Errata

Erratum: Heavy-quark symmetry and chiral dynamics [Phys. Rev. D 46, 1148 (1992)]

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[S0556-2821(97)05609-9]

PACS number(s): 11.30.Rd, 11.30.Hv, 14.20.Lq, 14.40.Lb, 99.10.+g

In Eq. (3.66) a factor of $\frac{1}{2}$ should appear in front of g_1/f_π.
Equation (3.68) should read $g_1=2g_A^{\Xi_Q'}(0)$.
The coupling constant g_1 in Eqs. (3.72) and (3.73) should read $g_1=\frac{4}{3}$.
In Eq. (3.74), what appears as $g_1=\frac{1}{3}\times 0.75$ should be $g_1=\frac{4}{3}\times 0.75$.

0556-2821/97/55(9)/5851(1)/$10.00

Erratum: Corrections to chiral dynamics of heavy hadrons: SU(3) symmetry breaking [Phys. Rev. D 49, 5857 (1994)]

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[S0556-2821(97)05509-4]

PACS number(s): 11.30.Rd, 12.39.Hg, 13.25.Ft, 13.40.Hq, 99.10.+g

In Eq. (3.5), what appears as $g_1=\frac{1}{3}g$ should be $g_1=\frac{4}{3}g$.
Figure 6 and Fig. 7 should be interchanged, but figure captions remain the same.
In Eq. (3.26), the parameter a_3 should read a_2.
In Eq. (4.15), the denominator term M_{Σ_c} should read $M^2_{\Sigma_c}$.
In Eq. (4.21), what appears as $g_1=\frac{1}{3}g$ should be $g_1=\frac{4}{3}g$.
In Eq. (4.22), what appears as 0.26 GeV^{-1} should be 2.6 GeV^{-1}.
Equation (4.23a) should read

$$Z_2(\Lambda_c)=1.40,\quad Z_2(\Xi_c)=1.83,\quad Z_2(\Sigma_c)=1.38,\quad Z_2(\Xi_c')=1.56,\quad Z_2(\Omega_c)=1.70.$$

Equation (4.23b) should read

$$Z_1'(\Sigma_c\to\Lambda_c\pi;5a)=1.21.$$

Equation (4.25) should read

$$Z_1(\Sigma_c^{*++}\to\Sigma_c^{++}\gamma)=0.95,\quad Z_1(\Sigma_c^{*+}\to\Sigma_c^{+}\gamma)=0.82,\quad Z_1(\Sigma_c^{*0}\to\Sigma_c^{0}\gamma)=1.07,\quad Z_1(\Xi_c'^{*+}\to\Xi_c'^{+}\gamma)=1.44,$$

$$Z_1(\Xi_c'^{*0}\to\Xi_c'^{0}\gamma)=1.02,\quad Z_1(\Omega_c^{*}\to\Omega_c^{+}\gamma)=0.95,\quad Z_1''(\Sigma_c^{*+}\to\Lambda_c^{+}\gamma)=0.99,\quad Z_1''(\Xi_c'^{+*}\to\Xi_c^{+}\gamma)=1.15.$$

Equation (4.26) should read

$$\delta a_1(\Sigma_Q^{+1(*)}\to\Sigma_Q^{+1}\gamma;6c)=\delta a_1(\Xi_Q'^{-(1/2)(*)}\to\Xi_Q'^{-1/2}\gamma;6c)=0.46e\ \ \mathrm{GeV}^{-1},$$

$$\delta a_1(\Omega_Q^{(*)}\to\Omega_Q\gamma;6c)=\delta a_1(\Sigma_Q^{0(*)}\to\Sigma_Q^{0}\gamma;6c)=0.72e\ \ \mathrm{GeV}^{-1},$$

$$\delta a_1(\Sigma_Q^{-1(*)}\to\Sigma_Q^{-1}\gamma;6c)=\delta a_1(\Xi_Q'^{(1/2)(*)}\to\Xi_Q'^{1/2}\gamma;6c)=0.20e\ \ \mathrm{GeV}^{-1},$$

$$\delta a_2(\Sigma_Q^{0(*)}\to\Lambda_Q\gamma;7c)=-0.31e\ \ \mathrm{GeV}^{-1},$$

$$\delta a_2(\Xi_Q'^{(1/2)(*)}\to\Xi_Q^{1/2}\gamma;7c)=-0.63e\ \ \mathrm{GeV}^{-1},$$

$$\delta a_2(\Xi_Q'^{-(1/2)(*)}\to\Xi_Q^{-1/2}\gamma;7a+7b+7c)=0.15a_2-0.11e\ \ \mathrm{GeV}^{-1}.$$

Equations (4.27a) and (4.27b) should read

$$(a_1-8a_1')_{\mathrm{eff}}(\Sigma_c^{*0}\to\Sigma_c^{0}\gamma)=1.06a_1-8a_1'=-1.34e\ \ \mathrm{GeV}^{-1},$$

$$(a_1-8a_1')_{\mathrm{eff}}(\Omega_c^{*}\to\Omega_c\gamma)=0.96a_1-8a_1'=-1.25e\ \ \mathrm{GeV}^{-1},$$

$$(a_1-8a_1')_{\mathrm{eff}}(\Xi_c'^{*0}\to\Xi_c'^{0}\gamma)=1.00a_1-8a_1'=-1.28e\ \ \mathrm{GeV}^{-1},$$

and

$$(a_1+16a_1')_{\mathrm{eff}}(\Xi_c'^{*+}\to\Xi_c'^{+}\gamma)=0.74a_1+16a_1'=0.09e\ \ \mathrm{GeV}^{-1},$$

$$(a_1+16a_1')_{\mathrm{eff}}(\Sigma_c^{*+}\to\Sigma_c^{+}\gamma)=0.74a_1+16a_1'=0.09e\ \ \mathrm{GeV}^{-1}.$$

Equation (4.30) is modified to

$$(a_2)_{\mathrm{eff}}(\Sigma_c^{+}\to\Lambda_c^{+}\gamma)=0.82a_2=0.44e\ \ \mathrm{GeV}^{-1},$$

$$(a_2)_{\mathrm{eff}}(\Xi_c'^{+}\to\Xi_c^{+}\gamma)=0.28a_2=0.15e\ \ \mathrm{GeV}^{-1},$$

$$(a_2)_{\mathrm{eff}}(\Xi_c'^{0}\to\Xi_c^{0}\gamma)=-0.06a_2=-0.03e\ \ \mathrm{GeV}^{-1}.$$

As a result, Eq. (4.33) should read

$$\Gamma(\Sigma_c^{+}\to\Lambda_c^{+}\gamma)=46\ \ \mathrm{keV},\quad \Gamma(\Xi_c'^{+}\to\Xi_c^{+}\gamma)=1.3\ \ \mathrm{keV},\quad \Gamma(\Xi_c'^{0}\to\Xi_c^{0}\gamma)=0.04\ \ \mathrm{keV}.$$

Equation (4.34) should read

$$\sum_{\mathrm{pol}}|A(D_s^{*+}\to D_s^{+}\gamma)|^2>\sum_{\mathrm{pol}}|A(D^{*+}\to D^{+}\gamma)|^2,\quad \sum_{\mathrm{pol}}|A(\Sigma_c^{*+}\to\Sigma_c^{+}\gamma)|^2=\sum_{\mathrm{pol}}|A(\Xi_c'^{*+}\to\Xi_c'^{+}\gamma)|^2.$$

Erratum: Rigorous QCD analysis of inclusive annihilation and production of heavy quarkonium [Phys. Rev. D 51, 1125 (1995)]

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[S0556-2821(97)01909-7]

PACS number(s): 13.25.Gv, 12.38.Bx, 12.39.Hg, 13.40.Hq, 99.10.+q

In this erratum, we clarify the velocity-scaling rules for those nonrelativistic quantum chromodynamics (NRQCD) matrix elements whose leading contributions come from $|Q\bar{Q}g\rangle$ Fock states that can be reached through a spin-flip transition from the dominant Fock state. A correct accounting of these spin-flip Fock states leads to revisions of the error estimates in several equations in the paper. In addition, we emphasize that the velocity-scaling rules should be used to estimate the probabilities of higher Fock states, rather than their amplitudes. We also correct some typographical errors.

Throughout the paper, phrases of the type ''amplitude of order v^n'' should be replaced with ''probability of order v^{2n}.'' The reason is that the probability of a $|Q\bar{Q}g\rangle$ Fock state is the square of the amplitude integrated over the phase space of the particles. Some of the dependence on v arises from the integration over the phase space of the gluon.

Throughout the paper, one should keep in mind that the velocity expansion may contain odd, as well as even, powers of v. Thus, for example, v^2 should be replaced with v in phrases such as ''expansion in powers of v^2.''

The following paragraph should be inserted after the paragraph that includes Eq. (2.6): The above estimates for the probabilities of $|Q\bar{Q}g\rangle$ Fock states apply if the spin state of the $Q\bar{Q}$ pair is the same as in the dominant $|Q\bar{Q}\rangle$ Fock state. If the spin state is different, we must replace $g\mathbf{A}\cdot\boldsymbol{\nabla}$ in Eq. (2.6) with $g\mathbf{B}\cdot\boldsymbol{\sigma}$ to obtain a nonzero matrix element. Using the velocity-scaling rules of Table I, we again obtain an estimate $\Delta E\sim Mv^4$ for the energy shift, implying that the probability for a $|Q\bar{Q}g\rangle$ state containing a gluon with momentum on the order of Mv is $P_{Q\bar{Q}g}\sim v^3$. However, in the derivation of the velocity-scaling rules in Ref. [14], it was assumed that dynamical gluons have momenta of order Mv. If the gluon has a much smaller momentum k, then the estimate M^2v^4 for the operator $g\mathbf{B}$ in Table I should be replaced with k^2v^2. Using this to estimate the energy shift from a $|Q\bar{Q}g\rangle$ Fock state containing a gluon with momentum of order Mv^2, we obtain $\Delta E\sim Mv^6$ and $P_{Q\bar{Q}g}\sim v^4$. Thus, gluons with very low momenta exhibit the suppression that is characteristic of the multipole expansion. We conclude that a $|Q\bar{Q}g\rangle$ Fock state that can be reached from the dominant $|Q\bar{Q}\rangle$ Fock state by a spin-flip transition is dominated by dynamical gluons with momenta of order Mv and that the probability of such a Fock state is $P_{Q\bar{Q}g}\sim v^3$.

The following paragraph should be added at the end of Sec. II D: The above discussion applies to Fock states $|Q\bar{Q}g\rangle$ in which the $Q\bar{Q}$ pair has the same total spin quantum number S as in the dominant $|Q\bar{Q}\rangle$ state. The probabilities for Fock states $|Q\bar{Q}g\rangle$ that can be reached from the dominant Fock state by a spin-flip transition also scale in a definite way with v. The probability for such a Fock state to contain a dynamical gluon with momentum of order Mv is of order v^3, just as in the case of a non-spin-flip transition. However, in the case of a spin-flip transition, this momentum region dominates because, as we have seen, gluons with softer momenta, on the order of Mv^2, are suppressed by the multipole expansion. Thus, if the $Q\bar{Q}$ pair in the dominant Fock state has angular-momentum quantum numbers ${}^{2S+1}L_J$, then the Fock state $|Q\bar{Q}g\rangle$, with the $Q\bar{Q}$ pair in a color-octet state with the same value of L but different total spin quantum number, has a probability of order v^3. For example, if the dominant Fock state consists of a $Q\bar{Q}$ pair in a ${}^3S_1$ state, then the Fock state $|Q\bar{Q}g\rangle$ with the $Q\bar{Q}$ pair in a color-octet ${}^1S_0$ state has a probability of order v^3. If the dominant Fock state consists of a $Q\bar{Q}$ pair in a ${}^1P_1$ state, then the Fock state $|Q\bar{Q}g\rangle$ with the $Q\bar{Q}$ pair in a color-octet ${}^3P_J$ state has probability of order v^3.

In the first paragraph of Sec. III A, the following two sentences should be inserted just before the last sentence of the paragraph: The matrix element is suppressed by v^3 relative to the velocity-scaling rules in Table I if $\mathcal{O}_n$ annihilates and creates $Q\bar{Q}$ pairs in the same color-spin-orbital state as appears in one of the Fock states $|Q\bar{Q}g\rangle$ that can be obtained from the dominant Fock state by a spin-flip transition. In such a Fock state, the $Q\bar{Q}$ pair must be in a color-octet state with the same orbital-angular-momentum quantum number L as in the dominant $|Q\bar{Q}\rangle$ state, but with a different total spin quantum number.

After the first paragraph of Sec. III A, the following new paragraph should be inserted: If perturbation theory remained accurate down to the scale Mv, then the spin-flip matrix elements would be suppressed by an additional power of v. The reason for this is that the contribution to a spin-flip matrix element that is suppressed by only v^3 relative to the velocity-scaling rules is power ultraviolet divergent. Therefore, one could carry out a renormalization of the matrix element in which this contribution is subtracted. The corresponding contribution to the decay rate would then reside in the short-distance coefficient of the matrix element that is associated with the dominant Fock state. (Such a subtraction is carried out automatically if dimensional regularization is used to cut off the ultraviolet divergences in the matrix element.) Once the subtraction has been made, the leading contribution to the spin-flip matrix element comes from the scale

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Mv^2. It is subject to the usual multipole suppression and scales as v^4 relative to the velocity-scaling rules. In practice, one usually makes such subtractions perturbatively. It is not clear, in the charmonium and bottomonium systems, that perturbation theory is sufficiently accurate at the scale Mv to remove the v^3 contribution completely. Therefore, we assume in the error estimates below that the spin-flip matrix elements scale as v^3 relative to the velocity-scaling rules.

In the second paragraph of Sec. III A, v^4 should be replaced with v^3 in the phrase ''suppressed by v^4 or more.'' In Eq. (3.1), the error estimate $O(v^4\Gamma)$ should be replaced with $O(v^3\Gamma)$. In the third paragraph of Sec. III A, v^4 should be replaced with v^3 in the phrase ''are of order $v^4\Gamma$ or higher.''

In Eqs. (4.1a), (4.1b), (4.3a), and (4.3b), the error estimates should be $O(v^3\Gamma)$. At the end of the paragraph containing Eq. (4.2), ''relative order v^4'' should be replaced with ''relative order v^3.''

In Eqs. (6.8a), (6.8b), (6.9a), and (6.9b), the error estimates should be $O(v^3\sigma)$.

There is a typesetting error in Eqs. (3.19a) and (3.19b). The first factor on the right side should be $\sqrt{3N_c/2\pi}$, just as in Eqs. (3.19c) and (3.19d). In the subsequent sentence, ''order v^2'' should be replaced with ''relative order v^2.''

In Eq. (5.4), the last color matrix should be $T^a_{i'j'}$. In Eq. (5.5), the coefficient of the second term on the right-hand side should be $4/(N_c^2-1)$, rather than $2/(N_c^2-1)$.

In Eqs. (A16) and (A25), the running coupling constant should be $\alpha_s(2M)$ rather than $\alpha_s(M)$.