Radiative decays of P-wave bottom baryons from light-cone sum rules

Xuan Luo

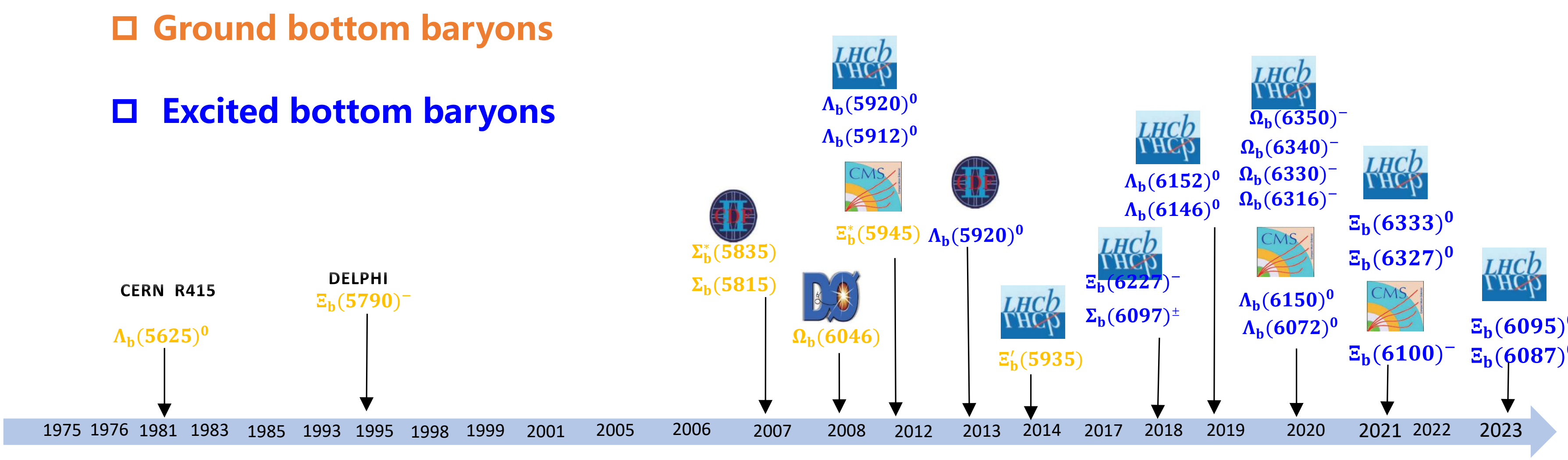
Southeast University

Collaborator：Wei-Han Tan, Hui-Min Yang, Hua-Xing Chen

Outline

- Introduction
- Internel structure of bottom baryons
- QCD sum rules
- Radiative decays of P-wave bottom baryons
- Summary

Introduction



- All the ground bottom baryons are well established in experiments except the Ω_b^{*-}.

Introduction

Theoretical works:

Hadronic molecular models:

- W.H.Liang and E.Oset,Phys. Rev. D 101 (2020) no.5, 054033;
- Y.Huang, C.j.Xiao, L.S.Geng and J.He,Phys. Rev. D 99 (2019) no.1, 014008 etc

The quark pair creation model::

- B.Chen, K.W.Wei, X.Liu and A.Zhang,Phys. Rev. D 98 (2018) no.3, 031502;
- B.Chen and X.Liu,Phys. Rev. D 98 (2018) no.7, 074032 etc.

The chiral perturbation theory:

- J.X.Lu, Y.Zhou, H.X.Chen, J.J.Xie and L.S.Geng,Phys. Rev. D 92 (2015) no.1, 014036;
- H.Y.Cheng and C.K.Chua,Phys. Rev. D 75 (2007), 014006 etc.

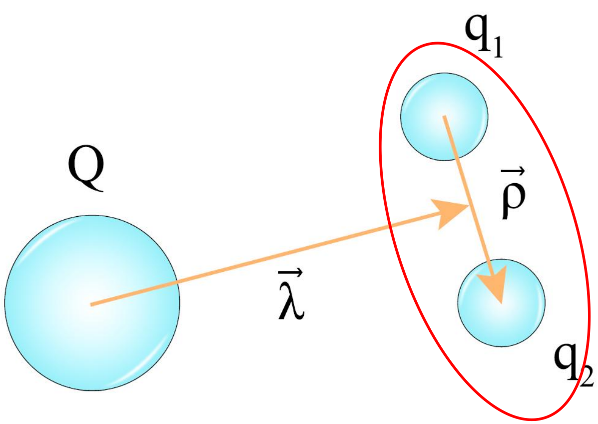
QCD sum rules:

- Q.Mao, H.X.Chen, W.Chen, A.Hosaka, X.Liu and S.L.Zhu,Phys. Rev. D 92 (2015) no.11, 114007;
- H.X.Chen, Q.Mao, W.Chen, A.Hosaka, X.Liu and S.L.Zhu,Phys. Rev. D 95 (2017) no.9, 094008 etc.

• • • • • •

Internal structure of bottom baryons

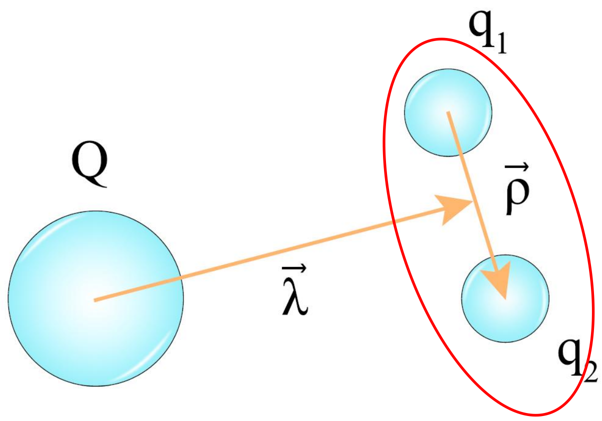
Heavy baryon ($Q - q_1 - q_2$):



λ-excitation and ρ-excitation

Internal structure of bottom baryons

Heavy baryon ($\mathbf{Q - q_1 - q_2}$):

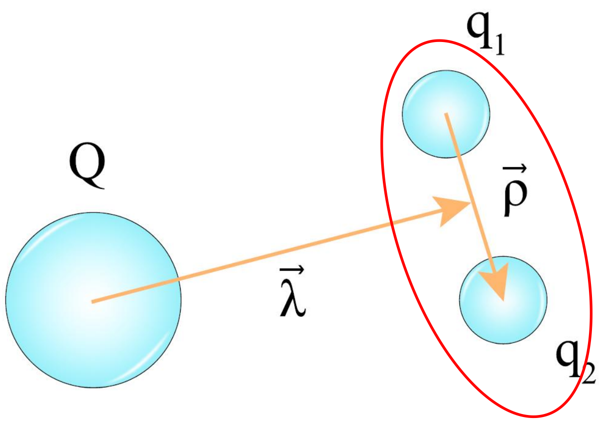


λ-excitation and ρ-excitation

$$J = s_Q \otimes s_{q1} \otimes s_{q2} \otimes l_\rho \otimes l_\lambda = s_Q \otimes \left(s_{q1} \otimes s_{q2} \otimes l_\rho \otimes l_\lambda\right)_{j_l}$$

Internal structure of bottom baryons

- color$\longrightarrow\overline{\mathbf{3}}_C$ **antisymmetric**
- orbital$\longrightarrow \boldsymbol{l_\rho} \begin{cases} \textbf{symmetric} \\ \textbf{antisymmetric} \end{cases}$
- spin$\longrightarrow \boldsymbol{s_{qq}} = \begin{cases} \textbf{1 symmetric} \\ \textbf{0 antisymmetric} \end{cases}$
- SU(3) flavor$\longrightarrow \begin{cases} \mathbf{6}_F \textbf{ symmetric} \\ \overline{\mathbf{3}}_F \textbf{ antisymmetric} \end{cases}$



λ-excitation and ρ-excitation

Internal structure of bottom baryons

The Pauli principle can be directly applied to the two light quarks:

- color⟶$\bar{\mathbf{3}}_C$ **antisymmetric**
- orbital⟶$\boldsymbol{l_\rho}\begin{cases}\text{symmetric}\\ \text{antisymmetric}\end{cases}$
- spin⟶$\boldsymbol{s_{qq}} = \begin{cases}1 \text{ symmetric}\\ 0 \text{ antisymmetric}\end{cases}$
- SU(3) flavor⟶$\begin{cases}\mathbf{6}_F \text{ symmetric}\\ \bar{\mathbf{3}}_F \text{ antisymmetric}\end{cases}$

} **Totally Antisymmetric**

We denote these multiplets as $[flavor, j_l, s_l, (\rho/\lambda)]$

Internal structure of bottom baryons

S-wave bottom baryons

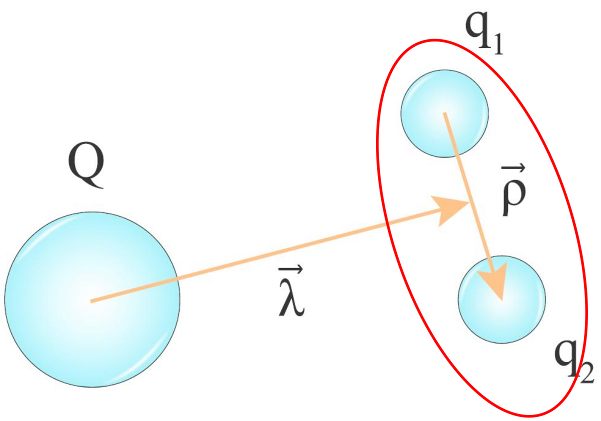
- color ⟶ $\bar{\mathbf{3}}_C$ **antisymmetric**
- orbital ⟶ $\boldsymbol{l_\rho = 0}$ **symmetric**
- spin ⟶ $\boldsymbol{s_{qq}} = \begin{cases} \mathbf{1} \text{ symmetric} \\ \mathbf{0} \text{ antisymmetric} \end{cases}$
- SU(3) flavor ⟶ $\begin{cases} \mathbf{6}_F \text{ symmetric} \\ \bar{\mathbf{3}}_F \text{ antisymmetric} \end{cases}$

Totally Antisymmetric

Internal structure of bottom baryons

S-wave bottom baryons

- color$\longrightarrow \bar{3}_C$ antisymmetric
- orbital$\longrightarrow l_\rho = 0$ symmetric
- spin$\longrightarrow s_{qq} = \begin{cases} 1 \text{ symmetric} \\ 0 \text{ antisymmetric} \end{cases}$
- SU(3) flavor$\longrightarrow \begin{cases} 6_F \text{ symmetric} \\ \bar{3}_F \text{ antisymmetric} \end{cases}$



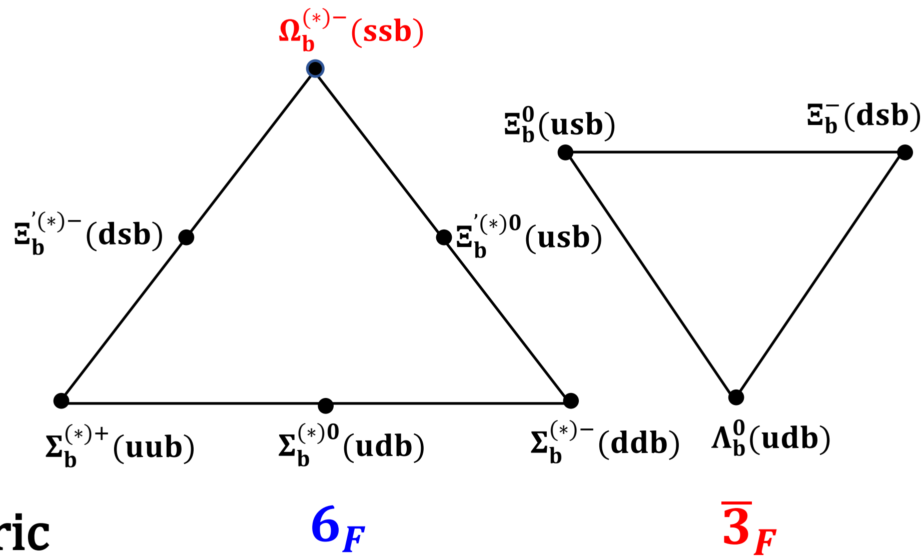
$\bar{3}_C \otimes \begin{matrix} l_\rho=0 \\ l_\lambda=0 \end{matrix}$

- s_{qq}=0(A), $\longrightarrow \bar{3}_F(A) \longrightarrow j_l = 0: J^P = \frac{1}{2}^+$ [$\bar{3}_F$,0,0]
- s_{qq}=1(S), $\longrightarrow 6_F(S) \longrightarrow j_l = 1: J^P = (\frac{1}{2}^+, \frac{3}{2}^+)$ [6_F,1,1]

Internal structure of bottom baryons

S-wave bottom baryons

- color $\longrightarrow \bar{3}_C$ antisymmetric
- orbital $\longrightarrow l_\rho = 0$ symmetric
- spin $\longrightarrow s_{qq} = \begin{cases} 1 \text{ symmetric} \\ 0 \text{ antisymmetric} \end{cases}$
- SU(3) flavor $\longrightarrow \begin{cases} 6_F \text{ symmetric} \\ \bar{3}_F \text{ antisymmetric} \end{cases}$



$\bar{3}_C \otimes$ l_ρ=0, l_λ=0

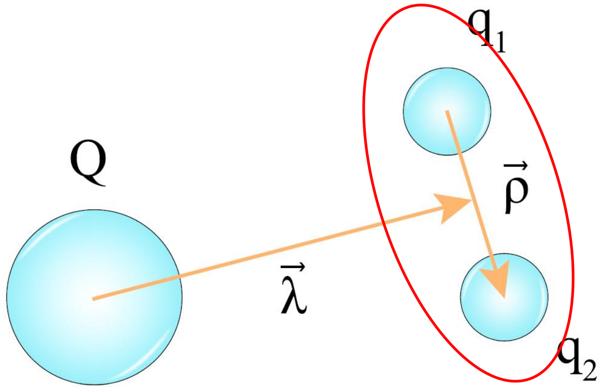
- s_{qq}=0(A), $\longrightarrow \bar{3}_F(A) \longrightarrow j_l = 0: J^P = \frac{1}{2}^+$ [$\bar{3}_F$,0,0]
- s_{qq}=1(S), $\longrightarrow 6_F(S) \longrightarrow j_l = 1: J^P = (\frac{1}{2}^+, \frac{3}{2}^+)$ [6_F,1,1]

Internal structure of bottom baryons

P-wave bottom baryons

$l_\rho + l_\lambda = 1$

- color $\longrightarrow \bar{3}_C$ antisymmetric
- orbital $\longrightarrow l_\rho \begin{cases} 0 \text{ symmetric} \\ 1 \text{ antisymmetric} \end{cases}$
- spin $\longrightarrow s_{qq} = \begin{cases} 1 \text{ symmetric} \\ 0 \text{ antisymmetric} \end{cases}$
- SU(3) flavor $\longrightarrow \begin{cases} 6_F \text{ symmetric} \\ \bar{3}_F \text{ antisymmetric} \end{cases}$



λ-excitation and ρ-excitation

Internal structure of bottom baryons

P-wave bottom baryons

$l_\rho + l_\lambda = 1$

- color$\longrightarrow \bar{3}_C$ antisymmetric
- orbital$\longrightarrow l_\rho \begin{cases} 0 \text{ symmetric} \\ 1 \text{ antisymmetric} \end{cases}$
- spin$\longrightarrow s_{qq} = \begin{cases} 1 \text{ symmetric} \\ 0 \text{ antisymmetric} \end{cases}$
- SU(3) flavor$\longrightarrow \begin{cases} 6_F \text{ symmetric} \\ \bar{3}_F \text{ antisymmetric} \end{cases}$

Totally Antisymmetric

Internal structure of bottom baryons

P-wave bottom baryons

8 multiplets, 35 baryons, , e.g., 7 Ω_b baryons

$\bar{3}_C(A)$

l_ρ=0(A), l_λ=1

- s_{qq}= 0 $\longrightarrow \bar{3}_F(A) \longrightarrow$ $j_l = 1$: $\Lambda_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Xi_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $[\bar{3}_F,1,0,\lambda]$
- s_{qq}= 1 $\longrightarrow 6_F(S)$
  - $j_l = 0$: $\Sigma_{b0}(\frac{1}{2}^-)$ $\Xi'_{b0}(\frac{1}{2}^-)$ $\Omega_{b0}(\frac{1}{2}^-)$ $[6_F,0,1,\lambda]$
  - $j_l = 1$: $\Sigma_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Xi'_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Omega_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $[6_F,1,1,\lambda]$
  - $j_l = 2$: $\Sigma_{b2}(\frac{3}{2}^-, \frac{5}{2}^-)$ $\Xi'_{b2}(\frac{3}{2}^-, \frac{5}{2}^-)$ $\Omega_{b2}(\frac{3}{2}^-, \frac{5}{2}^-)$ $[6_F,2,1,\lambda]$

l_ρ=1(S), l_λ=0

- s_{qq}= 0 $\longrightarrow 6_F(S) \longrightarrow$ $j_l = 1$: $\Lambda_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Xi'_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Omega_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $[6_F,1,0,\rho]$
- s_{qq}= 1 $\longrightarrow \bar{3}_F(A)$
  - $j_l = 0$: $\Lambda_{b0}(\frac{1}{2}^-)$ $\Xi_{b0}(\frac{1}{2}^-)$ $[\bar{3}_F,0,1,\rho]$
  - $j_l = 1$: $\Lambda_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $\Xi_{b1}(\frac{1}{2}^-, \frac{3}{2}^-)$ $[\bar{3}_F,1,1,\rho]$
  - $j_l = 2$: $\Lambda_{b2}(\frac{3}{2}^-, \frac{5}{2}^-)$ $\Xi_{b2}(\frac{3}{2}^-, \frac{5}{2}^-)$ $[\bar{3}_F,2,1,\rho]$

λ-excitation and ρ-excitation ($l_\rho+l_\lambda=1$)

Currents for P-wave bottom baryons of the flavor $\bar{3}_F$

$[\bar{3}_F, 1, 0, \lambda]$

$$J_{1/2,-,\bar{\mathbf{3}}_F,1,0,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma_5 q^b + q^{aT}C\gamma_5[\mathcal{D}^\mu_t q^b]\Big)\gamma^\mu_t\gamma_5 h^c_v\,,$$

$$J^\alpha_{3/2,-,\bar{\mathbf{3}}_F,1,0,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma_5 q^b + q^{aT}C\gamma_5[\mathcal{D}^\mu_t q^b]\Big)\Big(g^{\alpha\mu}_t - \frac{1}{3}\gamma^\alpha_t\gamma^\mu_t\Big)h^c_v\,.$$

$[\bar{3}_F, 0, 1, \rho]$

$$J_{1/2,-,\bar{\mathbf{3}}_F,0,1,\rho} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma^\mu_t q^b - q^{aT}C\gamma^\mu_t[\mathcal{D}^\mu_t q^b]\Big)h^c_v\,,$$

$[\bar{3}_F, 1, 1, \rho]$

$$J_{1/2,-,\bar{\mathbf{3}}_F,1,1,\rho} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma^\nu_t q^b - q^{aT}C\gamma^\nu_t[\mathcal{D}^\mu_t q^b]\Big)\sigma^{\mu\nu}_t h^c_v\,,$$

$$J^\alpha_{3/2,-,\bar{\mathbf{3}}_F,1,1,\rho} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma^\nu_t q^b - q^{aT}C\gamma^\nu_t[\mathcal{D}^\mu_t q^b]\Big) \times\Big(g^{\alpha\mu}_t\gamma^\nu_t\gamma_5 - g^{\alpha\nu}_t\gamma^\mu_t\gamma_5 - \frac{1}{3}\gamma^\alpha_t\gamma^\mu_t\gamma^\nu_t\gamma_5 + \frac{1}{3}\gamma^\alpha_t\gamma^\nu_t\gamma^\mu_t\gamma_5\Big)h^c_v\,.$$

$[\bar{3}_F, 2, 1, \rho]$

$$J^\alpha_{3/2,-,\bar{\mathbf{3}}_F,2,1,\rho} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma^\nu_t q^b - q^{aT}C\gamma^\nu_t[\mathcal{D}^\mu_t q^b]\Big)\times\Big(g^{\alpha\mu}_t\gamma^\nu_t\gamma_5 + g^{\alpha\nu}_t\gamma^\mu_t\gamma_5 - \frac{2}{3}g^{\mu\nu}_t\gamma^\alpha_t\gamma_5\Big)h^c_v\,,$$

$$J^{\alpha_1\alpha_2}_{5/2,-,\bar{\mathbf{3}}_F,2,1,\rho} = i\epsilon_{abc}\Big([\mathcal{D}^\mu_t q^{aT}]C\gamma^\nu_t q^b - q^{aT}C\gamma^\nu_t[\mathcal{D}^\mu_t q^b]\Big)\times\Gamma^{\alpha_1\alpha_2,\mu\nu}h^c_v\,,$$

Currents for P-wave bottom baryons of the flavor 6_F

$[6_F,\ 1,\ 0,\ \lambda]$

$$J_{1/2,-,6_F,1,0,\rho} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_5 q^b - q^{aT}C\gamma_5[\mathcal{D}_t^\mu q^b]\Big)\gamma_t^\mu\gamma_5 h_v^c\,,$$

$$J^\alpha_{3/2,-,6_F,1,0,\rho} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_5 q^b - q^{aT}C\gamma_5[\mathcal{D}_t^\mu q^b]\Big)\Big(g_t^{\alpha\mu} - \frac{1}{3}\gamma_t^\alpha\gamma_t^\mu\Big)h_v^c\,.$$

$[6_F,\ 0,\ 1,\ \rho]$

$$J_{1/2,-,6_F,0,1,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_t^\mu q^b + q^{aT}C\gamma_t^\mu[\mathcal{D}_t^\mu q^b]\Big)h_v^c\,.$$

$[6_F,\ 1,\ 1,\ \rho]$

$$J_{1/2,-,6_F,1,1,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_t^\nu q^b + q^{aT}C\gamma_t^\nu[\mathcal{D}_t^\mu q^b]\Big)\sigma_t^{\mu\nu}h_v^c\,,$$

$$J^\alpha_{3/2,-,6_F,1,1,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_t^\nu q^b + q^{aT}C\gamma_t^\nu[\mathcal{D}_t^\mu q^b]\Big) \times\Big(g_t^{\alpha\mu}\gamma_t^\nu\gamma_5 - g_t^{\alpha\nu}\gamma_t^\mu\gamma_5 - \frac{1}{3}\gamma_t^\alpha\gamma_t^\mu\gamma_t^\nu\gamma_5 + \frac{1}{3}\gamma_t^\alpha\gamma_t^\nu\gamma_t^\mu\gamma_5\Big)h_v^c\,.$$

$[6_F,\ 2,\ 1,\ \rho]$

$$J^\alpha_{3/2,-,6_F,2,1,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_t^\nu q^b + q^{aT}C\gamma_t^\nu[\mathcal{D}_t^\mu q^b]\Big)\times\Big(g_t^{\alpha\mu}\gamma_t^\nu\gamma_5 + g_t^{\alpha\nu}\gamma_t^\mu\gamma_5 - \frac{2}{3}g_t^{\mu\nu}\gamma_t^\alpha\gamma_5\Big)h_v^c\,,$$

$$J^{\alpha_1\alpha_2}_{5/2,-,6_F,2,1,\lambda} = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu q^{aT}]C\gamma_t^\nu q^b + q^{aT}C\gamma_t^\nu[\mathcal{D}_t^\mu q^b]\Big)\times\Gamma^{\alpha_1\alpha_2,\mu\nu}h_v^c\,.$$

Our QCD sum rule studies

- 1903.10369 Decays of P-wave bottom baryons (6_F, partly)
- 1909.13575 Decays of P-wave bottom baryons ($\bar{3}_F$ and 6_F, partly)
- 2003.07488 Masses/Decays of P-wave bottom baryons (6_F, fully)
- 2205.07224 Masses/Decays of P-wave charmed/bottom baryons ($\bar{3}_F$, partly)
- 2311.18380 Masses/Decays of P-wave bottom baryons ($\bar{3}_F$, fully)

……

QCD sum rule

SVZ sum rule

QCD AND RESONANCE PHYSICS. THEORETICAL FOUNDATIONS

M.A. SHIFMAN, A.I. VAINSHTEIN * and V.I. ZAKHAROV
Institute of Theoretical and Experimental Physics, Moscow, 117259, USSR

Received 24 July 1978

A systematic study is made of the non-perturbative effects in quantum chromodynamics. The basic object is the two-point functions of various currents. At large Euclidean momenta q the non-perturbative contributions induce a series in (μ^2/q^2) where μ is some typical hadronic mass. The terms of this series are shown to be of two distinct types. The first few of them are connected with vacuum fluctuations of large size, and can be consistently accounted for within the Wilson operator expansion. On the other hand, in high orders small-size fluctuations show up and the high-order terms do not reduce (generally speaking) to the vacuum-to-vacuum matrix elements of local operators. This signals the breakdown of the operator expansion. The corresponding critical dimension is found. We propose a Borel improvement of the power series. On one hand, it makes the two-point functions less sensitive to high-order terms, and on the other hand, it transforms the standard dispersion representation into a certain integral representation with exponential weight functions. As a result we obtain a set of the sum rules for the observable spectral densities which correlate the resonance properties to a few vacuum-to-vacuum matrix elements. As the last bid to specify the sum rules we estimate the matrix elements involved and elaborate several techniques for this purpose.

QCD sum rule

Light-cone sum rule

RADIATIVE DECAY $\Sigma^+ \to p\gamma$ IN QUANTUM CHROMODYNAMICS

I.I. BALITSKY, V.M. BRAUN and A.V. KOLESNICHENKO

Leningrad Nuclear Physics Institute, Gatchina, Leningrad 188350, USSR

Received 4 January 1988

We develop some new techniques extending the standard QCD sum-rules approach to hadron properties in alternating external fields. The string operator expansion in singularities near the light cone is used as a suitable alternative to the Wilson expansion in local operators. The response of soft vacuum quarks to external electromagnetic fields is characterized by photon wave functions which are studied in detail using the (approximate) conformal invariance of the theory. Sum rules are constructed, relating the amplitudes for the decay $\Sigma^+ \to p\gamma$ to properties of the QCD vacuum in alternating magnetic fields. The resulting branching ratio and the azimuthal asymmetry turn out to be in agreement with the experimental data.

QCD sum rule

- **SVZ sum rule**

$$\prod_{\mu\nu}(q^2) = i\int d^4x e^{-iqx} \langle 0|T\{J_\mu(x), J_\nu(0)\}|0\rangle$$

- **Light-cone sum rule (LCSR)**

$$\prod_{\mu\nu}(q^2) = i\int d^4x e^{-iqx} \langle B|T\{J_\mu(x), J_\nu(0)\}|0\rangle$$

Basic calculation procedure:

- Correlation function
- Operator product expansion(OPE)
- Hadronic Expression
- Quark-Hadron duality

$\Xi_b^0[1/2^-, \bar{3}_F, 1,1,\rho] \to \Xi_b^{*0}\gamma$

1.Correlation function

$$\Pi^\mu(\omega,\,\omega') = \int d^4x e^{-ik\cdot x}\langle 0|J_{\Xi_b^0[\frac{1}{2}^-],1,1,\rho}(0)\bar{J}^\mu_{\Xi_b^{*0}}(x)|\gamma\rangle$$
$$= \frac{1+\not{v}}{2}\epsilon^*_\mu G_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma}(\omega,\omega')\,,$$

Where

$$k' = k + q\,,\ \omega' = v\cdot k'\,,\ \omega = v\cdot k\,,$$

At the hadronic level, the function $G_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma}$ has the following pole term from the double dispersion relation:

$$G_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma}(\omega,\omega') = g_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma} \times \frac{f_{\Xi_b^0[\frac{1}{2}^-]}f_{\Xi_b^{*0}}}{(\bar{\Lambda}_{\Xi_b^0[\frac{1}{2}^-]}-\omega')(\bar{\Lambda}_{\Xi_b^{*0}}-\omega)} + \cdots\,,$$

$\Xi_b^0[1/2^-, \bar{3}_F, 1, 1, \rho] \to \Xi_b^{*0}\gamma$

Operator product expansion(OPE)

$$\Pi^\mu(\omega,\,\omega') = \int d^4x e^{-ik\cdot x}\langle 0|J_{\Xi_b^0[\frac{1}{2}^-],1,1,\rho}(0)\bar{J}^\mu_{\Xi_b^{*0}}(x)|\gamma\rangle$$

$$J_{\Xi_b^0[\frac{1}{2}^-],1,1,\rho}(x) = i\epsilon_{abc}\Big([\mathcal{D}_t^\mu u^{aT}(x)]C\gamma_t^\nu s^b(x) - u^{aT}(x)C\gamma_t^\nu[\mathcal{D}_t^\mu s^b(x)]\Big)\sigma_t^{\mu\nu}h_v^c(x)\,,$$

$$J^\mu_{\Xi_b^{*0}}(x) = \epsilon_{abc}[u^{aT}(x)C\gamma_\nu s^b(x)](-g_t^{\mu\nu} + \frac{1}{3}\gamma_t^\mu\gamma_t^\nu)h_v^c(x)\,,$$

$$\begin{aligned}
&G_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma}(\omega,\omega') \\
&= \int_0^\infty dt\int_0^1 du e^{i(1-u)\omega' t}e^{iu\omega t}\times 8\times(-\frac{e_s f_{3\gamma}\psi^\alpha(u)uv\cdot q}{48\pi^2t^2} + \frac{e_s\phi_\gamma(u)\chi uv\cdot q}{72}\langle\bar{q}q\rangle\langle\bar{s}s\rangle + \frac{e_s\phi_\gamma(u)\chi t^2uv\cdot q}{1152}\langle g_s\bar{q}\sigma Gs\rangle\langle\bar{s}s\rangle \\
&+ \frac{e_u f_{3\gamma}\psi^\alpha(u)uv\cdot q}{48\pi^2t^2} - \frac{e_u\phi_\gamma(u)\chi m_s uv\cdot q}{24\pi^2t^2}\langle\bar{q}q\rangle - \frac{e_u\phi_\gamma(u)\chi uv\cdot q}{72}\langle\bar{q}q\rangle\langle ss\rangle + \frac{e_u f_{3\gamma}\psi^\alpha(u)m_s t^2uv\cdot q}{1152}\langle\bar{s}s\rangle \\
&- \frac{e_u\phi_\gamma(u)\chi t^2uv\cdot q}{1152}\langle\bar{q}q\rangle\langle g_s\bar{s}\sigma Gs\rangle) - (\int_0^\infty dt\int_0^1 du\mathcal{D}\underline{\alpha}e^{i\omega' t(\alpha_2+u\alpha_3)}e^{i\omega t(1-\alpha_2-u\alpha_3)}(-\frac{f_{3\gamma}\mathcal{A}(\underline{\alpha})v\cdot q}{24\pi^2t^2} + \frac{f_{3\gamma}\mathcal{V}(\underline{\alpha})v\cdot q}{24\pi^2t^2} \\
&- \frac{f_{3\gamma}\mathcal{A}(\underline{\alpha})wv\cdot q}{24\pi^2t^2} - \frac{f_{3\gamma}\mathcal{V}(\underline{\alpha})wv\cdot q}{8\pi^2t^2} - \frac{if_{3\gamma}\mathcal{A}(\underline{\alpha})(v\cdot q)^2}{24\pi^2t} - \frac{if_{3\gamma}\mathcal{V}(\underline{\alpha})(v\cdot q)^2}{24\pi^2t} - \frac{if_{3\gamma}\mathcal{A}(\underline{\alpha})w(v\cdot q)^2}{24\pi^2t} - \frac{if_{3\gamma}\mathcal{V}(\underline{\alpha})w(v\cdot q)^2}{24\pi^2t} \\
&+ \frac{if_{3\gamma}\mathcal{A}(\underline{\alpha})\alpha_2(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}\mathcal{V}(\underline{\alpha})\alpha_2(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}Aw\alpha_2(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}Vw\alpha_2(v\cdot q)^2}{24\pi^2t} \\
&+ \frac{if_{3\gamma}\mathcal{A}(\underline{\alpha})w\alpha_3(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}\mathcal{V}(\underline{\alpha})w\alpha_3(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}\mathcal{A}(\underline{\alpha})w^2\alpha_3(v\cdot q)^2}{24\pi^2t} + \frac{if_{3\gamma}\mathcal{V}(\underline{\alpha})w^2\alpha_3(v\cdot q)^2}{24\pi^2t})(e_s - e_u)\,.
\end{aligned}$$

$\Xi_b^0[1/2^-, \bar{3}_F, 1,1, \rho] \to \Xi_b^{*0}\gamma$

Sum rule for $g_{\Xi_b^0[1/2^-,\bar{3}_F,1,1,\rho] \to \Xi_b^{*0}\gamma}$

$$
\begin{aligned}
& g_{\Xi_b^0[\frac{1}{2}^-]\to\Xi_b^{*0}\gamma} \times \frac{f_{\Xi_b^0[\frac{1}{2}^-]} f_{\Xi_b^{*0}}}{(\bar\Lambda_{\Xi_b^0[\frac{1}{2}^-]} - \omega')(\bar\Lambda_{\Xi_b^{*0}} - \omega)} \\
&= 8 \times \Big(\frac{e_s \chi}{72} \langle\bar q q\rangle \langle\bar s s\rangle (iT)^2 f_1(\frac{\omega_c}{T}) \frac{\partial}{\partial u_0}\phi_\gamma(u_0) u_0 + \frac{e_s\chi}{1152} \langle g_s \bar q \sigma G q\rangle \langle \bar s s\rangle \frac{\partial}{\partial u_0}\phi_\gamma(u_0) u_0 + \frac{e_u f_{3\gamma} m_s}{1152} \langle\bar s s\rangle \frac{\partial}{\partial u_0}\psi^\alpha(u_0) u_0 \\
&- \frac{e_u\chi}{1152}\langle\bar q q\rangle \langle g_s \bar s \sigma G s\rangle \frac{\partial}{\partial u_0}\phi_\gamma(u_0)u_0 - \frac{e_s f_{3\gamma}}{48\pi^2}(iT)^4 f_3(\frac{\omega_c}{T})\frac{\partial}{\partial u_0}\psi^\alpha(u_0)u_0 + \frac{e_u f_{3\gamma}}{48\pi^2}(iT)^4 f_3(\frac{\omega_c}{T})\frac{\partial}{\partial u_0}\psi^\alpha(u_0)u_0 \\
&- \frac{e_u\chi}{72}\langle\bar q q\rangle\langle\bar s s\rangle (iT)^2 f_1(\frac{\omega_c}{T})\frac{\partial}{\partial u_0}\phi_\gamma(u_0)u_0\Big) - \frac{e_u \chi m_s}{24\pi^2}\langle\bar q q\rangle (iT)^4 f_3(\frac{\omega_c}{T})\frac{\partial}{\partial u_0}\phi_\gamma(u_0)u_0 \\
&- \Big(-\frac{f_{3\gamma}}{8\pi^2 u_0}(iT)^4 f_3(\frac{\omega_c}{T})\Big(\int_0^{\frac{1}{2}} d\alpha_2 \int_{\frac{1}{2}-\alpha_2}^{1-\alpha_2} d\alpha_3 \Big(\big(\frac{1}{3\alpha_3}\frac{\partial}{\partial a_3}\mathcal{A}(\underline{\alpha}) - \frac{1}{3a_3}\frac{\partial}{\partial a_3}\mathcal{V}(\underline{\alpha}) + \frac{u_0}{3a_3}\frac{\partial}{\partial\alpha_3}\mathcal{A}(\underline{\alpha}) + \frac{u_0}{\alpha_3}\frac{\partial}{\partial a_3}\mathcal{V}(\underline{\alpha})\big) \\
&+ \frac{f_{3\gamma}}{24\pi^2 u_0^2}(iT)^4 f_3(\frac{\omega_c}{T})\Big(\int_0^{\frac{1}{2}} d\alpha_2 \int_{\frac{1}{2}-\alpha_2}^{1-\alpha_2} d\alpha_3 \Big(-\frac{1}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) - \frac{1}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha}) - \frac{u_0}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) - \frac{iu_0}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha}) \\
&+ \frac{\alpha_2}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) + \frac{\alpha_2}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha}) + \frac{u_0\alpha_2}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) + \frac{u_0\alpha_2}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha}) + \frac{u_0\alpha_3}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) + \frac{u_0\alpha_3}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha}) \\
&+ \frac{u_0^2\alpha_3}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{A}(\underline{\alpha}) + \frac{u_0^2\alpha_3}{\alpha_3}\frac{\partial^2}{\partial\alpha_3^2}\mathcal{V}(\underline{\alpha})\Big)\Big)(e_s - e_u)\,.
\end{aligned}
$$

$\Xi_b^0[1/2^-, \bar{3}_F, 1, 1, \rho] \to \Xi_b^{*0}\gamma$

2.M. A. Ivanov, etal., Phys. Rev. D 60, 094002(1999).

The radiative decay width can be calculated by

$$\Gamma(X_b \to Y_b\gamma) = \frac{1}{2J+1}\frac{|\vec{q}|}{8\pi M_{X_b}^2}\sum_{spins}|\mathcal{M}(X_b \to Y_b\gamma)|^2\,,$$

The relevant transition amplitudes[2]:

$$\mathcal{M}(X_b(1/2^-) \to Y_b(1/2^+)\gamma) = \frac{1}{\sqrt{3}} g\bar{X}_b[g^{\mu\nu}v\cdot q - v^\mu q^\nu]\gamma_\nu\gamma_5 Y_b\epsilon^*_\mu\,,$$

$$\mathcal{M}(X_b(1/2^-) \to Y_b(3/2^+)\gamma) = g\bar{X}_b[g^{\mu\nu}v\cdot q - v^\mu q^\nu]Y_b^\nu\epsilon^*_\mu\,,$$

$$\mathcal{M}(X_b(3/2^-) \to Y_b(1/2^+)\gamma) = g\bar{X}_b^\nu[g^{\mu\nu}v\cdot q - v^\mu q^\nu]Y_b\epsilon^*_\mu\,,$$

$$\mathcal{M}(X_b(3/2^-) \to Y_b(3/2^+)\gamma) = \frac{1}{\sqrt{3}} g\bar{X}_b^\alpha[g^{\mu\nu}v\cdot q - v^\mu q^\nu]\gamma_\nu\gamma_5 Y_{b\alpha}\epsilon^*_\mu\,,$$

$$\mathcal{M}(X_b(5/2^-) \to Y_b(3/2^+)\gamma) = g\bar{X}_b^{\alpha\nu}[g^{\mu\nu}v\cdot q - v^\mu q^\nu]Y_{b\alpha}\epsilon^*_\mu\,,$$

$$g(\Xi_b^0(1/2^-) \to \Xi_b^{*0}\gamma) = 0.052^{+0.020}_{-0.021}\ \mathrm{GeV}^{-1}$$

$$\Gamma(\Xi_b^0(1/2^-) \to \Xi_b^{*0}\gamma) = 1.2^{+8.1}_{-1.2}\ \mathrm{keV}$$

$\Lambda_b^0 \to \Lambda_b^0(\Sigma_b^0)\gamma$

TABLE II: Radiative decay widths of the P-wave bottom baryons Λ_b belonging to the $SU(3)$ flavor $\bar{\mathbf{3}}_F$ representation, calculated using the light-cone sum rule method within the framework of heavy quark effective theory. The total radiative decay widths (T.R.W.) are listed in the seventh column.

Multiplets	Baryon (j^P)	Mass (GeV)	Difference (MeV)	Decay channels	Coupling constants (GeV^{-1})	Decay width (keV)	T.R.W. (keV)
$[\bar{\mathbf{3}}_F, 0, 1, \rho]$	$\Lambda_b(\frac{1}{2}^-)$	$5.92^{+0.17}_{-0.19}$	-	$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^0\gamma$	$1.20^{+0.57}_{-0.49}$	170^{+2700}_{-130}	450^{+9500}_{-410}
				$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^{*0}\gamma$	$1.50^{+0.64}_{-0.69}$	280^{+6800}_{-280}	
$[\bar{\mathbf{3}}_F, 1, 1, \rho]$	$\Lambda_b(\frac{1}{2}^-)$	$5.92^{+0.13}_{-0.10}$	7 ± 3	$\Lambda_b^0(\frac{1}{2}^-) \to \Lambda_b^0\gamma$	$0.12^{+0.02}_{-0.04}$	34^{+64}_{-30}	34^{+78}_{-30}
				$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^0\gamma$	$0.10^{+0.04}_{-0.04}$	$0.10^{+11.10}_{-0.10}$	
				$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.057^{+0.019}_{-0.021}$	$0.32^{+2.95}_{-0.32}$	
	$\Lambda_b(\frac{3}{2}^-)$	$5.92^{+0.13}_{-0.10}$		$\Lambda_b^0(\frac{3}{2}^-) \to \Lambda_b^0\gamma$	$0.16^{+0.06}_{-0.05}$	65^{+130}_{-55}	65^{+140}_{-56}
				$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^0\gamma$	$0.070^{+0.023}_{-0.027}$	$0.60^{+2.60}_{-0.60}$	
				$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.080^{+0.029}_{-0.029}$	$0.24^{+3.26}_{-0.24}$	
$[\bar{\mathbf{3}}_F, 2, 1, \rho]$	$\Lambda_b(\frac{3}{2}^-)$	$5.93^{+0.13}_{-0.13}$	17 ± 7	$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^0\gamma$	$0.69^{+0.31}_{-0.25}$	73^{+520}_{-73}	77^{+560}_{-77}
				$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.28^{+0.14}_{-0.11}$	$3.8^{+38.2}_{-3.8}$	
	$\Lambda_b(\frac{5}{2}^-)$	$5.93^{+0.13}_{-0.13}$		$\Lambda_b^0(\frac{5}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.23^{+0.11}_{-0.10}$	11^{+84}_{-11}	11^{+84}_{-11}
$[\bar{\mathbf{3}}_F, 1, 0, \lambda]$	$\Lambda_b(\frac{1}{2}^-)$	$5.91^{+0.17}_{-0.13}$	4 ± 2	$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^0\gamma$	$1.90^{+0.86}_{-0.39}$	340^{+6200}_{-340}	450^{+9600}_{-420}
				$\Lambda_b^0(\frac{1}{2}^-) \to \Sigma_b^{*0}\gamma$	$1.10^{+0.53}_{-0.22}$	110^{+3400}_{-83}	
	$\Lambda_b(\frac{3}{2}^-)$	$5.91^{+0.17}_{-0.13}$		$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^0\gamma$	$1.40^{+0.51}_{-0.38}$	210^{+3500}_{-210}	220^{+3700}_{-220}
				$\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.55^{+0.20}_{-0.13}$	$9.2^{+250.0}_{-8.1}$	

Total: 15 decay channels

$\Xi_b \to \Xi_b(\Xi_b', \Xi_b^*)\gamma$

TABLE III: Radiative decay widths of the P-wave bottom baryons Ξ_b belonging to the $SU(3)$ flavor $\bar{\mathbf{3}}_F$ representation.

Doublets	Baryon (j^P)	Mass (GeV)	Difference (MeV)	Decay channels	Coupling constants (GeV^{-1})	Decay width (keV)	T.R.W. (keV)
$[\bar{\mathbf{3}}_F, 0, 1, \rho]$	$\Xi_b(\frac{1}{2}^-)$	$6.10^{+0.08}_{-0.08}$	-	$\Xi_b^0(\frac{1}{2}^-) \to \Xi_b^0\gamma$	$1.00^{+0.38}_{-0.30}$	440^{+390}_{-440}	1200^{+1000}_{-1200}
				$\Xi_b^0(\frac{1}{2}^-) \to \Xi_b^{*0}\gamma$	$1.10^{+0.41}_{-0.31}$	720^{+640}_{-720}	
				$\Xi_b^-(\frac{1}{2}^-) \to \Xi_b^-\gamma$	$0.10^{+0.01}_{-0.02}$	$4.4^{+1.5}_{-4.0}$	$12.9^{+8.4}_{-12.4}$
				$\Xi_b^-(\frac{1}{2}^-) \to \Xi_b^{*-}\gamma$	$0.12^{+0.01}_{-0.03}$	$8.5^{+6.9}_{-8.4}$	
$[\bar{\mathbf{3}}_F, 1, 1, \rho]$	$\Xi_b(\frac{1}{2}^-)$	$6.09^{+0.13}_{-0.12}$	7 ± 3	$\Xi_b^0(\frac{1}{2}^-) \to \Xi_b^0\gamma$	$0.13^{+0.04}_{-0.06}$	41^{+78}_{-41}	46^{+100}_{-46}
				$\Xi_b^0(\frac{1}{2}^-) \to \Xi_b'^0\gamma$	$0.10^{+0.03}_{-0.05}$	$3.5^{+17.9}_{-3.5}$	
				$\Xi_b^0(\frac{1}{2}^-) \to \Xi_b^{*0}\gamma$	$0.052^{+0.020}_{-0.021}$	$1.2^{+8.1}_{-1.2}$	
				$\Xi_b^-(\frac{1}{2}^-) \to \Xi_b^-\gamma$	$0.20^{+0.07}_{-0.05}$	97^{+200}_{-91}	97^{+200}_{-91}
				$\Xi_b^-(\frac{1}{2}^-) \to \Xi_b'^-\gamma$	$0.004^{+0.003}_{-0.004}$	$0.01^{+0.03}_{-0.01}$	
				$\Xi_b^-(\frac{1}{2}^-) \to \Xi_b^{*-}\gamma$	$0.005^{+0.002}_{-0.002}$	$0.01^{+0.08}_{-0.01}$	
	$\Xi_b(\frac{3}{2}^-)$	$6.10^{+0.13}_{-0.12}$		$\Xi_b^0(\frac{3}{2}^-) \to \Xi_b^0\gamma$	$0.18^{+0.06}_{-0.07}$	85^{+160}_{-85}	87^{+170}_{-87}
				$\Xi_b^0(\frac{3}{2}^-) \to \Xi_b'^0\gamma$	$0.064^{+0.026}_{-0.026}$	$1.7^{+7.9}_{-1.7}$	
				$\Xi_b^0(\frac{3}{2}^-) \to \Xi_b^{*0}\gamma$	$0.074^{+0.030}_{-0.031}$	$0.84^{+4.89}_{-0.84}$	
				$\Xi_b^-(\frac{3}{2}^-) \to \Xi_b^-\gamma$	$0.29^{+0.10}_{-0.10}$	220^{+420}_{-210}	220^{+430}_{-210}
				$\Xi_b^-(\frac{3}{2}^-) \to \Xi_b'^-\gamma$	$0.006^{+0.002}_{-0.002}$	$1.5^{+6.8}_{-1.5}$	
				$\Xi_b^-(\frac{3}{2}^-) \to \Xi_b^{*-}\gamma$	$0.007^{+0.002}_{-0.002}$	$0.75^{+5.19}_{-0.75}$	

Total: 30 decay channels

$\Sigma_b^0 \to \Lambda_b^0(\Sigma_b^0, \Sigma_b^{*0})\gamma$

TABLE IV: Radiative decay widths of the P-wave bottom baryons Σ_b belonging to the $SU(3)$ flavor $\mathbf{6}_F$ representation.

Multiplets	Baryon (j^P)	Mass (GeV)	Difference (MeV)	Decay channels	Coupling constants (GeV^{-1})	Decay width (keV)	T.R.W. (keV)
$[\mathbf{6}_F, 0, 1, \lambda]$	$\Sigma_b(\frac{1}{2}^-)$	6.05 ± 0.11	-	$\Sigma_b^0(\frac{1}{2}^-) \to \Sigma_b^0\gamma$	$0.22^{+0.12}_{-0.10}$	62^{+150}_{-62}	180^{+500}_{-180}
				$\Sigma_b^0(\frac{1}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.25^{+0.16}_{-0.11}$	120^{+350}_{-120}	
				$\Sigma_b^+(\frac{1}{2}^-) \to \Sigma_b^+\gamma$	$0.87^{+0.60}_{-0.36}$	960^{+2600}_{-960}	3500^{+9600}_{-3500}
				$\Sigma_b^+(\frac{1}{2}^-) \to \Sigma_b^{*+}\gamma$	$1.0^{+0.70}_{-0.40}$	2500^{+7000}_{-2500}	
				$\Sigma_b^-(\frac{1}{2}^-) \to \Sigma_b^-\gamma$	$0.43^{+0.31}_{-0.17}$	230^{+660}_{-230}	720^{+2100}_{-720}
				$\Sigma_b^-(\frac{1}{2}^-) \to \Sigma_b^{*-}\gamma$	$0.50^{+0.35}_{-0.21}$	490^{+1400}_{-490}	
$[\mathbf{6}_F, 1, 1, \lambda]$	$\Sigma_b(\frac{1}{2}^-)$	6.06 ± 0.13	6 ± 3	$\Sigma_b^0(\frac{1}{2}^-) \to \Sigma_b^0\gamma$	$0.040^{+0.018}_{-0.013}$	$2.4^{+6.3}_{-2.4}$	$3.7^{+9.9}_{-3.7}$
				$\Sigma_b^0(\frac{1}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.024^{+0.010}_{-0.010}$	$1.3^{+3.6}_{-1.3}$	
				$\Sigma_b^+(\frac{1}{2}^-) \to \Sigma_b^+\gamma$	$0.16^{+0.08}_{-0.05}$	12^{+35}_{-11}	32^{+92}_{-31}
				$\Sigma_b^+(\frac{1}{2}^-) \to \Sigma_b^{*+}\gamma$	$0.094^{+0.040}_{-0.034}$	20^{+57}_{-20}	
				$\Sigma_b^-(\frac{1}{2}^-) \to \Sigma_b^-\gamma$	$0.082^{+0.026}_{-0.022}$	$9.6^{+24.1}_{-9.5}$	14^{+38}_{-14}
				$\Sigma_b^-(\frac{1}{2}^-) \to \Sigma_b^{*-}\gamma$	$0.047^{+0.019}_{-0.016}$	$4.9^{+14.3}_{-4.9}$	
	$\Sigma_b(\frac{3}{2}^-)$	6.07 ± 0.07		$\Sigma_b^0(\frac{3}{2}^-) \to \Sigma_b^0\gamma$	$0.029^{+0.013}_{-0.011}$	$1.3^{+3.4}_{-1.3}$	$2.2^{+5.8}_{-2.2}$
				$\Sigma_b^0(\frac{3}{2}^-) \to \Sigma_b^{*0}\gamma$	$0.035^{+0.015}_{-0.012}$	$0.86^{+2.35}_{-0.86}$	
				$\Sigma_b^+(\frac{3}{2}^-) \to \Sigma_b^+\gamma$	$0.12^{+0.05}_{-0.05}$	21^{+53}_{-21}	34^{+91}_{-34}
				$\Sigma_b^+(\frac{3}{2}^-) \to \Sigma_b^{*+}\gamma$	$0.14^{+0.05}_{-0.04}$	13^{+38}_{-13}	
				$\Sigma_b^-(\frac{3}{2}^-) \to \Sigma_b^-\gamma$	$0.058^{+0.026}_{-0.022}$	$5.4^{+13.3}_{-5.4}$	$8.9^{+22.8}_{-8.9}$
				$\Sigma_b^-(\frac{3}{2}^-) \to \Sigma_b^{*-}\gamma$	$0.070^{+0.031}_{-0.025}$	$3.5^{+9.5}_{-3.5}$	

Total: 39 decay channels

$\Xi_b^{'-} \to \Xi_b^{-}(\Xi_b^{'-}, \Xi_b^{*-})\gamma$

TABLE V: Radiative decay widths of the P-wave bottom baryons Ξ_b' belonging to the $SU(3)$ flavor $\mathbf{6}_F$ representation.

Multiplets	Baryon (j^P)	Mass (GeV)	Difference (MeV)	Decay channels	Coupling constants (GeV^{-1})	Decay width (keV)	T.R.W. (keV)
$[\mathbf{6}_F, 0, 1, \lambda]$	$\Xi_b'(\frac{1}{2}^-)$	6.20 ± 0.11	-	$\Xi_b^{\prime 0}(\frac{1}{2}^-) \to \Xi_b^{\prime 0}\gamma$	$0.32^{+0.18}_{-0.12}$	180^{+410}_{-180}	$580^{+1300}_{-\ 580}$
				$\Xi_b^{\prime 0}(\frac{1}{2}^-) \to \Xi_b^{*0}\gamma$	$0.37^{+0.21}_{-0.13}$	400^{+930}_{-400}	
				$\Xi_b^{\prime -}(\frac{1}{2}^-) \to \Xi_b^{\prime -}\gamma$	$0.49^{+0.32}_{-0.20}$	$420^{+1000}_{-\ 420}$	$740^{+1800}_{-\ 740}$
				$\Xi_b^{\prime -}(\frac{1}{2}^-) \to \Xi_b^{*-}\gamma$	$0.33^{+0.22}_{-0.14}$	320^{+810}_{-320}	
$[\mathbf{6}_F, 1, 1, \lambda]$	$\Xi_b'(\frac{1}{2}^-)$	6.21 ± 0.11	7 ± 2	$\Xi_b^{\prime 0}(\frac{1}{2}^-) \to \Xi_b^{\prime 0}\gamma$	$0.070^{+0.021}_{-0.020}$	$10.0^{+8.3}_{-9.5}$	15^{+19}_{-14}
				$\Xi_b^{\prime 0}(\frac{1}{2}^-) \to \Xi_b^{*0}\gamma$	$0.040^{+0.011}_{-0.010}$	$5.2^{+10.3}_{-\ 4.8}$	
				$\Xi_b^{\prime -}(\frac{1}{2}^-) \to \Xi_b^{\prime -}\gamma$	$0.096^{+0.040}_{-0.033}$	18^{+22}_{-18}	28^{+43}_{-28}
				$\Xi_b^{\prime -}(\frac{1}{2}^-) \to \Xi_b^{*-}\gamma$	$0.056^{+0.021}_{-0.021}$	10^{+21}_{-10}	
	$\Xi_b'(\frac{3}{2}^-)$	6.22 ± 0.11		$\Xi_b^{\prime 0}(\frac{3}{2}^-) \to \Xi_b^{\prime 0}\gamma$	$0.050^{+0.016}_{-0.017}$	$5.3^{+4.5}_{-5.2}$	$8.8^{+9.0}_{-8.7}$
				$\Xi_b^{\prime 0}(\frac{3}{2}^-) \to \Xi_b^{*0}\gamma$	$0.059^{+0.020}_{-0.016}$	$3.5^{+4.5}_{-3.5}$	
				$\Xi_b^{\prime -}(\frac{3}{2}^-) \to \Xi_b^{\prime -}\gamma$	$0.068^{+0.028}_{-0.024}$	$10.0^{+18.7}_{-\ 9.5}$	17^{+31}_{-16}
				$\Xi_b^{\prime -}(\frac{3}{2}^-) \to \Xi_b^{*-}\gamma$	$0.083^{+0.028}_{-0.028}$	$6.9^{+12.8}_{-6.4}$	
$[\mathbf{6}_F, 2, 1, \lambda]$	$\Xi_b'(\frac{3}{2}^-)$	6.23 ± 0.15	11 ± 5	$\Xi_b^{\prime 0}(\frac{3}{2}^-) \to \Xi_b^{\prime 0}\gamma$	$0.10^{+0.12}_{-0.10}$	19^{+44}_{-19}	27^{+73}_{-27}
				$\Xi_b^{\prime 0}(\frac{3}{2}^-) \to \Xi_b^{*0}\gamma$	$0.088^{+0.074}_{-0.037}$	$8.4^{+28.7}_{-\ 8.4}$	
				$\Xi_b^{\prime -}(\frac{3}{2}^-) \to \Xi_b^{\prime -}\gamma$	$0.14^{+0.23}_{-0.10}$	$46^{+250}_{-\ 46}$	$67^{+340}_{-\ 67}$
				$\Xi_b^{\prime -}(\frac{3}{2}^-) \to \Xi_b^{*-}\gamma$	$0.14^{+0.14}_{-0.10}$	21^{+86}_{-21}	
	$\Xi_b'(\frac{5}{2}^-)$	6.24 ± 0.14		$\Xi_b^{\prime 0}(\frac{5}{2}^-) \to \Xi_b^{*0}\gamma$	$0.059^{+0.053}_{-0.035}$	11^{+38}_{-11}	11^{+38}_{-11}
				$\Xi_b^{\prime -}(\frac{5}{2}^-) \to \Xi_b^{*-}\gamma$	$0.089^{+0.084}_{-0.054}$	26^{+92}_{-26}	26^{+92}_{-26}

Total: 26 decay channels

$\Omega_b^- \to \Omega_b^-(\Omega_b^{*-})\gamma$

TABLE VI: Radiative decay widths of the P-wave bottom baryons Ω_b belonging to the $SU(3)$ flavor $\mathbf{6}_F$ representation.

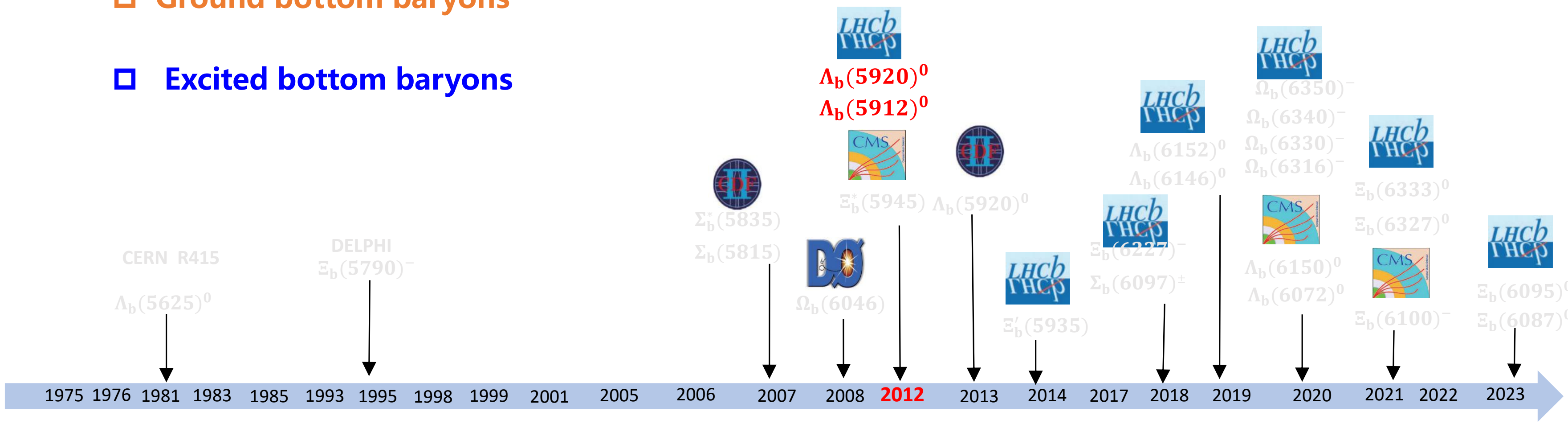
Multiplets	Baryon (j^P)	Mass (GeV)	Difference (MeV)	Decay channels	Coupling Constants (GeV^{-1})	Decay width (keV)	T.R.W. (keV)
$[\mathbf{6}_F, 0, 1, \lambda]$	$\Omega_b(\frac{1}{2}^-)$	6.34 ± 0.11	-	$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^-\gamma$	$0.20^{+0.16}_{-0.10}$	$380^{+1000}_{-\ 360}$	$850^{+2200}_{-\ 830}$
				$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^{*-}\gamma$	$0.17^{+0.13}_{-0.10}$	$470^{+1200}_{-\ 470}$	
$[\mathbf{6}_F, 1, 1, \lambda]$	$\Omega_b(\frac{1}{2}^-)$	6.34 ± 0.11	6 ± 2	$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^-\gamma$	$0.038^{+0.016}_{-0.014}$	12^{+21}_{-12}	19^{+33}_{-19}
				$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^{*-}\gamma$	$0.022^{+0.010}_{-0.010}$	$7.1^{+12.1}_{-\ 7.0}$	
	$\Omega_b(\frac{3}{2}^-)$	6.34 ± 0.09		$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^-\gamma$	$0.027^{+0.011}_{-0.011}$	$6.9^{+10.0}_{-\ 6.4}$	12^{+17}_{-11}
				$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^{*-}\gamma$	$0.033^{+0.012}_{-0.013}$	$4.8^{+7.3}_{-4.5}$	
$[\mathbf{6}_F, 2, 1, \lambda]$	$\Omega_b(\frac{3}{2}^-)$	6.35 ± 0.13	10 ± 4	$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^-\gamma$	$0.10^{+0.15}_{-0.10}$	17^{+52}_{-17}	21^{+69}_{-21}
				$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^{*-}\gamma$	$0.055^{+0.069}_{-0.027}$	$3.7^{+16.9}_{-\ 3.7}$	
	$\Omega_b(\frac{5}{2}^-)$	6.36 ± 0.12		$\Omega_b^-(\frac{5}{2}^-) \to \Omega_b^{*-}\gamma$	$0.015^{+0.019}_{-0.010}$	$0.83^{+3.45}_{-0.83}$	$0.83^{+3.45}_{-0.83}$
$[\mathbf{6}_F, 1, 0, \rho]$	$\Omega_b(\frac{1}{2}^-)$	6.32 ± 0.11	2 ± 1	$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^-\gamma$	$0.18^{+0.10}_{-0.05}$	$60^{+130}_{-\ 55}$	$70^{+150}_{-\ 65}$
				$\Omega_b^-(\frac{1}{2}^-) \to \Omega_b^{*-}\gamma$	$0.057^{+0.031}_{-0.017}$	10^{+23}_{-10}	
	$\Omega_b(\frac{3}{2}^-)$	6.32 ± 0.11		$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^-\gamma$	$0.070^{+0.041}_{-0.022}$	$9.1^{+20.6}_{-\ 5.0}$	18^{+39}_{-13}
				$\Omega_b^-(\frac{3}{2}^-) \to \Omega_b^{*-}\gamma$	$0.010^{+0.05}_{-0.02}$	$8.6^{+18.8}_{-\ 7.9}$	

Total: 13 decay channels

Decay properties

□ Ground bottom baryons

□ Excited bottom baryons

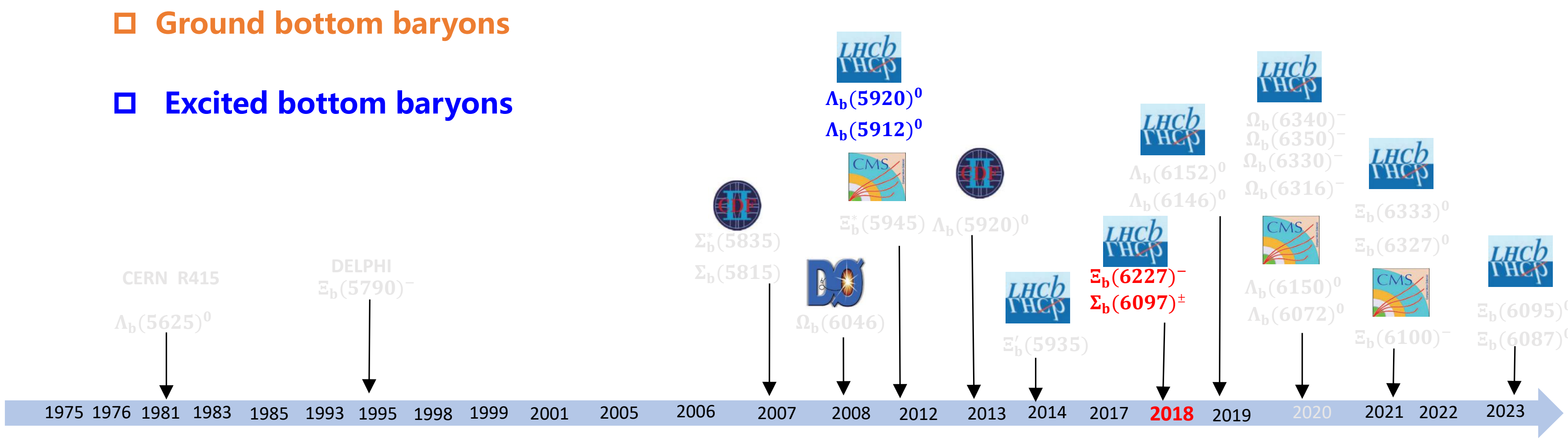


- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\,(\frac{1}{2}^-, \frac{3}{2}^-)$ $[\bar{3}_F,\ 1,\ 1, \rho]$.

$$\Gamma(\Lambda_b^0(1/2^-) \to \Lambda_b^0\gamma) = 36^{+69}_{-32}\ \text{keV}$$

$$\Gamma(\Lambda_b^0(3/2^-) \to \Lambda_b^0\gamma) = 65^{+11}_{-55}\ \text{keV}$$

Decay properties

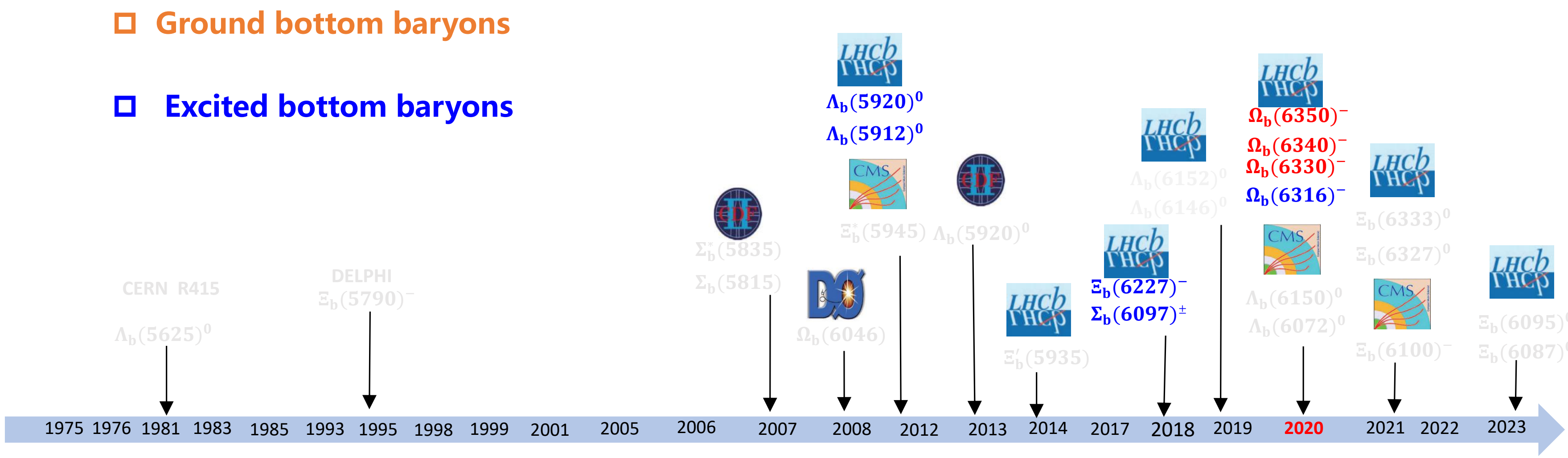


- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F,\ 1,\ 1, \rho]$.
- $\Sigma_b(6097)/\Xi_b(6227)$: $\Sigma_b\left(\frac{3}{2}^-\right)/\Xi_b\left(\frac{3}{2}^-\right)$ $[6_F,\ 2,\ 1, \lambda]$

$\Gamma(\Sigma_b^+(3/2^-) \to \Sigma_b^+\gamma) = 120^{+1100}_{-120}$ keV

$\Gamma(\Xi_b^{'-}(3/2^-) \to \Xi_b^{'-}\gamma) = 46^{+250}_{-46}$ keV

Decay properties

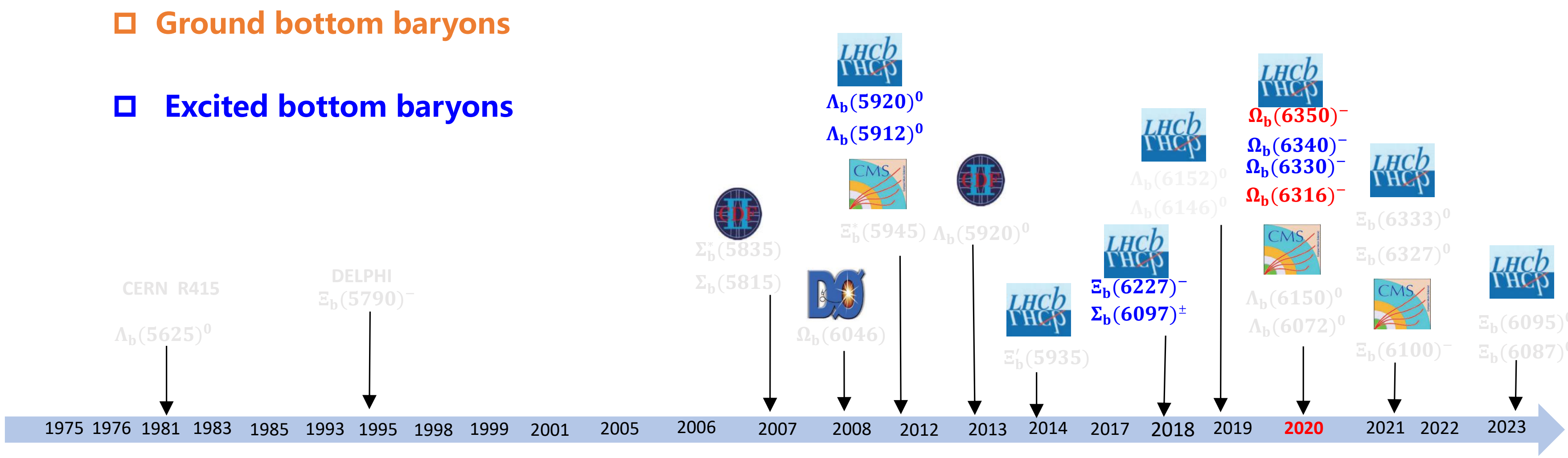


- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F,\ 1,\ 1, \rho]$.
- $\Sigma_b(6097)/\Xi_b(6227)$: $\Sigma_b\left(\frac{3}{2}^-\right)/\Xi_b\left(\frac{3}{2}^-\right)$ $[6_F,\ 2,\ 1, \lambda]$
- $\Omega_b(6316)$: $\Omega_b\left(\frac{1}{2}^-/\frac{3}{2}^-\right)$ $[6_F,\ 1,\ 0, \rho]$

$$\Gamma(\Omega_b^-(1/2^-) \to \Omega_b^- \gamma) = 60^{+130}_{-55}\ \text{keV}$$

$$\Gamma(\Omega_b^-(3/2^-) \to \Omega_b^- \gamma) = 9.1^{+20.6}_{-5.0}\ \text{keV}$$

Decay properties

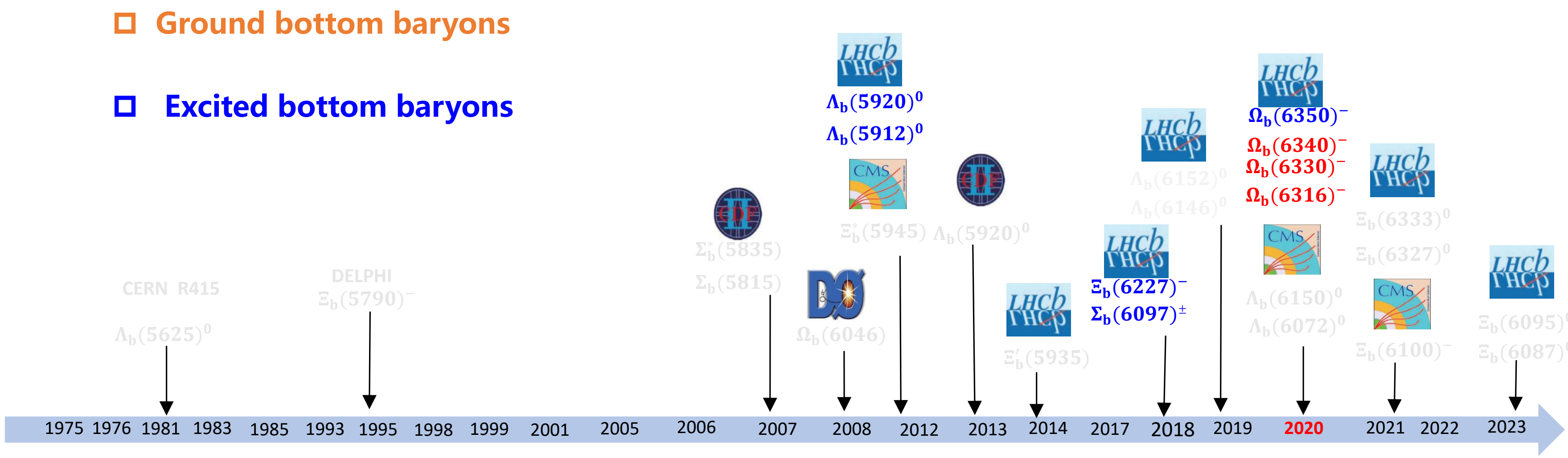


- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F, 1, 1, \rho]$.
- $\Sigma_b(6097)/\Xi_b(6227)$: $\Sigma_b\left(\frac{3}{2}^-\right)/\Xi_b\left(\frac{3}{2}^-\right)$ $[6_F, 2, 1, \lambda]$
- $\Omega_b(6316)$: $\Omega_b\left(\frac{1}{2}^-/\frac{3}{2}^-\right)$ $[6_F, 1, 0, \rho]$
- $\Omega_b(6330,6340)$: $\Omega_b\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[6_F, 1, 1, \lambda]$

$\Gamma(\Omega_b^-(1/2^-) \to \Omega_b^- \gamma) = 12^{+21}_{-12}$ keV

$\Gamma(\Omega_b^-(3/2^-) \to \Omega_b^- \gamma) = 6.9^{+10.0}_{-6.4}$ keV

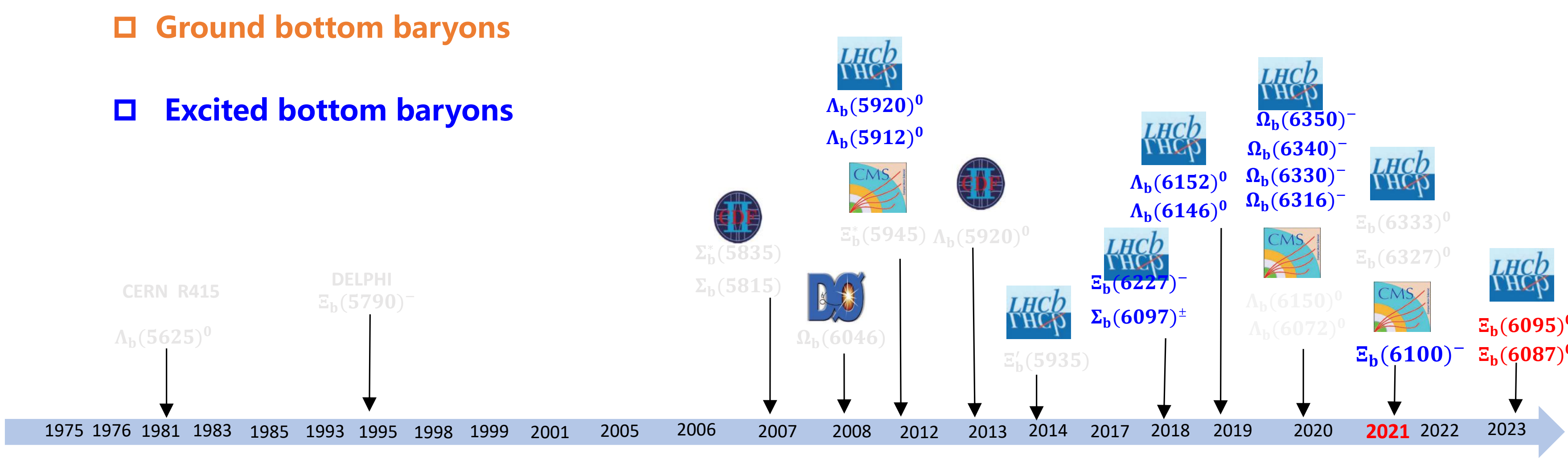
Decay properties



- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F, 1, 1, \rho]$.
- $\Sigma_b(6097)/\Xi_b(6227)$: $\Sigma_b\left(\frac{3}{2}^-\right)/\Xi_b\left(\frac{3}{2}^-\right)$ $[6_F, 2, 1, \lambda]$
- $\Omega_b(6316)$: $\Omega_b\left(\frac{1}{2}^-/\frac{3}{2}^-\right)$ $[6_F, 1, 0, \rho]$
- $\Omega_b(6330,6340)$: $\Omega_b\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[6_F, 1, 1, \lambda]$
- $\Omega_b(6350)$: $\Omega_b\left(\frac{3}{2}^-\right)$ $[6_F, 2, 1, \lambda]$

$\Gamma(\Omega_b(3/2^-) \to \Xi_b K) = 4.6^{+3.3}_{-1.9}$ MeV $\quad$ $\Gamma(\Omega_b^-(3/2^-) \to \Omega_b^- \gamma) = 17^{+52}_{-17}$ keV

Decay properties



- $\Lambda_b^0(5912, 5920)$: $\Lambda_b^0\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F, 1, 1, \rho]$.
- $\Sigma_b(6097)/\Xi_b(6227)$: $\Sigma_b\left(\frac{3}{2}^-\right)/\Xi_b\left(\frac{3}{2}^-\right)$ $[6_F, 2, 1, \lambda]$
- $\Omega_b(6316)$: $\Omega_b\left(\frac{1}{2}^- / \frac{3}{2}^-\right)$ $[6_F, 1, 0, \rho]$
- $\Omega_b(6330, 6340)$: $\Omega_b\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[6_F, 1, 1, \lambda]$
- $\Omega_b(6350)$: $\Omega_b\left(\frac{3}{2}^-\right)$ $[6_F, 2, 1, \lambda]$
- $\Xi_b(6087, 6095)$: $\Xi_b\left(\frac{1}{2}^-, \frac{3}{2}^-\right)$ $[\bar{3}_F, 1, 1, \rho]$

$\Gamma(\Xi_b^0(1/2^-) \to \Xi_b^0\gamma) = 41^{+78}_{-41}$ keV $\quad$ $\Gamma(\Xi_b'^0(3/2^-) \to \Xi_b'^0\gamma) = 85^{+160}_{-85}$ keV

Decay properties

TABLE VII: Mass spectra and decay properties of the P-wave bottom baryons Λ_b^0 and Ξ_b^0 that are possible to be observed in their radiative decay processes. We use the Λ_b^0 and Ξ_b^0 as examples, and the four $SU(3)$ flavor $\bar{\mathbf{3}}_F$ bottom baryon multiplets, $[\bar{\mathbf{3}}_F, 1, 0, \lambda]$, $[\bar{\mathbf{3}}_F, 0, 1, \rho]$, $[\bar{\mathbf{3}}_F, 1, 1, \rho]$, and $[\bar{\mathbf{3}}_F, 2, 1, \rho]$, are investigated here.

B	Multiplet	Baryon (j^P)	Mass (GeV)	Splitting (MeV)	Partial Decay Width	Total width	Candidate
Λ_b	$[\bar{\mathbf{3}}_F, 1, 1, \rho]$	$\Lambda_b(\frac{1}{2}^-)$	$5.92^{+0.13}_{-0.10}$	7 ± 3	$\Gamma(\Lambda_b(\frac{1}{2}^-) \to \Sigma_b\pi \to \Lambda_b\pi\pi)=2^{+5}_{-2}$ keV	36^{+69}_{-32} keV	$\Lambda_b(5912)^0$ [8]
					$\Gamma(\Lambda_b^0(\frac{1}{2}^-) \to \Lambda_b^0\gamma) = 34^{+64}_{-30}$ keV		
		$\Lambda_b(\frac{3}{2}^-)$	$5.92^{+0.13}_{-0.10}$		$\Gamma(\Lambda_b(\frac{3}{2}^-) \to \Sigma_b^*\pi \to \Lambda_b\pi\pi)=5^{+11}_{-5}$ keV	70^{+140}_{-60} keV	$\Lambda_b(5920)^0$ [8]
					$\Gamma(\Lambda_b^0(\frac{3}{2}^-) \to \Lambda_b^0\gamma) =65^{+130}_{-55}$ keV		
	$[\bar{\mathbf{3}}_F, 2, 1, \rho]$	$\Lambda_b(\frac{3}{2}^-)$	$5.93^{+0.13}_{-0.13}$	17 ± 7	$\Gamma(\Lambda_b(\frac{3}{2}^-) \to \Sigma_b^*\pi)=0.0^{+12.0}_{-0.0}$ MeV	$0.0^{+12.0}_{-0.0}$ MeV	-
					$\Gamma(\Lambda_b^0(\frac{3}{2}^-) \to \Sigma_b^0\gamma)=73^{+520}_{-73}$ keV		
		$\Lambda_b(\frac{5}{2}^-)$	$5.93^{+0.13}_{-0.13}$		$\Gamma(\Lambda_b^0(\frac{5}{2}^-) \to \Sigma_b^{*0}\gamma) =11^{+84}_{-11}$ keV	11^{+84}_{-11} keV	-
Ξ_b	$[\bar{\mathbf{3}}_F, 1, 1, \rho]$	$\Xi_b(\frac{1}{2}^-)$	$6.09^{+0.13}_{-0.12}$	7 ± 3	$\Gamma(\Xi_b(\frac{1}{2}^-) \to \Xi_b'\pi) =3.7^{+9.5}_{-3.7}$ MeV	$3.7^{+9.5}_{-3.7}$ MeV	$\Xi_b(6087)^0$ [15]
					$\Gamma(\Xi_b^0(\frac{1}{2}^-) \to \Xi_b^0\gamma)=41^{+78}_{-41}$ keV		
		$\Xi_b(\frac{3}{2}^-)$	$6.10^{+0.13}_{-0.12}$		$\Gamma(\Xi_b(\frac{3}{2}^-) \to \Xi_b^*\pi) =640^{+1700}_{-640}$ keV	730^{+1900}_{-730} keV	$\Xi_b(6095)^0$ [15]
					$\Gamma(\Xi_b(\frac{3}{2}^-) \to \Xi_b'\pi) =2^{+4}_{-2}$ keV		
					$\Gamma(\Xi_b^0(\frac{3}{2}^-) \to \Xi_b^0\gamma)=85^{+160}_{-85}$ keV		
	$[\bar{\mathbf{3}}_F, 2, 1, \rho]$	$\Xi_b(\frac{3}{2}^-)$	$6.10^{+0.15}_{-0.10}$	14 ± 7	$\Gamma(\Xi_b(\frac{3}{2}^-) \to \Xi_b\pi) = 1.0^{+8.3}_{-1.0}$ MeV	$1.5^{+12.0}_{-1.5}$ MeV	-
					$\Gamma(\Xi_b(\frac{3}{2}^-) \to \Xi_b'\pi) = 0^{+390}_{-0}$ keV		
					$\Gamma(\Xi_b(\frac{3}{2}^-) \to \Xi_b^*\pi) = 370^{+3260}_{-370}$ keV		
					$\Gamma(\Xi_b^0(\frac{3}{2}^-) \to \Xi_b'^0\gamma) = 140^{+510}_{-140}$ keV		
		$\Xi_b(\frac{5}{2}^-)$	$6.11^{+0.15}_{-0.10}$		$\Gamma(\Xi_b(\frac{5}{2}^-) \to \Xi_b\pi) = 1.0^{+7.2}_{-1.0}$ MeV	$1.0^{+7.4}_{-1.0}$ MeV	-
					$\Gamma(\Xi_b(\frac{5}{2}^-) \to \Xi_b'\pi) = 0^{+180}_{-0}$ keV		
					$\Gamma(\Xi_b(\frac{5}{2}^-) \to \Xi_b^*\pi) = 0^{+10}_{-0}$ keV		
					$\Gamma(\Xi_b^0(\frac{5}{2}^-) \to \Xi_b^{*0}\gamma) = 19^{+74}_{-19}$ keV		

Decay properties

TABLE VIII: Mass spectra and decay properties of the P-wave bottom baryons Σ_b, Ξ_b', and Ω_b that are possible to be observed in their radiative decay processes. We use the Σ_b^+, $\Xi_b'^-$, and Ω_b^- as examples, and the four $SU(3)$ flavor $\mathbf{6}_F$ bottom baryon multiplets, $[\mathbf{6}_F, 1, 0, \rho]$, $[\mathbf{6}_F, 0, 1, \lambda]$, $[\mathbf{6}_F, 1, 1, \lambda]$, and $[\mathbf{6}_F, 2, 1, \lambda]$, are investigated here.

B	Multiplet	Baryon (j^P)	Mass (GeV)	Splitting (MeV)	Partial Decay Width	Total width	Candidate
Σ_b	$[\mathbf{6}_F, 1, 1, \lambda]$	$\Sigma_b(\frac{1}{2}^-)$	6.06 ± 0.13	6 ± 3	$\Gamma(\Sigma_b(\frac{1}{2}^-) \to \Sigma_b\pi) = 14^{+21}_{-11}$ MeV $\Gamma(\Sigma_b(\frac{1}{2}^-) \to \Sigma_b^*\pi) = 76^{+144}_{-76}$ keV $\Gamma(\Sigma_b(\frac{1}{2}^-) \to \Lambda_b\rho \to \Lambda_b\pi\pi) = 87$ keV $\Gamma(\Sigma_b^+(\frac{1}{2}^-) \to \Sigma_b^{*+}\gamma) = 20^{+57}_{-20}$ keV	14^{+21}_{-11} MeV	-
		$\Sigma_b(\frac{3}{2}^-)$	6.07 ± 0.07		$\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Sigma_b^*\pi) = 4.0^{+5.8}_{-2.9}$ MeV $\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Sigma_b\pi) = 550^{+740}_{-360}$ keV $\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Lambda_b\rho \to \Lambda_b\pi\pi) = 230$ keV $\Gamma(\Sigma_b^+(\frac{3}{2}^-) \to \Sigma_b^{*+}\gamma) = 21^{+53}_{-21}$ keV	$4.8^{+5.9}_{-2.9}$ MeV	-
	$[\mathbf{6}_F, 2, 1, \lambda]$	$\Sigma_b(\frac{3}{2}^-)$	6.11 ± 0.16	12 ± 5	$\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Lambda_b\pi) = 49^{+76}_{-33}$ MeV $\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Sigma_b\pi) = 1.6^{+3.2}_{-1.1}$ MeV $\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Sigma_b^*\pi) = 250^{+370}_{-160}$ keV $\Gamma(\Sigma_b(\frac{3}{2}^-) \to \Sigma_b\rho \to \Sigma_b\pi\pi) = 0.14$ keV $\Gamma(\Sigma_b^+(\frac{3}{2}^-) \to \Sigma_b^+\gamma) = 120^{+1100}_{-120}$ keV	51^{+76}_{-33} MeV	$\Sigma_b(6097)^+$ [10]
		$\Sigma_b(\frac{5}{2}^-)$	6.12 ± 0.15		$\Gamma(\Sigma_b(\frac{5}{2}^-) \to \Lambda_b\pi) = 21^{+24}_{-14}$ MeV $\Gamma(\Sigma_b(\frac{5}{2}^-) \to \Sigma_b^*\pi) = 1.1^{+1.8}_{-0.8}$ MeV $\Gamma(\Sigma_b(\frac{5}{2}^-) \to \Sigma_b^{\pi}) = 360^{+710}_{-240}$ keV $\Gamma(\Sigma_b^+(\frac{5}{2}^-) \to \Sigma_b^{*+}\gamma) = 58^{+180}_{-58}$ keV	22^{+24}_{-14} MeV	-

Decay properties

Ξ_b'	$[\mathbf{6}_F,1,1,\lambda]$	$\Xi_b'(\frac{1}{2}^-)$	6.21 ± 0.11	7 ± 2	$\Gamma(\Xi_b'(\frac{1}{2}^-)\to\Xi_b'\pi)=4.5^{+5.8}_{-3.3}$ MeV $\Gamma(\Xi_b'(\frac{1}{2}^-)\to\Xi_b\pi)=160^{+180}_{-100}$ keV $\Gamma(\Xi_b'(\frac{1}{2}^-)\to\Xi_b\rho\to\Xi_b\pi\pi)=43$ keV $\Gamma(\Xi_b'^-(\frac{1}{2}^-)\to\Xi_b'^-\gamma)=18^{+22}_{-18}$ keV	$4.7^{+6.0}_{-3.4}$ MeV	-
		$\Xi_b'(\frac{3}{2}^-)$	6.22 ± 0.11		$\Gamma(\Xi_b(\frac{3}{2}^-)\to\Xi_b^*\pi)=1.4^{+1.0}_{-0.9}$ MeV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b'\pi)=340^{+350}_{-200}$ keV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b\rho\to\Xi_b\pi\pi)=78$ keV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b'\rho\to\Xi_b'\pi\pi)=0.006$ keV $\Gamma(\Xi_b'^-(\frac{3}{2}^-)\to\Xi_b'^-\gamma)=10.0^{+18.7}_{-9.5}$ keV	$1.8^{+1.1}_{-1.0}$ MeV	-
	$[\mathbf{6}_F,2,1,\lambda]$	$\Xi_b'(\frac{3}{2}^-)$	6.23 ± 0.15	11 ± 5	$\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b\pi)=19^{+26}_{-13}$ MeV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Lambda_b K)=7.4^{+11.0}_{-4.8}$ MeV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b'\pi)=790^{+1100}_{-790}$ keV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b^*\pi)=130^{+170}_{-80}$ keV $\Gamma(\Xi_b'(\frac{3}{2}^-)\to\Xi_b'\rho\to\Xi_b'\pi\pi)=0.56$ keV $\Gamma(\Xi_b'^-(\frac{3}{2}^-)\to\Xi_b'^-\gamma)=46^{+250}_{-46}$ keV	27^{+29}_{-14} MeV	$\Xi_b(6227)^-$ [11]
		$\Xi_b'(\frac{5}{2}^-)$	6.24 ± 0.14		$\Gamma(\Xi_b(\frac{5}{2}^-)\to\Xi_b\pi)=8.1^{+11.2}_{-5.7}$ MeV $\Gamma(\Xi_b(\frac{5}{2}^-)\to\Lambda_b K)=3.4^{+5.1}_{-2.2}$ MeV $\Gamma(\Xi_b(\frac{5}{2}^-)\to\Xi_b'\pi)=170^{+240}_{-110}$ keV $\Gamma(\Xi_b(\frac{5}{2}^-)\to\Xi_b^*\pi)=580^{+800}_{-380}$ keV $\Gamma(\Xi_b'(\frac{5}{2}^-)\to\Xi_b^*\rho\to\Xi_b^*\pi\pi)=0.06$ keV $\Gamma(\Xi_b'^-(\frac{5}{2}^-)\to\Xi_b^{*-}\gamma)=26^{+92}_{-26}$ keV	$12.3^{+12.3}_{-6.1}$ MeV	-
Ω_b	$[\mathbf{6}_F,1,0,\rho]$	$\Omega_b(\frac{1}{2}^-)$	6.32 ± 0.11	2 ± 1	$\Gamma(\Omega_b^-(\frac{1}{2}^-)\to\Omega_b^-\gamma)=60^{+130}_{-55}$ keV	60^{+130}_{-55} keV	$\Omega_b(6316)^-$ [13]
		$\Omega_b(\frac{3}{2}^-)$	6.32 ± 0.11		$\Gamma(\Omega_b^-(\frac{3}{2}^-)\to\Omega_b^-\gamma)=9.1^{+20.6}_{-5.0}$ keV	$9.1^{+20.6}_{-5.0}$ keV	
	$[\mathbf{6}_F,1,1,\lambda]$	$\Omega_b(\frac{1}{2}^-)$	6.34 ± 0.11	6 ± 2	$\Gamma(\Omega_b^-(\frac{1}{2}^-)\to\Omega_b^-\gamma)=12^{+21}_{-12}$ keV	12^{+21}_{-12} keV	$\Omega_b(6330)^-$ [13]
		$\Omega_b(\frac{3}{2}^-)$	6.34 ± 0.09		$\Gamma(\Omega_b^-(\frac{3}{2}^-)\to\Omega_b^-\gamma)=6.9^{+10.0}_{-6.4}$ keV	$6.9^{+10.0}_{-6.4}$ keV	$\Omega_b(6340)^-$ [13]
	$[\mathbf{6}_F,2,1,\lambda]$	$\Omega_b(\frac{3}{2}^-)$	6.35 ± 0.13	10 ± 4	$\Gamma(\Omega_b(\frac{3}{2}^-)\to\Xi_b K)=4.6^{+3.3}_{-1.9}$ MeV $\Gamma(\Omega_b^-(\frac{3}{2}^-)\to\Omega_b^-\gamma)=17^{+52}_{-17}$ keV	$4.6^{+3.3}_{-1.9}$ MeV	$\Omega_b(6350)^-$ [13]
		$\Omega_b(\frac{5}{2}^-)$	6.36 ± 0.12		$\Gamma(\Omega_b(\frac{5}{2}^-)\to\Xi_b K)=2.5^{+3.5}_{-1.6}$ MeV $\Gamma(\Omega_b^-(\frac{5}{2}^-)\to\Omega_b^{*-}\gamma)=0.83^{+3.45}_{-0.83}$ keV	$2.5^{+3.5}_{-1.6}$ MeV	-

Summary

- The radiative decays of flavor $\bar{3}_F$ P-wave baryons into ground-state bottom baryons together with a photon

- The radiative decays of flavor 6_F P-wave baryons into ground-state bottom baryons together with a photon

- We propose to measure these electromagnetic transitions in the future Belle-II, BESIII, and LHCb experiments.

Thanks for your attention !