

北京科技大学



北京科技大学
University of Science and Technology Beijing

单重味重子的强衰变 性质研究

汇报人：王文佳

指导老师：肖立叶

汇报时间：2023.7.20

中高能核物理暑期学校

- 研究背景
- 理论方法
- 主要研究内容
- 总结展望

北京科技大学
University of Science and Technology Beijing



1、夸克模型

名称	符号	电荷 ^{a)}	质量(MeV/c ²)
下(down)	d	$-\frac{1}{3}e$	$4.67^{+0.48}_{-0.17}$
上(up)	u	$\frac{2}{3}e$	$2.16^{+0.49}_{-0.26}$
奇异(strange)	s	$-\frac{1}{3}e$	93^{+11}_{-5}
粲(charm)	c	$\frac{2}{3}e$	$(1.27 \pm 0.02) \times 10^3$
底(bottom)	b	$-\frac{1}{3}e$	$(4.18^{+0.03}_{-0.02}) \times 10^3$
顶(top)	t	$\frac{2}{3}e$	$(172.76 \pm 0.30) \times 10^3$

普通强子态



重子



介子

奇特强子态



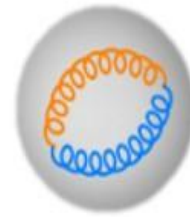
四夸克态



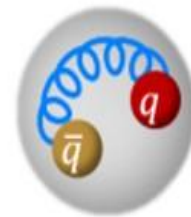
五夸克态



强子分子态



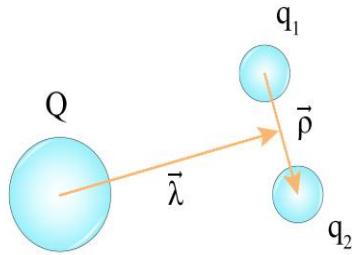
胶球



混杂态

研究对象：单重味重子 (qqQ)

2、单重味重子夸克模型分类



$$\Psi = \Psi_{color} \cdot \Psi_{flavor} \cdot \Psi_{spin} \cdot \Psi_{space}$$

		state	flavor
$\bar{3}_F$	Λ_c	Λ_c^+	$\frac{1}{\sqrt{2}}(ud - du)c$
6_F	Σ_c	$\Sigma_c^{++}(\Sigma_c^{*++})$	uuc
		$\Sigma_c^+(\Sigma_c^{*+})$	$\frac{1}{\sqrt{2}}(ud + du)c$
		$\Sigma_c^0(\Sigma_c^{*0})$	ddc
$\bar{3}_F$	Ξ_c	Ξ_c^+	$\frac{1}{\sqrt{2}}(us - su)c$
		Ξ_c^0	$\frac{1}{\sqrt{2}}(ds - sd)c$
6_F	Ξ'_c	$\Xi_c'^+(\Xi_c^{*+})$	$\frac{1}{\sqrt{2}}(us + su)c$
		$\Xi_c'^0(\Xi_c^{*0})$	$\frac{1}{\sqrt{2}}(ds + sd)c$
6_F	Ω_c	$\Omega_c^0(\Omega_c^{*0})$	ssc

$$\chi_{3/2}^s = \uparrow\uparrow\uparrow, \chi_{-3/2}^s = \downarrow\downarrow\downarrow,$$

$$\chi_{1/2}^s = \frac{1}{\sqrt{3}}(\uparrow\uparrow\downarrow + \uparrow\downarrow\uparrow + \downarrow\uparrow\uparrow),$$

$$\chi_{-1/2}^s = \frac{1}{\sqrt{3}}(\uparrow\downarrow\downarrow + \downarrow\downarrow\uparrow + \downarrow\uparrow\downarrow),$$

$$\chi_{1/2}^\lambda = -\frac{1}{\sqrt{6}}(\uparrow\downarrow\uparrow + \downarrow\uparrow\uparrow - 2\uparrow\uparrow\downarrow),$$

$$\chi_{-1/2}^\lambda = \frac{1}{\sqrt{6}}(\uparrow\downarrow\downarrow + \downarrow\uparrow\downarrow - 2\downarrow\downarrow\uparrow),$$

$$\chi_{1/2}^p = \frac{1}{\sqrt{2}}(\uparrow\downarrow\uparrow - \downarrow\uparrow\uparrow),$$

$$\chi_{-1/2}^p = \frac{1}{\sqrt{2}}(\uparrow\downarrow\downarrow - \downarrow\uparrow\downarrow).$$

$$H = \frac{1}{2m}(\mathbf{P}_1^2 + \mathbf{P}_2^2) + \frac{1}{2m'}\mathbf{P}_3^2 + \frac{1}{2}K\sum(\mathbf{r}_i - \mathbf{r}_j)^2,$$

$$\vec{\rho} = \frac{1}{\sqrt{2}}(\mathbf{r}_1 - \mathbf{r}_2),$$

$$\vec{\lambda} = \frac{1}{\sqrt{6}}(\mathbf{r}_1 + \mathbf{r}_2 - 2\mathbf{r}_3),$$

$$\mathbf{R}_{cm} = \frac{m(\mathbf{r}_1 + \mathbf{r}_2) + m'\mathbf{r}_3}{2m + m'}.$$

$$H = \frac{P_{cm}^2}{2M} + \frac{1}{2m_p}\mathbf{P}_p^2 + \frac{1}{2m_\lambda}\mathbf{P}_\lambda^2 + \frac{3}{2}K(\rho^2 + \lambda^2),$$

$$\frac{\omega_\lambda}{\omega_\rho} = \sqrt{\frac{1}{3} + \frac{2m_q}{3m_q}} < 1. \quad \alpha_\lambda^2 = \sqrt{\frac{3m_Q}{2m_q + m_Q}}\alpha_p^2.$$

按 [flavor, j_l, s_l, mode] 定义, 单粲重子谱($N \leq 2$).

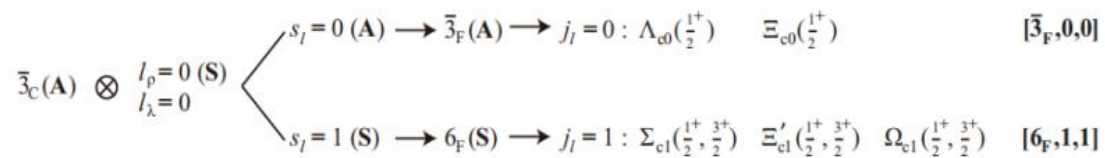


图 1-6 S波单粲重子谱

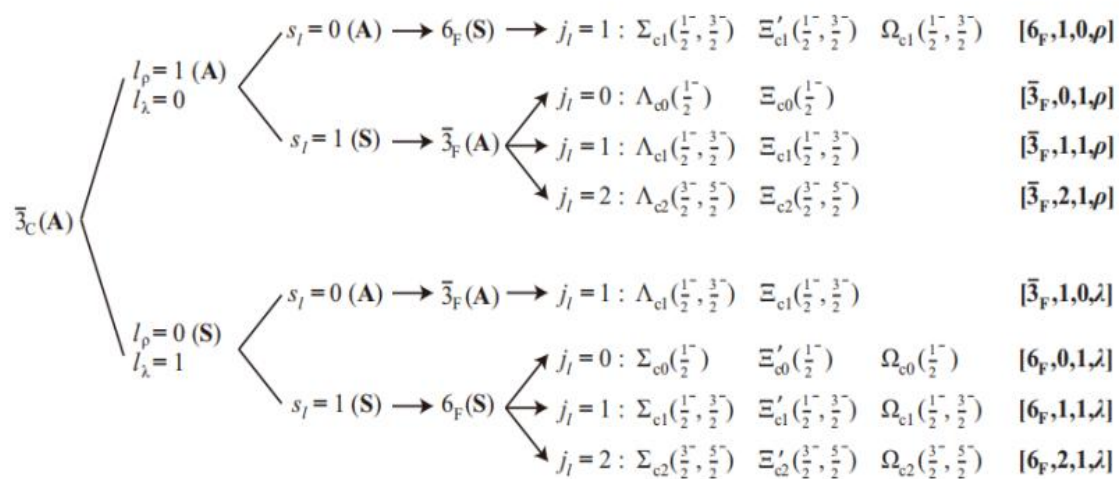


图 1-7 1P波单粲重子谱

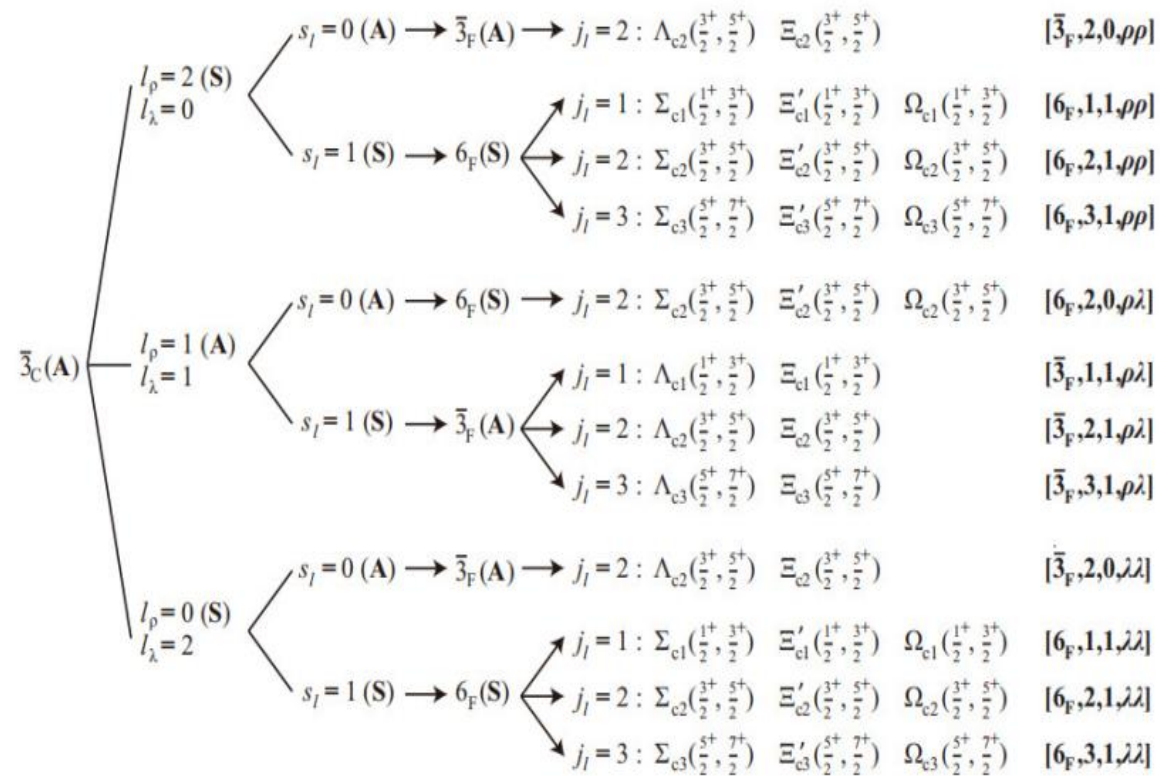


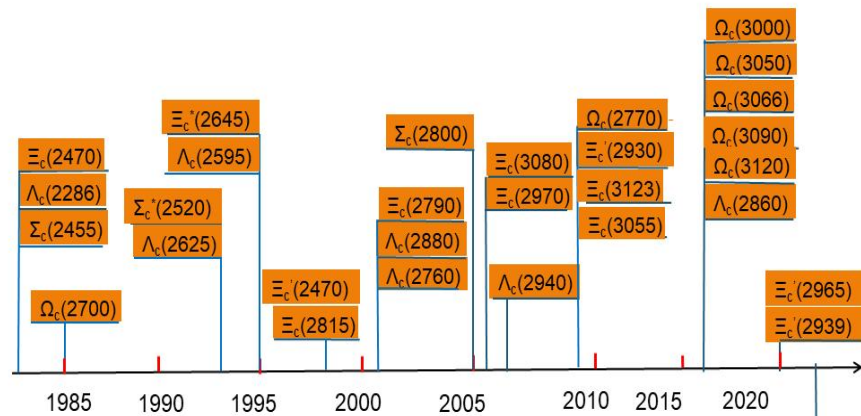
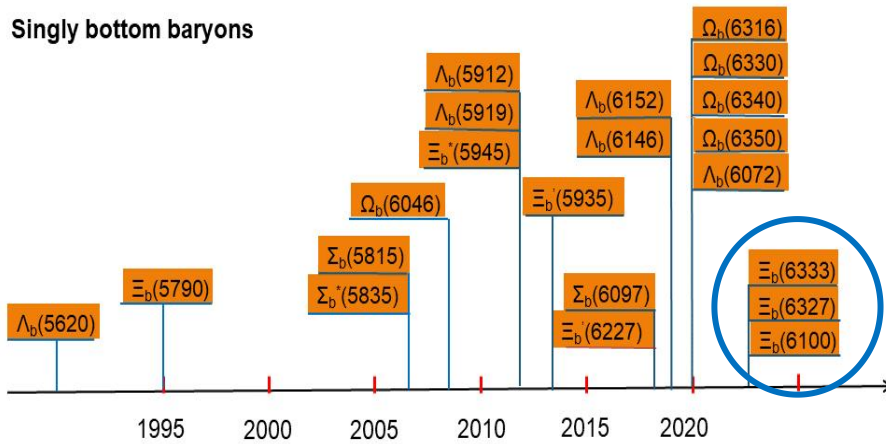
图 1-8 1D波单粲重子谱

3、单重味重子研究现状



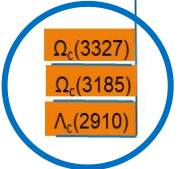
state	J^P	Exp.Mass	Exp.Width	RQM	CQM
$\Lambda_b(1P)$	$1/2^-$	$\Lambda_b(5912)$	< 0.66	5930	5930
$\Lambda_b(1P)$	$1/2^-$	$\Lambda_b(5920)$	< 0.63	5942	5947
$\Xi_b(1P)$	$1/2^-$			6120	6119
$\Xi_b(1P)$	$1/2^-$	$\Xi_b(6100)$	< 1.9	6130	6130
$\Sigma_b(1P)$	$1/2^-$			6101	6122
$\Sigma_b(1P)$	$1/2^-$			6095	6108
$\Sigma_b(1P)$	$1/2^-$			6096	6106
$\Sigma_b(1P)$	$1/2^-$	$\Sigma_b(6097)$	31.0 ± 5.5	6087	6076
$\Sigma_b(1P)$	$1/2^-$			6084	6083
$\Xi_b'(1P)$	$1/2^-$			6233	6249
$\Xi_b'(1P)$	$1/2^-$			6227	6238
$\Xi_b'(1P)$	$1/2^-$			6234	6237
$\Xi_b'(1P)$	$1/2^-$	$\Xi_b(6227)$	18.1 ± 5.7	6224	6212
$\Xi_b'(1P)$	$1/2^-$			6226	6218
$\Omega_b(1P)$	$1/2^-$			6339	6361
$\Omega_b(1P)$	$1/2^-$	$\Omega_b(6316)$	< 2.8	6330	6352
$\Omega_b(1P)$	$1/2^-$	$\Omega_b(6330)$	< 3.1	6340	6351
$\Omega_b(1P)$	$1/2^-$	$\Omega_b(6340)$	< 1.5	6331	6330
$\Omega_b(1P)$	$1/2^-$	$\Omega_b(6350)$	$1.4^{+1.0}_{-0.8}$	6334	6336
$\Lambda_b(1D)$	$3/2^+$	$\Lambda_b(6152)$	2.1 ± 0.9	6190	6189
$\Lambda_b(1D)$	$3/2^+$	$\Lambda_b(6146)$	2.9 ± 1.3	6196	6197
$\Xi_b(1D)$	$3/2^+$	$\Xi_b(6327)$	< 2.20	6366	6359
$\Xi_b(1D)$	$3/2^+$	$\Xi_b(6333)$	< 1.55	6373	6365
$\Sigma_b(1D)$	$3/2^+$			6311	6300
$\Sigma_b(1D)$	$3/2^+$			6326	6287
$\Sigma_b(1D)$	$3/2^+$			6285	6291
$\Sigma_b(1D)$	$3/2^+$			6284	6279
$\Sigma_b(1D)$	$3/2^+$			6270	6248
$\Sigma_b(1D)$	$3/2^+$			6260	6262
$\Xi_b'(1D)$	$3/2^+$			6447	6420
$\Xi_b'(1D)$	$3/2^+$			6459	6410
$\Xi_b'(1D)$	$3/2^+$			6431	6412
$\Xi_b'(1D)$	$3/2^+$			6432	6403
$\Xi_b'(1D)$	$3/2^+$			6420	6377
$\Xi_b'(1D)$	$3/2^+$			6414	6390
$\Omega_b(1D)$	$3/2^+$			6540	6526
$\Omega_b(1D)$	$3/2^+$			6549	6518
$\Omega_b(1D)$	$3/2^+$			6530	6520
$\Omega_b(1D)$	$3/2^+$			6529	6512
$\Omega_b(1D)$	$3/2^+$			6520	6490
$\Omega_b(1D)$	$3/2^+$			6517	6502

Singly bottom baryons



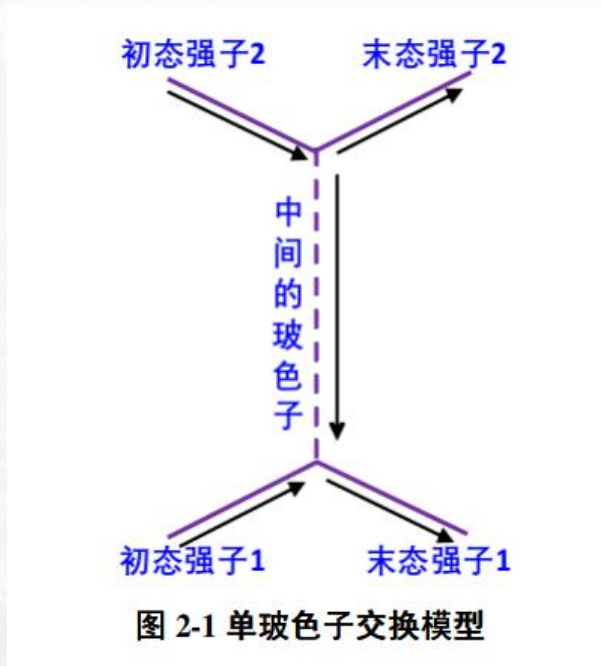
Singly charmed baryons

state	J^P	Exp.Mass	Exp.Width	RQM	CQM
$\Lambda_c(1P)$	$1/2^-$	$\Lambda_c(2595)$	2.59 ± 0.56	2598	2598
$\Lambda_c(1P)$	$1/2^-$	$\Lambda_c(2625)$	< 0.97	2627	2628
$\Xi_c(1P)$	$1/2^-$	$\Xi_c(2790)$	8.9 ± 1.0	2792	2801
$\Xi_c(1P)$	$1/2^-$	$\Xi_c(2815)$	2.43 ± 0.26	2819	2820
$\Sigma_c(1P)$	$1/2^-$			2799	2805
$\Sigma_c(1P)$	$1/2^-$			2713	2795
$\Sigma_c(1P)$	$1/2^-$			2798	2799
$\Sigma_c(1P)$	$1/2^-$	$\Sigma_c(2800)$	62^{+64}_{-44}	2773	2761
$\Sigma_c(1P)$	$1/2^-$			2789	2790
$\Xi_c'(1P)$	$1/2^-$			2936	2934
$\Xi_c'(1P)$	$1/2^-$	$\Xi_c(2923)$	7.1 ± 2.0	2854	2928
$\Xi_c'(1P)$	$1/2^-$	$\Xi_c(2939)$	10.2 ± 1.4	2935	2931
$\Xi_c'(1P)$	$1/2^-$	$\Xi_c(2965)$	14.1 ± 1.6	2912	2900
$\Xi_c'(1P)$	$1/2^-$			2929	2921
$\Omega_c(1P)$	$1/2^-$			3055	3025
$\Omega_c(1P)$	$1/2^-$	$\Omega_c(3000)$	4.5 ± 0.7	2966	3020
$\Omega_c(1P)$	$1/2^-$	$\Omega_c(3050)$	< 1.2	3054	3026
$\Omega_c(1P)$	$1/2^-$	$\Omega_c(3066)$	3.5 ± 0.4	3029	2998
$\Omega_c(1P)$	$1/2^-$	$\Omega_c(3090)$	8.7 ± 1.3	3051	3022
$\Lambda_c(1D)$	$3/2^+$	$\Lambda_c(2860)$	$67.6^{+11.8}_{-21.6}$	2874	2874
$\Lambda_c(1D)$	$3/2^+$	$\Lambda_c(2880)$	$5.6^{+0.8}_{-0.6}$	2880	2883
$\Xi_c(1D)$	$3/2^+$	$\Xi_c(3055)$	7.8 ± 1.9	3059	3030
$\Xi_c(1D)$	$3/2^+$	$\Xi_c(3080)$	3.6 ± 1.1	3076	3042
$\Sigma_c(1D)$	$3/2^+$			3041	3014
$\Sigma_c(1D)$	$3/2^+$			3043	3005
$\Sigma_c(1D)$	$3/2^+$			3040	3010
$\Sigma_c(1D)$	$3/2^+$			3038	3001
$\Sigma_c(1D)$	$3/2^+$			3023	2960
$\Sigma_c(1D)$	$3/2^+$			3013	3015
$\Xi_c'(1D)$	$3/2^+$			3163	3132
$\Xi_c'(1D)$	$3/2^+$			3167	3127
$\Xi_c'(1D)$	$3/2^+$			3160	3131
$\Xi_c'(1D)$	$3/2^+$			3166	3123
$\Xi_c'(1D)$	$3/2^+$			3153	3087
$\Xi_c'(1D)$	$3/2^+$			3147	3136
$\Omega_c(1D)$	$3/2^+$			3287	3222
$\Omega_c(1D)$	$3/2^+$			3298	3215
$\Omega_c(1D)$	$3/2^+$			3282	3217
$\Omega_c(1D)$	$3/2^+$			3297	3218
$\Omega_c(1D)$	$3/2^+$			3286	3187
$\Omega_c(1D)$	$3/2^+$			3283	3237



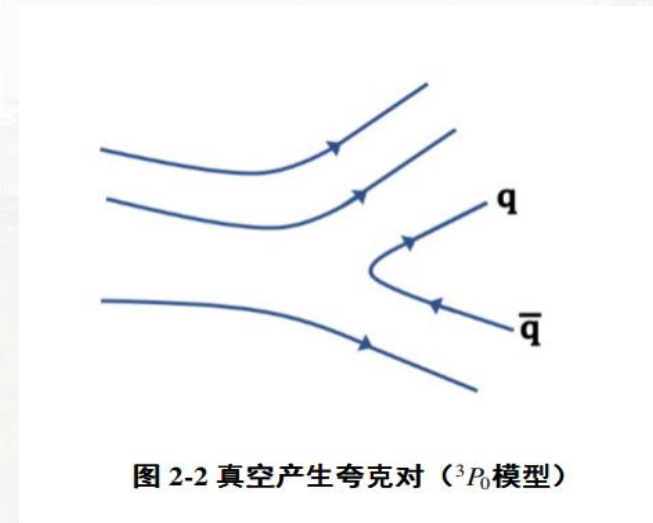
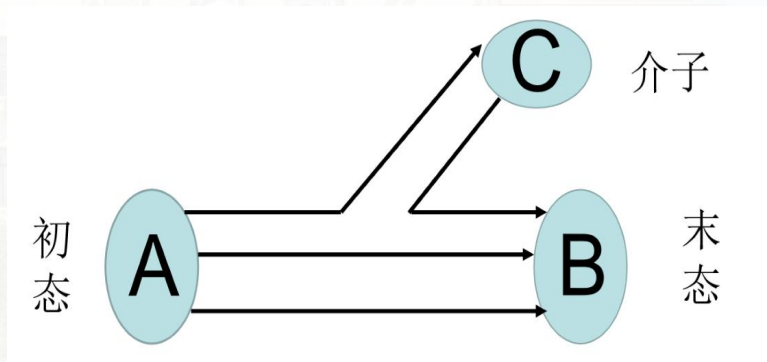
1、唯象模型

强子层次

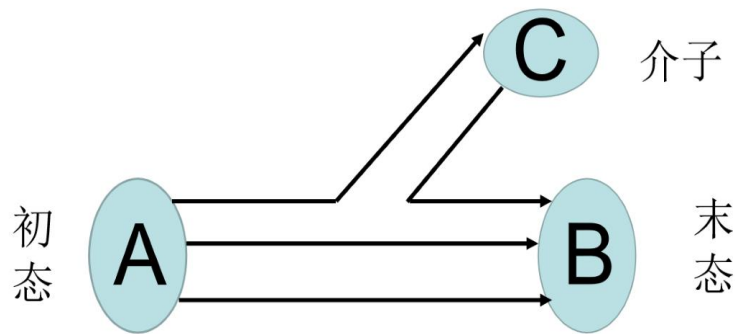


夸克层次

常见的研究方法有：手征夸克模型、手征微扰理论、QCD求和规则和光锥求和规则以及基于真空中产生夸克对机制的模型（3P0模型，流管模型等）。



2、手征夸克模型



在 SU(3) 味对称性下，树图层次上的轻味夸克和轻味赝标量介子的耦合顶点可以表示为：

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

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

轻味夸克和轻味赝标量介子耦合顶点的非相对论形式：

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

对于 $A \rightarrow B+C$ 强衰变过程，赝标量介子仅和其中两味轻夸克耦合，其衰变振幅可表示为：

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

$$G \equiv -\frac{\omega_\pi}{E_f + M_f} - 1, h \equiv \frac{\omega_\pi}{m},$$

我们选择 $\mathbf{q} = qz^{\wedge}$ ，即介子沿 z 轴方向移动，进一步将振幅简化为：

$$\begin{aligned} M[B_c \rightarrow B'_c \pi(q)] = & 2[Gq - \frac{1}{\sqrt{2}}(\frac{1}{\sqrt{3}}q_\lambda + q_\rho)h] \langle B'_c | \sigma_{1z} \phi I_1 | B_c \rangle \\ & - i\sqrt{\frac{2}{3}}h \langle B'_c | (\sigma_1 \cdot \vec{\nabla}_\lambda - \alpha_\lambda^2 \sigma_1 \cdot \vec{\lambda}) \phi I_1 | B_c \rangle \\ & - i\sqrt{2}h \langle B'_c | (\sigma_1 \cdot \vec{\nabla}_\rho - \alpha_\rho^2 \sigma_1 \cdot \vec{\rho}) \phi I_1 | B_c \rangle. \end{aligned}$$

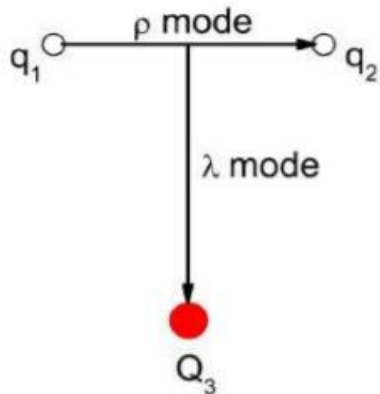
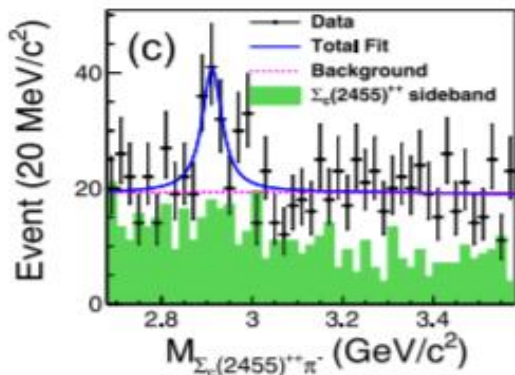
$$\Gamma_m = \left(\frac{\delta}{f_m}\right)^2 \frac{(E_f + M_f)|q|}{4\pi M_i} \frac{1}{2J_i + 1} \sum_{J_{iz}, J_{fz}} |M_{J_{iz}, J_{fz}}|^2.$$

δ 是表示夸克和介子耦合强度的参数，早期工作中通过拟合轻味重子的强衰变实验数据确定 $\delta = 0.557$ 。



1、1P波ρ激发单重味重子的强衰变性质

对于单重味重子，包括两种激发模式：ρ激发和λ激发。



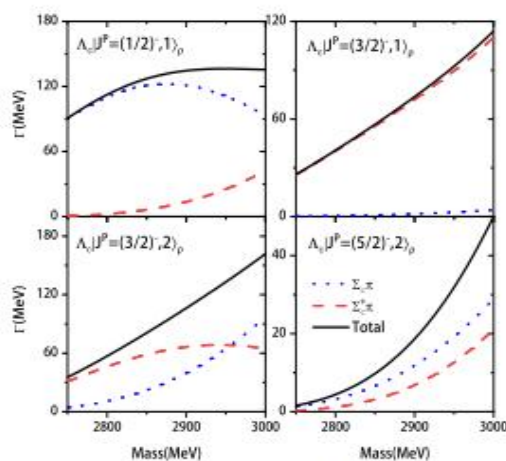
State	Main decay channels	Total width	Possible interpretations	Our results
$\Lambda_c(2910)^+$	$\Sigma_c(2455)^{u,++}\pi^\pm$	$51.8 \pm 20.0 \pm 18.8$	2P-wave with $J^P = 1/2^-$	$\Lambda_c |J^P = 5/2^-, 2\rangle_\rho$
$\Xi_b(6227)^-$	$\Lambda_b K, \Xi_b \pi$	18 ± 6	1P-wave Ξ_b with $J^P = 3/2^-$ 1P-wave Ξ_b with $J^P = 5/2^-$ 1P-wave or 2S-wave state with $J = 3/2$ pentaquark molecular state with $J^P = 1/2^\pm$ $\Sigma_b \bar{K}$ molecular state with $J^P = 1/2^-$	$\Xi_b |J^P = 5/2^-, 2\rangle_\rho$

基于质量谱和强衰变分析， $\Lambda_c(2940)$ 可能是2P波或者1D波λ激发态候选者。然而，还有很多其他解释，比如：2S波激发态、1P波ρ激发态、分子态等。

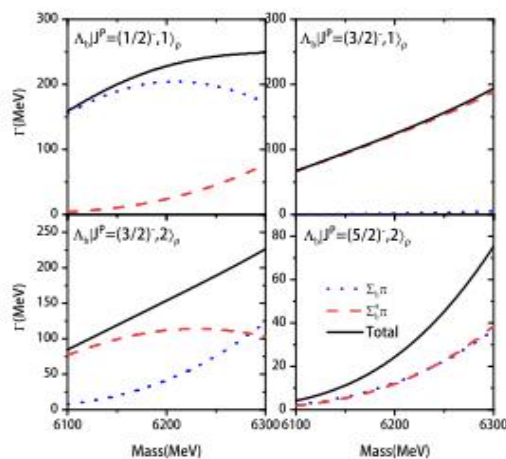
表 3-2 1P波 ρ 激发单重味重子质量 (取自不同夸克模型)

state	n_ρ	l_ρ	L	S_ρ	j	J^P	CQM	RQM	AQM	Mass Formula
$\Sigma_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$	2909	2840	2848	
$\Sigma_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$	2910	2865	2860	
$\Lambda_c |J^P = \frac{1}{2}^-, 0\rangle_\rho$	0	1	1	1	0	$\frac{1}{2}^-$	2890	2780	2816	
$\Lambda_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{3}{2}^-$	2933	2830	2816	
$\Lambda_c |J^P = \frac{5}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{5}{2}^-$	2917	2840	2830	
$\Lambda_c |J^P = \frac{1}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{1}{2}^-$	2956	2885	2830	
$\Lambda_c |J^P = \frac{3}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{3}{2}^-$	2960	2900	2872	
$\Xi_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$				3060
$\Xi_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$				3096
$\Xi_c |J^P = \frac{1}{2}^-, 0\rangle_\rho$	0	1	1	1	0	$\frac{1}{2}^-$				2951
$\Xi_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{3}{2}^-$				2980
$\Xi_c |J^P = \frac{5}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{5}{2}^-$				2987
$\Xi_c |J^P = \frac{1}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{1}{2}^-$				3016
$\Xi_c |J^P = \frac{3}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{3}{2}^-$				3076
$\Omega_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$	3110		3046	
$\Omega_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$	3112		3056	
$\Sigma_b |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$	6246	6170	6200	
$\Sigma_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$	6246	6180	6202	
$\Lambda_b |J^P = \frac{1}{2}^-, 0\rangle_\rho$	0	1	1	1	0	$\frac{1}{2}^-$	6236	6100	6180	
$\Lambda_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{3}{2}^-$	6273	6165	6206	
$\Lambda_b |J^P = \frac{5}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{5}{2}^-$	6273	6185	6211	
$\Lambda_b |J^P = \frac{1}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{1}{2}^-$	6285	6190	6191	
$\Lambda_b |J^P = \frac{3}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{3}{2}^-$	6289	6205	6206	
$\Xi_b' |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$		6305		6356
$\Xi_b' |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$		6308		6364
$\Xi_b |J^P = \frac{1}{2}^-, 0\rangle_\rho$	0	1	1	1	0	$\frac{1}{2}^-$				6214
$\Xi_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{3}{2}^-$				6226
$\Xi_b |J^P = \frac{5}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{5}{2}^-$				6222
$\Xi_b |J^P = \frac{1}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{1}{2}^-$				6234
$\Xi_b |J^P = \frac{3}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{3}{2}^-$				6247
$\Omega_b |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{1}{2}^-$	6437		6388	
$\Omega_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$	0	1	1	0	1	$\frac{3}{2}^-$	6438		6390	

1.1 1P波 ρ 激发 $\Lambda_c(b)$ 、 $\Xi_c(b)$ 重子的强衰变性质

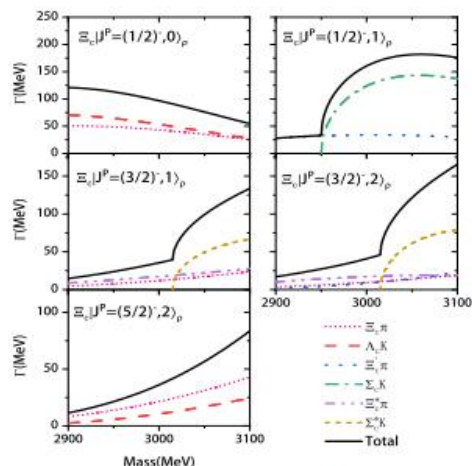


(a) 1P波 ρ 激发 Λ_c 重子

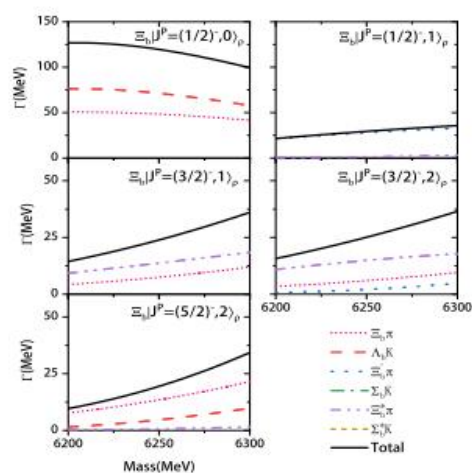


(b) 1P波 ρ 激发 Λ_b 重子

图 3-1 1P波 ρ 激发 $\Lambda_{c,b}$ 重子衰变宽度随质量变化图



(a) 1P波 ρ 激发 Ξ_c 重子



(b) 1P波 ρ 激发 Ξ_b 重子

图 3-2 1P波 ρ 激发 $\Xi_{c,b}$ 重子衰变宽度随质量变化图

表 3-3 1P波 ρ 激发 Ξ_c 和 Ξ_b 重子的强衰变性质

Decay width	$\Xi_c|J^P = \frac{1}{2}^-, 0\rangle_\rho$	$\Xi_c|J^P = \frac{1}{2}^-, 1\rangle_\rho$	$\Xi_c|J^P = \frac{3}{2}^-, 1\rangle_\rho$	$\Xi_c|J^P = \frac{3}{2}^-, 2\rangle_\rho$	$\Xi_c|J^P = \frac{5}{2}^-, 2\rangle_\rho$
	$M=2951$	$M=2980$	$M=2987$	$M=3016$	$M=3076$
$\Gamma[\Xi_c\pi]$	48.6	0.0	10.7	10.8	37.1
$\Gamma[\Lambda_c K]$	64.2	0.0	5.1	5.5	20.7
$\Gamma[\Xi_c^*\pi]$	0.0	33.5	0.3	10.2	5.5
$\Gamma[\Sigma_c K]$	0.0	102.9	0.0	1.9	2.9
$\Gamma[\Xi_c^* K]$	0.0	1.9	16.1	17.9	3.5
$\Gamma[\Sigma_c^* K]$	-	-	-	11.5	0.6
$\Gamma[\Xi_c(2790)\pi]$	0.0	0.0	0.0	0.0	0.1
$\Gamma[\Xi_c(2815)\pi]$	0.0	0.0	0.0	0.0	0.1
Γ_{Total}	112.8	138.3	32.2	57.8	70.5
Decay width	$\Xi_b|J^P = \frac{1}{2}^-, 0\rangle_\rho$	$\Xi_b|J^P = \frac{1}{2}^-, 1\rangle_\rho$	$\Xi_b|J^P = \frac{3}{2}^-, 1\rangle_\rho$	$\Xi_b|J^P = \frac{3}{2}^-, 2\rangle_\rho$	$\Xi_b|J^P = \frac{5}{2}^-, 2\rangle_\rho$
	$M = 6214$	$M = 6226$	$M = 6222$	$M = 6234$	$M = 6247$
$\Gamma[\Xi_b\pi]$	50.6	0.0	5.5	5.1	13.1
$\Gamma[\Lambda_b K]$	76.0	0.0	1.5	1.5	4.4
$\Gamma[\Xi_b^*\pi]$	0.0	25.0	0.1	1.5	0.6
$\Gamma[\Sigma_b K]$	0.0	0.0	0.0	0.0	0.0
$\Gamma[\Xi_b^* K]$	0.0	0.8	11.2	13.7	0.6
$\Gamma[\Sigma_b^* K]$	0.0	0.0	0.0	0.0	0.0
Γ_{Total}	126.6	25.8	18.3	21.9	18.7

表 3-4 $\Xi_b(6227)^-$ 作为 $\Xi_b|J^P = \frac{5}{2}^-, 2\rangle_\rho$ 的衰变宽度

Decay width	$\Xi_b|J^P = \frac{5}{2}^-, 2\rangle_\rho$
$\Gamma[\Xi_b\pi]$	10.7
$\Gamma[\Lambda_b K]$	3.0
$\Gamma[\Xi_b^*\pi]$	0.4
$\Gamma[\Xi_b^* K]$	0.4
Γ_{Total}	14.5
$\Gamma_{Expt.}$	19.9 ± 2.6

$\Lambda_c(2910)$

$$\Gamma_{Total} \approx 22 \text{ MeV}, \quad (18)$$

is close to the lower limit of the observed one $\Gamma_{Expt.} = 51.8 \pm 20.0 \pm 18.8 \text{ MeV}$. The branching fraction for the dominant decay channel $\Sigma_c\pi$ can reach up to

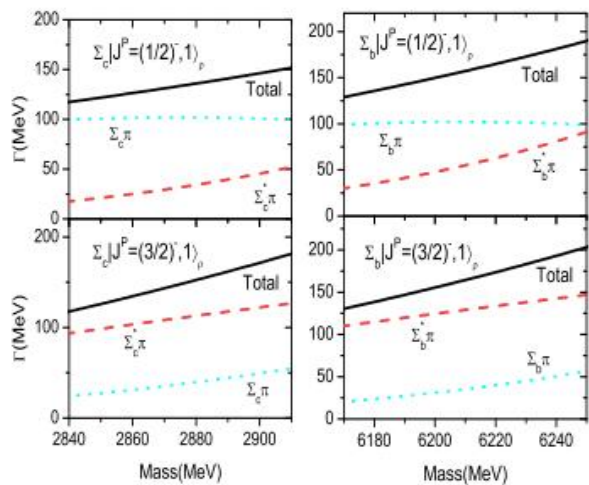
$$\frac{\Gamma[\Lambda_c|J^P = \frac{5}{2}^-, 2\rangle_\rho \rightarrow \Sigma_c\pi]}{\Gamma_{Total}} \sim 63\%. \quad (19)$$

1.2 1P波 ρ 激发 $\Sigma_c(b)$ 、 Ξ_c' (b)、 $\Omega_c(b)$ 重子的强衰变性质

表 3-5 1P波 ρ 激发 Σ_c 和 Σ_b 重子的强衰变性质

	$\Sigma_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$ (2909)		$\Sigma_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$ (2910)	
	Γ_i	$B_i(\%)$	Γ_i	$B_i(\%)$
$\Sigma_c \pi$	100	66	55	30
$\Sigma_c^* \pi$	51	34	127	70
Total	151		182	

	$\Sigma_b |J^P = \frac{1}{2}^-, 1\rangle_\rho$ (6246)		$\Sigma_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$ (6246)	
	Γ_i	$B_i(\%)$	Γ_i	$B_i(\%)$
$\Sigma_b \pi$	99	53	54	27
$\Sigma_b^* \pi$	87	47	145	73
Total	145		199	



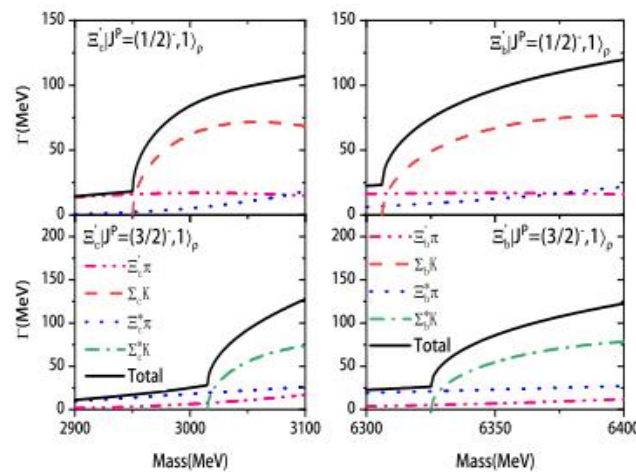
(a) 1P波 ρ 激发 Σ_c 重子 (b) 1P波 ρ 激发 Σ_b 重子

图 3-3 1P波 ρ 激发 Σ_c 和 Σ_b 重子衰变宽度随质量变化图

表 3-6 1P波 ρ 激发 Ξ_c' 和 Ξ_b' 重子的强衰变性质

States	Decay modes				
	$\Xi_c' \pi$	$\Xi_c'^* \pi$	$\Sigma_c K$	$\Sigma_c^* K$	Total
$\Xi_c' |J^P = \frac{1}{2}^-, 1\rangle_\rho$ (3060)	16.3	11.7	71.7	1.1	100.8
$\Xi_c' |J^P = \frac{3}{2}^-, 1\rangle_\rho$ (3096)	16.4	25.8	10.4	72.8	125.4

States	Decay modes				
	$\Xi_b' \pi$	$\Xi_b'^* \pi$	$\Sigma_b K$	$\Sigma_b^* K$	Total
$\Xi_b' |J^P = \frac{1}{2}^-, 1\rangle_\rho$ (6356)	16.9	13.4	69.6	0.6	100.4
$\Xi_b' |J^P = \frac{3}{2}^-, 1\rangle_\rho$ (6364)	8.3	24.3	1.5	65.1	99.1



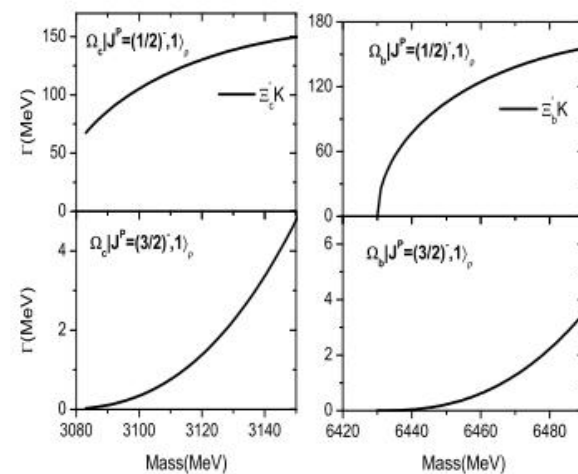
(a) 1P波 ρ 激发 Ξ_c' 重子 (b) 1P波 ρ 激发 Ξ_b' 重子

图 3-4 1P波 ρ 激发 Ξ_c' 和 Ξ_b' 重子衰变宽度随质量变化图

表 3-7 1P波 ρ 激发 Ω_c 和 Ω_b 重子的强衰变性质

States	$\Omega_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$	$\Omega_c |J^P = \frac{3}{2}^-, 1\rangle_\rho$
		$M = 3110$	$M = 3112$
$\Gamma[\Xi_c' K]$	119.4	0.9

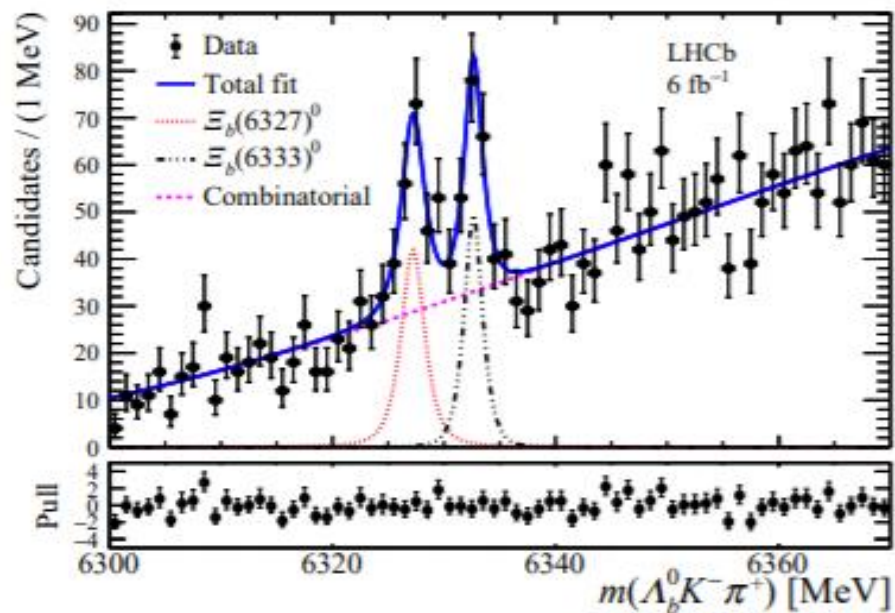
States	$\Omega_b |J^P = \frac{1}{2}^-, 1\rangle_\rho$	$\Omega_b |J^P = \frac{3}{2}^-, 1\rangle_\rho$
		$M = 6437$	$M = 6438$
$\Gamma[\Xi_b' K]$	65.2	0.02



(a) 1P波 ρ 激发 Ω_c 重子 (b) 1P波 ρ 激发 Ω_b 重子

图 3-5 1P波 ρ 激发 Ω_c 和 Ω_b 重子衰变宽度随质量变化图

2、1D波 Ξ_b 和 Ξ_b' 重子的强衰变性质



$$m(\Xi_b^0(6327)) = 6327.28_{-0.21}^{+0.23} \pm 0.08 \pm 0.24 \text{ MeV},$$

$$m(\Xi_b^0(6333)) = 6332.69_{-0.18}^{+0.17} \pm 0.03 \pm 0.22 \text{ MeV},$$

$$\Gamma(\Xi_b^0(6327)) < 2.2(2.56) \text{ MeV},$$

$$\Gamma(\Xi_b^0(6333)) < 1.55(1.85) \text{ MeV}.$$

表 4-1 1D波 Ξ_b 和 Ξ_b' 重子的质量

state	l_ρ	l_λ	L	S_ρ	j	J^P	RQM ^[94]	QM ^[28]	CQC ^[96]	CQM ^[8]	hCQM ^[97]
$\Xi_b |J^P = \frac{3}{2}^+, 2\rangle_\lambda$	0	2	2	0	2	$\frac{3}{2}^+$	6366	6311	6373	6359	...
$\Xi_b |J^P = \frac{5}{2}^+, 2\rangle_\lambda$	0	2	2	0	2	$\frac{5}{2}^+$	6373	6300	...	6365	...
$\Xi_b |J^P = \frac{3}{2}^+, 2\rangle_\rho$	2	0	2	0	2	$\frac{3}{2}^+$					
$\Xi_b |J^P = \frac{5}{2}^+, 2\rangle_\rho$	2	0	2	0	2	$\frac{5}{2}^+$					
$\Xi_b' |J^P = \frac{1}{2}^+, 1\rangle_\lambda$	0	2	2	1	1	$\frac{1}{2}^+$	6447	...	...	6420	6389
$\Xi_b' |J^P = \frac{3}{2}^+, 1\rangle_\lambda$	0	2	2	1	1	$\frac{3}{2}^+$	6459	...	...	6410	6371
$\Xi_b' |J^P = \frac{5}{2}^+, 2\rangle_\lambda$	0	2	2	1	2	$\frac{5}{2}^+$	6431	...	...	6412	6337
$\Xi_b' |J^P = \frac{5}{2}^+, 2\rangle_\lambda$	0	2	2	1	2	$\frac{5}{2}^+$	6432	6402	...	6403	6355
$\Xi_b' |J^P = \frac{5}{2}^+, 3\rangle_\lambda$	0	2	2	1	3	$\frac{5}{2}^+$	6420	...	...	6377	6361
$\Xi_b' |J^P = \frac{7}{2}^+, 3\rangle_\lambda$	0	2	2	1	3	$\frac{7}{2}^+$	6414	6405	...	6390	6341
$\Xi_b' |J^P = \frac{1}{2}^+, 1\rangle_\rho$	2	0	2	1	1	$\frac{1}{2}^+$					
$\Xi_b' |J^P = \frac{3}{2}^+, 1\rangle_\rho$	2	0	2	1	1	$\frac{3}{2}^+$					
$\Xi_b' |J^P = \frac{3}{2}^+, 2\rangle_\rho$	2	0	2	1	2	$\frac{3}{2}^+$					
$\Xi_b' |J^P = \frac{5}{2}^+, 2\rangle_\rho$	2	0	2	1	2	$\frac{5}{2}^+$					
$\Xi_b' |J^P = \frac{5}{2}^+, 3\rangle_\rho$	2	0	2	1	3	$\frac{5}{2}^+$					
$\Xi_b' |J^P = \frac{7}{2}^+, 3\rangle_\rho$	2	0	2	1	3	$\frac{7}{2}^+$					

基于LHCb最新观测到的两个窄的共振态，使用手征夸克模型在j-j耦合框架下系统地研究了 λ 激发和 ρ 激发模式的1D波 Ξ_b 和 Ξ_b' 重子的强衰变性质。

2.1 1D波 Ξ_b 重子的强衰变性质

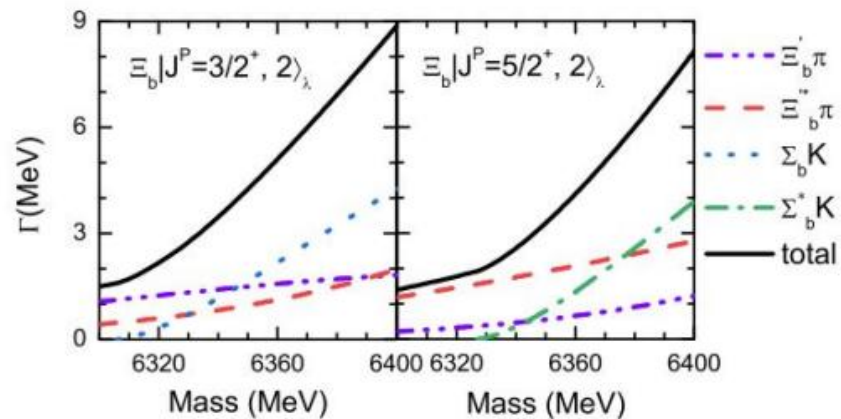


图 4-1 λ 激发 1D 波 Ξ_b 重子的强衰变性质

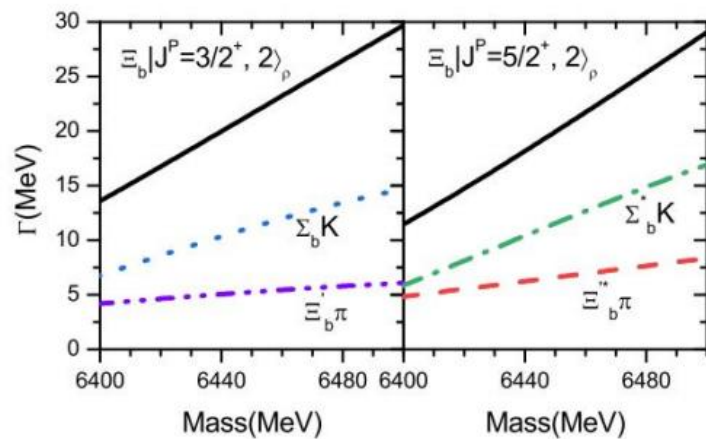


图 4-2 ρ 激发 1D 波 Ξ_b 重子的强衰变性质

表 4-2 $\Xi_b(6327)$ 和 $\Xi_b(6333)$ 作为 λ 激发的 1D 波 Ξ_b 重子的衰变宽度

Decay mode	$\Xi_b(6327)[J^P = \frac{3}{2}^+]$	$\Xi_b(6333)[J^P = \frac{5}{2}^+]$
$\Sigma_b K$	0.587	0.003
$\Sigma_b^* K$	0	0.112
$\Xi_b^* \pi$	1.305	0.409
$\Xi_b^{*'} \pi$	0.671	1.643
Total width	2.563	2.167
Expt.	<2.20(2.56)	<1.55(1.85)

倘若不考虑质量, ρ 激发 1D 波 Ξ_b 重子是 $\Xi_b(6327)$ 和 $\Xi_b(6333)$ 很好的候选者。

2.2 1D波 Ξ_b' 重子的强衰变性质



表 4-3 1D 波 Ξ_b' 重子的强衰变性质(包括 $\lambda\lambda$ 激发和 $\rho\rho$ 激发)

state	$|J^P = \frac{1}{2}^+, 1\rangle_{\lambda\lambda}$	$|J^P = \frac{3}{2}^+, 1\rangle_{\lambda\lambda}$	$|J^P = \frac{3}{2}^+, 2\rangle_{\lambda\lambda}$	$|J^P = \frac{5}{2}^+, 2\rangle_{\lambda\lambda}$	$|J^P = \frac{5}{2}^+, 3\rangle_{\lambda\lambda}$	$|J^P = \frac{7}{2}^+, 3\rangle_{\lambda\lambda}$
mass	6447	6459	6431	6432	6420	6414
$\Gamma[\Xi_b \pi]$	2.2	2.0	-	-	9.6	9.1
$\Gamma[\Xi_b' \pi]$	1.3	0.3	2.9	1.3	1.2	0.6
$\Gamma[\Xi_b^* \pi]$	0.6	1.6	2.3	4.1	2.1	0.6
$\Gamma[\Lambda_b K]$	2.4	2.1	-	-	5.8	5.4
$\Gamma[\Sigma_b K]$	4.1	1.1	8.4	0.5	0.4	0.2
$\Gamma[\Sigma_b^* K]$	1.8	4.9	1.8	6.8	0.8	0.1
$\Gamma[\Xi_b \eta]$	0.4	0.1	0.1	0.9	0.2	-
$\Gamma[\Lambda_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda K]$	32.3	0.2	1.1	2.6	0.1	-
$\Gamma[\Lambda_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda K]$	0.1	15.8	1.4	-	0.2	-
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda \pi]$	13.8	1.1	0.4	0.6	0.5	-
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda \pi]$	0.4	10.2	1.0	0.2	0.1	1.5
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 0\rangle_\lambda \pi]$	1.0	0.1	0.2	0.1	-	-
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda \pi]$	9.0	-	0.1	0.1	0.1	-
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda \pi]$	0.9	0.3	0.6	-	-	-
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 2\rangle_\lambda \pi]$	0.3	-	6.2	-	-	-
$\Gamma[\Xi_b |J^P = \frac{5}{2}^-, 2\rangle_\lambda \pi]$	0.6	0.2	0.1	1.3	-	-
$\Gamma[\text{total}]$	71.2	40.0	26.6	18.5	21.0	17.5

state	$|J^P = \frac{1}{2}^+, 1\rangle_{\rho\rho}$	$|J^P = \frac{3}{2}^+, 1\rangle_{\rho\rho}$	$|J^P = \frac{3}{2}^+, 2\rangle_{\rho\rho}$	$|J^P = \frac{5}{2}^+, 2\rangle_{\rho\rho}$	$|J^P = \frac{5}{2}^+, 3\rangle_{\rho\rho}$	$|J^P = \frac{7}{2}^+, 3\rangle_{\rho\rho}$
mass	6547	6559	6531	6532	6520	6514
$\Gamma[\Xi_b \pi]$	11.0	10.6	-	-	10.5	10.1
$\Gamma[\Xi_b' \pi]$	4.3	1.1	9.6	2.0	2.0	1.1
$\Gamma[\Xi_b^* \pi]$	2.1	5.4	4.8	11.4	5.3	2.7
$\Gamma[\Lambda_b K]$	7.6	7.2	-	-	6.7	6.5
$\Gamma[\Sigma_b K]$	11.1	2.8	24.2	1.8	1.7	0.9
$\Gamma[\Sigma_b^* K]$	4.4	13.8	7.2	21.1	5.3	2.0
$\Gamma[\Xi_b \eta]$	0.8	0.6	1.0	2.6	0.6	-
$\Gamma[\Xi_b' \eta]$	0.6	0.7	0.2	0.2	-	-
$\Gamma[\Xi_b^* \eta]$	0.1	0.8	0.4	0.2	0.1	-
$\Gamma[\Lambda_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda K]$	0.5	0.6	-	-	-	-
$\Gamma[\Lambda_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda K]$	0.9	1.9	0.1	-	-	-
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda \pi]$	0.5	0.5	-	-	0.1	0.1
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda \pi]$	0.8	1.9	0.1	-	0.1	0.1
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 0\rangle_\lambda \pi]$	-	-	-	-	-	-
$\Gamma[\Xi_b |J^P = \frac{1}{2}^-, 1\rangle_\lambda \pi]$	-	0.1	-	-	-	-
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 1\rangle_\lambda \pi]$	-	-	-	-	-	-
$\Gamma[\Xi_b |J^P = \frac{3}{2}^-, 2\rangle_\lambda \pi]$	0.1	0.2	-	-	-	-
$\Gamma[\Xi_b |J^P = \frac{5}{2}^-, 2\rangle_\lambda \pi]$	-	-	-	0.1	-	-
$\Gamma[\text{total}]$	44.8	48.2	47.6	39.4	32.4	23.5

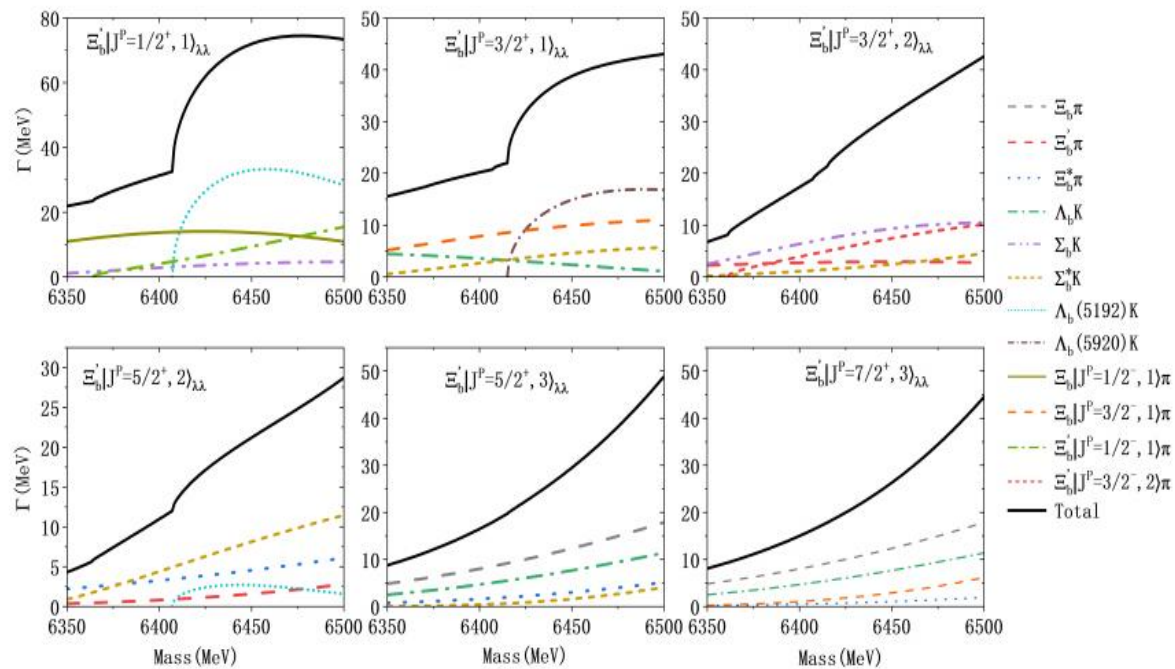


图 4-3 λ 激发 $1D$ 波 Ξ'_b 重子的强衰变性质

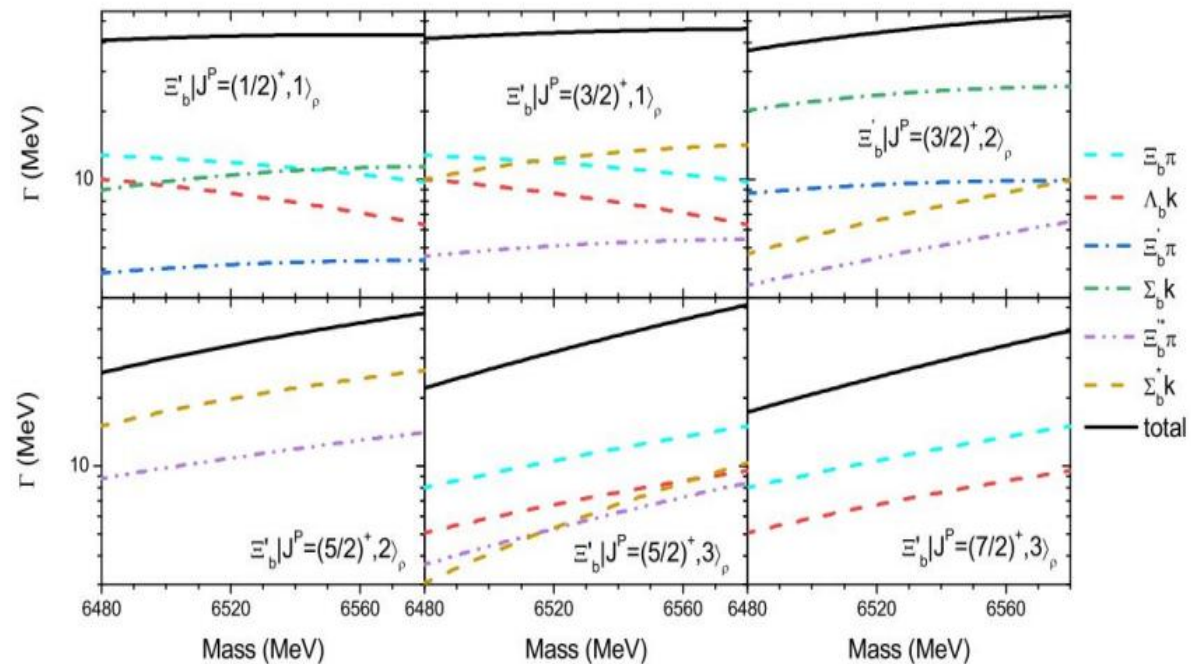


图 4-4 ρ 激发 $1D$ 波 Ξ'_b 重子的强衰变性质

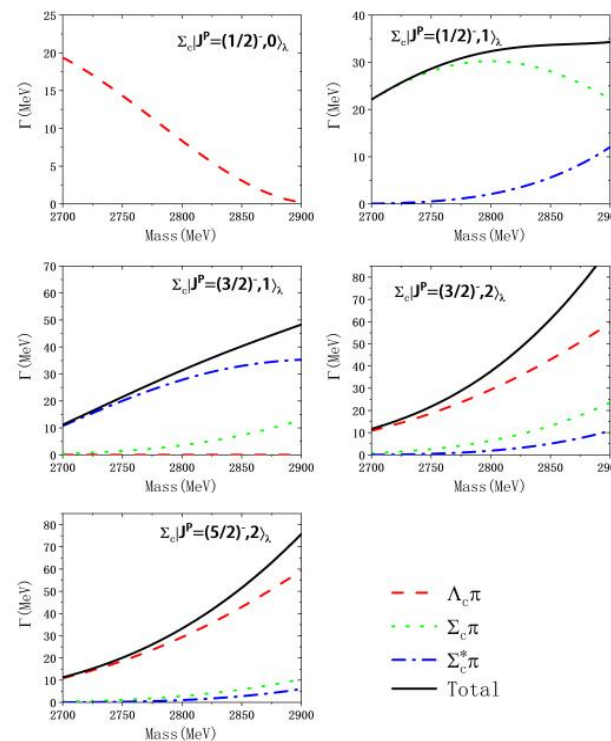
3、1P、1D波 Σ_c 重子的强衰变性质

表 5-1 1P和1D波 Σ_c 重子的质量

Notation	Quantum Number						Mass					
	l_λ	l_ρ	L	s_ρ	j	J^P	GIM ^[103]	RQM ^[94]	RQM ^[8]	NQM ^[23]	NQM ^[7]	QCD ^[22]
$\Sigma_c |J^P = \frac{1}{2}^-, 0\rangle_\lambda$	1	0	1	1	0	$\frac{1}{2}^-$	2823	2799	2805	2702	2802	2820
$\Sigma_c |J^P = \frac{1}{2}^-, 1\rangle_\lambda$	1	0	1	1	1	$\frac{1}{2}^-$	2809	2713	2795	2765	2826	2790
$\Sigma_c |J^P = \frac{3}{2}^-, 1\rangle_\lambda$	1	0	1	1	1	$\frac{3}{2}^-$	2829	2798	2799	2785	2807	2820
$\Sigma_c |J^P = \frac{3}{2}^-, 2\rangle_\lambda$	1	0	1	1	1	$\frac{3}{2}^-$	2802	2773	2761	2798	2837	2800
$\Sigma_c |J^P = \frac{5}{2}^-, 2\rangle_\lambda$	1	0	1	1	2	$\frac{5}{2}^-$	2835	2789	2790	2790	2839	2890
$\Sigma_c |J^P = \frac{1}{2}^-, 1\rangle_\rho$	0	1	1	1	1	$\frac{1}{2}^-$						2909
$\Sigma_c |J^P = \frac{3}{2}^-, 2\rangle_\rho$	0	1	1	1	2	$\frac{3}{2}^-$						2910
$\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda\lambda}$	2	0	2	1	1	$\frac{1}{2}^+$	3073	3041	3014	2949	3103	
$\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda\lambda}$	2	0	2	1	1	$\frac{3}{2}^+$	3084	3043	3005	2952	3065	
$\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\lambda\lambda}$	2	0	2	1	2	$\frac{3}{2}^+$	3073	3040	3010	2964	3094	
$\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\lambda\lambda}$	2	0	2	1	2	$\frac{5}{2}^+$	3085	3038	3001	2942	3099	
$\Sigma_c |J^P = \frac{5}{2}^+, 3\rangle_{\lambda\lambda}$	2	0	2	1	3	$\frac{5}{2}^+$	3072	3023	2960	2962	3114	
$\Sigma_c |J^P = \frac{7}{2}^+, 3\rangle_{\lambda\lambda}$	2	0	2	1	3	$\frac{7}{2}^+$	3086	3013	3015	2943		
$\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\rho\rho}$	0	2	2	1	1	$\frac{1}{2}^+$						
$\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\rho\rho}$	0	2	2	1	1	$\frac{3}{2}^+$						
$\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\rho\rho}$	0	2	2	1	2	$\frac{3}{2}^+$						
$\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\rho\rho}$	0	2	2	1	2	$\frac{5}{2}^+$						
$\Sigma_c |J^P = \frac{5}{2}^+, 3\rangle_{\rho\rho}$	0	2	2	1	3	$\frac{5}{2}^+$						
$\Sigma_c |J^P = \frac{7}{2}^+, 3\rangle_{\rho\rho}$	0	2	2	1	3	$\frac{7}{2}^+$						

表 5-2 λ 激发 1P 波 Σ_c 重子的强衰变性质

Decay width	$\Sigma_c |J^P = \frac{1}{2}^-, 0\rangle_\lambda$	$\Sigma_c |J^P = \frac{1}{2}^-, 1\rangle_\lambda$	$\Sigma_c |J^P = \frac{3}{2}^-, 1\rangle_\lambda$	$\Sigma_c |J^P = \frac{3}{2}^-, 2\rangle_\lambda$	$\Sigma_c |J^P = \frac{5}{2}^-, 2\rangle_\lambda$
	$M=2823$	$M=2809$	$M=2829$	$M=2802$	$M=2835$
$\Gamma[\Sigma_c \pi]$	...	30.2	5.5	6.6	4.8
$\Gamma[\Lambda_c \pi]$	5.7	...	...	29.8	38.6
$\Gamma[\Sigma_c^* \pi]$		0.5	31.2	2.0	2.1
Γ_{Total}	5.7	30.7	36.7	38.4	45.5



与实验在 $\Lambda_c \pi$ 不变质量谱上观测到的 $\Sigma_c(2800)$ 性质一致

图 5-1 λ 激发 1P 波 Σ_c 重子的强衰变性质



表 5-3 1D波 Σ_c 重子的强衰变性质(包括 $\lambda\lambda$ 激发和 $\rho\rho$ 激发)

Decay width	$\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda\lambda}$	$\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda\lambda}$	$\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\lambda\lambda}$	$\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\lambda\lambda}$	$\Sigma_c |J^P = \frac{5}{2}^+, 3\rangle_{\lambda\lambda}$	$\Sigma_c |J^P = \frac{7}{2}^+, 3\rangle_{\lambda\lambda}$
	M=3041	M=3043	M=3040	M=3038	M=3023	M=3013
$\Gamma[\Sigma_c \pi]$	3.5	0.9	7.9	4.8	4.7	2.4
$\Gamma[\Lambda_c \pi]$	2.3	2.2	...	...	15.5	14.5
$\Gamma[\Sigma_c^* \pi]$	1.7	4.3	6.0	10.8	5.2	1.5
$\Gamma[\Xi_c K]$	3.4	3.6	...	...	...	...
$\Gamma[\Lambda_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda} \pi]$	13.8	8.1	0.2	...	2.2	...
$\Gamma[\Lambda_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda} \pi]$	1.4	10.8	0.2	1.9	1.2	8.0
$\Gamma[\Sigma_c |J^P = \frac{1}{2}^+, 0\rangle_{\lambda} \pi]$	0.3	0.4	1.3	0.5	0.2	...
$\Gamma[\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda} \pi]$	24.9	0.5	4.3	0.1	3.9	...
$\Gamma[\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda} \pi]$	3.4	0.6	2.9	0.1	...	0.1
$\Gamma[\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\lambda} \pi]$	1.5	0.3	22.9	...	0.3	0.2
$\Gamma[\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\lambda} \pi]$	0.9	1.3	0.9	7.6	0.8	0.4
Γ_{Total}	57.0	33.0	34.6	25.8	34.0	27.1
Decay width	$\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\rho\rho}$	$\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\rho\rho}$	$\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\rho\rho}$	$\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\rho\rho}$	$\Sigma_c |J^P = \frac{5}{2}^+, 3\rangle_{\rho\rho}$	$\Sigma_c |J^P = \frac{7}{2}^+, 3\rangle_{\rho\rho}$
	M=3141	M=3143	M=3140	M=3138	M=3123	M=3113
$\Gamma[\Sigma_c \pi]$	14.1	3.5	31.7	10.2	10.4	5.4
$\Gamma[\Lambda_c \pi]$	14.3	14.2	...	...	24.3	23.1
$\Gamma[\Sigma_c^* \pi]$	6.9	17.3	17.3	39.4	18.8	9.3
$\Gamma[\Xi_c K]$	19.6	19.9	...	...	0.6	0.5
$\Gamma[\Xi_c' K]$	2.1	0.5	4.6	...	...	...
$\Gamma[\Lambda_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda} \pi]$	1.1	1.5	...	...	0.6	0.5
$\Gamma[\Lambda_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda} \pi]$	1.9	2.4	...	...	0.8	0.6
$\Gamma[\Sigma_c |J^P = \frac{1}{2}^+, 0\rangle_{\lambda} \pi]$	0.2	0.1	0.1	0.1	...	...
$\Gamma[\Sigma_c |J^P = \frac{1}{2}^+, 1\rangle_{\lambda} \pi]$	0.1	0.1	0.2	...	0.1	...
$\Gamma[\Sigma_c |J^P = \frac{3}{2}^+, 1\rangle_{\lambda} \pi]$	0.2	...	...	0.1	...	...
$\Gamma[\Sigma_c |J^P = \frac{3}{2}^+, 2\rangle_{\lambda} \pi]$	0.4	0.5	0.1	...	...	...
$\Gamma[\Sigma_c |J^P = \frac{5}{2}^+, 2\rangle_{\lambda} \pi]$	0.1	...	0.1	0.5	...	...
Γ_{Total}	61.0	60.0	54.1	50.3	55.6	39.4



1P波 ρ 激发单重味重子的强衰变性质

Wen-Jia Wang, Li-Ye Xiao, and Xian-Hui Zhong
Phys. Rev. D 106, 074020 (2022)



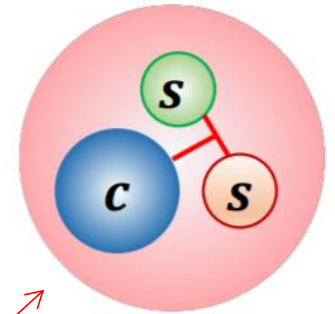
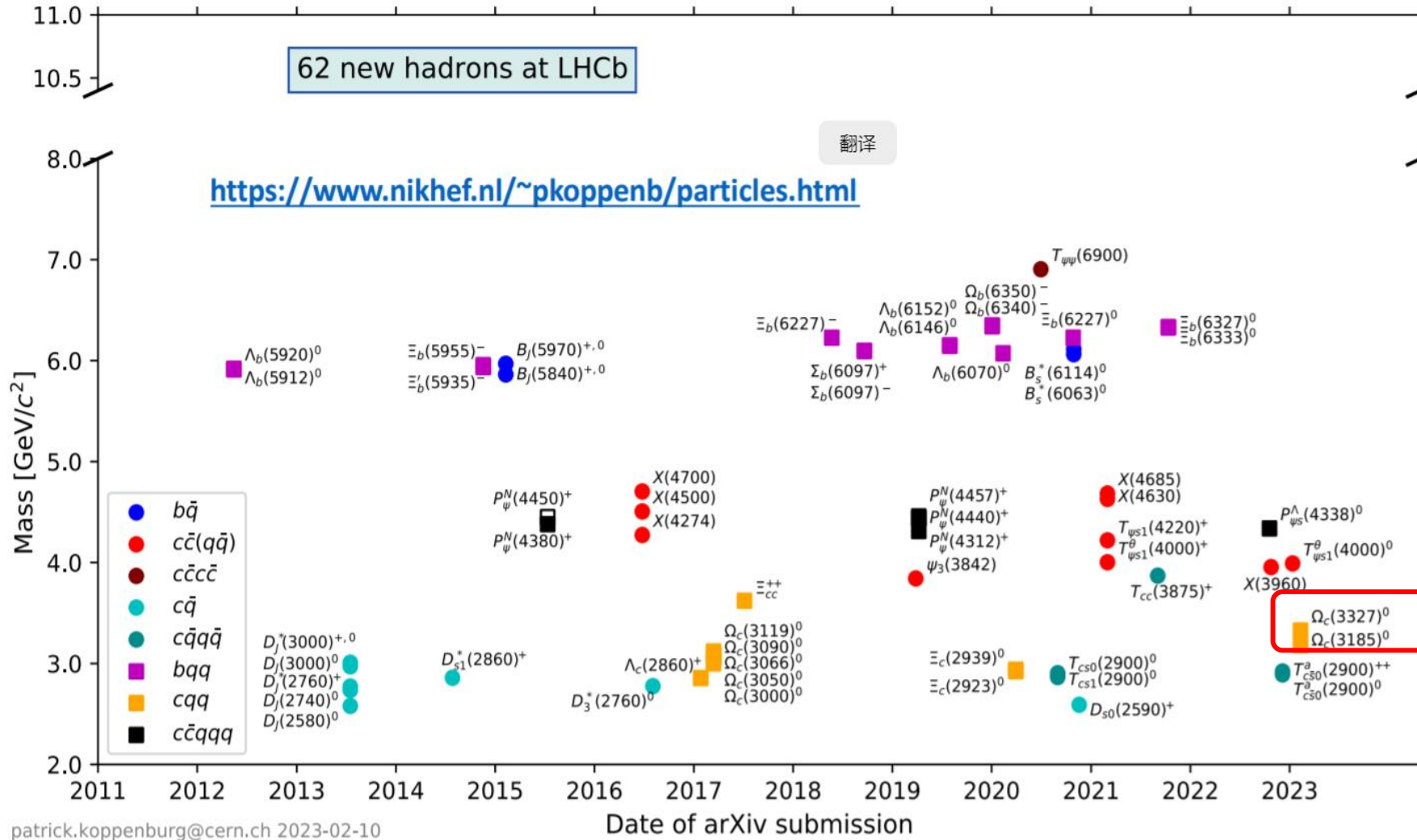
1D波 Ξ_b 和 Ξ_b' 重子的强衰变性质

Wen-Jia Wang, Yu-Hui Zhou, Li-Ye Xiao, and Xian-Hui Zhong
Phys. Rev. D 105, 074008 (2022)



1P、1D波 Σ_c 重子的强衰变性质

Yu-Hui Zhou, Wen-Jia Wang, Li-Ye Xiao, and Xian-Hui Zhong
Phys. Rev. D 108, 014019 (2023)



- New “Exotic hadron naming convention” proposed by LHCb arXiv: 2206.15233

北京科技大学

University of Science and Technology Beijing



北京科技大学

University of Science and Technology Beijing

谢谢观看!

汇报人：王文佳

中高能核物理暑期学校