Based on arXiv:2208.14858

Predictions on the molecular states Ω_{cc}, Ω_{bb} and Ω_{bc}

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Outline

- Motivation for Ω_{cc}, Ω_{bb} and Ω_{bc}
- Formalism
- Results and discussions
- Summary

Motivation for Ω_{cc}, Ω_{bb} and Ω_{bc}

1) The discovery of new states with heavy quarks and the search for doubly heavy baryons on experimental side

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Hidden charm pentaquarks P_c and P_{cs} from LHCb:
PRL 115, 072001 (2015); PRL 122, 222001 (2019);
PRL 128, 062001 (2022); Sci.Bull.66, 1278 (2021)

Doubly charmed tetraquark T_{cc} from LHCb
Nat.Phys. 18, 751(2022)

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Five narrow excited Ω_c states from LHCb:
$\Omega_c(3000), \Omega_c(3050), \Omega_c(3066), \Omega_c(3090), \Omega_c(3119)$
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$\Omega_c(3050)^0$	Significance	9.9σ
	ΔM	$88.5 \pm 0.3 \pm 0.2$ MeV
	m	$3050.1 \pm 0.3 \pm 0.2^{+0.19}_{-0.22}$ MeV
	Γ	< 1.6 MeV, 95% CL
	$\mathcal{P}$	$0.15 \pm 0.02 \pm 0.02$
$\Omega_c(3090)^0$	Significance	7.8σ
	ΔM	$129.4 \pm 1.1 \pm 1.0$ MeV
	m	$3091.0 \pm 1.1 \pm 1.0^{+0.19}_{-0.22}$ MeV
	Γ	$7.4 \pm 3.1 \pm 2.8$ MeV
	$\mathcal{P}$	$0.19 \pm 0.02 \pm 0.04$

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PHYSICAL REVIEW D **97,** 094035 (2018)

Molecular Ω_c states generated from coupled meson-baryon channels

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[3]*Department of Physics, Guangxi Normal University, Guilin 541004, China*

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We have investigated Ω_c states that are dynamically generated from the meson-baryon interaction. We use an extension of the local hidden gauge to obtain the interaction from the exchange of vector mesons

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MOLECULAR Ω_c STATES GENERATED FROM … PHYS. REV. D **97,** 094035 (2018)

TABLE VI. The coupling constants to various channels for the poles in the $J^P = 1/2^-$ sector, with $q_{\max} = 650$ MeV, and $g_i G_i^{II}$ in MeV.

$\Omega_c(3050)$

$3054.05 + i0.44$	$\Xi_c\bar{K}$	$\Xi_c'\bar{K}$	ΞD	$\Omega_c\eta$	ΞD^*	$\Xi_c\bar{K}^*$	$\Xi_c'\bar{K}^*$
g_i	$-0.06 + i0.14$	$1.94 + i0.01$	$-2.14 + i0.26$	$1.98 + i0.01$	0	0	0
$g_i G_i^{II}$	$-1.40 - i3.85$	$-34.41 - i0.30$	$9.33 - i1.10$	$-16.81 - i0.11$	0	0	0

$\Omega_c(3090)$

$3091.28 + i5.12$	$\Xi_c\bar{K}$	$\Xi_c'\bar{K}$	ΞD	$\Omega_c\eta$	ΞD^*	$\Xi_c\bar{K}^*$	$\Xi_c'\bar{K}^*$
g_i	$0.18 - i0.37$	$0.31 + i0.25$	$5.83 - i0.20$	$0.38 + i0.23$	0	0	0
$g_i G_i^{II}$	$5.05 + i10.19$	$-9.97 - i3.67$	$-29.82 + i0.31$	$-3.59 - i2.23$	0	0	0

only show the results with the pseudoscalar-baryon inter- choose the same cutoff as in the $J^P = 1/2^-$ sector we find a

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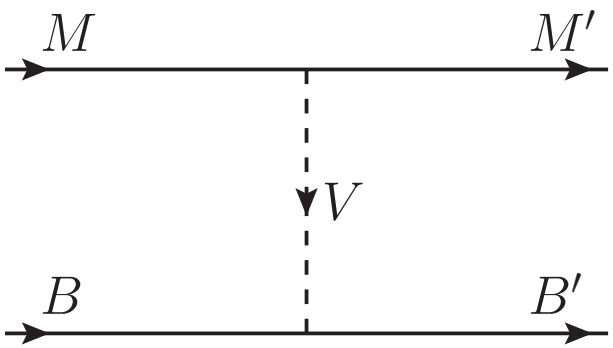
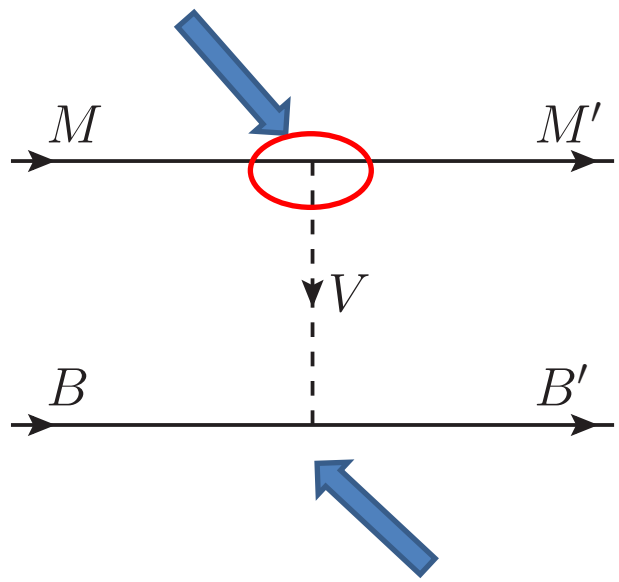
$$\Omega_c \Longrightarrow \Omega_{cc}, \Omega_{bb}, \Omega_{bc}$$

Vector exchange from the extension to the heavy quark sector of the local hidden gauge approach



Vector exchange from the extension to the heavy quark sector of the local hidden gauge approach

$$\mathcal{L}_{\rm VPP} = -ig\,\langle [P, \partial_\mu P]\, V^\mu \rangle\,,$$
$$\mathcal{L}_{\rm VVV} = ig\,\langle (V^\mu \partial_\nu V_\mu - \partial_\nu V^\mu V_\mu)\, V^\nu \rangle\,.$$



$$\widetilde{\mathcal{L}}_{\rm VBB} \equiv g q \bar{q}(V),$$

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$g = \frac{m_V}{2 f_\pi}$ with $m_V = 800$ MeV

Formalism

Vector exchange from the extension to the heavy quark sector of the local hidden gauge approach

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$$\mathcal{L}_{\rm VVV} = ig\,\langle (V^\mu \partial_\nu V_\mu - \partial_\nu V^\mu V_\mu)\, V^\nu \rangle\,.$$

$$P = \begin{pmatrix} \frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{3}}\eta + \frac{1}{\sqrt{6}}\eta' & \pi^+ & K^+ & \bar{D}^0 \\ \pi^- & -\frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{3}}\eta + \frac{1}{\sqrt{6}}\eta' & K^0 & D^- \\ K^- & \bar{K}^0 & -\frac{1}{\sqrt{3}}\eta + \sqrt{\frac{2}{3}}\eta' & D_s^- \\ D^0 & D^+ & D_s^+ & \eta_c \end{pmatrix},$$

$$V = \begin{pmatrix} \frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & \rho^+ & K^{*+} & \bar{D}^{*0} \\ \rho^- & -\frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & K^{*0} & \bar{D}^{*-} \\ K^{*-} & \bar{K}^{*0} & \phi & D_s^{*-} \\ D^{*0} & D^{*+} & D_s^{*+} & J/\psi \end{pmatrix},$$

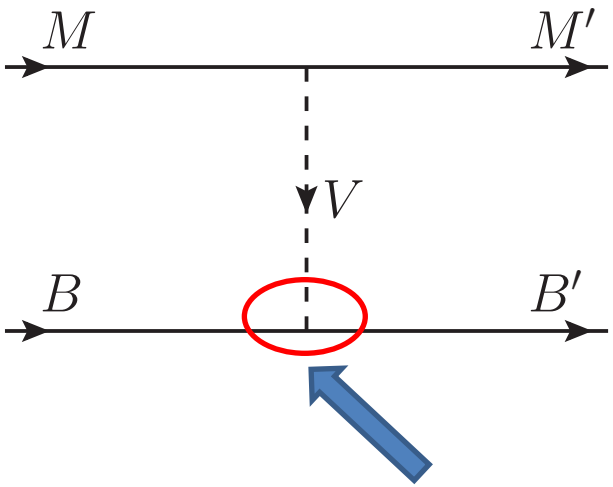
For charm sector

$$P = \begin{pmatrix} \frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{3}}\eta + \frac{1}{\sqrt{6}}\eta' & \pi^+ & K^+ & B^+ \\ \pi^- & -\frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{3}}\eta + \frac{1}{\sqrt{6}}\eta' & K^0 & B^0 \\ K^- & \bar{K}^0 & -\frac{1}{\sqrt{3}}\eta + \sqrt{\frac{2}{3}}\eta' & B_s^0 \\ B^- & \bar{B}^0 & \bar{B}_s^0 & \eta_b \end{pmatrix},$$

$$V = \begin{pmatrix} \frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & \rho^+ & K^{*+} & B^{*+} \\ \rho^- & -\frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & K^{*0} & B^{*0} \\ K^{*-} & \bar{K}^{*0} & \phi & B_s^{*0} \\ B^{*-} & \bar{B}^{*0} & \bar{B}_s^{*0} & \Upsilon \end{pmatrix},$$

For bottom sector

Formalism



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$\widetilde{\mathcal{L}}_{\mathrm{VBB}} \equiv g q\bar{q}(V),$

$q\bar{q}$ is the vector wave function in terms of quarks

$$\widetilde{\mathcal{L}}_{VBB} \equiv g \begin{cases} \frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d}), & \rho^0 \\ \frac{1}{\sqrt{2}}(u\bar{u} + d\bar{d}), & \omega \\ s\bar{s}, & \phi \end{cases}$$

Formalism

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State	I, J	flavor	spin
Ξ_{cc}^{++}	$1/2, 1/2$	ccu	$\chi_{MS}(12)$
Ξ_{cc}^{+}	$1/2, 1/2$	ccd	$\chi_{MS}(12)$
Ω_{cc}^{+}	$0, 1/2$	ccs	$\chi_{MS}(12)$
Ξ_{c}^{+}	$1/2, 1/2$	$\frac{1}{\sqrt{2}}c(us - su)$	$\chi_{MA}(23)$
Ξ_{c}^{0}	$1/2, 1/2$	$\frac{1}{\sqrt{2}}c(ds - sd)$	$\chi_{MA}(23)$
$\Xi_{c}^{'+}$	$1/2, 1/2$	$\frac{1}{\sqrt{2}}c(us + su)$	$\chi_{MS}(23)$
$\Xi_{c}^{'0}$	$1/2, 1/2$	$\frac{1}{\sqrt{2}}c(ds + sd)$	$\chi_{MS}(23)$
Ω_{c}^{0}	$0, 1/2$	css	$\chi_{MS}(23)$

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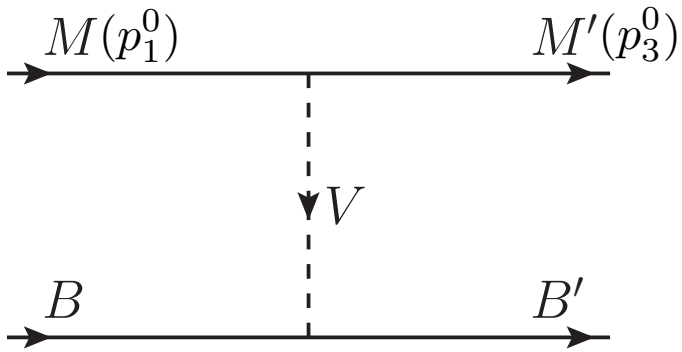
Ξ_{cc}^{+}	$1/2, 1/2$	ccd	$\chi_{MS}(12)$
Ω_{cc}^{+}	$0, 1/2$	ccs	$\chi_{MS}(12)$
Ξ_{c}^{+}	[illegible]	[illegible]	$\chi_{MA}(23)$
Ξ_{c}^{0}	[illegible]	[illegible]	$\chi_{MA}(23)$
$\Xi_{c}^{\prime +}$	[illegible]	[illegible]	$\chi_{MS}(23)$
$\Xi_{c}^{\prime 0}$	[illegible]	[illegible]	$\chi_{MS}(23)$
Ω_{c}^{0}	[illegible]	[illegible]	$\chi_{MS}(23)$

$$\chi_{MS}(12) = \frac{1}{\sqrt{6}}(\uparrow\downarrow\uparrow + \downarrow\uparrow\uparrow - 2\uparrow\uparrow\downarrow)$$

$$\chi_{MS}(23) = \frac{1}{\sqrt{6}}(\uparrow\downarrow\uparrow + \uparrow\uparrow\downarrow - 2\downarrow\uparrow\uparrow)$$

$$\chi_{MA}(23) = \frac{1}{\sqrt{2}}(\uparrow\uparrow\downarrow - \uparrow\downarrow\uparrow).$$

Vector exchange from the extension to the heavy quark sector of the local hidden gauge approach



$$V_{ij} = -\frac{1}{4f_\pi^2}(p_1^0 + p_3^0)C_{ij} \ ,$$

Formalism

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TABLE V: Coefficients C_{ij} for the PB sector with $J^P = \frac{1}{2}^-$.

	$\Xi_{cc}\bar{K}$	$\Omega_{cc}\eta$	$\Xi_c D$	$\Xi_c' D$
$\Xi_{cc}\bar{K}$	2	$\frac{2\sqrt{2}}{\sqrt{3}}$	$\frac{-\sqrt{3}}{2\sqrt{2}}\lambda$	$\frac{1}{2\sqrt{2}}\lambda$
$\Omega_{cc}\eta$		0	$-\frac{1}{2}\lambda$	$\frac{-1}{2\sqrt{3}}\lambda$
$\Xi_c D$			2	0
$\Xi_c' D$				2

Ω_{cc}

$\boldsymbol{\lambda \approx 0.25}$

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$\lambda_b \approx m_V^2/m_{B^*}^2$

negligible

TABLE VI: Coefficients C_{ij} for the VB sector with $J^P = \frac{1}{2}^-, \frac{3}{2}^-$.

	$\Xi_c D^*$	$\Omega_{cc}\omega$	$\Xi_{cc}\bar{K}^*$	$\Xi_c' D^*$
$\Xi_c D^*$	2	$\frac{-\sqrt{3}}{2\sqrt{2}}\lambda$	$\frac{-\sqrt{3}}{2\sqrt{2}}\lambda$	0
$\Omega_{cc}\omega$		0	1	$\frac{-1}{2\sqrt{2}}\lambda$
$\Xi_{cc}\bar{K}^*$			2	$\frac{1}{2\sqrt{2}}\lambda$
$\Xi_c' D^*$				2

Formalism

$$V_{ij} = -\frac{1}{4f_\pi^2}(p_1^0 + p_3^0)C_{ij} \ ,$$

$$\Downarrow$$

BS equation

$$T = [1 - VG]^{-1}V$$

Formalism

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$$\Downarrow$$

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$$\Uparrow$$

G is the diagonal loop function for the meson baryon intermediate state

Formalism

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G is the diagonal loop function for the meson baryon intermediate state

$$G_j^{II} = G_j^I + i\frac{2M_j\, q}{4\pi\sqrt{s}} \ , \qquad \mathrm{Re}\sqrt{s} > m_j + M_j$$

$$q = \frac{\lambda^{1/2}(s, m_j^2, M_j^2)}{2\sqrt{s}} \ ,$$

Formalism

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G is the diagonal loop function for the meson baryon intermediate state

$$T_{ij} = \frac{g_i g_j}{\sqrt{s} - z_R} \qquad Z_R : \ (M, i\Gamma/2)$$

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$$\Searrow \qquad \Swarrow$$

$$g_i G_i^{II}$$

Results and discussions

Ω_{cc}

$J^P = \frac{1}{2}^-$ sector from $PB(\frac{1}{2}^+)$

Poles		$\Xi_{cc}\bar{K}$	$\Omega_{cc}\eta$	$\Xi_c D$	$\Xi_c' D$
4069.86	g_i	**2.63**	1.55	-1.10	0.26
	$g_i G_i^{II}$	**-40.42**	-13.26	3.59	-0.65
$4205.22 + i0.94$	g_i	$0.10 + i0.20$	$0.04 + i0.09$	**$6.25 - i0.04$**	$0.09 + i0.01$
	$g_i G_i^{II}$	$-5.86 - i1.84$	$-0.57 - i1.32$	**$-31.79 + i0.06$**	$-0.30 - i0.05$
$4310.76 + i0.28$	g_i	$0.02 + i0.01$	$-0.13 - i0.04$	$-0.02 + i0.00$	**$6.35 + i0.00$**
	$g_i G_i^{II}$	$-0.45 + i0.64$	$3.47 - i0.96$	$0.23 - i0.01$	**$-31.95 - i0.05$**

Note: We write in bold face for the most important channel.

$J^P = \frac{1}{2}^-, \frac{3}{2}^-$ sector from $VB(\frac{1}{2}^+)$

Poles		$\Xi_c D^*$	$\Omega_{cc}\omega$	$\Xi_{cc}\bar{K}^*$	$\Xi_c' D^*$
4332.86	g_i	**6.51**	-0.70	-1.35	-0.07
	$g_i G_i^{II}$	**-29.78**	5.66	9.74	0.23
4405.47	g_i	1.27	1.41	**3.81**	0.83
	$g_i G_i^{II}$	-8.44	-15.17	**-35.89**	-3.33
4446.29	g_i	-0.08	-0.32	-0.24	**6.58**
	$g_i G_i^{II}$	0.73	4.34	2.81	**-30.80**

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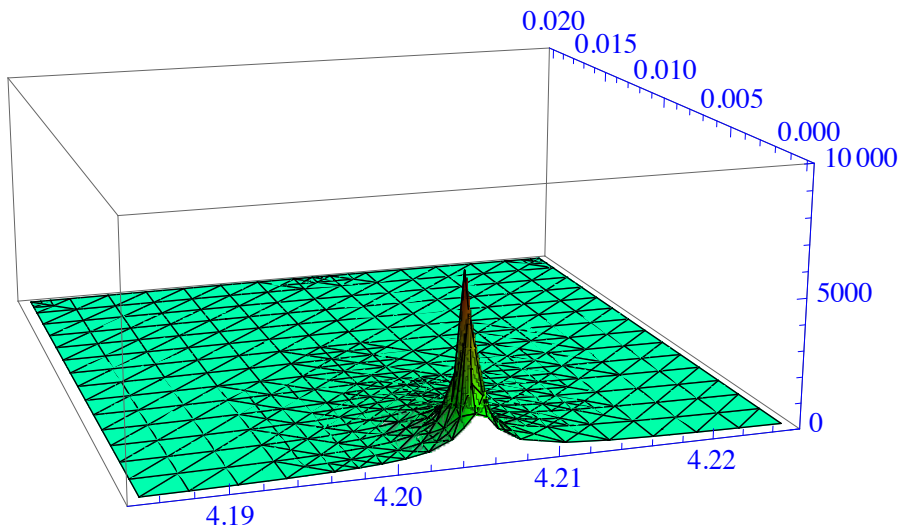

$\Xi_{cc}\bar{K}$	$\Omega_{cc}\eta$	$\Xi_c D$	$\Xi_c' D$
4115	4263	4338	4448

Results and discussions

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PDG $m_s \approx 100$ MeV, $m_c \approx 1270$ MeV

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Ω_c

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$4205.22 + i0.94$	g_i	$0.10 + i0.20$	$0.04 + i0.09$	**$6.25 - i0.04$**	$0.09 + i0.01$
	$g_i G_i^{II}$	$-5.86 - i1.84$	$-0.57 - i1.32$	**$-31.79 + i0.06$**	$-0.30 - i0.05$
$4310.76 + i0.28$	g_i	$0.02 + i0.01$	$-0.13 - i0.04$	$-0.02 + i0.00$	**$6.35 + i0.00$**
	$g_i G_i^{II}$	$-0.45 + i0.64$	$3.47 - i0.96$	$0.23 + i0.01$	**$-31.95 - i0.05$**

PDG $m_s \approx 100$ MeV, $m_c \approx 1270$ MeV

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Ω_c

$3054.05 + i0.44$	$\Xi_c\bar{K}$	$\Xi'_c\bar{K}$	ΞD	$\Omega_c\eta$
g_i	$-0.06 + i0.14$	$1.94 + i0.01$	$-2.14 + i0.26$	$1.98 + i0.01$
$g_i G_i^{II}$	$-1.40 - i3.85$	$-34.41 - i0.30$	$9.33 - i1.10$	$-16.81 - i0.11$

$3091.28 + i5.12$	$\Xi_c\bar{K}$	$\Xi'_c\bar{K}$	ΞD	$\Omega_c\eta$
g_i	$0.18 - i0.37$	$0.31 + i0.25$	$5.83 - i0.20$	$0.38 + i0.23$
$g_i G_i^{II}$	$5.05 + i10.19$	$-9.97 - i3.67$	$-29.82 + i0.31$	$-3.59 - i2.23$

Results and discussions

Ω_{cc}

$J^P = \frac{3}{2}^-$ sector from $PB(\frac{3}{2}^+)$

Poles		$\Xi_{cc}^*\bar{K}$	$\Omega_{cc}^*\eta$	Ξ_c^*D
4123.85	g_i	**2.62**	1.55	0.84
	$g_iG_i^{II}$	**−40.61**	−13.14	−2.09
$4380.36 + i0.73$	g_i	$-0.01 - i0.15$	$0.02 - i0.05$	$\mathbf{6.28 - i0.03}$
	$g_iG_i^{II}$	$4.71 + i0.76$	$0.41 + i1.37$	$\mathbf{-31.94 + i0.05}$

$J^P = \frac{1}{2}^-, \frac{3}{2}^-, \frac{5}{2}^-$ sector from $VB(\frac{3}{2}^+)$

Poles		$\Omega_{cc}^*\omega$	$\Xi_{cc}^*\bar{K}^*$	$\Xi_c^*D^*$
4446.59	g_i	1.59	**3.93**	2.64
	$g_iG_i^{II}$	−16.03	**−35.31**	−9.69
4520.38	g_i	−0.18	−0.94	**6.10**
	$g_iG_i^{II}$	2.78	12.44	**−29.41**

Results and discussions

Ω_{bb}

$J^P = \frac{1}{2}^-$ sector from $PB(\frac{1}{2}^+)$

Poles		$\Omega_{bb}\eta$	$\Xi_{bb}\bar{K}$	$\Xi_b\bar{B}$	$\Xi'_b\bar{B}$
10741.65	g_i	1.50	**2.72**	0	0
	$g_iG_i^{II}$	−25.56	**−34.78**	0	0
10864.15	g_i	0	0	**11.87**	0
	$g_iG_i^{II}$	0	0	**−20.43**	0
11001.63	g_i	0	0	0	**11.87**
	$g_iG_i^{II}$	0	0	0	**−20.43**

$J^P = \frac{1}{2}^-, \frac{3}{2}^-$ sector from $VB(\frac{1}{2}^+)$

Poles		$\Omega_{bb}\omega$	$\Xi_b\bar{B}^*$	$\Xi_{bb}\bar{K}^*$	$\Xi'_b\bar{B}^*$
10909.88	g_i	0	**11.92**	0	0
	$g_iG_i^{II}$	0	**−20.35**	0	0
11047.36	g_i	0	0	0	**11.92**
	$g_iG_i^{II}$	0	0	0	**−20.34**

Results and discussions

Ω_{bb}

$J^P = \frac{3}{2}^-$ sector from $PB(\frac{3}{2}^+)$

Poles		$\Omega^*_{bb}\eta$	$\Xi^*_{bb}\bar{K}$	$\Xi^*_b\bar{B}$
10770.91	g_i	1.50	**2.71**	0
	$g_iG_i^{II}$	-25.70	**-34.62**	0
11018.56	g_i	0	0	**11.87**
	$g_iG_i^{II}$	0	0	**-20.43**

$J^P = \frac{1}{2}^-, \frac{3}{2}^-, \frac{5}{2}^-$ sector from $VB(\frac{3}{2}^+)$

Poles		$\Omega^*_{bb}\omega$	$\Xi^*_{bb}\bar{K}^*$	$\Xi^*_b\bar{B}^*$
11064.30	g_i	0	0	**11.94**
	$g_iG_i^{II}$	0	0	**-20.37**

Results and discussions

Ω_{bc}

$J^P = \frac{1}{2}^-$ sector from $PB(\frac{1}{2}^+)$

Poles		$\Xi_{bc}\bar{K}$	$\Xi'_{bc}\bar{K}$	$\Omega_{bc}\eta$	$\Omega'_{bc}\eta$	$\Xi_b D$	$\Xi_c \bar{B}$	$\Xi'_b D$	$\Xi'_c \bar{B}$
7362.26	g_i	**2.64**	0	1.57	0	1.70	0	0	0
	$g_i G_i^{II}$	**−40.41**	0	−13.52	0	−5.35	0	0	0
7392.60	g_i	0	**2.61**	0	1.51	0	0	−0.73	0
	$g_i G_i^{II}$	0	**−41.08**	0	−12.83	0	0	1.81	0
$7514.32 + i2.21$	g_i	$-0.14 - i0.27$	0	$-0.05 - i0.13$	0	$\mathbf{6.19 - i0.08}$	0	0	0
	$g_i G_i^{II}$	$9.18 + i2.42$	0	$0.83 + i2.04$	0	$\mathbf{-32.11 + i0.12}$	0	0	0
7566.65	g_i	0	0	0	0	0	**11.50**	0	0
	$g_i G_i^{II}$	0	0	0	0	0	**−20.01**	0	0
$7641.20 + i2.26$	g_i	0	$-0.06 - i0.03$	0	$0.34 + i0.11$	0	0	$\mathbf{6.50 + i0.02}$	0
	$g_i G_i^{II}$	0	$1.60 - i1.76$	0	$-10.29 + i2.74$	0	0	$\mathbf{-32.20 - i0.41}$	0
7674.29	g_i	0	0	0	0	0	0	0	**11.53**
	$g_i G_i^{II}$	0	0	0	0	0	0	0	**−20.05**

Results and discussions

Ω_{bc}

$J^P = \frac{1}{2}^-, \frac{3}{2}^-$ sector from $VB(\frac{1}{2}^+)$

Poles		$\Omega_{bc}\omega$	$\Xi_c\bar{B}^*$	$\Xi_b D^*$	$\Xi_{bc}\bar{K}^*$	$\Omega'_{bc}\omega$	$\Xi'_{bc}\bar{K}^*$	$\Xi'_c\bar{B}^*$	$\Xi'_b D^*$
7612.44	g_i	0	**11.56**	0	0	0	0	0	0
	$g_i G_i^{II}$	0	**−19.93**	0	0	0	0	0	0
7627.73	g_i	1.09	0	**6.36**	2.14	0	0	0	0
	$g_i G_i^{II}$	−9.13	0	**−28.05**	−15.65	0	0	0	0
7707.67	g_i	1.19	0	−2.17	**3.40**	0	0	0	0
	$g_i G_i^{II}$	−13.85	0	14.00	**−33.94**	0	0	0	0
7716.28	g_i	0	0	0	0	1.43	**4.03**	0	−1.77
	$g_i G_i^{II}$	0	0	0	0	−14.61	**−37.19**	0	6.54
7720.07	g_i	0	0	0	0	0	0	**11.59**	0
	$g_i G_i^{II}$	0	0	0	0	0	0	**−19.97**	0
7777.47	g_i	0	0	0	0	0.78	0.38	0	**6.50**
	$g_i G_i^{II}$	0	0	0	0	−11.04	−4.84	0	**−30.09**

Results and discussions

Ω_{bc}

$J^P = \frac{3}{2}^-$ sector from $PB(\frac{3}{2}^+)$

Poles		$\Xi^*_{bc}\bar{K}$	$\Omega^*_{bc}\eta$	$\Xi^*_b D$	$\Xi^*_c \bar{B}$
7415.55	g_i	**2.63**	1.56	1.21	0
	$g_i G_i^{II}$	**−40.83**	−13.37	−3.05	0
$7667.65 + i1.40$	g_i	$-0.02 - i0.20$	$0.02 - i0.06$	$\mathbf{6.25 - i0.05}$	0
	$g_i G_i^{II}$	$6.82 + i0.98$	$0.53 + i1.88$	$\mathbf{-32.26 + i0.09}$	0
7740.93	g_i	0	0	0	**11.52**
	$g_i G_i^{II}$	0	0	0	**−20.08**

$J^P = \frac{1}{2}^-, \frac{3}{2}^-, \frac{5}{2}^-$ sector from $VB(\frac{3}{2}^+)$

Poles		$\Omega^*_{bc}\omega$	$\Xi^*_{bc}\bar{K}^*$	$\Xi^*_b D^*$	$\Xi^*_c \bar{B}^*$
7729.11	g_i	1.60	**3.82**	3.54	0
	$g_i G_i^{II}$	−15.96	**−33.56**	−12.92	0
7786.71	g_i	0	0	0	**11.61**
	$g_i G_i^{II}$	0	0	0	**−19.99**
7811.82	g_i	−0.23	−1.24	**5.71**	0
	$g_i G_i^{II}$	3.72	16.77	**−28.48**	0

Summary

1). With the inputs successfully used in Ω_c and P_c, P_{cs} states, and using an extension of the local hidden gauge approach, we looked into the interactions of meson-baryon channels leading to the states Ω_{cc}, Ω_{bb} and Ω_{bc}.

2). We found many bound states or resonances in each sector. And the Ω_{bc} sector is more rich, has more states.

3). These states are presently under the investigation by the LHCb collaboration.

Summary

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Thank You !