Institute of Theoretical Physics
Chinese Academy of Sciences

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INSTITUT DE FÍSICA CORPUSCULAR

Molecular states of Ω_c, Ω_b, Ξ_{cc}, Ξ_{bb}, and Ξ_{bc} type

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In collaboration with
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W. H. Liang
Ju-Jun Xie
V. R. Debastiani
Qi-Xin Yu

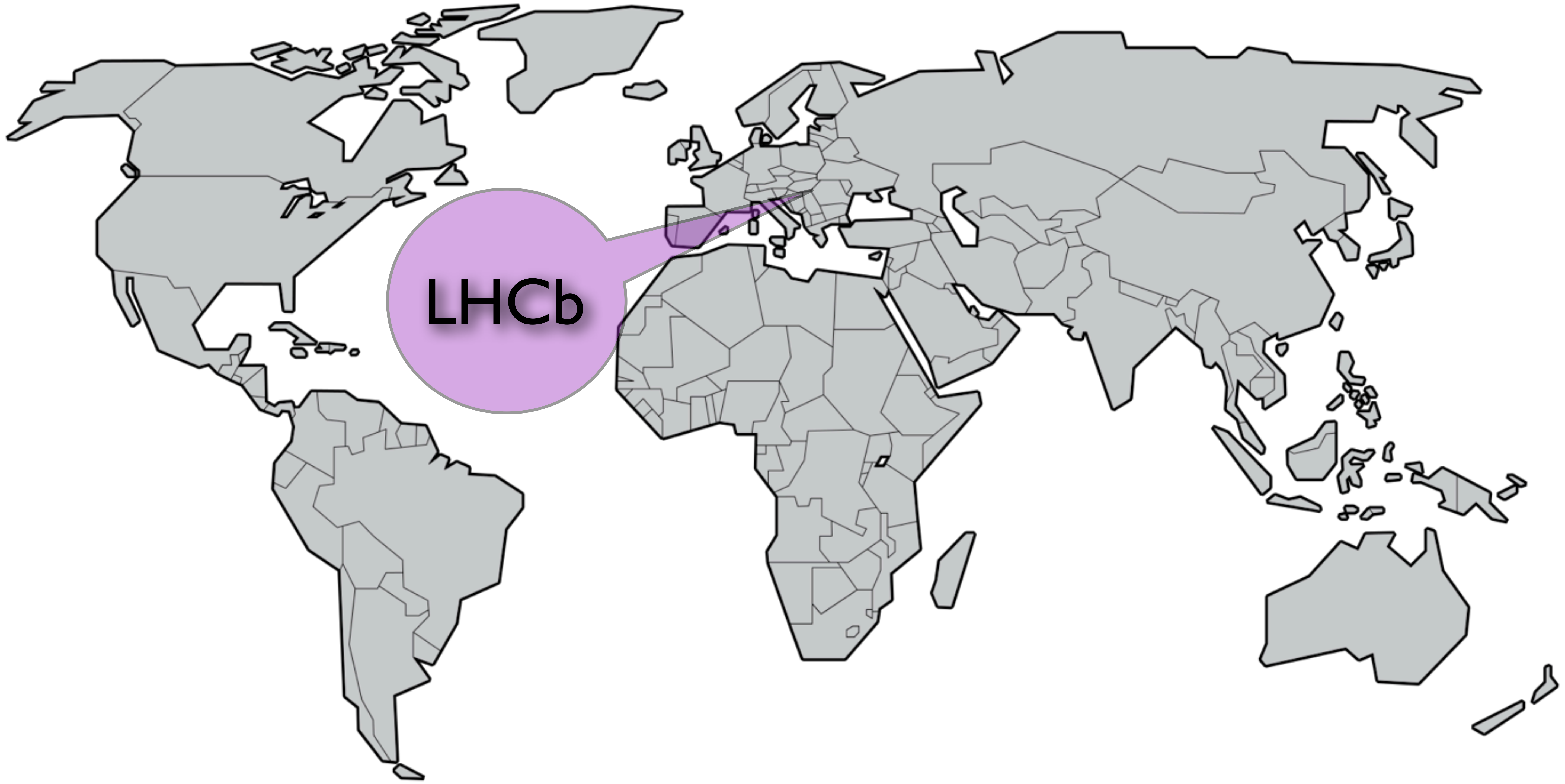
HADRON SPECTROSCOPY

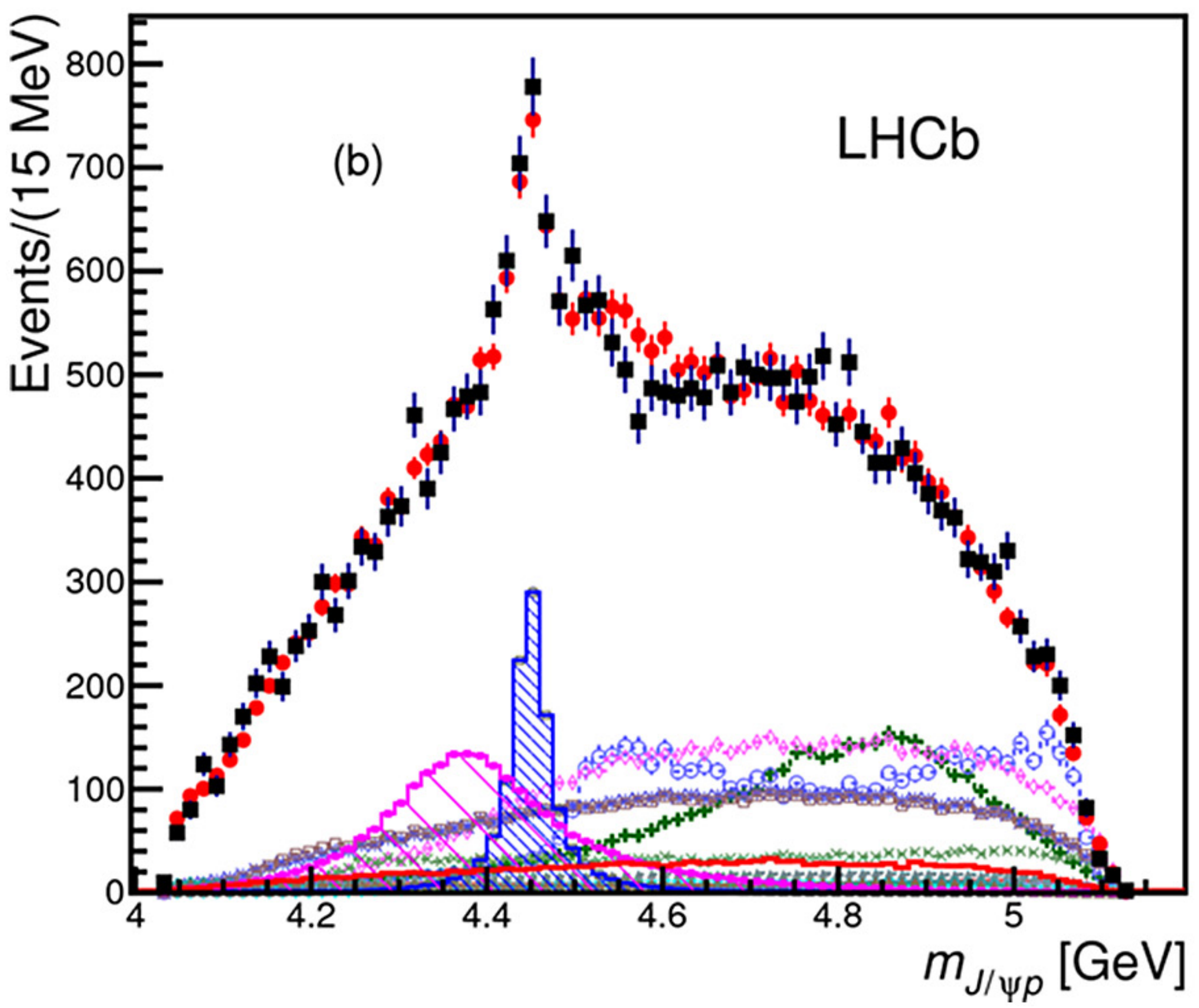
In baryon sector...

Pentaquarks →

$P_c^+(4380)$ and

$P_c^+(4450)$



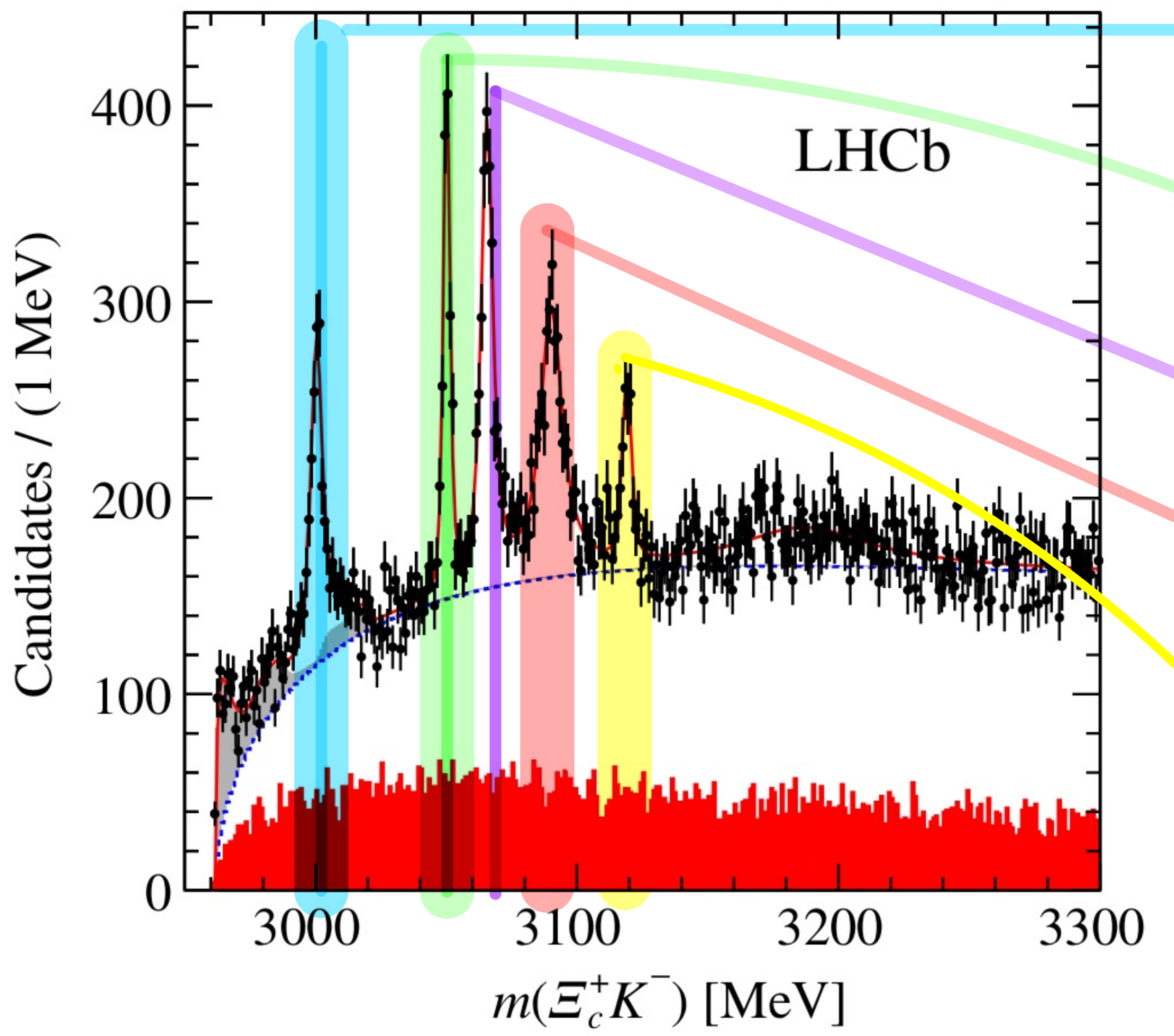


$\Lambda_b^0 \to J/\psi p \bar{K}$

Phys. Rev. Lett 115, 072001 (2015)

Phys. Rev. Lett 117, 082002 (2016)

Phys. Rev. Lett. 118, 182001 (2017)



$\Omega_c(3000)$

$\Omega_c(3050)$

$\Omega_c(3066)$

$\Omega_c(3090)$

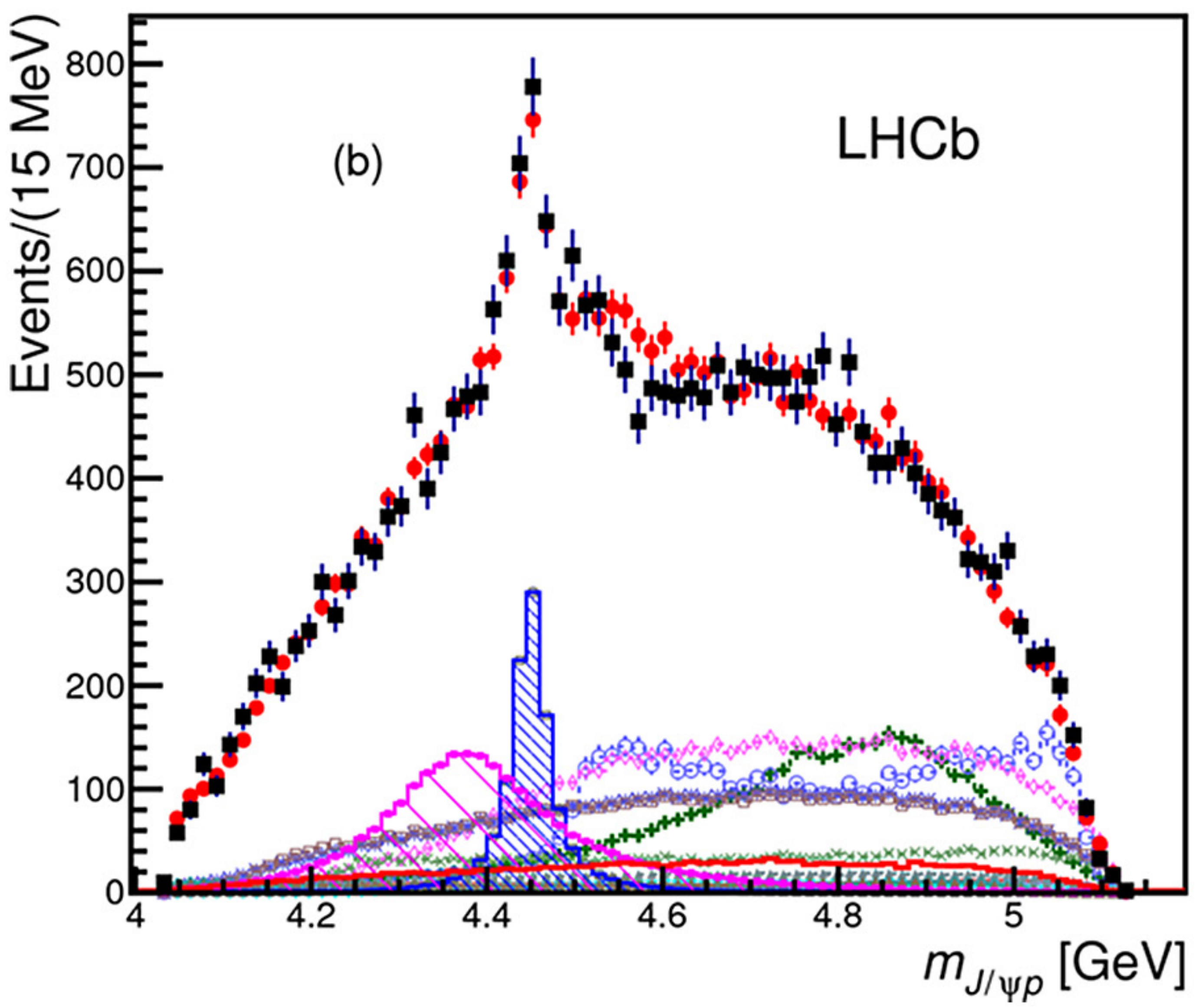
$\Omega_c(3119)$

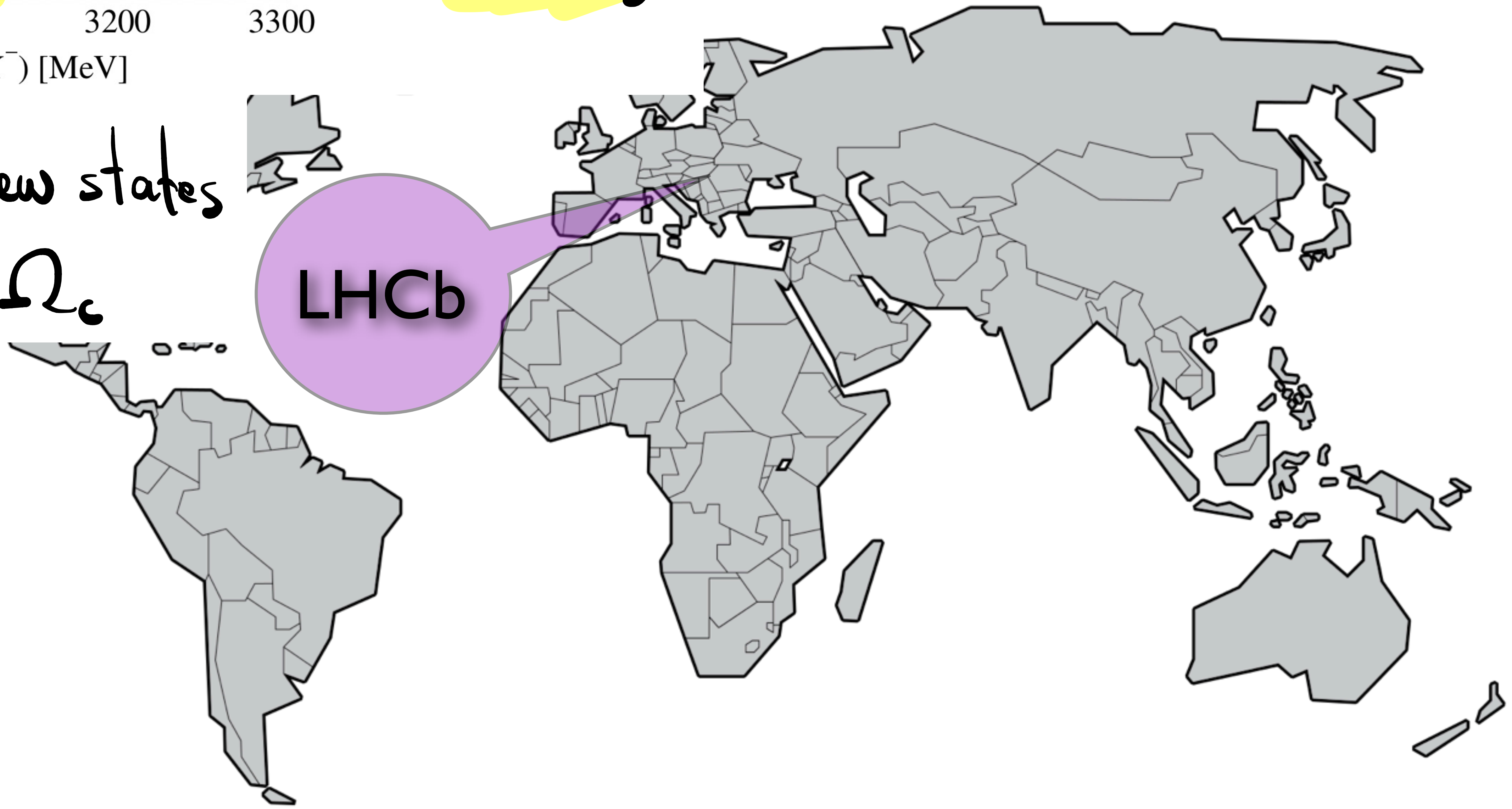
Five new states called Ω_c

Pentaquarks $\Rightarrow$

$P_c^+(4380)$ and

$P_c^+(4450)$





$\Lambda_b^0 \rightarrow J/\psi\, p \bar{K}$

Phys. Rev. Lett 115, 072001 (2015)

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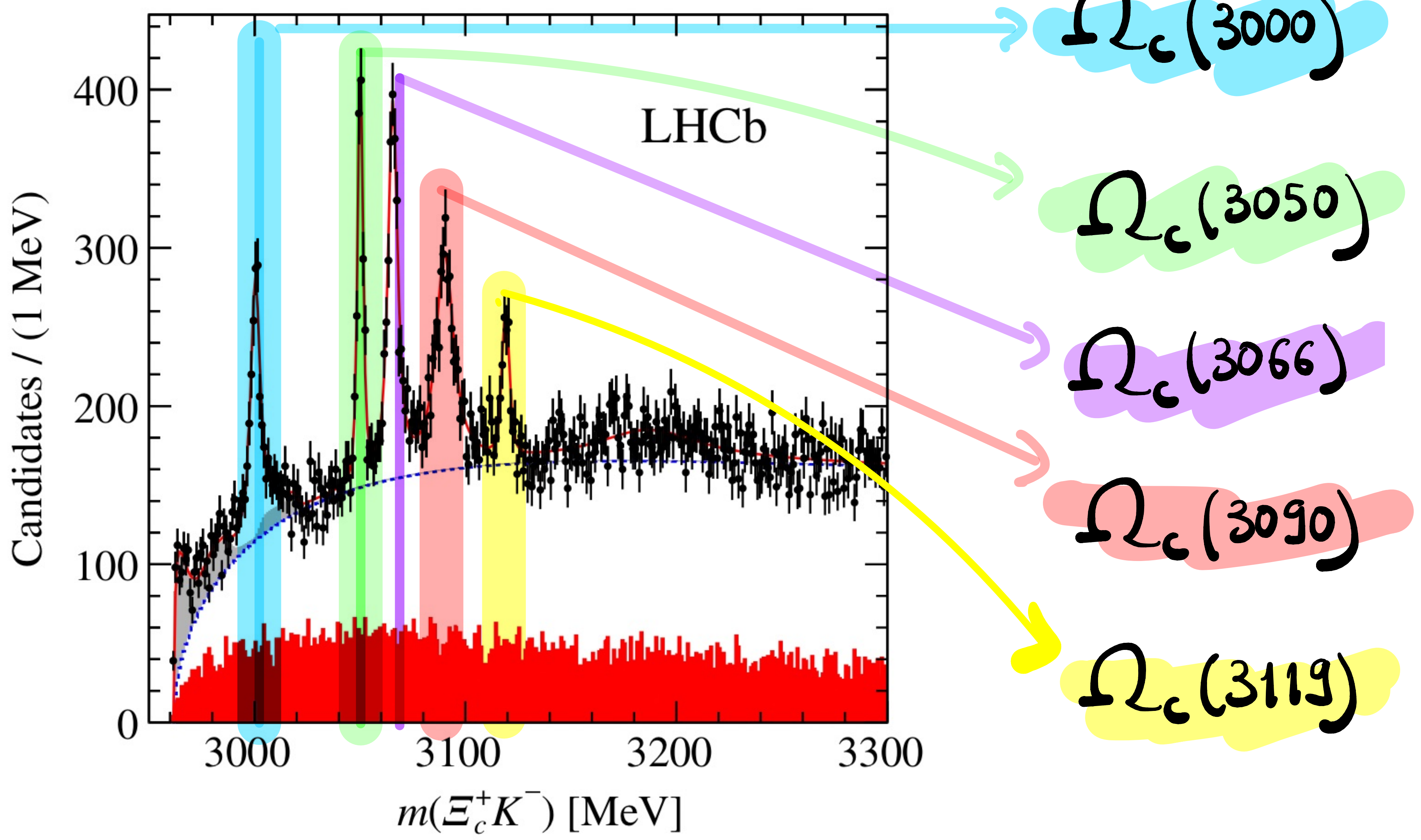
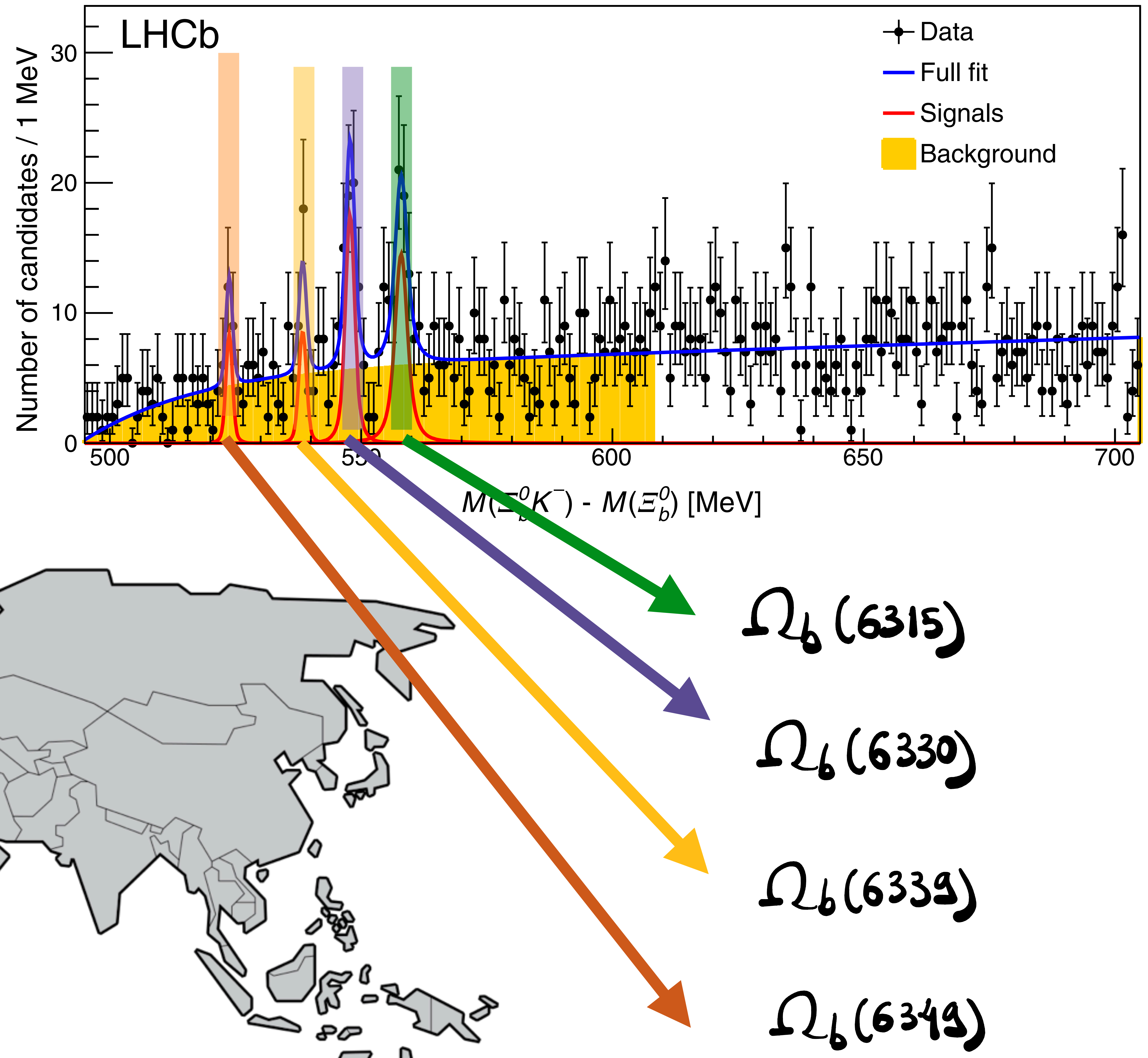
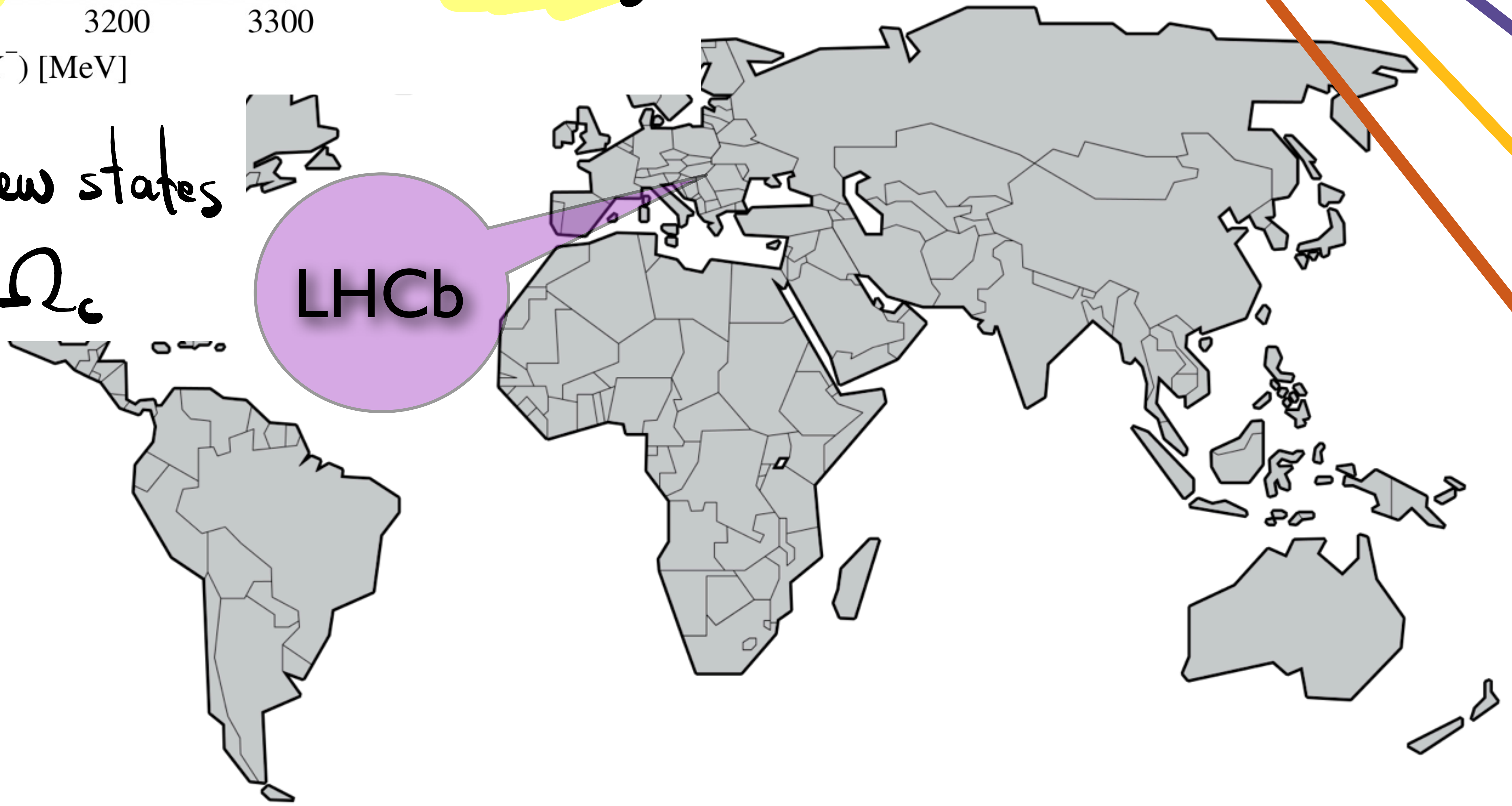




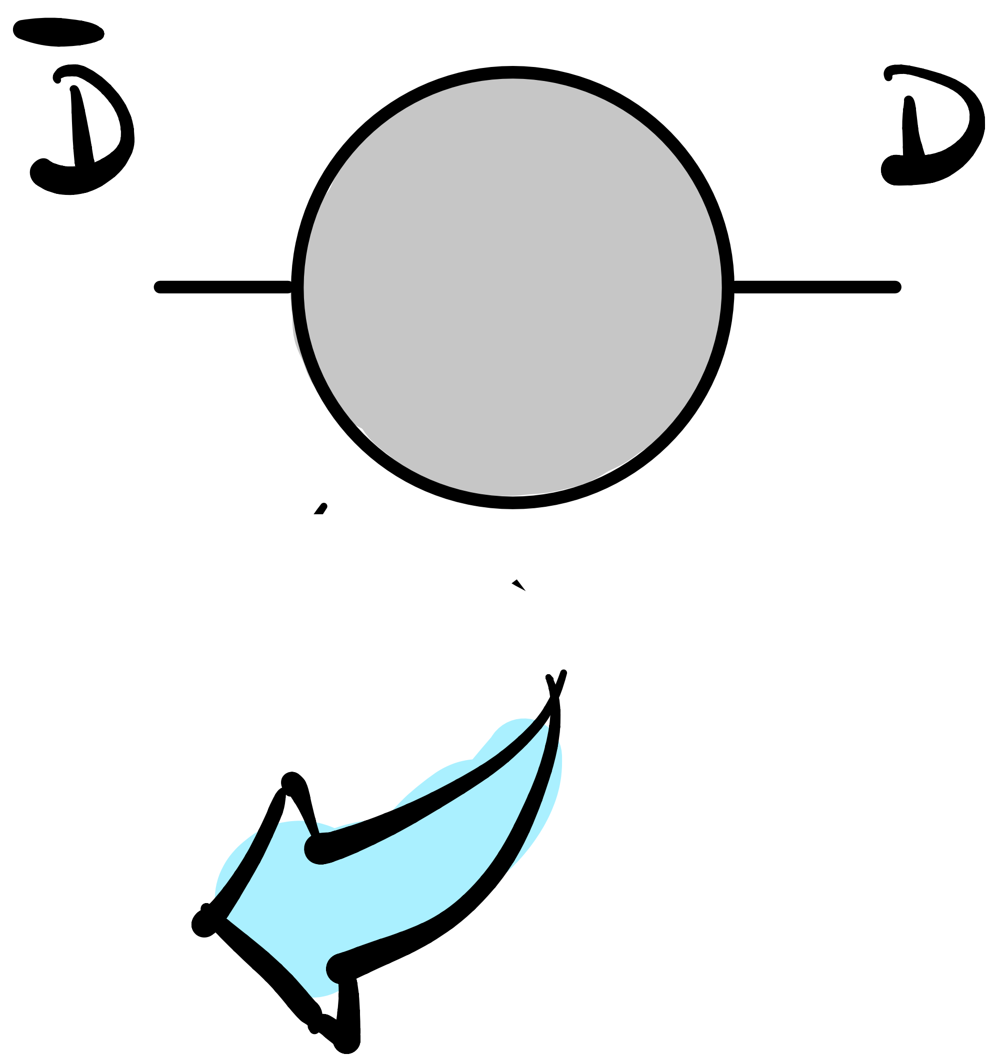
Phys. Rev. Lett. 124, 082002 (2020)

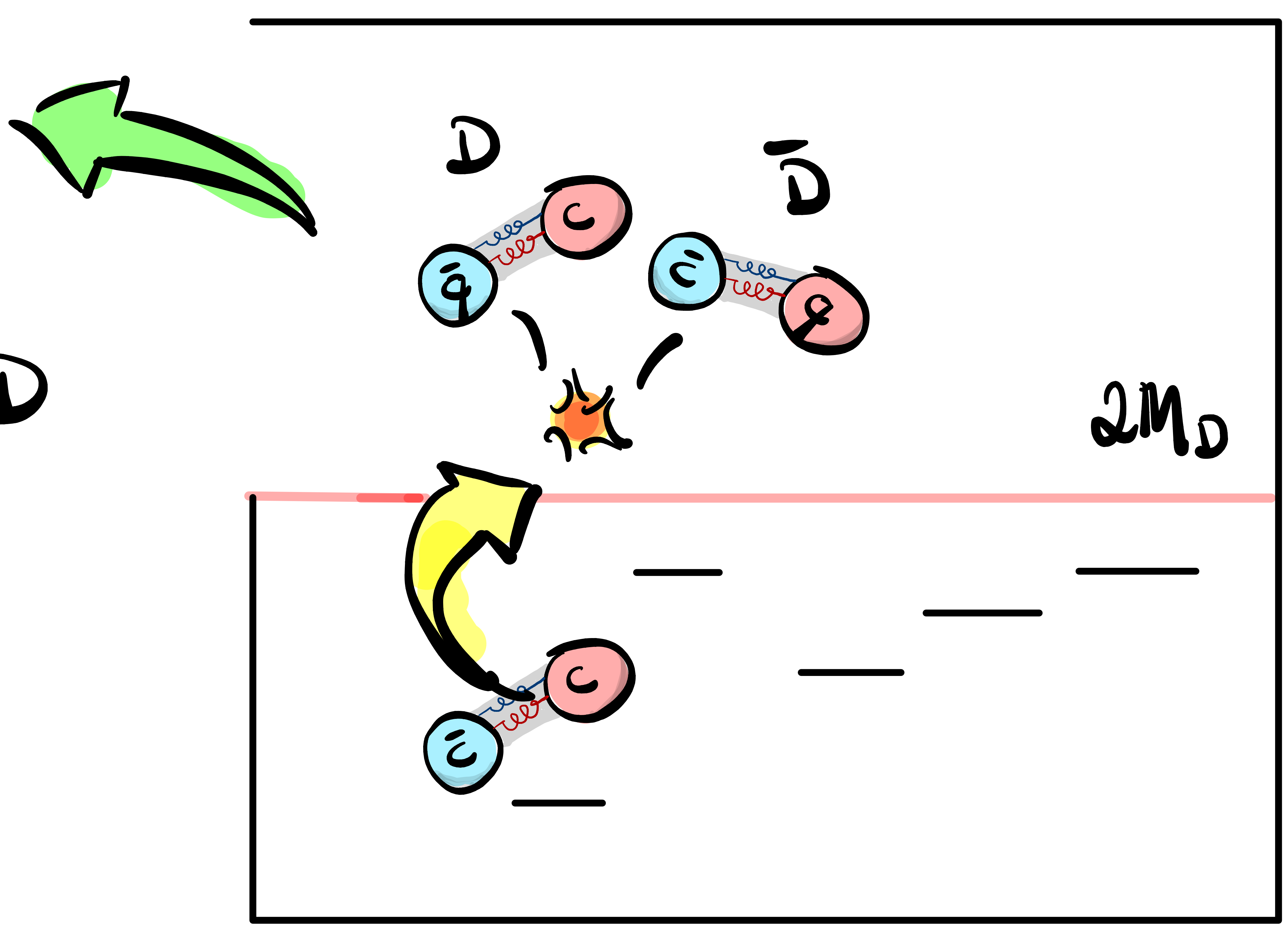
Five new states called Ω_c

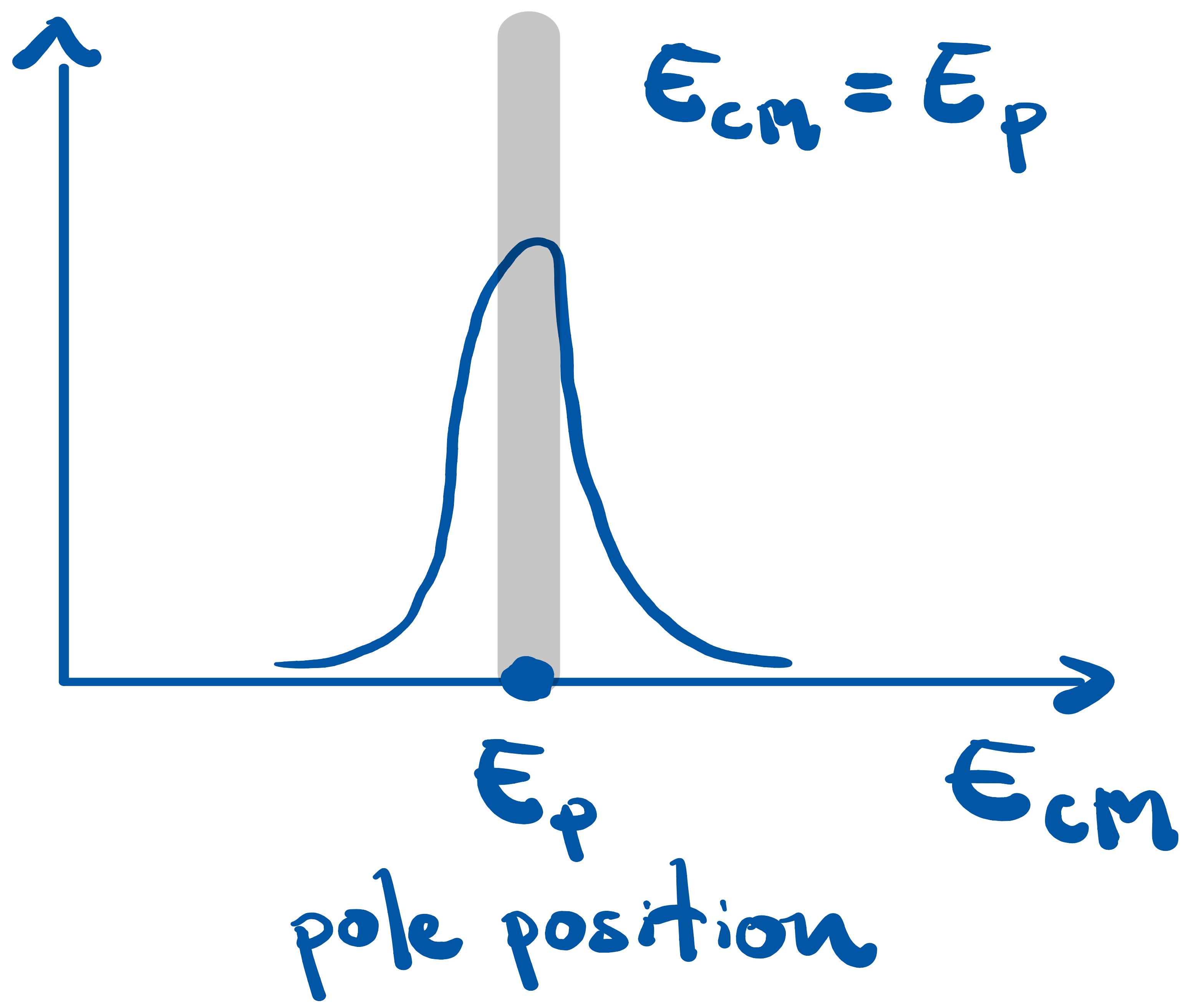


Chiral Unitary Approach

• They might interact



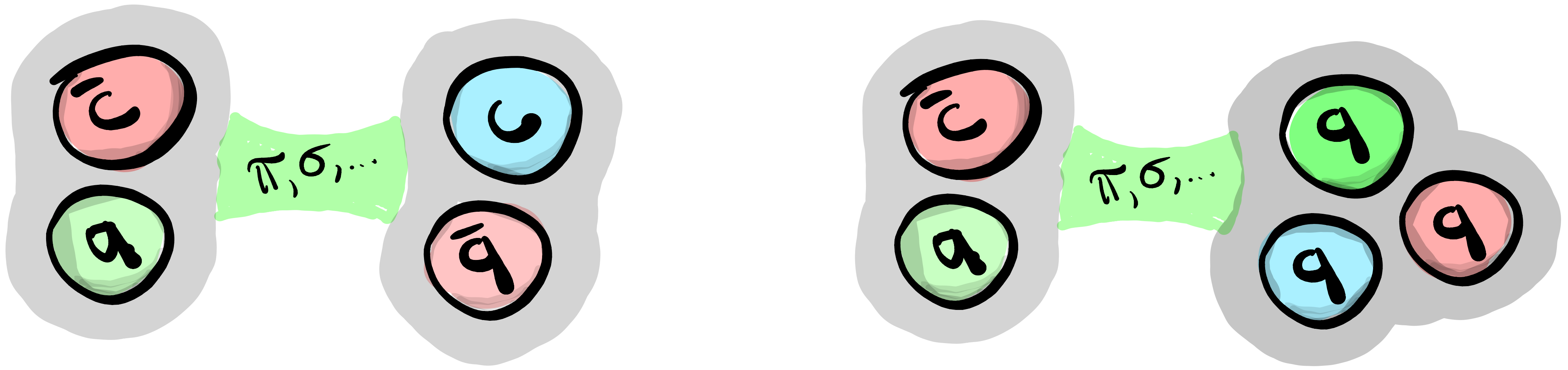




• Dinamically generated through the meson-meson interaction !

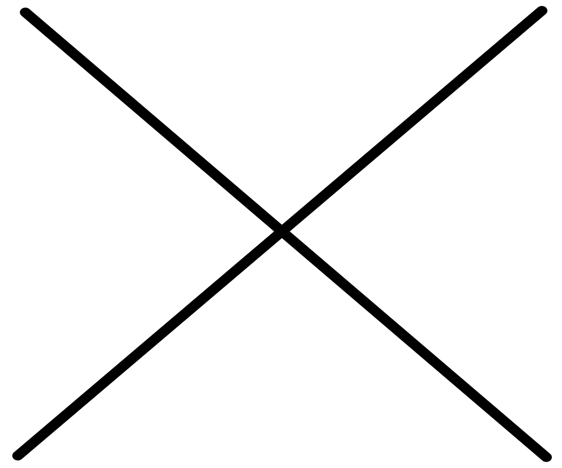
CHIRAL UNITARY FORMULATION

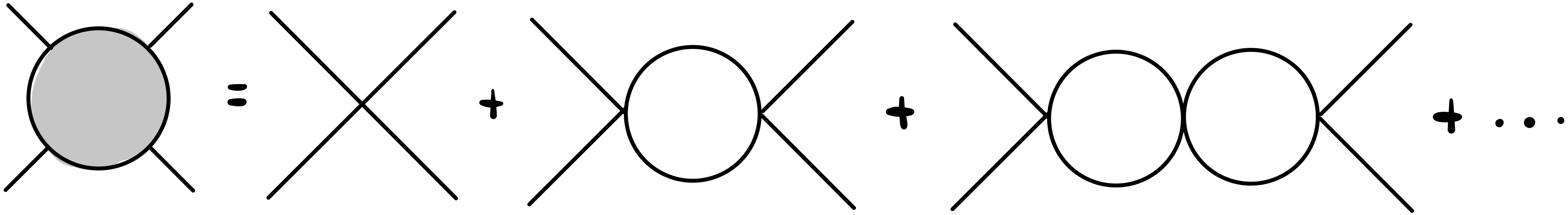
- Good for $\underbrace{\text{meson-meson}}$ and $\underbrace{\text{meson-baryon}}$ interactions

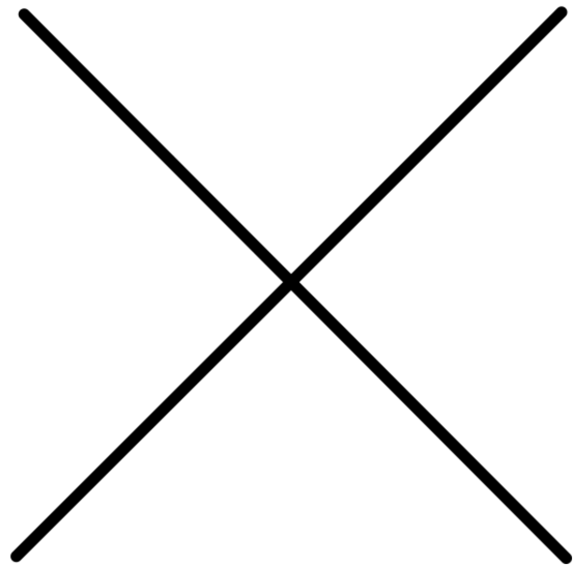


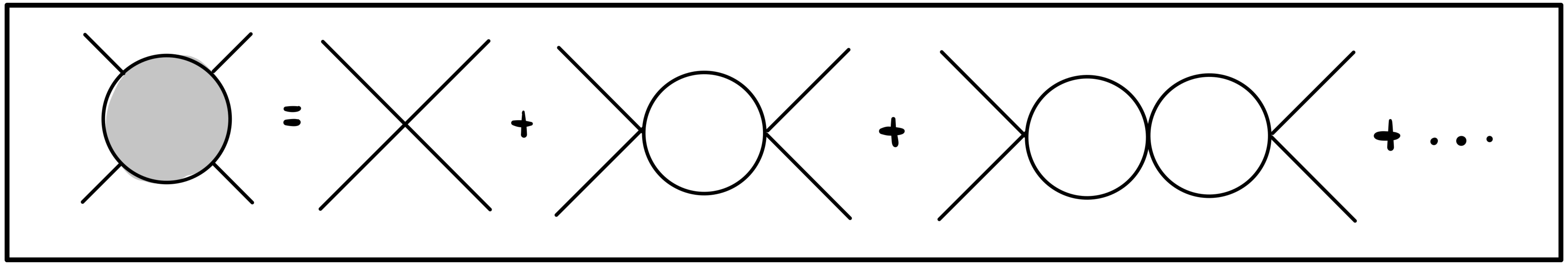
Molecular states

- The interaction is described at lowest order in χPT → V ~



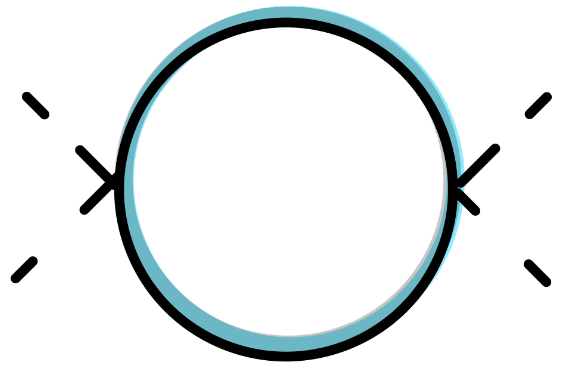


- The interaction is described at lowest order in χPT $\rightarrow$ $V \sim$ 



$$T = \frac{V}{(1-VG)}$$

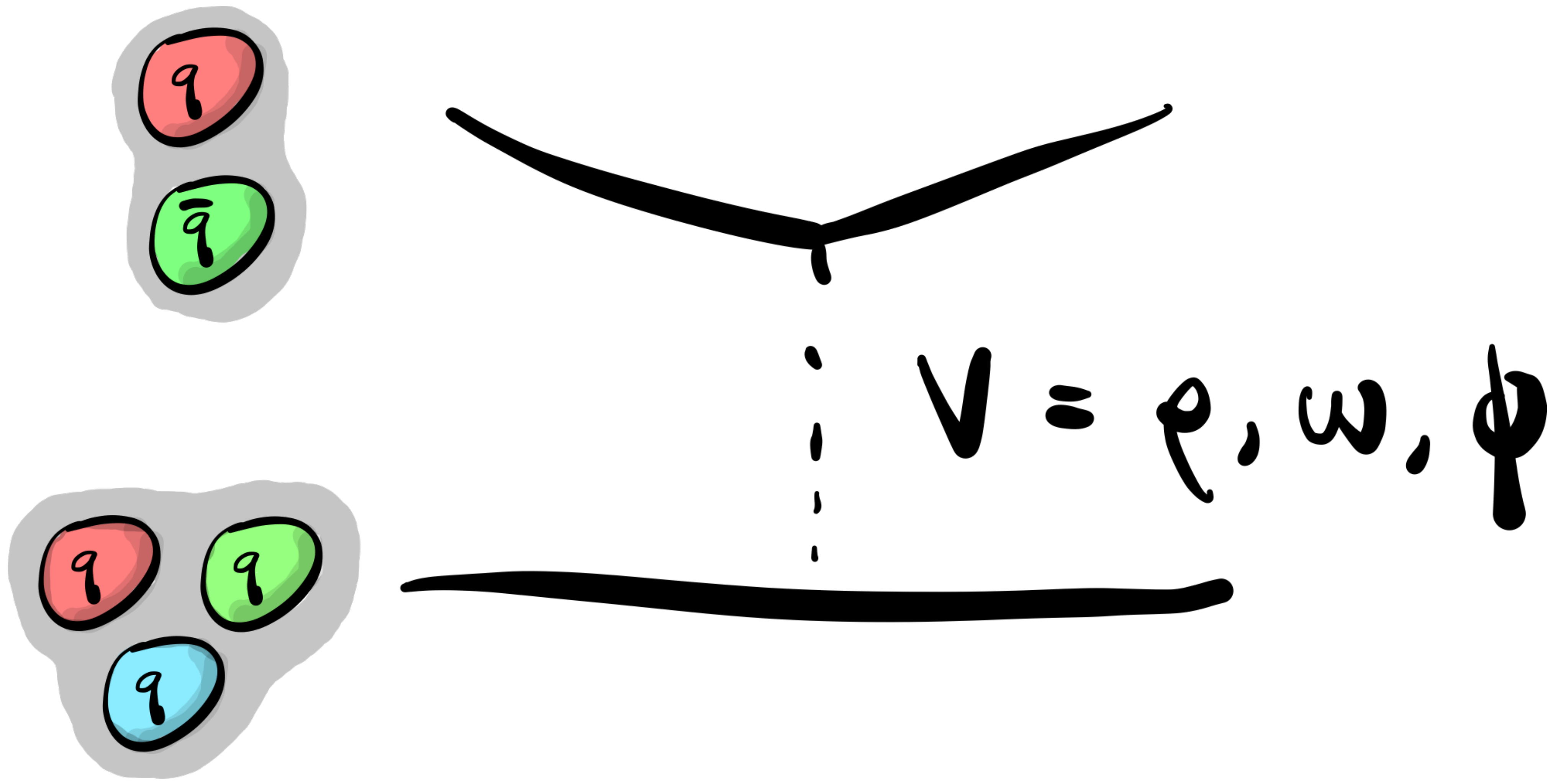
Unitarization implies

$G \rightarrow$ Loop-function $\sim$ 

It must be regularized either by a cut-off or by dim. reg. !

Singly and doubly heavy baryon states as meson-baryon interactions

TRANSITION AMPLITUDES



HIDDEN GAUGE SYMMETRY !

Phys. Rep. 391, 1 (2003)

Phys. Rep. 164, 217 (1988)

Phys. Rep. 161, 213 (1988)

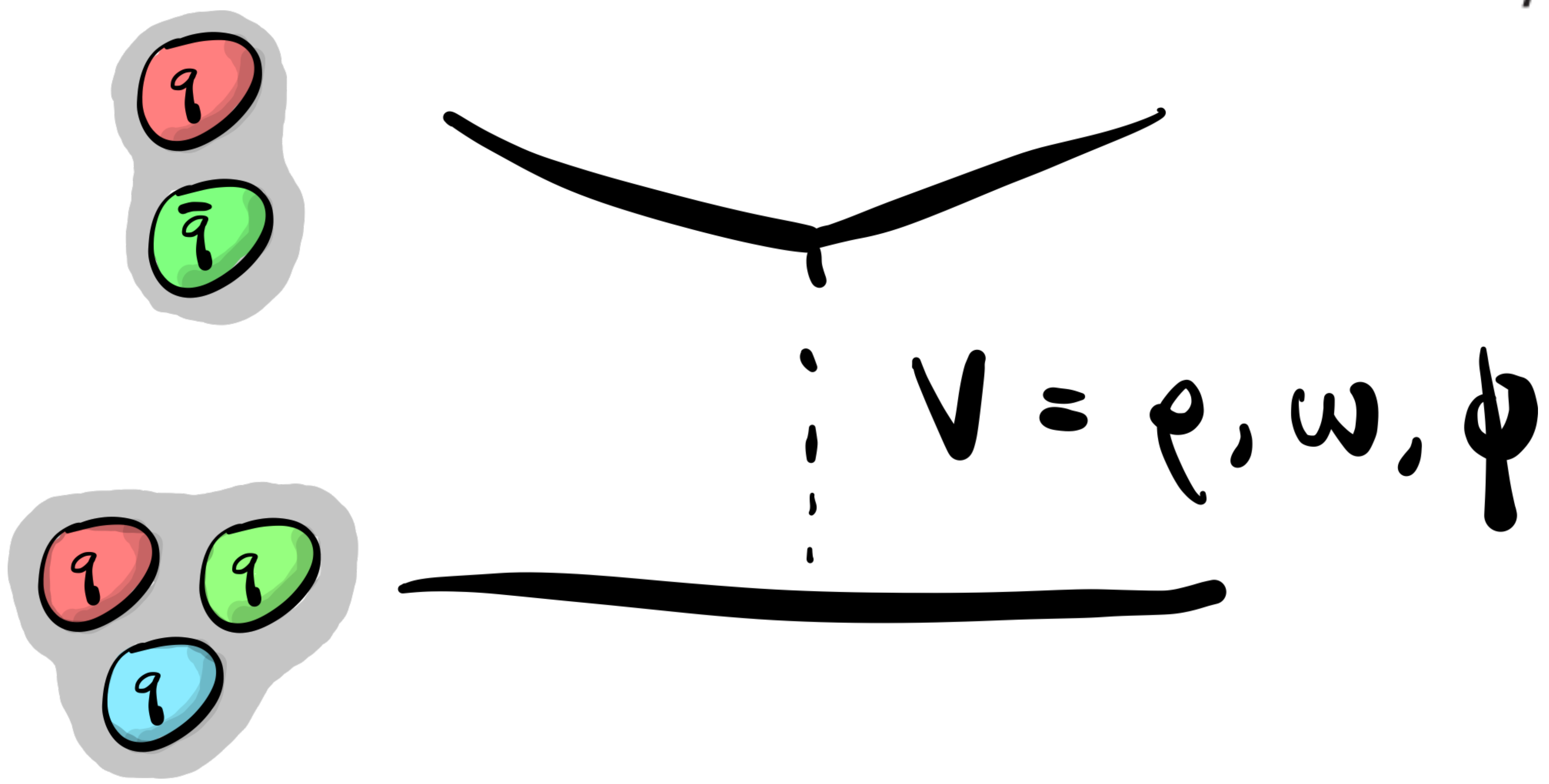
HOWEVER, ...

~~Chiral Lagrangians~~

$$\mathcal{L}_{PPV} = -ig\langle [\phi, \partial_\mu \phi] V^\mu \rangle$$

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

TRANSITION AMPLITUDES



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

$$V_\mu = \begin{pmatrix} \frac{\rho^0}{\sqrt{2}} + \frac{\omega}{\sqrt{2}} & \rho^+ & K^{*+} \\ \rho^- & -\frac{\rho^0}{\sqrt{2}} + \frac{\omega}{\sqrt{2}} & K^{*0} \\ K^{*-} & \bar{K}^{*0} & \phi \end{pmatrix}_\mu,$$

SU(3)

HIDDEN GAUGE SYMMETRY!

$$\mathcal{L}_{PPV} = -ig\langle [\phi, \partial_\mu \phi] V^\mu \rangle$$

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

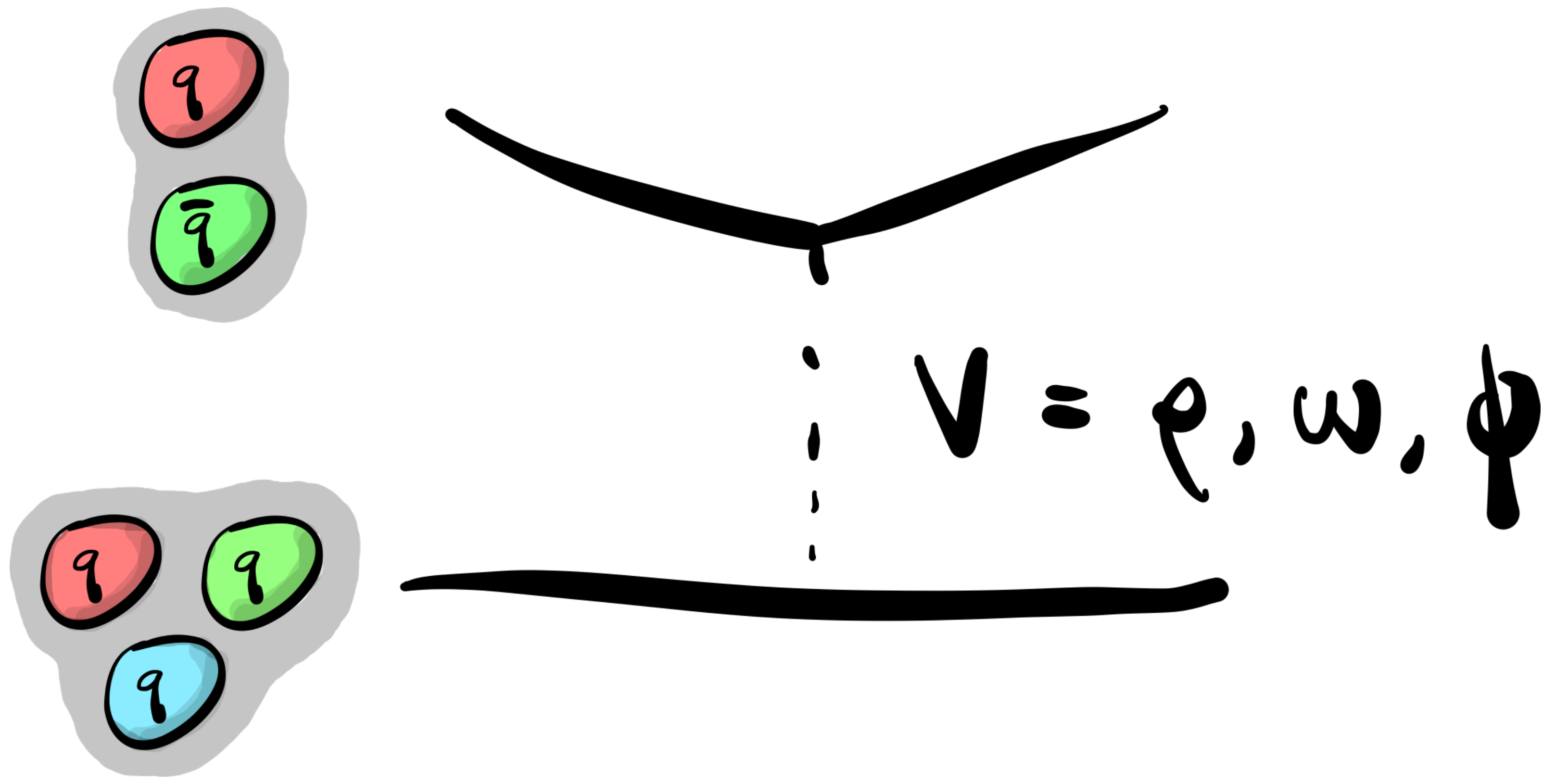
Phys. Rep. 391, 1 (2003)

Phys. Rep. 164, 217 (1988)

Phys. Rep. 161, 213 (1988)

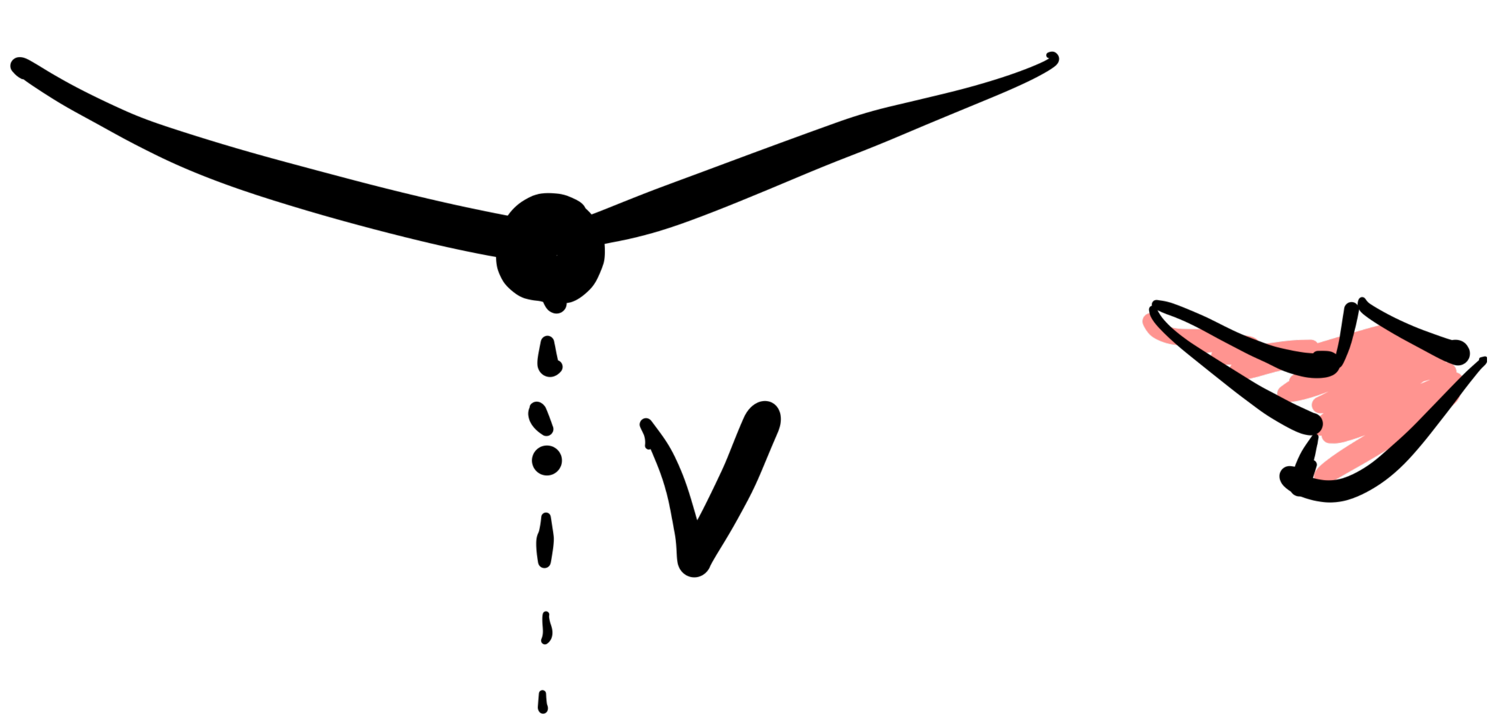
MESON - BARYON WITH CHARM ... ϕ, and V → ~~SU(4)~~

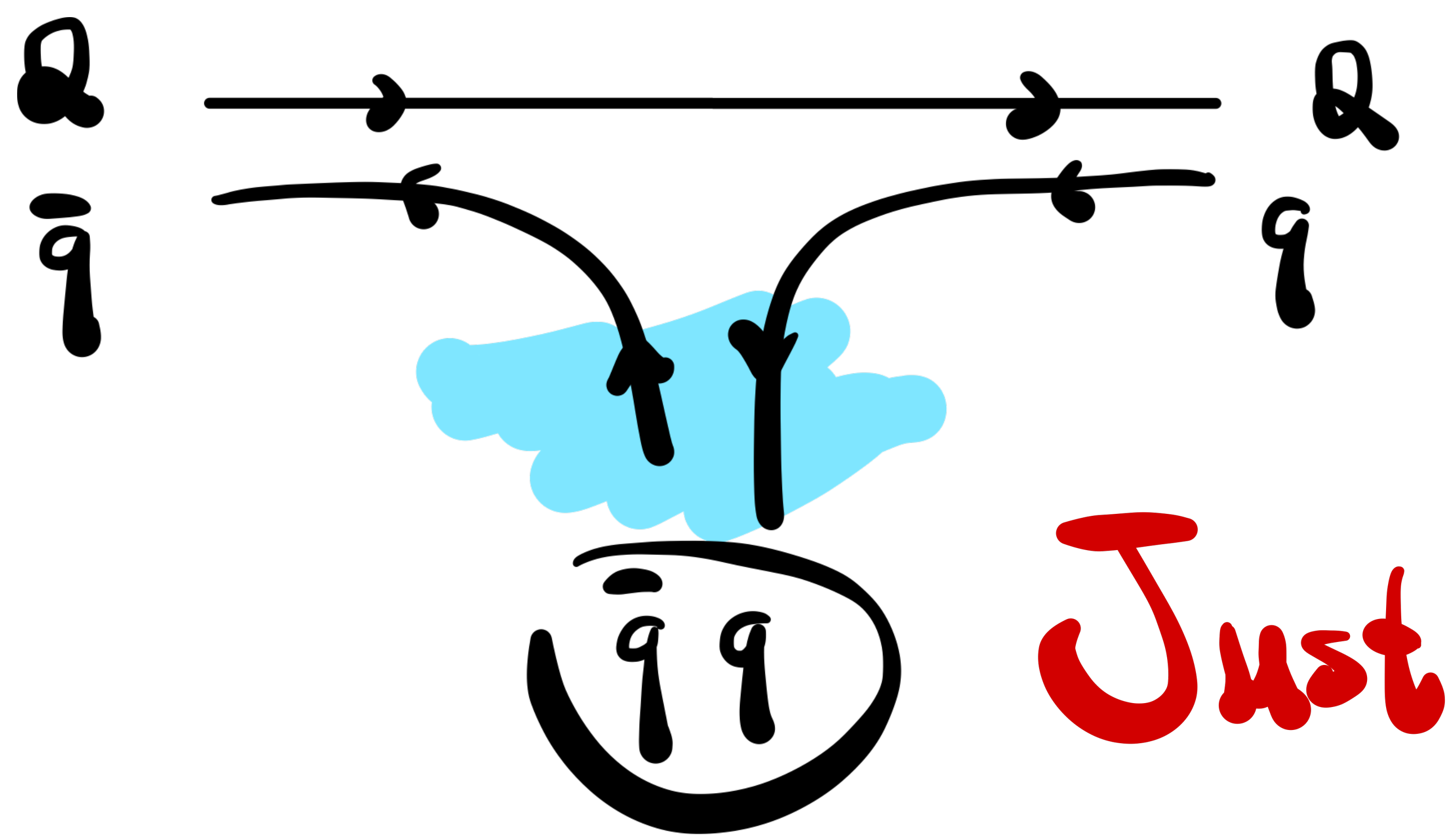
not a good sym. !



BUT, IF ... at the quark level

Q is an spectator!

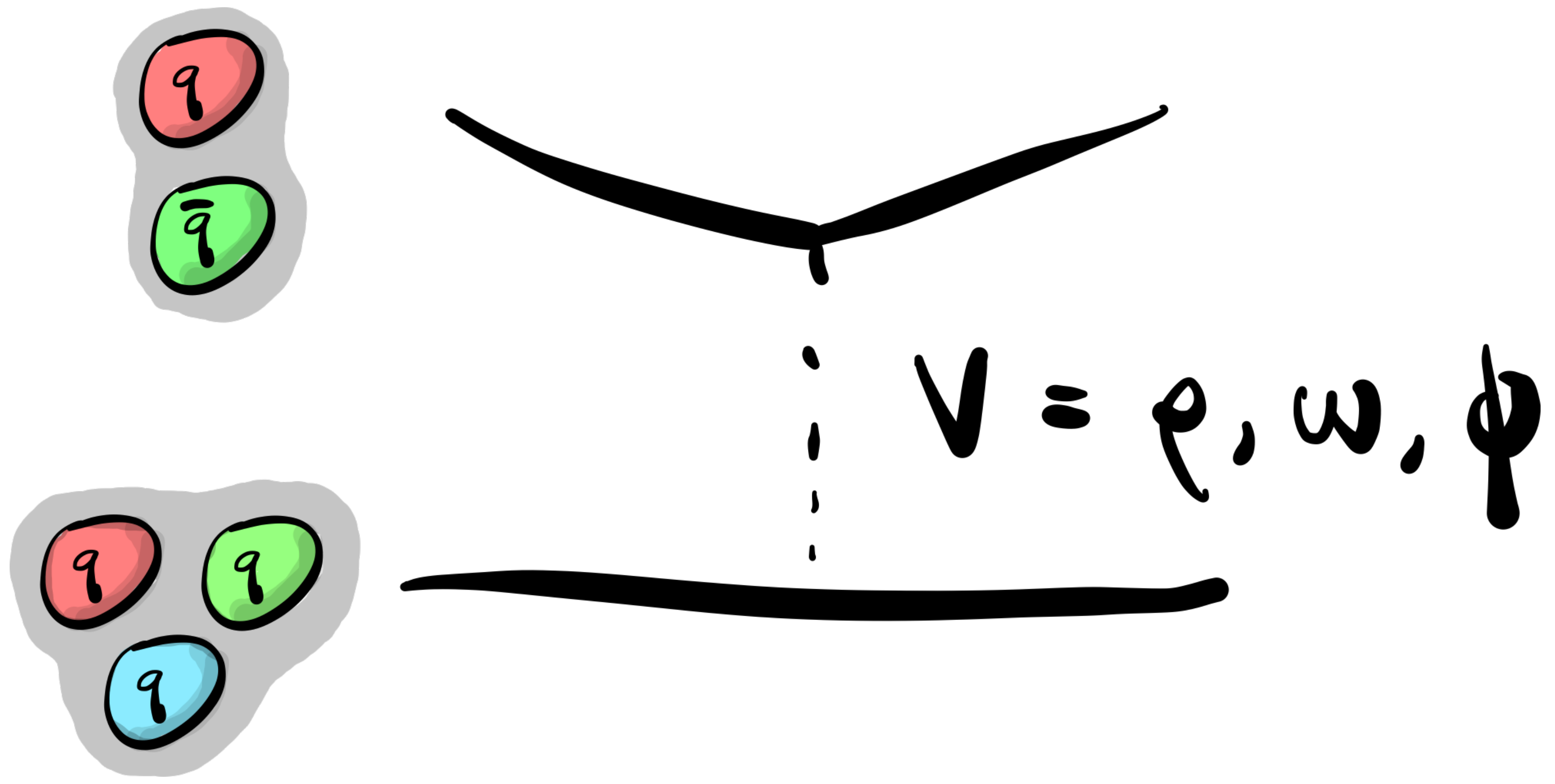




Just light flavors!

MESON - BARYON WITH CHARM ... ϕ, and V → ~~SU(4)~~

not a good sym.!



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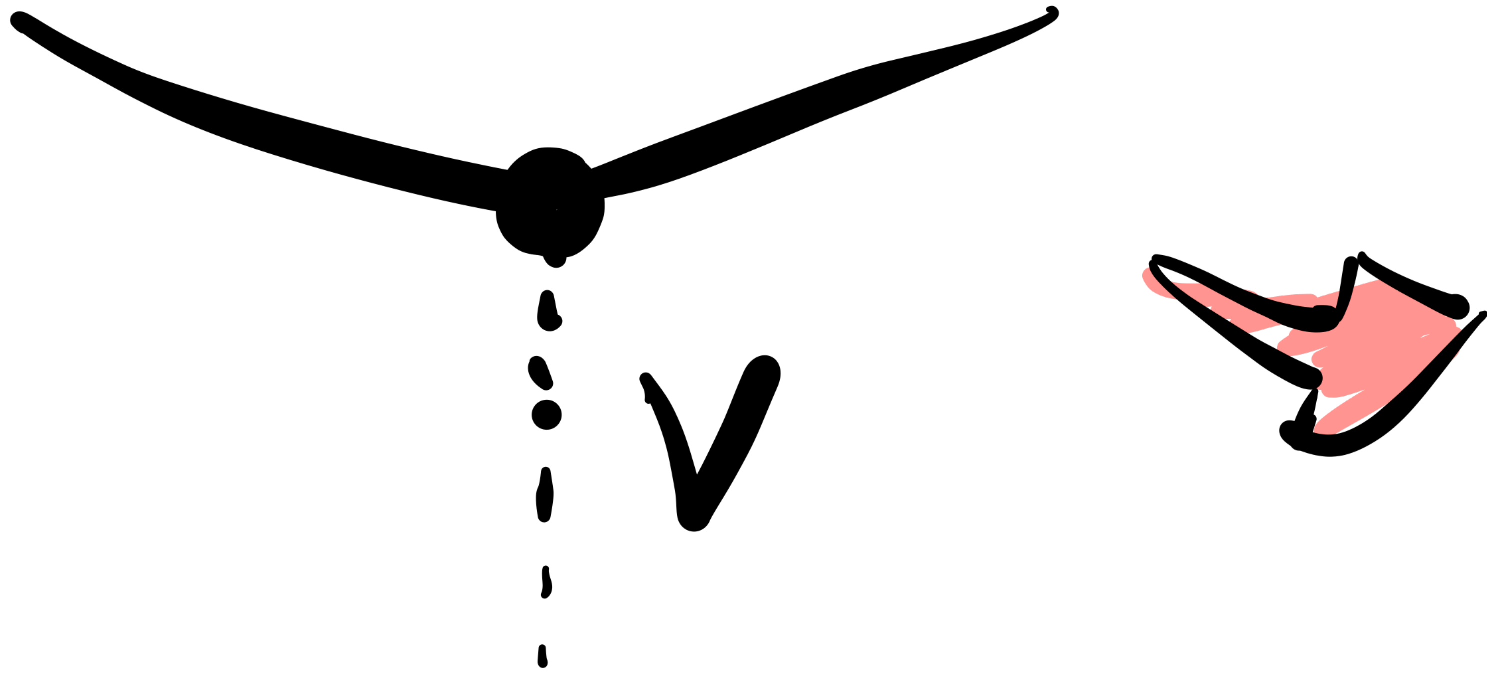
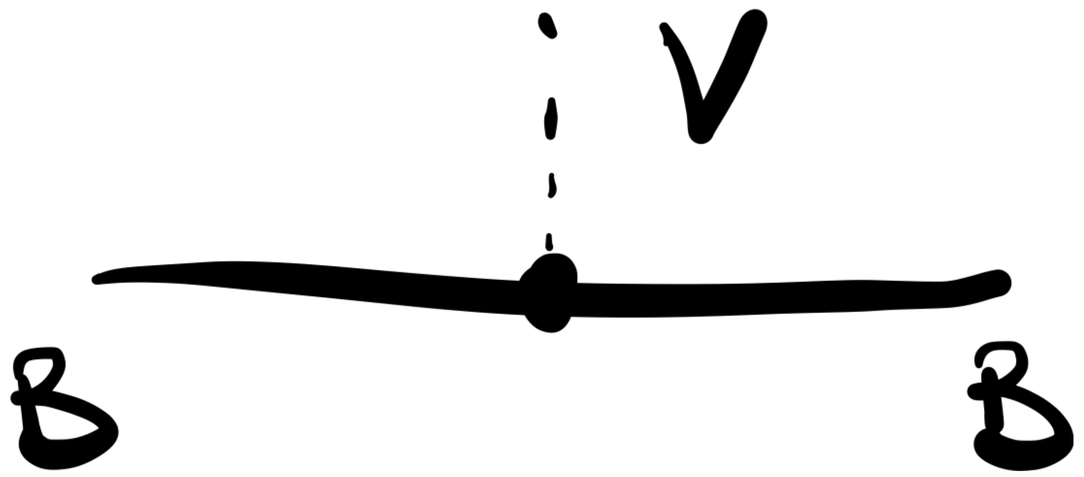


$\left(\boxed{SU(3)} \right)$

In fact, we are not using SU(4) explicitly, but the SU(3)!

What about the other vertex?



acts like an operator!

$$\langle B | gV | B \rangle$$

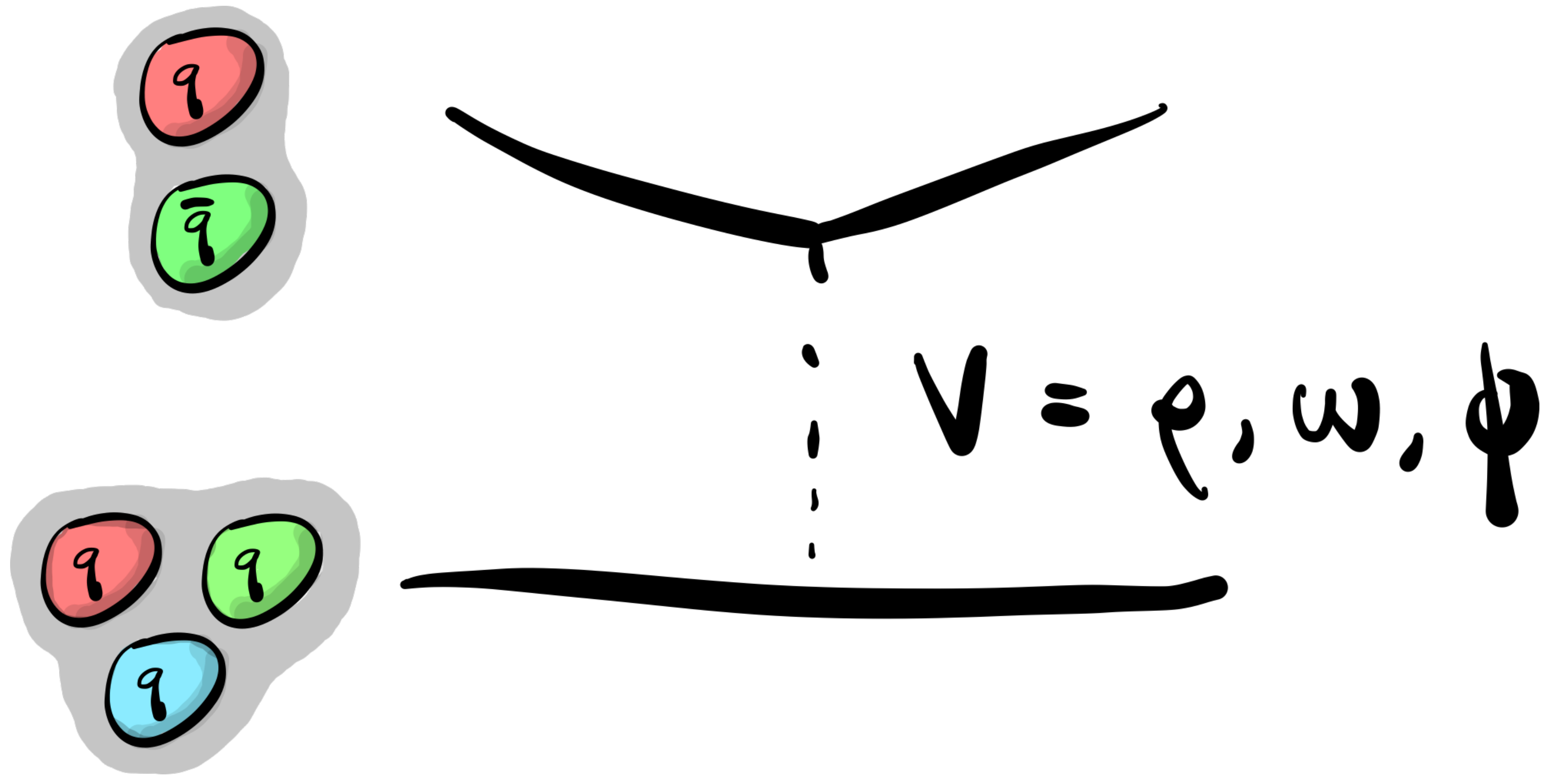
- $g \to$ coupling
- $V \to$ vector meson

- For example: $B = \Xi_{cc}$, and $V = \rho^0$

$$\langle \Xi_{cc} | g\rho^0 | \Xi_{cc}\rangle \sim g \underbrace{\langle \chi_{MS}| \otimes \langle cuu|}_{\Xi_{cc}} \underbrace{\frac{1}{\sqrt{2}}(u\bar{u} - \cancel{d\bar{d}})}_{\rho^0} \underbrace{|cuu\rangle \otimes |\chi_{MS}\rangle}_{\Xi_{cc}}$$

$$\sim g\frac{1}{\sqrt{2}}$$

Therefore,



$$\boxed{V_{ij} = C_{ij}\,\frac{1}{4f^2}\,(p^0 + p'^0)}$$

Phys. Rev. D 98, 094017 (2017)

TABLE VII. C_{ij} coefficients of Eq. (12) for the pseudoscalar meson-baryon states coupling to $J^P = 1/2^-$ in S-wave.

$PB_{1/2}$	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi'_c D_s$
$\Xi_{cc}\pi$	-2	0	$-\frac{\sqrt{2}}{3}$	$-\sqrt{\frac{3}{2}}$	0	0	0
$\Lambda_c D$		-1	0	0	0	-1	0
$\Xi_{cc}\eta$			0	$-\frac{1}{\sqrt{3}}$	0	0	0
$\Omega_{cc}K$				-1	0	0	0
$\Sigma_c D$					-3	0	$-\frac{1}{\sqrt{3}}$
$\Xi_c D_s$						-1	0
$\Xi'_c D_s$							-1

Ω_c states
as meson-baryon interactions

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

Molecular Ω_c states generated from coupled meson-baryon channels

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[2]*Instituto de Física, Universidade de São Paulo, Rua do Matão, 1371, Butantã, São Paulo, São Paulo CEP 05508-090, Brazil*
[3]*Department of Physics, Guangxi Normal University, Guilin 541004, China*

Channels

TABLE I. $J = 1/2$ states chosen and threshold mass in MeV.

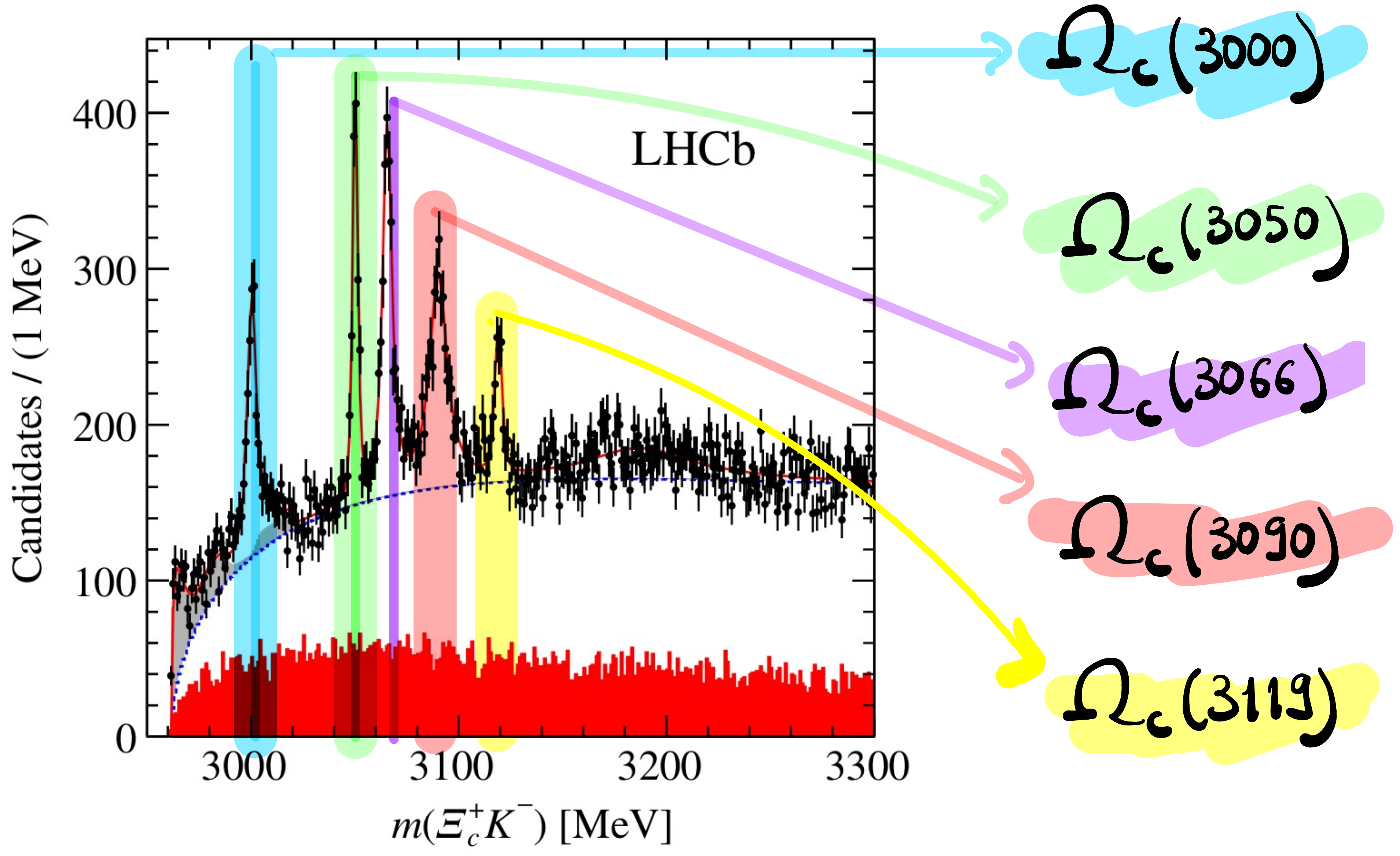
States	$\Xi_c \bar{K}$	$\Xi'_c \bar{K}$	ΞD	$\Omega_c \eta$	ΞD^*	$\Xi_c \bar{K}^*$	$\Xi'_c \bar{K}^*$
Threshold	2965	3074	3185	3243	3327	3363	3472

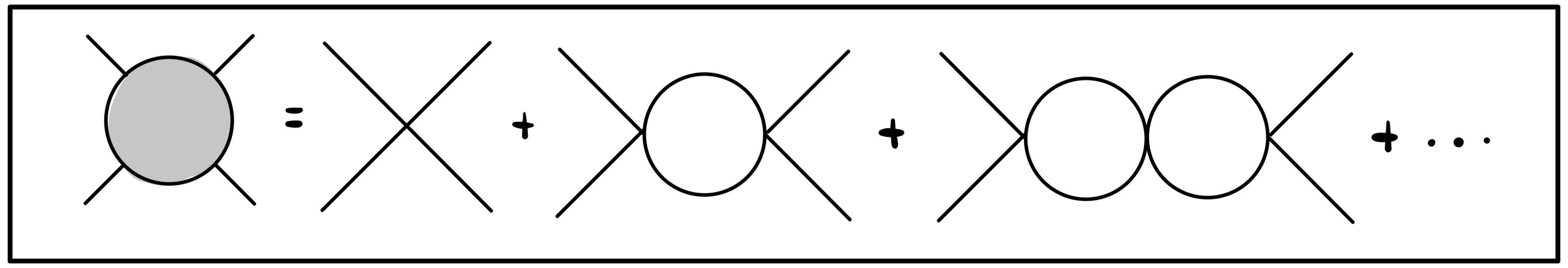
TABLE II. $J = 3/2$ states chosen and threshold mass in MeV.

States	$\Xi^*_c \bar{K}$	$\Omega^*_c \eta$	ΞD^*	$\Xi_c \bar{K}^*$	$\Xi^* D$	$\Xi'_c \bar{K}^*$
Threshold	3142	3314	3327	3363	3401	3472

$$V_{ij} = D_{ij} \frac{2\sqrt{s} - M_{B_i} - M_{B_j}}{4 f_\pi^2} \sqrt{\frac{M_{B_i} + E_{B_i}}{2M_{B_i}}} \sqrt{\frac{M_{B_j} + E_{B_j}}{2M_{B_j}}}$$

Phys. Rev. Lett. 118, 182001 (2017)





$$T = \frac{V}{(1 - VG)}$$

LHCb

$\Omega_c(3050)$

$\Gamma \sim (0.88 \pm 0.2 \pm 0.1)$ MeV

$\Omega_c(3090)$

$\Gamma \sim (8.7 \pm 1.0 \pm 0.8)$ MeV

$\Omega_c(3119)$

$\Gamma \sim (1.1 \pm 0.8 \pm 0.4)$ MeV

Pseudoscalar meson - Baryon (1/2)

Pole position [MeV], couplings g_i [dimensionless], and wave functions at the origin $g_iG_i^{II}$ [MeV] from pseudoscalar(0^-)-baryon($1/2^+$) interaction describing the $\Omega_c(3050)$ and $\Omega_c(3090)$.

3054.05 + i0.44	$\Xi_c\bar{K}$	$\Xi_c'\bar{K}$	ΞD	$\Omega_c\eta$
g_i	$-0.06 + i0.14$	**$1.94 + i0.01$**	$-2.14 + i0.26$	$1.98 + i0.01$
$g_iG_i^{II}$	$-1.40 - i3.85$	**$-34.41 - i0.30$**	$9.33 - i1.10$	$-16.81 - i0.11$
3091.28 + i5.12	$\Xi_c\bar{K}$	$\Xi_c'\bar{K}$	ΞD	$\Omega_c\eta$
g_i	$0.18 - i0.37$	$0.31 + i0.25$	**$5.83 - i0.20$**	$0.38 + i0.23$
$g_iG_i^{II}$	$5.05 + i10.19$	$-9.97 - i3.67$	**$-29.82 + i0.31$**	$-3.59 - i2.23$

Pseudoscalar meson - Baryon (3/2)

The coupling constants to various channels for the poles in the $J^P = 3/2^-$ sector, with $q_{\max} = 650$ MeV, and $g_iG_i^{II}$ in MeV.

3124.84	$\Xi_c^*\bar{K}$	$\Omega_c^*\eta$	ΞD^*	$\Xi_c\bar{K}^*$	$\Xi^* D$	$\Xi_c'\bar{K}^*$
g_i	1.95	1.98	0	0	−0.65	0
$g_iG_i^{II}$	−35.65	−16.83	0	0	1.93	0
3290.31 + i0.03	$\Xi_c^*\bar{K}$	$\Omega_c^*\eta$	ΞD^*	$\Xi_c\bar{K}^*$	$\Xi^* D$	$\Xi_c'\bar{K}^*$
g_i	$0.01 + i0.02$	$0.31 + i0.01$	0	0	$6.22 - i0.04$	0
$g_iG_i^{II}$	$-0.62 - i0.18$	$-5.25 - i0.18$	0	0	$-31.08 + i0.20$	0

Ω_b states
as meson-baryon interactions

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Nuclear Physics B 930 (2018) 524–532

NUCLEAR PHYSICS B

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Molecular Ω_b states

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[b] Departamento de Física Teórica and IFIC, Centro Mixto Universidad de Valencia - CSIC, Institutos de Investigación de Paterna, Aptdo. 22085, 46071 Valencia, Spain
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Channels

The pseudoscalar–baryon states with $J^P = \frac{1}{2}^-$ and their threshold masses in MeV.

States	$\Xi_b \bar{K}$	$\Xi'_b \bar{K}$	$\Omega_b \eta$	$\Xi \bar{B}$
Threshold	6289	6431	6594	6598

The pseudoscalar–baryon states with $J^P = \frac{3}{2}^-$ and their threshold masses in MeV.

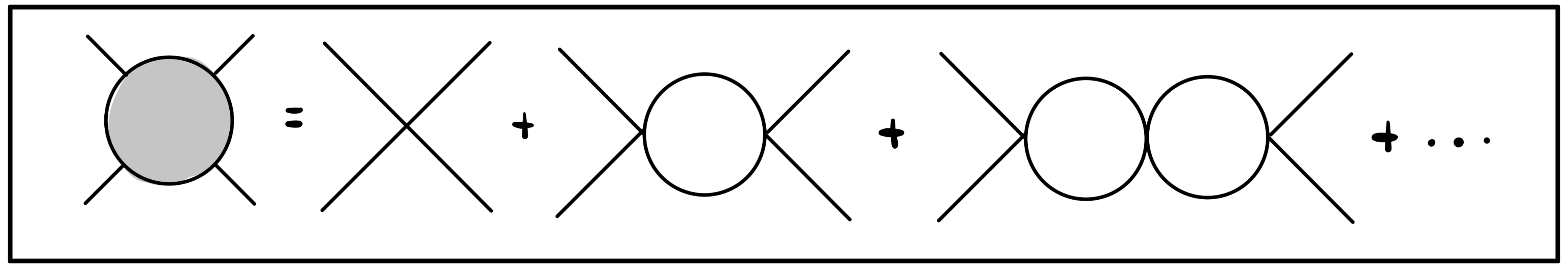
States	$\Xi^*_b \bar{K}$	$\Omega^*_b \eta$	$\Xi^* \bar{B}$
Threshold	6451	6619	6813

The vector–baryon states with $J^P = \frac{1}{2}^-, \frac{3}{2}^-$ and their threshold masses in MeV.

States	$\Xi \bar{B}^*$	$\Xi_b \bar{K}^*$	$\Xi'_b \bar{K}^*$
Threshold	6643	6687	6829

Channels

$$V_{ij} = D_{ij} \frac{2\sqrt{s} - M_{B_i} - M_{B_j}}{4 f_\pi^2} \sqrt{\frac{M_{B_i} + E_{B_i}}{2M_{B_i}}} \sqrt{\frac{M_{B_j} + E_{B_j}}{2M_{B_j}}}$$



$$T = \frac{V}{(1 - VG)}$$

The poles, and coupling constants of the poles to various channels in the PB sector with $J^P = 1/2^-$, taking $q_{max} = 650$ MeV. g_i has no dimension and $g_i\,G_i^{II}$ has dimension of MeV.

6405.2	$\Xi_b \bar{K}$	$\Xi_b' \bar{K}$	$\Xi \bar{B}$	$\Omega_b \eta$
g_i	$-0.01 + i0.02$	$\mathbf{2.04 + i0.01}$	$-1.62 + i0.02$	$\mathbf{2.08 + i0.01}$
$g_i\,G_i^{II}$	$-0.34 - i0.47$	$\mathbf{-37.31 - i0.18}$	$2.27 - i0.02$	$\mathbf{-18.28 - i0.09}$

$\mathbf{6465.3 + i1.2}$	$\Xi_b \bar{K}$	$\Xi_b' \bar{K}$	$\Xi \bar{B}$	$\Omega_b \eta$
g_i	$0.07 - i0.15$	$0.11 + i0.125$	$\mathbf{10.70 - i0.10}$	$0.15 + i0.11$
$g_i\,G_i^{II}$	$3.92 + i3.91$	$-4.53 - i1.66$	$\mathbf{-18.89 + i0.08}$	$-1.55 - i1.14$

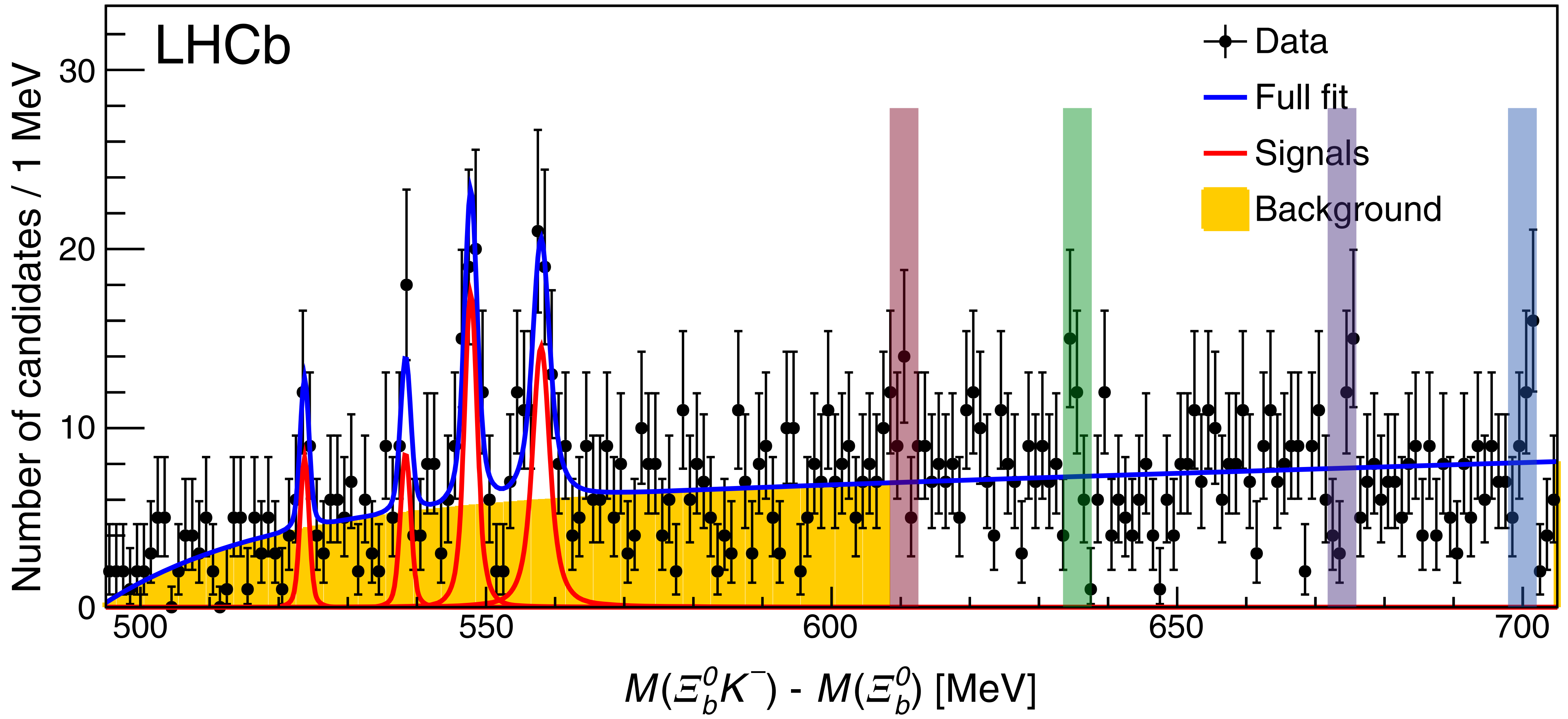
The poles, and coupling constants of the poles to various channels in the PB sector with $J^P = 3/2^-$, taking $q_{max} = 650$ MeV. g_i has no dimension and $g_i\,G_i^{II}$ has dimension of MeV.

6427.1	$\Xi_b^* \bar{K}$	$\Omega_b^* \eta$	$\Xi^* \bar{B}$
g_i	**2.01**	**2.05**	-0.60
$g_i\,G_i^{II}$	**−37.17**	**−17.86**	0.53

The poles, and coupling constants of the poles to various channels in the VB sector with $J^P = 1/2^-, 3/2^-$, taking $q_{max} = 650$ MeV. g_i has no dimension and $g_i\,G_i^{II}$ has dimension of MeV.

6508.0	$\Xi \bar{B}^*$	$\Xi_b \bar{K}^*$	$\Xi_b' \bar{K}^*$
g_i	**10.88**	0.32	-0.15
$g_i\,G_i^{II}$	**−18.86**	-2.37	0.77

Phys. Rev. Lett. 124, 082002 (2020)

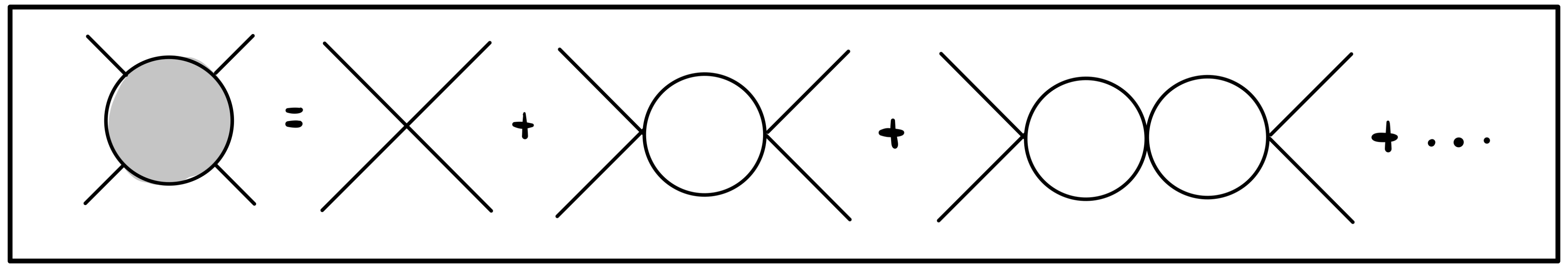


~ 6402 MeV

~ 6495 MeV

~ 6427 MeV

~ 6468 MeV



$$T = \frac{V}{(1 - VG)}$$

Ξ_{cc} states
as meson-baryon interactions

PHYSICAL REVIEW D **98,** 094017 (2018)

Channels

TABLE I. Baryon-pseudoscalar states ($J^P = 1/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi'_c D_s$
Threshold	3759	4154	4169	4208	4321	4438	4545

TABLE II. Baryon-pseudoscalar states ($J^P = 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi^*_{cc}\pi$	$\Xi^*_{cc}\eta$	$\Omega^*_{cc}K$	$\Sigma^*_c D$	$\Xi^*_c D_s$
Threshold	3840	4250	4291	4385	4615

TABLE III. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Lambda_c D^*$	$\Xi_{cc}\rho$	$\Xi_{cc}\omega$	$\Sigma_c D^*$	$\Xi_c D^*_s$	$\Omega_{cc}K^*$	$\Xi_{cc}\phi$	$\Xi'_c D^*_s$
Threshold	4295	4397	4404	4462	4582	4606	4641	4689

TABLE IV. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-, 5/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi^*_{cc}\rho$	$\Xi^*_{cc}\omega$	$\Sigma^*_c D^*$	$\Omega^*_{cc}K^*$	$\Xi^*_{cc}\phi$	$\Xi^*_c D^*_s$
Threshold	4478	4485	4526	4689	4722	4759

Doubly charmed Ξ_{cc} molecular states from meson-baryon interaction

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Results

TABLE XI. Poles and couplings in the $PB_{1/2}$, $J^P = 1/2^-$ sector, with $q_{\max} = 650$ MeV, and $g_l G_l^{\rm II}$ in MeV.

3837.26 + i100.48	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi'_c D_s$
g_l	**1.72 + i1.30**	0	0.41 + i0.32	0.80 + i0.77	0	0	0
$g_l G_l^{II}$	**−74.27 − i12.89**	0	−2.11 − i2.41	−4.03 − i5.35	0	0	0
4082.79	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi'_c D_s$
g_l	0	0	0	0	**8.86**	0	1.93
$g_l G_l^{\rm II}$	0	0	0	0	**−31.29**	0	−4.04
4092.20	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi'_c D_s$
g_l	0	**4.01**	0	0	0	3.75	0
$g_l G_l^{\rm II}$	0	**−29.49**	0	0	0	−9.76	0

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Results

TABLE XII. Poles and couplings in the $PB_{3/2}$, $J^P = 3/2^-$ sector, with $q_{\rm max} = 650$ MeV, and $g_l G_l^{\rm II}$ in MeV.

3918.15 + i100.32	$\Xi_{cc}^*\pi$	$\Xi_{cc}^*\eta$	Ω_{cc}^*K	Σ_c^*D	$\Xi_c^*D_s$
g_l	**1.72 + i1.30**	0	$0.41 + i0.32$	$0.80 + i0.76$	0
$g_l G_l^{II}$	**−74.27 − i12.91**	0	$-2.10 - i2.41$	$-3.99 - i5.30$	0
4149.67	$\Xi_{cc}^*\pi$	$\Xi_{cc}^*\eta$	Ω_{cc}^*K	Σ_c^*D	$\Xi_c^*D_s$
g_l	0	0	0	**8.82**	1.30
$g_l G_l^{\rm II}$	0	0	0	**−31.46**	−2.71

Channels

TABLE I. Baryon-pseudoscalar states ($J^P = 1/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi_c' D_s$
Threshold	3759	4154	4169	4208	4321	4438	4545

TABLE II. Baryon-pseudoscalar states ($J^P = 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}^*\pi$	$\Xi_{cc}^*\eta$	Ω_{cc}^*K	Σ_c^*D	$\Xi_c^*D_s$
Threshold	3840	4250	4291	4385	4615

TABLE III. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Lambda_c D^*$	$\Xi_{cc}\rho$	$\Xi_{cc}\omega$	$\Sigma_c D^*$	$\Xi_c D_s^*$	$\Omega_{cc}K^*$	$\Xi_{cc}\phi$	$\Xi_c' D_s^*$
Threshold	4295	4397	4404	4462	4582	4606	4641	4689

TABLE IV. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-, 5/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}^*\rho$	$\Xi_{cc}^*\omega$	$\Sigma_c^*D^*$	$\Omega_{cc}^*K^*$	$\Xi_{cc}^*\phi$	$\Xi_c^*D_s^*$
Threshold	4478	4485	4526	4689	4722	4759

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Results

TABLE XIV. Poles and couplings in the $VB_{3/2}$, $J^P = 1/2^-, 3/2^-, 5/2^-$ sector, with $q_{\max} = 650$ MeV, and $g_l G_l^{\rm II}$ in MeV.

4280.43	$\Xi_{cc}^*\rho$	$\Xi_{cc}^*\omega$	$\Sigma_c^* D^*$	$\Omega_{cc}^* K^*$	$\Xi_{cc}^*\phi$	$\Xi_c^* D_s^*$
g_l	0	0	**9.31**	0	0	2.03
$g_l G_l^{\rm II}$	0	0	**−30.42**	0	0	−3.90
4374.00	$\Xi_{cc}^*\rho$	$\Xi_{cc}^*\omega$	$\Sigma_c^* D^*$	$\Omega_{cc}^* K^*$	$\Xi_{cc}^*\phi$	$\Xi_c^* D_s^*$
g_l	**3.70**	1.15	0	2.42	−0.44	0
$g_l G_l^{\rm II}$	**−37.53**	−11.30	0	−12.35	1.94	0

Channels

TABLE I. Baryon-pseudoscalar states ($J^P = 1/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}\pi$	$\Lambda_c D$	$\Xi_{cc}\eta$	$\Omega_{cc}K$	$\Sigma_c D$	$\Xi_c D_s$	$\Xi_c' D_s$
Threshold	3759	4154	4169	4208	4321	4438	4545

TABLE II. Baryon-pseudoscalar states ($J^P = 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}^*\pi$	$\Xi_{cc}^*\eta$	$\Omega_{cc}^* K$	$\Sigma_c^* D$	$\Xi_c^* D_s$
Threshold	3840	4250	4291	4385	4615

TABLE III. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-$) chosen and threshold mass in MeV.

Channel	$\Lambda_c D^*$	$\Xi_{cc}\rho$	$\Xi_{cc}\omega$	$\Sigma_c D^*$	$\Xi_c D_s^*$	$\Omega_{cc} K^*$	$\Xi_{cc}\phi$	$\Xi_c' D_s^*$
Threshold	4295	4397	4404	4462	4582	4606	4641	4689

TABLE IV. Baryon-vector meson states ($J^P = 1/2^-, 3/2^-, 5/2^-$) chosen and threshold mass in MeV.

Channel	$\Xi_{cc}^*\rho$	$\Xi_{cc}^*\omega$	$\Sigma_c^* D^*$	$\Omega_{cc}^* K^*$	$\Xi_{cc}^*\phi$	$\Xi_c^* D_s^*$
Threshold	4478	4485	4526	4689	4722	4759

Ξ_{bb} states
as meson-baryon interactions

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Ξ_{bb} and Ω_{bbb} molecular states*

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Results

- 10408 MeV $\Rightarrow \Xi_{bb}\pi$
  $\Gamma \sim 186$ MeV
- 10686 MeV $\Rightarrow \Sigma_b \bar{B}$
  $\Gamma \sim 0.08$ MeV

Channels

Table 3. Pseudoscalar-baryon($\frac{1}{2}^+$) (PB) channels considered for the sector with $J^P = \frac{1}{2}^-$.

channel	$\Xi_{bb}\pi$	$\Xi_{bb}\eta$	$\Omega_{bb}K$	$\Lambda_b\bar{B}$	$\Sigma_b\bar{B}$	$\Xi_b\bar{B}_s$	$\Xi'_b\bar{B}_s$
threshold/MeV	10335	10745	10756	10899	11092	11160	11302

- 10732 MeV $\Rightarrow \Sigma_b \bar{B}^*$
- 10807 MeV $\Rightarrow \Lambda_b \bar{B}^*$
- 10869 MeV $\Rightarrow \Xi_{bb}\rho$

Table 5. Vector-baryon($\frac{1}{2}^+$) (VB) channels considered for the sector with $J^P = \frac{1}{2}^-, \frac{3}{2}^-$.

channel	$\Lambda_b\bar{B}^*$	$\Xi_{bb}\rho$	$\Xi_{bb}\omega$	$\Sigma_b\bar{B}^*$	$\Omega_{bb}K^*$	$\Xi_b\bar{B}^*_s$	$\Xi_{bb}\phi$	$\Xi'_b\bar{B}^*_s$
threshold/MeV	10945	10972	10980	11138	11156	11208	11216	11350

channel	$\Xi^*_{bb}\pi$	$\Xi^*_{bb}\eta$	$\Omega^*_{bb}K$	$\Sigma^*_b\bar{B}$	$\Xi^*_b\bar{B}_s$
threshold/MeV	10374	10784	10793	11113	11320

Conclusions

1) The new hadronic states have been challenging our comprehension of the QCD dynamics at low-energies;

2) The Chiral Unitary approach has been proving a successful tool to describe these new states at the heavy sector;

3) We have investigated the meson-baryon interaction in coupled-channels to describe the properties of the new baryon structures observed by the LHCb: $\Omega_{c(b)}$ states. In particular, our results are in good agreement with those reported by the LHCb collaboration;

4) Motived by such agreement we have extended the model for different quark flavor configurations in order to make predictions for new structures;

5) The success in describing the hidden charm pentaquark states supports our confidence that such predictions are realistic.