STRONG COUPLING CONSTANTS OF HEAVY BARYONS WITH LIGHT MESONS IN QCD

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Outline

- Introduction
- Interpolating Currents
- Sum Rules for Strong Coupling Constants of Heavy Baryons with Light Mesons
- Results & Conclusion

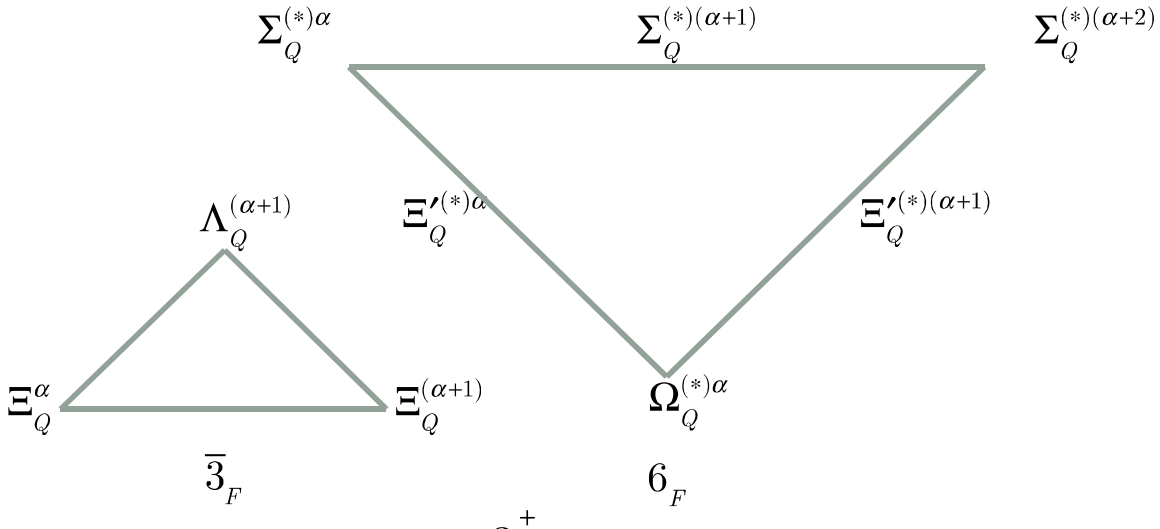
Introduction

- $SU(3)$ classifications of heavy baryons

$3 \times 3 = 6 + \overline{3}$

- Ground states : 1 for 6_F (two light
- Total spin 0 for $\overline{3}_F$ quarks)
- $J^P = \frac{1}{2}^+$ or $\frac{3}{2}^+$ 6_F

$J^P = \frac{1}{2}^+$ $\overline{3}_F$



$\alpha, \alpha+1, \alpha+2$

$(\alpha = -1 \text{ or } 0)$(Charges of baryons, $*$ – denote $J^P = \frac{3}{2}^+$ states

Introduction

Exciting experimental results :

- $\frac{1}{2}^+$ and $\frac{1}{2}^-\overline{3}_F$ states $\Lambda^+_c, \Xi^+_c, \Xi^0_c$

  $\Lambda^+_c(2593), \Xi^+_c(2790), \Xi^0_c(2790)$

- $\frac{1}{2}^+$ and $\frac{3}{2}^+ 6_F$ states $\Omega^{(*)}_c, \Sigma^{(*)}_c, \Xi^{(*)}_c$ are observed
- $\Lambda_b, \Sigma_b, \Sigma_b^*, \Xi_b^0$ and Ω_b are observed.
- LHC B - $\Lambda^*_b(5912), \Lambda^*_b(5920)$
- LHC (CMS) $\Xi_b^{*0}(5945)$
- LHC - New window for Heavy Baryon Physics.

Introduction

- A detailed theoretical study of experimental results and various weak & strong decays can provide us useful information about the quark structure of new hadrons at $\Lambda_{had}(\rightarrow$ non-perturbative sector).

- Nonperturbative methods

- SUM RULES (STANDART OR LIGHT CONE VERSION)

$B_Q B_Q M$ Coupling Constants in QCD

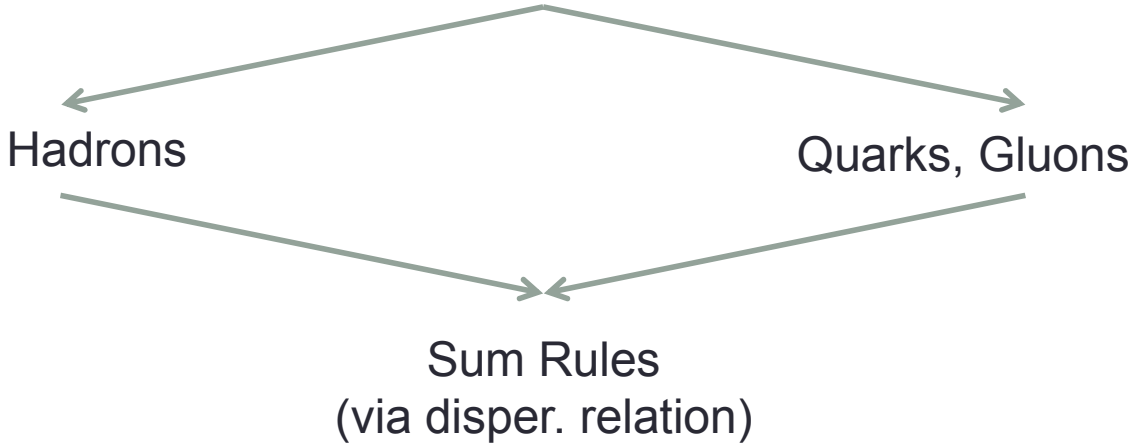
$$\Pi^{ij}{}_{(\mu),(\nu)} = i\int d^4x e^{ipx} \left\langle M(q)\left|\left\{\eta^{(i)}{}_{(\mu)}\eta^{(i)}{}_{(\nu)}\right\}\right|0\right\rangle$$

$i=1, j=1$ $\quad 6 \text{ - } 6$

$i=1, j=2$ $\quad 6 \text{ - } \overline{3}$

$i=2, j=2$ $\quad$ Antitriplet - antitriplet

- Π – two different representations



Interpolating Currents

$$\eta^{(s)} = -\frac{1}{\sqrt{2}}\varepsilon^{abc}\Big\{(q_1^{aT} c Q^b)\gamma_5 q_2^c - (Q^{aT} c q_2^b)\gamma_5 q_1^c + \beta\Big[(q_1^{aT} c\gamma_5 Q^b) q_2^c - (Q^{aT} c\gamma_5 q_2^b) q_1^c\Big]\Big\}$$

$$\eta^{(a)} = \frac{1}{\sqrt{6}}\varepsilon^{abc}\Big\{2(q_1^{aT} C q_2^b)\gamma_5 Q^c + (q_1^{aT} C Q^b)\gamma_5 q_2^c + (Q^{aT} C q_2^b)\gamma_5 q_1^c + \beta\Big[2(q_1^{aT} C\gamma_5 q_2^b) Q^c + (q_1^{aT} C\gamma_5 Q^b) q_2^c + (Q^{aT} C\gamma_5 q_2^b) q_1^c\Big]\Big\}$$

$\eta^{(s)}$ is symmetric $q_1 \leftrightarrow q_2$

$\eta^{(a)}$ is antisymmetric $q_1 \leftrightarrow q_2$

Interpolating Currents

	q_1	q_2
$\Sigma_{b(c)}^{+(++)}$	u	u
$\Sigma_{b(c)}^{0(+)}$	u	d
$\Sigma_{b(c)}^{-(0)}$	d	d
$\Xi_{b(c)}^{\prime -(0)}$	d	s
$\Xi_{b(c)}^{\prime 0(+)}$	u	s
$\Omega_{b(c)}^{-(0)}$	s	s
$\Lambda_{b(c)}^{0(+)}$	u	d
$\Xi_{b(c)}^{-(0)}$	d	s
$\Xi_{b(c)}^{0(+)}$	u	s

Interpolating Currents

$$\eta_\mu = A\varepsilon^{abc}\left\{(q_1^{aT} C\gamma_\mu q_2^{b})Q^c + (q_2^{aT} C\gamma_\mu Q^{b})q_2^{c} + (Q^{aT} C\gamma_\mu q_1^{b})q_2^{c}\right\}$$

	q_1	q_2	A
$\Sigma_{b(c)}^{*+(++)}$	u	u	$1/\sqrt{3}$
$\Sigma_{b(c)}^{*0(+)}$	u	d	$\sqrt{2}/\sqrt{3}$
$\Sigma_{b(c)}^{*-(0)}$	d	d	$1/\sqrt{3}$
$\Xi_{b(c)}^{*0(+)}$	u	s	$\sqrt{2}/\sqrt{3}$
$\Xi_{b(c)}^{*-(0)}$	d	s	$\sqrt{2}/\sqrt{3}$
$\Omega_{b(c)}^{*-(0)}$	s	s	$1/\sqrt{3}$

Relations Between Invariant Functions

SSP:

$$\Pi^{\Sigma_b^0\to\Sigma_b^0\pi^0} = g_{\pi uu}\Pi_1^{(1)}(u,d,b) + g_{\pi dd}\Pi_1'^{(1)}(u,d,b) + g_{\pi bb}\Pi_2^{(1)}(u,d,b)$$

$$J_{\pi^0} = \sum g_{\pi qq}\bar{q}\gamma_5 q$$

$$\Rightarrow g_{\pi uu} = -g_{\pi dd} = \frac{1}{\sqrt{2}},\ g_{\pi bb} = 0$$

$$\Pi_1'^{(1)}(u,d,b) = \Pi_1^{(1)}(d,u,b)$$

$$\Pi^{\Sigma_b^0\to\Sigma_b^0\pi^0} = \frac{1}{\sqrt{2}}\left[\Pi_1^{(1)}(u,d,b) - \Pi_1^{(1)}(d,u,b)\right]$$

In $SU(2)$ limit $\Pi^{\Sigma_b^0\to\Sigma_b^0\pi^0} = 0$

Relations Between Invariant Functions

- For $\Sigma_b^+ \to \Sigma_b^+ \pi^0$ can be obtained from

$\Sigma_b^0 \to \Sigma_b^0 \pi^0 : d \to u$ and $\Sigma_b^0 = -\sqrt{2}\Sigma_b^+$

$$\underset{\downarrow}{4}\,\Pi_1^{(1)}(u,d,b) = -2\left\langle uu \left| \Sigma^+\Sigma^+ \right| 0 \right\rangle$$

Σ^+ cont. $2u \to 4$ ways for rad. π^0 from u

$$\Pi^{\Sigma_b^+ \to \Sigma_b^+ \pi^0} = \sqrt{2}\Pi_1^{(1)}(u,u,b)$$

- $\Xi_b'^{-(0)} \to \Xi_b'^{-(0)} \pi^0$

From $\Sigma_b^0 \to \Sigma_b^0 \pi^0 : \Xi_b'^0 = \Sigma_b^0(d \to s),\ \Xi_b'^- = \Sigma_b^0(u \to s)$

$$\Pi^{\Xi_b'^0 \to \Xi_b'^0 \pi^0} = \frac{1}{\sqrt{2}}\,\Pi_1^{(1)}(u,s,b)$$

$$\Pi^{\Xi_b'^- \to \Xi_b'^- \pi^0} = -\frac{1}{\sqrt{2}}\,\Pi_1^{(1)}(d,s,b)$$

Relations Between Invariant Functions

- For charged pion

$$\left\langle \bar{d}d \left| \Sigma_b{}^0 \bar{\Sigma}^0{}_b \right| 0 \right\rangle$$

d from Σ_b, $\bar{d}$ from $\bar{\Sigma}^0{}_b$ form $\bar{d}d$ final state u,b, spectators

$$\left\langle \bar{u}d \left| \Sigma^+{}_b \bar{\Sigma}_b{}^0 \right| 0 \right\rangle \sim \left\langle dd \left| \Sigma^0{}_b \bar{\Sigma}_b \right| 0 \right\rangle$$

Calculations :

$$\Pi^{\Sigma_b{}^0 \to \Sigma_b{}^+ \pi^-} = \left\langle \bar{u}d \left| \Sigma^+{}_b \bar{\Sigma}_b{}^0 \right| 0 \right\rangle = -\sqrt{2} \left\langle \bar{d}d \left| \Sigma^0{}_b \Sigma^0{}_b \right| 0 \right\rangle$$

$$= -\sqrt{2}\Pi_1{}^{(1)}(d,u,b)$$

$u \leftrightarrow d$

$$\Pi^{\Sigma_b{}^0 \to \Sigma_b{}^- \pi^+} = \sqrt{2} \left\langle u\bar{u} \left| \Sigma^0{}_b \bar{\Sigma}^0{}_b \right| 0 \right\rangle = \Pi_1{}^{(1)}(u,d,b)$$

Relations Between Invariant Functions

Similar arguments holds for all
SSP, SAP, AAP, SSV, SAV, AAV
transitions:

- Main results: All these transitions (with P, V) can be represented in terms of only one invariant function for each class.
- Relations among the invariant functions are structure independent, but their explicit forms are structure dependent.

$B_Q B_Q M$ Coupling Constants in QCD

$$\Pi^{ij}_{(\mu),(\nu)} = \frac{\left\langle 0\left|\eta^{(i)}{}_{(\mu)}\right|B_2(p)\right\rangle\left\langle B_2(p)M(q)\left|B_1(p+q)\right.\right\rangle\left\langle B_1(p+q)\left|\overline{\eta}_\nu{}^j\right|0\right\rangle}{\left(p^2-m_2{}^2\right)\left[(p+q)^2-m_1{}^2\right]}$$

$+\ldots$

Matrix Elements

$$\left\langle 0\left|\eta^{(i)}{}_{(\mu)}\right|B_2(p)\right\rangle = \lambda^i u_{(\mu)}(p)$$

$$\left\langle B_1(p+q)\left|\overline{\eta}_\nu{}^j\right|0\right\rangle = \lambda^j \overline{u}(p+q)$$

$$\left\langle B_2(p)M(q)\left|B_1(p+q)\right.\right\rangle =$$

$B_Q B_Q M$ Coupling Constants in QCD

$$= g\bar{u}(p) i\gamma_5 u(p+q) \qquad \text{spin } 1/2 \;\; \text{spin } 1/2 \;\; P$$

$$\bar{u}(p)\left[f_1\gamma_\mu - i\frac{\sigma_{\mu\nu}q^\nu}{m_1+m_2} f_2 \right] u(p+q)\varepsilon^\mu \; 1/2 \to 1/2V$$

charge — magnetic formfactors

$$g\bar{u}(p)u_\alpha(p+q)q^\alpha \quad 3/2 \to 1/2P$$

$$\bar{u}(p)\{g_1(q_\alpha \not{\varepsilon} - \varepsilon_\alpha \not{q})\gamma_5 + g_2((p\varepsilon)q_\alpha - Pq\varepsilon_\alpha)\gamma_5 +$$

$$g_3((q\varepsilon)q_\alpha - q^2\varepsilon_\alpha)\gamma_5\}u_\alpha(p+q) \quad 3/2 \to 1/2V$$

$B_Q B_Q M$ Coupling Constants in QCD

$$g\bar{u}_\alpha(p) i\gamma_5 u_\alpha(p+q) \quad 3/2 \to 3/2P$$

$$\bar{u}_\alpha(p)\left\{ g^{\alpha\beta}\left[\not{\varepsilon} g_1 + 2p\varepsilon \frac{g_2}{m_1+m_2} \right] + \right.$$

$$\left. \frac{q^\alpha q^\beta}{(m_1+m_2)^2}\left[\not{\varepsilon} g_3 + 2p\varepsilon \frac{g_4}{m_1+m_2} \right] \right\} u^\beta(p+q)$$

$$3/2 \to 3/2V$$

$B_Q B_Q M$ Coupling Constants in QCD

Two problems (in participation of spin $3/2$ baryons)

- The spin $1/2$ states also contribute to the matrix element

$$\left\langle 0\left|\eta_\mu\right|B\left(1/2\right)\right\rangle = A\left(\gamma_\mu - \frac{4}{m}p_\mu\right)u(p)$$

i.e. η_μ – couples to both spin $3/2$ and spin $1/2$

- Not all structures are independent.

$B_Q B_Q M$ Coupling Constants in QCD

Solution: Ordering Dirac Matrices!

In $\frac{3}{2} \to \frac{1}{2} P$ Ordering $\not{q}\not{p}\gamma_\mu$ ($\not{q} q_\mu$ structure is chosen)

$\frac{3}{2} \to \frac{1}{2} V$ Ordering $\gamma_\mu \not{\varepsilon}\not{q}\not{p}\gamma_5$

$\not{\varepsilon}\not{p}\gamma_5 q_\mu$	for g_1
$\not{q}\not{p}(p\varepsilon)$	g_2
$q^2 \not{q}\not{p}\varepsilon_\mu \gamma_5$	g_3

$B_Q B_Q M$ Coupling Constants in QCD

$\frac{3}{2} \to \frac{3}{2} P \qquad \gamma_\mu \not{p} \not{q} \gamma_\nu \gamma_5$

$g_{\mu\nu} \not{p} \not{q} \gamma_5$

$\frac{3}{2} \to \frac{3}{2} V \quad \gamma_\mu \not{\varepsilon} \not{q} \not{p} \gamma_\nu$

$g_{\mu\nu} q \varepsilon p \qquad g_1 + \dfrac{g_2 m_2}{m_1 + m_2}$

$q_\mu q_\nu \varepsilon q p \qquad \dfrac{g_2}{m_1 + m_2}$

$2 \varepsilon p q_\mu q_\nu q p \qquad \dfrac{g_3}{(m_1 + m_2)^2}$

Results

SSP	Bottom Baryons	Charmed Baryons
$g^{\Xi_Q^{10(+)}\to\Xi_Q^{10(+)}\pi^0}$	9 ± 3	4 ± 1.4
$g^{\Sigma_Q^{0(+)}\to\Sigma_Q^{-(0)}\pi^+}$	17 ± 6	8 ± 2.8
$g^{\Xi_Q^{10(+)}\to\Sigma_Q^{+(++)}K^-}$	19 ± 6.7	9 ± 3.4
$g^{\Omega_Q^{-(0)}\to\Xi_Q^{10(+)}K^-}$	21 ± 6.8	9 ± 3.4
SAP		
$g^{\Xi_Q^{10(+)}\to\Xi_Q^{10(+)}\pi^0}$	7.5 ± 2.6	3.1 ± 1.1
$g^{\Sigma_Q^{-(0)}\to\Lambda_Q^{0(+)}\pi^-}$	15 ± 4.9	6.5 ± 2.4
$g^{\Sigma_Q^{0(+)}\to\Xi_Q^{0(+)}\bar{K}^0}$	11.5 ± 3.9	5.0 ± 1.7
$g^{\Xi_Q^{10(+)}\to\Xi_Q^{-(+)}K^+}$	12 ± 4.3	4.5 ± 1.6
AAP		
$g^{\Xi_Q^{0(+)}\to\Xi_Q^{0(+)}\pi^0}$	1 ± 0.3	0.7 ± 0.22
$g^{\Xi_Q^{-(0)}\to\Lambda_Q^{0(+)}K^-}$	1.5 ± 0.5	0.9 ± 0.3
$g^{\Xi_Q^{0(+)}\to\Xi_Q^{0(+)}\eta_1}$	0.6 ± 0.2	0.07 ± 0.02
$g^{\Lambda_Q^{0(+)}\to\Lambda_Q^{0(+)}\eta_1}$	1 ± 0.3	0.75 ± 0.24

$f_1$channel	Bottom Baryons		$f_1$channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\rho^0}$	2.2±0.7	2.0±0.7	$f_1^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\rho^0}$	2.5±0.8	5.0±1.7
$f_1^{\Sigma_b^0\to\Sigma_b^-\rho^+}$	4.5±1.5	3.4±1.1	$f_1^{\Sigma_c^+\to\Sigma_c^0\rho^+}$	4.0±1.3	3.4±1.1
$f_1^{\Xi_b^{\prime 0}\to\Sigma_b^+K^{*-}}$	6.0±2.0	3.9±1.3	$f_1^{\Xi_c^{\prime +}\to\Sigma_c^{++}K^{*-}}$	5.0±1.7	3.8±1.3
$f_1^{\Omega_b^-\to\Xi_b^{\prime 0}\bar{K}^{*-}}$	6.0±2.0	4.8±1.6	$f_1^{\Omega_c^0\to\Xi_c^{\prime +}\bar{K}^{*-}}$	7.0±2.0	14.0±5.0
$f_1^{\Sigma_b^+\to\Sigma_b^+\omega}$	4.0±1.3	3.0±1.0	$f_1^{\Sigma_c^{++}\to\Sigma_c^{++}\omega}$	3.5±1.2	3.0±1.0
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\omega}$	2.1±0.7	1.7±0.6	$f_1^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\omega}$	2.4±0.8	4.9±1.6
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\phi}$	5.0±1.7	2.6±0.9	$f_1^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\phi}$	4.0±1.3	2.5±0.8
$f_1^{\Omega_b^-\to\Omega_b^-\phi}$	10.0±3.4	7.0±2.4	$f_1^{\Omega_c^0\to\Omega_c^0\phi}$	11.0±4.0	23.0±8.0

The values of the strong coupling constants f_1 for the transitions among the sextet–sextet heavy baryons with vector mesons.

$f_1$channel	Bottom Baryons		$f_1$channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^0\rho^0}$	1.4±0.5	0.6±0.2	$f_1^{\Xi_c^{\prime +}\to\Xi_c^+\rho^0}$	1.5±0.5	0.7±0.2
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^- K^{*+}}$	2.5±0.8	1.3±0.4	$f_1^{\Xi_c^{\prime +}\to\Xi_c^0 K^{*+}}$	2.3±0.8	1.2±0.4
$f_1^{\Sigma_b^-\to\Lambda_b^0\rho^-}$	2.8±0.9	0.8±0.3	$f_1^{\Sigma_c^0\to\Lambda_c^+\rho^-}$	2.6±0.9	0.6±0.2
$f_1^{\Sigma_b^0\to\Xi_b^0\bar{K}^{*0}}$	2.6±0.8	1.5±0.5	$f_1^{\Sigma_c^+\to\Xi_c^+\bar{K}^{*0}}$	2.2±0.7	0.8±0.3
$f_1^{\Omega_b^-\to\Xi_b^-\bar{K}^{*0}}$	3.5±1.2	2.0±0.6	$f_1^{\Omega_c^0\to\Xi_c^0\bar{K}^{*0}}$	3.3±1.1	1.7±0.6
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^-\omega}$	1.3±0.4	0.5±0.2	$f_1^{\Xi_c^{\prime +}\to\Xi_c^0\omega}$	1.2±0.4	1.1±0.4
$f_1^{\Xi_b^{\prime 0}\to\Xi_b^0\phi}$	2.6±0.9	2.0±0.7	$f_1^{\Xi_c^{\prime +}\to\Xi_c^+\phi}$	2.1±0.7	1.4±0.5

The values of the strong coupling constants f_1 for the transitions among the sextet-antitriplet heavy baryons with vector mesons.

$f_1$channel	Bottom Baryons		$f_1$channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$f_1^{\Xi_b^0\to\Xi_b^0\rho^0}$	3.1±1.1	2.5±0.8	$f_1^{\Xi_c^+\to\Xi_c^+\rho^0}$	6.0±2.0	1.5±0.5
$f_1^{\Xi_b^-\to\Lambda_b^0 K^{*-}}$	5.0±1.7	4.6±1.5	$f_1^{\Xi_c^0\to\Lambda_c^+ K^{*-}}$	4.6±1.5	4.1±1.4
$f_1^{\Xi_b^0\to\Xi_b^0\omega}$	2.8±0.9	2.3±0.8	$f_1^{\Xi_c^+\to\Xi_c^+\omega}$	5.5±1.8	1.2±0.4
$f_1^{\Lambda_b^0\to\Lambda_b^0\omega}$	5.2±1.7	4.6±1.5	$f_1^{\Lambda_c^+\to\Lambda_c^+\omega}$	4.9±1.6	4.3±1.4
$f_1^{\Lambda_b^0\to\Lambda_b^0\phi}$	5.0±1.7	4.7±1.6	$f_1^{\Lambda_c^+\to\Lambda_c^+\phi}$	4.6±1.5	4.1±1.4

The values of the strong coupling constants f_1 for the transitions among the antriplet-antitriplet heavy baryons with vector mesons.

$f_2$channel	Bottom Baryons		$f_2$channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$f_2^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\rho^0}$	30.0±10.0	39.0±13.0	$f_2^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\rho^0}$	16.0±5.2	18.0±6.0
$f_2^{\Sigma_b^0\to\Sigma_b^-\rho^+}$	55.0±18.0	72.0±24.0	$f_2^{\Sigma_c^+\to\Sigma_c^0\rho^+}$	27.0±9.0	33.0±11.0
$f_2^{\Xi_b^{\prime 0}\to\Sigma_b^+K^{*-}}$	60.0±20.0	80.0±27.0	$f_2^{\Xi_c^{\prime +}\to\Sigma_c^{++}K^{*-}}$	30.0±10.0	36.0±12.0
$f_2^{\Omega_b^-\to\Xi_b^{\prime 0}\bar{K}^{*-}}$	70.0±23.0	88.0±29.0	$f_2^{\Omega_c^0\to\Xi_c^{\prime +}\bar{K}^{*-}}$	35.0±12.0	41.0±14.0
$f_2^{\Sigma_b^+\to\Sigma_b^+\omega}$	50.0±17.0	64.0±21.0	$f_2^{\Sigma_c^{++}\to\Sigma_c^{++}\omega}$	24.0±8.0	29.0±9.5
$f_2^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\omega}$	27.0±9.0	34.0±11.0	$f_2^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\omega}$	15.0±5.0	16.0±6.3
$f_2^{\Xi_b^{\prime 0}\to\Xi_b^{\prime 0}\phi}$	45.0±15.0	57.0±19.0	$f_2^{\Xi_c^{\prime +}\to\Xi_c^{\prime +}\phi}$	21.0±7.0	26.0±8.6
$f_2^{\Omega_b^-\to\Omega_b^-\phi}$	95.0±32.0	125.0±42.0	$f_2^{\Omega_c^0\to\Omega_c^0\phi}$	52.0±17.0	60.0±20.0

The values of the strong coupling constants of f_2 for the transitions among the sextet-sextet heavy baryons with vector mesons

g channel	Bottom Baryons		g channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$g^{\Xi_b^{*0}\to\Xi_b^{\prime 0}\pi^0}$	2.0±0.4	1.6±0.4	$g^{\Xi_c^{*+}\to\Xi_c^{\prime +}\pi^0}$	2.1±0.3	2.3±0.4
$g^{\Sigma_b^{*0}\to\Sigma_b^{-}\pi^+}$	3.7±0.6	3.5±0.5	$g^{\Sigma_c^{*+}\to\Sigma_c^{0}\pi^+}$	4.2±0.5	4.3±0.4
$g^{\Xi_b^{*0}\to\Sigma_b^{+}K^-}$	4.8±1.0	2.6±0.5	$g^{\Xi_c^{*+}\to\Sigma_c^{++}K^-}$	4.5±0.5	3.9±0.4
$g^{\Omega_b^{*-}\to\Xi_b^{\prime 0}K^-}$	5.0±1.4	2.5±0.4	$g^{\Omega_c^{*0}\to\Xi_c^{\prime +}K^-}$	4.3±0.5	4.5±0.4
$g^{\Sigma_b^{*+}\to\Sigma_b^{+}\eta_1}$	2.9±0.7	2.0±0.4	$g^{\Sigma_c^{*++}\to\Sigma_c^{++}\eta_1}$	2.9±0.4	2.7±0.4
$g^{\Xi_b^{*0}\to\Xi_b^{\prime 0}\eta_1}$	1.3±0.3	0.9±0.3	$g^{\Xi_c^{*+}\to\Xi_c^{\prime +}\eta_1}$	1.5±0.3	1.0±0.2
$g^{\Omega_b^{*-}\to\Omega_b^{-}\eta_1}$	5.8±1.6	3.6±0.6	$g^{\Omega_c^{*0}\to\Omega_c^{0}\eta_1}$	5.9±0.8	5.8±0.4

Values of the strong coupling constants g in GeV^{-1} for the transitions among the sextet spin -3/2 and sextet spin -1/2 heavy baryons with pseudoscalar mesons

g channel	Bottom Baryons		g channel	Charmed Baryons	
	General current	Ioffe current		General current	Ioffe current
$g^{\Xi_b^{*0}\to\Xi_b^0\pi^0}$	3.0±0.6	1.4±0.3	$g^{\Xi_c^{*+}\to\Xi_c^+\pi^0}$	3.5±0.5	2.0±0.3
$g^{\Sigma_b^{*-}\to\Lambda_b^0\pi^-}$	6.0±1.1	2.5±0.5	$g^{\Sigma_c^{*0}\to\Lambda_c^+\pi^-}$	7.8±1.0	3.9±0.6
$g^{\Sigma_b^{*0}\to\Xi_b^0\bar{K}^0}$	3.7±0.5	2.0±0.5	$g^{\Sigma_c^{*+}\to\Xi_c^+\bar{K}^0}$	5.0±1.0	3.1±0.4
$g^{\Omega_b^{*-}\to\Xi_b^-\bar{K}^0}$	5.0±0.8	2.6±0.4	$g^{\Omega_c^{*0}\to\Xi_c^0\bar{K}^0}$	6.2±1.5	4.1±0.5
$g^{\Xi_b^{*0}\to\Xi_b^-K^+}$	3.6±0.5	1.9±0.6	$g^{\Xi_c^{*+}\to\Xi_c^0K^+}$	4.4±0.8	3.0±0.4
$g^{\Xi_b^{*0}\to\Xi_b^0\eta_1}$	5.4±1.0	2.5±0.4	$g^{\Xi_c^{*+}\to\Xi_c^+\eta_1}$	6.9±1.5	4.0±0.5

Values of the strong coupling constants g in GeV^{-1} for the transitions among the sextet spin -3/2 and anti-triplet -1/2 heavy baryons with pseudoscalar mesons

	Our work	CQM	LFQM	RQM	NRQM	Experiment
$\Gamma(\Sigma_c^{*++} \to \Lambda_c^+ \pi^+)$	14.6 ± 3.8	20	12.84	21.90 ± 0.87	17.52 ± 0.74	14.9 ± 1.9
$\Gamma(\Sigma_c^{*+} \to \Lambda_c^+ \pi^0)$	14.6 ± 3.8	20	–	–	–	< 17
$\Gamma(\Sigma_c^{*0} \to \Lambda_c^0 \pi^0)$	14.6 ± 3.8	20	12.40	21.20 ± 0.81	16.90 ± 0.71	16.1 ± 2.1
$\Gamma(\Xi_c^{*+} \to \Xi_c^0 \pi^+)$	2.8 ± 0.9	–	1.12	1.78 ± 0.33	–	< 3.1
$\Gamma(\Xi_c^{*+} \to \Xi_c^+ \pi^0)$	1.4 ± 0.4	–	0.69	1.26 ± 0.17	–	< 3.1
$\Gamma(\Xi_c^{*0} \to \Xi_c^+ \pi^-)$	2.8 ± 0.9	–	1.16	2.11 ± 0.29	–	< 5.5
$\Gamma(\Xi_c^{*0} \to \Xi_c^0 \pi^0)$	1.4 ± 0.4	–	0.72	1.01 ± 0.15	–	< 5.5

Strong one-pion decay rates. Here the short keys stands for : (CQM) Constituent Quark Model, (LFQM) Light-Front Quark Model, (RQM) Relativistic Quark Model, (NRQM) Non-Relativistic Quark Model. The results are presented in units of MeV.

transition	g_1	g_1^{Ioffe}	g_2	g_2^{Ioffe}	g_3	g_3^{Ioffe}	NRQM
$\Sigma_b^{*0} \to \Sigma_b^- \rho^+$	4.2±1.0	4.6±1.2	0.7±0.2	0.7±0.2	84±20	90±23	$(2/3)c$
$\Sigma_b^{*+} \to \Sigma_b^+ \omega$	3.8±1.1	4.2±1.1	0.6±0.2	0.7±0.2	70±20	74±21	$(2/3)c$
$\Sigma_b^{*-} \to \Lambda_b \rho^-$	8.0±2.1	8.4±1.4	0.7±0.2	0.8±0.2	148±38	154±26	$(2/\sqrt{3})c$
$\Sigma_b^{*+} \to \Xi_b^{\prime 0} K^{*+}$	4.6±1.4	5.2±1.3	0.9±0.3	1.2±0.4	64±18	70±18	$(2/3)c$
$\Sigma_b^{*0} \to \Xi_b^0 K^{*0}$	6.4±1.7	6.8±1.2	0.9±0.2	1.1±0.2	87±20	88±15	$(\sqrt{2/3})c$
$\Xi_b^{*0} \to \Xi_b^{\prime 0} \rho^0$	2.4±0.7	2.7±0.7	0.4±0.1	0.4±0.1	48±10	52±14	$(1/3)c$
$\Xi_b^{*0} \to \Xi_b^{\prime 0} \omega$	2.4±0.5	2.4±0.6	0.4±0.1	0.3±0.1	40±10	42±12	$(1/3)c$
$\Xi_b^{*0} \to \Xi_b^{\prime 0} \phi$	3.2±1.0	3.6±1.0	0.3±0.1	0.4±0.1	35±11	39±12	$(\sqrt{2}/3)c$
$\Xi_b^{*0} \to \Sigma_b^+ K^{*-}$	4.7±1.4	4.9±1.4	1.0±0.3	1.2±0.4	64±16	66±16	$(2/3)c$
$\Xi_b^{*0} \to \Omega_b^- K^{*+}$	5.3±1.6	5.9±1.7	1.0±0.2	1.3±0.3	74±21	83±20	$(2/3)c$
$\Xi_b^{*0} \to \Xi_b^0 \rho^0$	4.3±1.1	4.4±0.8	0.4±0.1	0.4±0.1	82±20	84±16	$(1/\sqrt{3})c$
$\Xi_b^{*0} \to \Xi_b^0 \omega$	4.3±1.1	4.4±0.8	0.4±0.1	0.4±0.1	82±20	84±16	$(1/\sqrt{3})c$
$\Xi_b^{*0} \to \Xi_b^0 \phi$	5.9±1.6	6.4±1.1	0.7±0.2	0.7±0.2	65±17	69±12	$(\sqrt{2/3})c$
$\Xi_b^{*0} \to \Lambda_b \bar{K}^{*0}$	6.3±1.7	6.6±1.0	0.5±0.1	0.6±0.2	86±20	88±15	$(\sqrt{2/3})c$
$\Omega_b^{*-} \to \Omega_b^- \phi$	7.2±1.8	8.2±2.2	1.0±0.2	1.2±0.3	85±15	90±25	$(2\sqrt{2}/3)c$
$\Omega_b^{*-} \to \Xi_b^{\prime 0} K^{*-}$	5.3±1.5	5.8±1.6	1.0±0.3	1.2±0.4	74±18	77±15	$(2/3)c$
$\Omega_b^{*-} \to \Xi_b^- \bar{K}^{*0}$	9.7±2.5	10.0±2.0	1.3±0.3	1.5±0.3	136±31	133±25	$(2/\sqrt{3})c$

The absolute values of the coupling constants $g_{1,2,3}$ for transitions of b-baryons. The couplings, g_1, g_2, and g_3 are in GeV^{-1}, GeV^{-2} and GeV^{-2} respectively.

	Bottom Baryons		Charmed Baryons
$g^{\Xi_b^{*0}\to\Xi_b^{*0}\pi^0}$	$41\pm9\ (4.0\pm0.5)$	$g^{\Xi_c^{*+}\to\Xi_c^{*+}\pi^0}$	$22\pm6\ (5.3\pm0.6)$
$g^{\Sigma_b^{*0}\to\Sigma_b^{*-}\pi^+}$	$75\pm15\ (8.0\pm0.7)$	$g^{\Sigma_c^{*+}\to\Sigma_c^{*0}\pi^+}$	$42\pm10\ (11.0\pm0.7)$
$g^{\Xi_b^{*0}\to\Sigma_b^{*+}K^-}$	$65\pm14\ (7.8\pm0.8)$	$g^{\Xi_c^{*+}\to\Sigma_c^{*++}K^-}$	$37\pm8\ (10.2\pm0.6)$
$g^{\Omega_b^{*-}\to\Xi_b^{*0}K^-}$	$73\pm16\ (8.0\pm0.8)$	$g^{\Omega_c^{*0}\to\Xi_c^{*+}K^-}$	$37\pm9\ (9.8\pm0.8)$
$g^{\Sigma_b^{*+}\to\Sigma_b^{*+}\eta_8}$	$45\pm10\ (5.8\pm0.6)$	$g^{\Sigma_c^{*++}\to\Sigma_c^{*++}\eta_8}$	$25\pm6\ (7.8\pm0.6)$
$g^{\Xi_b^{*0}\to\Xi_b^{*0}\eta_8}$	$19\pm4\ (2.7\pm0.3)$	$g^{\Xi_c^{*+}\to\Xi_c^{*+}\eta_8}$	$11.5\pm1.8\ (3.2\pm0.4)$
$g^{\Omega_b^{*-}\to\Omega_b^{*-}\eta_8}$	$95\pm22\ (11.5\pm1.8)$	$g^{\Omega_c^{*0}\to\Omega_c^{*0}\eta_8}$	$52\pm10\ (13.6\pm0.7)$

The values of the strong coupling constants for the transitions among the heavy spin -3/2 baryons with pseudoscalar mesons.

transition	g_1	g_2	g_3	g_4
$\Xi_b^{*0} \to \Xi_b^{*0}\rho^0$	9±1	19±2	50±5	15±2
$\Sigma_b^{*0} \to \Sigma_b^{*-}\rho^+$	18±2	36±4	100±20	27±3
$\Xi_b^{*0} \to \Sigma_b^{*+}K^{*-}$	30±5	40±4	110±15	28±3
$\Omega_b^{*-} \to \Xi_b^{*0}K^{*-}$	30±5	41±4	110±20	28±3
$\Sigma_b^{*+} \to \Xi_b^{*0}K^{*+}$	30±5	40±4	100±20	28±3
$\Xi_b^{*0} \to \Omega_b^{*-}K^{*+}$	35±5	42±5	100±20	28±3
$\Sigma_b^{*+} \to \Sigma_b^{*+}\omega$	16±2	32±3	90±10	24±4
$\Xi_b^{*0} \to \Xi_b^{*0}\omega$	10±2	17±2	45±5	13±2
$\Xi_b^{*0} \to \Xi_b^{*0}\phi$	17±2	25±3	85±10	25±5
$\Omega_b^{*-} \to \Omega_b^{*-}\phi$	40±5	50±6	140±20	50±10

Coupling constants of the light vector mesons with heavy spin -3/2 baryons containing b quark

transition	g_1	g_2	g_3	g_4
$\Xi_c^{*+} \to \Xi_c^{*+}\rho^0$	8±1	13±1	27±3	16±2
$\Sigma_c^{*+} \to \Sigma_c^{*0}\rho^+$	15±1	18±1	45±5	10±2
$\Xi_c^{*+} \to \Sigma_c^{*++}K^{*-}$	29±2	19±1	50±10	13±2
$\Omega_c^{*0} \to \Xi_c^{*+}K^{*-}$	18±2	26±4	50±10	30±4
$\Sigma_c^{*++} \to \Xi_c^{*+}K^{*+}$	27±4	19±1	50±10	13±2
$\Xi_c^{*+} \to \Omega_c^{*0}K^{*+}$	21±6	27±2	52±10	31±4
$\Sigma_c^{*++} \to \Sigma_c^{*++}\omega$	13±2	16±2	40±5	9±2
$\Xi_c^{*+} \to \Xi_c^{*+}\omega$	10±2	11±2	23±3	17±3
$\Xi_c^{*+} \to \Xi_c^{*+}\phi$	13±2	12±1	38±5	9±2
$\Omega_c^{*0} \to \Omega_c^{*0}\phi$	36±6	35±5	80±10	45±5

Coupling constants of the light vector mesons with heavy spin -3/2 baryons containing c quark

Conclusion

- Using the symmetry arguments it is shown that all SSM, SAM, and AAM transitions are described by only one universal function for each class of transition for any Lorentz structure.

- Violation of SU(3) does not produce any new structure in addition than that one existing in SU(3) symmetry case.

- Relations between invariant functions are structure independent, while their explicit expressions are structure dependent.