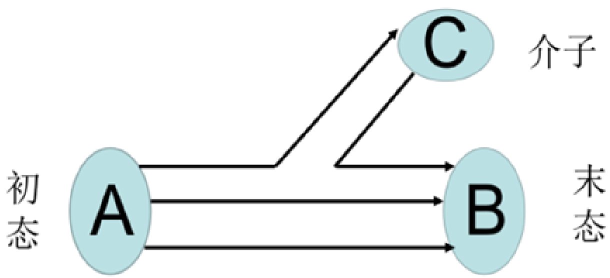
$$\left\langle \varphi_B^{124}\varphi_C^{35}\middle|\varphi_A^{123}\varphi_0^{45}\right\rangle I_{M_{L_B},M_{L_C}}^{M_{L_A},m}(\mathbf{p})$$

Partial decay width: $$\Gamma = \pi^2 \frac{|P|}{M_A}\frac{1}{2J_A+1}\sum_{M_{J_A},M_{J_B},M_{J_C}}\left|\mathcal{M}^{M_{J_A}M_{J_B}M_{J_C}}\right|^2$$

Theory

◆ **Chiral Quark Model:**

The effective low energy quark pseudoscalar-meson coupling in the SU(3) flavor basis at tree level is given by



$$H_{\mathrm{m}} = \sum_j \frac{1}{f_m} \bar{\psi}_j \gamma_\mu^j \gamma_5^j \psi_j \partial^\mu \phi_m$$

ϕ_m denotes the pseudoscalar meson octet

$$\phi_m = \begin{pmatrix} \frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{6}}\eta & \pi^+ & K^+ \\ \pi^- & -\frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{6}}\eta & K^0 \\ K^- & \bar{K}^0 & -\sqrt{\frac{2}{3}}\eta \end{pmatrix}.$$

In the nonrelativistic limit,

$$H_m^{nr} = \sum_j \left\{ \frac{\omega_m}{E_f + M_f} \sigma_j \cdot \mathbf{P}_f + \frac{\omega_m}{E_i + M_i} \sigma_j \cdot \mathbf{P}_i - \sigma_j \cdot \mathbf{q} + \frac{\omega_m}{2\mu_q} \sigma_j \cdot \mathbf{p}'_j \right\} I_j \phi_m.$$

The partial decay amplitudes for B → B′M can be calculated by $\langle B'_C | H_m^{nr} | B_C \rangle$:

$$M[B_c \to B'_c \pi(q)] = 2\langle B'_c | [G\sigma_1 \cdot \mathbf{q} + h\sigma_1 \cdot P'_1] I_1 e^{-i\mathbf{q}\cdot r_1} | B_c \rangle.$$

Partial decay width :

$$\Gamma_m = \left(\frac{\delta}{f_m}\right)^2 \frac{(E_f + M_f)|q|}{4\pi M_i} \frac{1}{2J_i + 1} \sum_{J_{iz} J_{fz}} |M_{J_{iz}, J_{fz}}|^2.$$

Results

Decay properties of 1P λ-mode Σ_c

Masses are taken from Nucl.Phys.B 990 (2023) 116183

	$\Sigma_c \lvert J^P=\frac{1}{2}^-,0\rangle_\lambda$		$\Sigma_c \lvert J^P=\frac{1}{2}^-,1\rangle_\lambda$		$\Sigma_c \lvert J^P=\frac{3}{2}^-,1\rangle_\lambda$		$\Sigma_c \lvert J^P=\frac{3}{2}^-,2\rangle_\lambda$		$\Sigma_c \lvert J^P=\frac{5}{2}^-,2\rangle_\lambda$	
	M=2823		M=2809		M=2829		M=2802		M=2835	
Decay width	QPC	ChQM [63]	QPC	ChQM [63]	QPC	ChQM [63]	QPC	ChQM [63]	QPC	ChQM [63]
$\Gamma[DN]$	10.3	-	2.7	-	...	-	...	-	...	-
$\Gamma[\Sigma_c\pi]$	0.1	...	73.9	30.2	1.0	5.5	0.8	6.6	1.3	4.8
$\Gamma[\Lambda_c\pi]$	38.1	5.7	...	...	...	...	3.5	29.8	4.7	38.6
$\Gamma[\Sigma_c^*\pi]$	...	...	0.3	0.5	68.5	31.2	0.2	2.0	0.8	2.1
Γ_{Total}	48.5	5.7	76.9	30.7	69.5	36.7	4.5	38.4	6.8	45.5

Different explanations of Σ_c(2800)

Different intepretations of Σ_c(2800)	
charmed baryon Σ_c	bound state DN
$1/2^-$[ours],[1–4]	$1/2^-$[5–10]
$3/2^-$[11–15]	$1/2^+$[16]
$5/2^-$[13, 14, 17]	$3/2^-$[16]
mixing state	

Based on the results of QPC model, it is suggested to search in the DN channel.

Results

Interpretations of $\Xi_b(6327)^0$ and $\Xi_b(6333)^0$

Comparison with ChQM and QPC Model

Masses of ρ-mode excitations are taken from Chin.Phys.C 46 (2022) 093102.

Decay Width	$\Xi_b\,\vert J^P=\frac{3}{2}^+,2\rangle_{\lambda\lambda}$		$\Xi_b\,\vert J^P=\frac{5}{2}^+,2\rangle_{\lambda\lambda}$		$\Xi_b\,\vert J^P=\frac{3}{2}^+,2\rangle_{\rho\rho}$		$\Xi_b\,\vert J^P=\frac{5}{2}^+,2\rangle_{\rho\rho}$	
	$\Xi_b(6327)^0$		$\Xi_b(6333)^0$		M=6420		M=6430	
	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]
$\Gamma[\Sigma_b K]$	0.16	0.59	...	...	17.7	8.59	0.67	0.34
$\Gamma[\Sigma_b^* K]$	...	...	0.04	0.11	2.91	1.56	18.2	9.25
$\Gamma[\Xi_b'\pi]$	0.41	1.30	0.02	0.41	21.6	4.63	1.57	0.95
$\Gamma[\Xi_b'^*\pi]$	0.17	0.67	0.96	1.64	6.02	1.97	27.0	5.87
Γ[Total]	0.74	2.56	1.02	2.16	48.3	16.75	47.5	16.42
Expt.	$0.93^{+0.74}_{-0.60}$		$0.25^{+0.58}_{-0.25}$		-		-	

Other possibility: 1P $1/2^-, 3/2^-$ *Phys.Rev.D* 105 (2022) 9, 094004

$$\Sigma_b(6097) = \Sigma_b^{1/2^-}(\mathbf{6}', J=0)\,,$$

$$\Xi_b(6327) = \Xi_b^{1/2^-}(\mathbf{6}', J=1)\,,$$

$$\Xi_b(6333) = \Xi_b^{3/2^-}(\mathbf{6}', J=1)$$

$\Xi_b'\pi$ and $\Xi_b'^*\pi$ are interesting channels for searching $\Xi_b(6327)^0$ and $\Xi_b(6333)^0$.

Results

1D λ −mode Σ_c

	$\Sigma_c\|J^P=\frac{1}{2}^+,1\rangle_{\lambda\lambda}$		$\Sigma_c\|J^P=\frac{3}{2}^+,1\rangle_{\lambda\lambda}$		$\Sigma_c\|J^P=\frac{3}{2}^+,2\rangle_{\lambda\lambda}$		$\Sigma_c\|J^P=\frac{5}{2}^+,2\rangle_{\lambda\lambda}$		$\Sigma_c\|J^P=\frac{5}{2}^+,3\rangle_{\lambda\lambda}$		$\Sigma_c\|J^P=\frac{7}{2}^+,3\rangle_{\lambda\lambda}$	
	$M=3041$		$M=3043$		$M=3040$		$M=3038$		$M=3023$		$M=3013$	
Decay width	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM
$\Gamma[DN]$	17.1	⋯	1.1	⋯	9.6	⋯	0.3	⋯	⋯	⋯	0.6	⋯
$\Gamma[D^*N]$	3.9	⋯	7.5	⋯	4.6	⋯	6.8	⋯	0.1	⋯	⋯	⋯
$\Gamma[\Sigma_c\pi]$	2.5	3.5	0.7	0.9	5.3	7.9	0.3	4.8	0.3	4.7	0.1	2.4
$\Gamma[\Lambda_c\pi]$	2.8	2.3	2.4	2.2	0.1	⋯	⋯	⋯	0.7	15.5	0.6	14.5
$\Gamma[\Sigma_c^*\pi]$	1.0	1.7	2.8	4.3	3.5	6.0	5.5	10.8	0.2	5.2	0.2	1.5
$\Gamma[\Xi_cK]$	0.9	3.4	0.8	3.6	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯
$\Gamma[\Lambda_c\|J^P=\frac{1}{2}^-,1\rangle_\lambda\pi]$	37.2	13.8	⋯	8.1	0.4	0.2	0.2	⋯	1.7	2.2	⋯	⋯
$\Gamma[\Lambda_c\|J^P=\frac{3}{2}^-,1\rangle_\lambda\pi]$	0.1	1.4	37.3	10.8	0.3	0.2	0.5	1.9	0.3	1.2	1.0	8.0
$\Gamma[\Sigma_c\|J^P=\frac{1}{2}^-,0\rangle_\lambda\pi]$	4.3	0.3	⋯	0.4	0.2	1.3	⋯	0.5	⋯	0.2	1.0	⋯
$\Gamma[\Sigma_c\|J^P=\frac{1}{2}^-,1\rangle_\lambda\pi]$	27.9	24.9	0.3	0.5	0.5	4.3	0.2	0.1	⋯	3.9	0.8	⋯
$\Gamma[\Sigma_c\|J^P=\frac{3}{2}^-,1\rangle_\lambda\pi]$	⋯	3.4	6.7	0.6	4.0	2.9	2.0	0.1	2.3	⋯	2.7	0.1
$\Gamma[\Sigma_c\|J^P=\frac{3}{2}^-,2\rangle_\lambda\pi]$	⋯	1.5	4.6	0.3	55.6	22.9	0.5	⋯	1.0	0.3	0.5	0.2
$\Gamma[\Sigma_c\|J^P=\frac{5}{2}^-,2\rangle_\lambda\pi]$	14.7	0.9	3.3	1.3	5.0	0.9	8.6	7.6	6.9	0.8	1.4	0.4
Γ_{Total}	112.4	57.0	67.5	33.0	89.1	46.6	24.9	25.8	13.5	34.0	8.9	27.1

1D ρ −mode Σ_c

	$\Sigma_c\|J^P=\frac{1}{2}^+,1\rangle_{\rho\rho}$		$\Sigma_c\|J^P=\frac{3}{2}^+,1\rangle_{\rho\rho}$		$\Sigma_c\|J^P=\frac{3}{2}^+,2\rangle_{\rho\rho}$		$\Sigma_c\|J^P=\frac{5}{2}^+,2\rangle_{\rho\rho}$		$\Sigma_c\|J^P=\frac{5}{2}^+,3\rangle_{\rho\rho}$		$\Sigma_c\|J^P=\frac{7}{2}^+,3\rangle_{\rho\rho}$	
	$M=3141$		$M=3143$		$M=3140$		$M=3138$		$M=3123$		$M=3113$	
Decay width	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM	QPC	ChQM
$\Gamma[\Sigma_c\pi]$	69.0	14.1	29.0	3.5	126.4	31.7	11.1	10.2	11.1	10.4	5.7	5.4
$\Gamma[\Lambda_c\pi]$	136.8	14.3	137.8	14.2	⋯	⋯	⋯	⋯	21.7	24.3	20.3	23.1
$\Gamma[\Sigma_c^*\pi]$	24.8	6.9	62.6	17.3	33.3	17.3	136.3	39.4	7.4	18.8	8.9	9.3
$\Gamma[\Xi_cK]$	23.1	19.6	37.5	19.9	⋯	⋯	⋯	⋯	1.0	0.6	0.8	0.5
$\Gamma[\Xi_c'K]$	1.9	2.1	0.6	0.5	3.8	4.6	⋯	⋯	⋯	⋯	⋯	⋯
$\Gamma[\Lambda_c\|J^P=\frac{1}{2}^-,1\rangle_\lambda\pi]$	9.2	1.1	1.2	1.5	⋯	⋯	⋯	⋯	1.7	0.6	⋯	0.5
$\Gamma[\Lambda_c\|J^P=\frac{3}{2}^-,1\rangle_\lambda\pi]$	1.8	1.9	8.8	2.4	⋯	⋯	⋯	⋯	0.4	0.8	1.8	0.6
$\Gamma[\Sigma_c\|J^P=\frac{1}{2}^-,0\rangle_\lambda\pi]$	⋯	0.2	⋯	0.1	⋯	0.1	0.1	0.1	⋯	⋯	⋯	⋯
$\Gamma[\Sigma_c\|J^P=\frac{1}{2}^-,1\rangle_\lambda\pi]$	7.0	0.1	0.2	0.1	1.6	0.2	0.7	⋯	1.3	0.1	⋯	⋯
$\Gamma[\Sigma_c\|J^P=\frac{3}{2}^-,1\rangle_\lambda\pi]$	1.3	0.2	2.1	⋯	1.3	⋯	0.2	0.1	0.1	⋯	0.2	⋯
$\Gamma[\Sigma_c\|J^P=\frac{3}{2}^-,2\rangle_\lambda\pi]$	⋯	0.4	0.1	0.5	6.5	0.1	0.1	⋯	0.2	⋯	0.1	⋯
$\Gamma[\Sigma_c\|J^P=\frac{5}{2}^-,2\rangle_\lambda\pi]$	1.9	0.1	0.8	⋯	1.1	0.1	5.5	0.5	0.1	⋯	0.3	⋯
Γ_{Total}	276.7	61.0	280.7	60.0	174.0	54.1	153.9	50.3	44.9	55.6	38.1	39.4

Results

1D λ −mode Ξ_b'

Decay width	$\Xi_b'\,\lvert J^P=\frac{1}{2}^+,1\rangle_{\lambda\lambda}$		$\Xi_b'\,\lvert J^P=\frac{3}{2}^+,1\rangle_{\lambda\lambda}$		$\Xi_b'\,\lvert J^P=\frac{3}{2}^+,2\rangle_{\lambda\lambda}$		$\Xi_b'\,\lvert J^P=\frac{5}{2}^+,2\rangle_{\lambda\lambda}$		$\Xi_b'\,\lvert J^P=\frac{5}{2}^+,3\rangle_{\lambda\lambda}$		$\Xi_b'\,\lvert J^P=\frac{7}{2}^+,3\rangle_{\lambda\lambda}$	
	M=6447		M=6459		M=6431		M=6432		M=6420		M=6414	
	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]
$\Gamma[\Lambda_b K]$	2.8	2.4	2.8	2.1	...	...	1.3	...	2.0	5.8	0.5	5.4
$\Gamma[\Sigma_b^* K]$	0.7	1.8	1.9	4.9	0.5	1.8	3.1	6.8	...	0.8	...	0.1
$\Gamma[\Sigma_b K]$	1.6	4.1	0.4	1.1	3.1	8.4	1.0	0.5	3.6	0.4	...	0.2
$\Gamma[\Xi_b \eta]$	0.4	0.4	0.5	0.1	...	0.1	0.1	0.9	0.2	0.2	...	...
$\Gamma[\Xi_b \pi]$	4.6	2.2	4.6	2.0	...	...	2.0	...	3.2	9.6	0.5	9.1
$\Gamma[\Xi_b' \pi]$	1.1	1.3	0.3	0.3	2.3	2.9	0.8	1.3	3.2	1.2	...	0.6
$\Gamma[\Xi_b'^* \pi]$	0.5	0.6	1.3	1.6	0.5	2.3	2.6	4.1	0.1	2.1	0.1	0.6
$\Gamma[\Lambda B]$	10.7	-	0.9	-	3.8	-	...	-	...	-	...	-
$\Gamma[\Lambda_b\,\lvert J^P=1/2^-,1\rangle_\lambda\,K]$	34.7	32.3	...	0.2	...	1.1	...	2.6	...	0.1	...	...
$\Gamma[\Lambda_b\,\lvert J^P=3/2^-,1\rangle_\lambda\,K]$	...	0.1	36.0	15.8	...	1.4	...	...	...	0.2	-	...
$\Gamma[\Xi_b\,\lvert J^P=1/2^-,1\rangle_\lambda\,\pi]$	52.0	13.8	...	1.1	0.1	0.4	...	0.6	0.3	0.5	...	...
$\Gamma[\Xi_b\,\lvert J^P=3/2^-,1\rangle_\lambda\,\pi]$	...	0.4	52.3	10.2	0.1	1.0	0.1	0.2	0.1	0.1	0.2	1.5
$\Gamma[\Xi_b'\,\lvert J^P=1/2^-,0\rangle_\lambda\,\pi]$	...	1.0	...	0.1	11.2	0.2	...	0.1	...	...	...	...
$\Gamma[\Xi_b'\,\lvert J^P=1/2^-,1\rangle_\lambda\,\pi]$	21.4	9.0	...	...	...	0.1	...	0.1	0.1	0.1	0.2	...
$\Gamma[\Xi_b'\,\lvert J^P=3/2^-,1\rangle_\lambda\,\pi]$	...	0.9	3.0	0.3	1.3	0.6	0.7	...	0.7	...	0.8	...
$\Gamma[\Xi_b'\,\lvert J^P=3/2^-,2\rangle_\lambda\,\pi]$	...	0.3	1.9	...	18.0	6.2	0.2	...	0.2	...	0.2	...
$\Gamma[\Xi_b'\,\lvert J^P=5/2^-,2\rangle_\lambda\,\pi]$	6.1	0.6	1.6	0.2	1.8	0.1	3.3	1.3	2.4	...	0.5	...
Γ_{Total}	136.7	71.2	107.6	40.0	42.6	26.6	15.3	18.5	16.0	21.0	3.0	17.5

Results

1D ρ −mode Ξ_b'

Decay width	$\Xi_b' \|J^P=\frac{1}{2}^+,1\rangle_{\rho\rho}$		$\Xi_b' \|J^P=\frac{3}{2}^+,1\rangle_{\rho\rho}$		$\Xi_b' \|J^P=\frac{3}{2}^+,2\rangle_{\rho\rho}$		$\Xi_b' \|J^P=\frac{5}{2}^+,2\rangle_{\rho\rho}$		$\Xi_b' \|J^P=\frac{5}{2}^+,3\rangle_{\rho\rho}$		$\Xi_b' \|J^P=\frac{7}{2}^+,3\rangle_{\rho\rho}$	
	M=6547		M=6559		M=6531		M=6532		M=6520		M=6514	
	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]	QPC	ChQM [42]
$\Gamma[\Lambda_b K]$	192.1	7.6	203.7	7.2	...	...	...	...	22.9	6.7	21.7	6.5
$\Gamma[\Sigma_b^* K]$	1.1	4.4	20.9	13.8	22.8	7.2	108.1	21.1	3.5	5.3	4.2	2.0
$\Gamma[\Sigma_b K]$	54.5	11.1	15.1	2.8	105.9	24.2	4.3	1.8	4.0	1.7	2.0	0.9
$\Gamma[\Xi_b \pi]$	259.9	11.0	275.9	10.6	...	...	...	...	26.8	10.5	25.4	10.1
$\Gamma[\Xi_b' \pi]$	38.4	4.3	5.2	1.1	77.5	9.6	4.0	2.0	3.9	2.0	2.1	1.1
$\Gamma[\Xi_b'^* \pi]$	0.3	2.1	45.9	5.4	19.3	4.8	195.6	11.4	11.0	5.3	9.3	2.7
$\Gamma[\Xi_b \eta]$	14.4	0.8	16.2	0.6	...	1.0	...	2.6	0.4	0.6	0.4	...
$\Gamma[\Xi_b' \eta]$	0.5	0.6	0.2	0.7	0.7	0.2	...	0.2	...	...	...	...
$\Gamma[\Xi_b'^* \eta]$	0.1	0.1	0.6	0.8	0.1	0.4	2.3	0.2	0.1	0.1	...	...
$\Gamma[\Lambda_b \|J^P=1/2^-,1\rangle_\lambda K]$	6.4	0.5	0.6	0.6	...	...	...	...	0.4	...	...	...
$\Gamma[\Lambda_b \|J^P=3/2^-,1\rangle_\lambda K]$	0.8	0.9	7.2	1.9	...	0.1	...	...	0.1	...	0.5	...
$\Gamma[\Xi_b \|J^P=1/2^-,1\rangle_\lambda \pi]$	9.8	0.5	0.9	0.5	...	...	...	...	0.8	0.1	...	0.1
$\Gamma[\Xi_b \|J^P=3/2^-,1\rangle_\lambda \pi]$	1.3	0.8	10.8	1.9	...	0.1	...	...	0.2	0.1	1.0	0.1
$\Gamma[\Xi_b' \|J^P=1/2^-,0\rangle_\lambda \pi]$	0.1	...	0.3	...	1.6	...	...	...	...	...	...	...
$\Gamma[\Xi_b' \|J^P=1/2^-,1\rangle_\lambda \pi]$	4.4	...	0.1	0.1	...	...	...	...	...	...	...	...
$\Gamma[\Xi_b' \|J^P=3/2^-,1\rangle_\lambda \pi]$	0.6	...	1.0	...	0.5	...	...	...	...	...	...	...
$\Gamma[\Xi_b' \|J^P=3/2^-,2\rangle_\lambda \pi]$	...	0.1	...	0.2	2.4	...	...	...	...	...	...	...
$\Gamma[\Xi_b' \|J^P=5/2^-,2\rangle_\lambda \pi]$	0.8	...	0.4	...	0.4	...	1.1	0.1	...	...	0.1	...
Γ_{Total}	585.6	44.8	604.7	48.2	231.2	47.6	312.8	39.4	74.3	32.4	66.8	23.5

Summary

- Two body strong decays of low-lying **1P-, 1D-wave** Σ_c and **1D-wave** Ξ_b /Ξ_b' excitations have been systematically investigated in **the QPC model** within the j-j coupling scheme. Both λ**-mode** and ρ**-mode** excitations are studied.
- $\Xi_b(6327)^0$ and $\Xi_b(6333)^0$ can be assigned as 1D λ-mode Ξ_b states with $J^P=3/2^+$ and $5/2^+$, respectively. $\Xi_b'\pi$ and $\Xi_b'^*\pi$ are interesting channels in the forthcoming experiments.
- As for $\Sigma_c(2800)$, we favor explaining it as 1P λ-mode Σ_c state with $J^P = 1/2^-$. Additionally, DN is another interesting channel for the observation.

Appendix

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Thanks for your attention!