Quantum Field Theory and the Standard Model

by Matthew D. Schwartz

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This page lists corrections to the **third printing**, which was printed January 2015.
Corrections to the second printing (June 2014) can be found here.
Corrections to the first printing (December 2013) can be found here.

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Important corrections (Errors in derivations or results)

None so far.

Minor corrections (Unimportant errors in equations)

p. 49, Eq (4.16): The factors of "e" should not be there in any of the terms.
p. 50, Eq (4.18): The factor of "e/2" after the first = sign should not be there.
p. 138, Problem 8.4: This problem is extremely difficult. See Greiner and Reinhardt "Field Quantization" Chapter 7 for a solution. A more reasonable problem is to calculate the propagator for a photon in a physical gauge, such as axial gauge, $A_0 = 0$.
p. 149 Eq. (9.42) and p. 150 Eqs. (9.44) and (9.45): There is a missing factor of $(2\pi)^4$ on the right-hand side of all of these

equations.

p. 179, Eq. (10.131): The matrix in this equation should be negated to be consistent with Eq. (10.134). That is, the top row should be 0 -1 and the bottom row 1 0.

p. 181, Problem 10.1(b): The expression "$(H_D + e A_0)^2$" should be "$(H_D - e A_0)^2$".

p. 201,Line after Eq. (11.90): There should be a minus sign in the transformation of A_μ. That is, CPT sends, $A_\mu(x)$ -> - $A_\mu(-x)$.

p. 201, Eq. (11.91): There should be no i in the ψAψ term.

p. 221, Eq. (12.81): There should be no factor of "i" in the definition of D_1 on the last line.

p. 264, Eq. (14.62): There is a missing factor of "$Z_0[0]$" on both terms on the right hand side of the first equality. That is, "1/Z[0]" should be "$Z_0[0]/Z[0]$" in two places.

p. 278, Eq. (14.132): The "+m" in the Dirac Lagrangian should be "-m".

p. 278, First line below Eq. (114.132): "... represent any globally symmetric terms." should be "... represent any locally symmetric terms.".

p. 283 Problem 14.1: There are a few mistakes in Eq. (14.158). Corrections as follows:

Reads in third printing:

$$\int \mathcal{D}\phi^\star \mathcal{D}\phi \exp\left[i\int d^4x(\phi^\star M\phi + JM)\right] = \mathcal{N}\frac{1}{\det M}\exp(iJM^{-1}J) \quad (14.158)$$

Should read:

$$\int \mathcal{D}\phi^\star \mathcal{D}\phi \exp\left[i\int d^4x(\phi^\star M\phi + J^\star\phi + J\phi^\star)\right] = \mathcal{N}\frac{1}{\det M}\exp(iJ^\star M^{-1}J) \quad (14.158)$$

p. 301, 3rd line of paragraph beginning "In Section 15.4...": The inline equation should be "< φ^4 > = − λ − .." rather than "< φ^4 > = λ − ..".

p. 324, First paragraph: The diagrams vanish, but not because there are an odd number of γ matrices. More simply, they must be proportional to the photon momentum, but Lorentz invariance (it is the only 4-vector around), but this momentum must vanish, by momentum conservation.

p. 334, Problem 16.3c: This problem should be asking about the total rate for $\pi^+\pi^- \to \tau^+\tau^-$ not $\pi^+\pi^- \to e^+e^-$.

p. 336, First line on page: "with residue i" should not be there.

p. 344, First line after Eq. (19.34): There is an extra factor of p^4 in the definition of $\Pi(p^2)$. The line should read: "$\Pi(p^2)$ is defined as the coefficient of i/p^2 $(-g^{\mu\nu} - p^\mu p^\nu/p^2)$" as it is on p. 349, second paragraph.

p. 346, Eq. (19.43): m_e should be m_R.

p. 380, Eq. (20.44): Tr [q1 S q2 S] should be Tr[p3 S p4 S], as in Eq. (20.43).

p. 427, Eq. (23.31): The power of the β_2 term should be 3, not 2.

p. 447, Fig. 23.2: The x-axis in the figure should have positive numbers (0.5, 0.55, etc.). Also the caption should read "... the value of λ6 (Λ_L) goes to a constant value, entirely set by λ4 (Λ_L) ... " instead of "... the value of λ6 (Λ) goes to a constant value, entirely set by λ4 (Λ) ... ".

p. 457, Eq. (24.30): There is a missing factor of "i" on the left-hand side ("M" should be "i M"). Eq. (24.31) still follows, as it is the imaginary part of i times the Feynman propagator to which Eq. (24.25) applies.

p. 458, Eq. (24.34): There is a missing factor of $(2\pi)^4$ on the right-hand side.

p. 459, Eq. (24.39): A factor of $(2\pi)^4\delta^4(p - q_1 - q_2)$" is missing from the right-hand side.

p. 459, Eq. (24.40): The first factor of "$\delta(q_2{}^2)$" should be "$\delta(q_1{}^2)$"

p. 471, Eq. (24.85): The first line should be evaluated at t=0 after the derivative is taken.

p. 471, Eq. (24.86): The left hand side should be integrated over x, rather than p. That is

Reads in third printing:

$$\int \frac{d^4p}{(2\pi)^4} e^{ip(x-y)} \langle\Omega|T\{\phi_0(x)\phi_0(y)\}|\Omega\rangle$$

Should read:

$$\int d^4x e^{ipx} \langle\Omega|T\{\phi_0(x)\phi_0(0)\}|\Omega\rangle$$

pp. 503-505: All instances of "N" should be "n" in this section. That is, W(N) should be W(n), A(N) should be A(n), etc.. The exception is the factor of N in the denominator in Eqs. (25.133) and (25.134) which are $N=N_c$, the number of colors. These N's really are N's.

p. 515, Above Eq. (25.27): Summing over colors gives $\mathrm{Tr}[T^aT^a] = N\, C_F$, not just C_F as written. The extra factor of N is already included in the sum over colors at tree-level, so Eq. (26.27) is correct.

p. 524, Eq. (26.70): The -½ on the first line should be a -1, as in Eq. (19.54).

p. 538, Eq. (27.19): The σ's in this equation should be barred.

p. 571, Eq. (28.31): One of the currents should have †. That is, "$J_\mu{}^L J_\mu{}^L$" should be "$J_\mu{}^{L\dagger} J_\mu{}^L$".

p. 571, Eq. (28.32): In the second term on the right-hand side, "$\gamma^\mu\gamma^5$" should be "$\gamma^\mu (1-\gamma^5)$".

p. 571, 4th line after Eq. (28.35): The transformation law for M should be "$M \to g_R\, M\, g_L{}^\dagger$" instead of "$M \to g_L\, M\, g_R{}^\dagger$".

p. 581, Eq. (28.62): The left hand side should have "$G[A_\mu + D_\mu, \pi - \alpha]$" instead o f "$G[A_\mu - D_\mu, \pi - \alpha]$". Also, on the right-hand side, "m_A" should be squared in both instances.

p. 581, Eq. (28.64): The sign of the ghost mass term is wrong. The expression "$-\xi\, m_A{}^2$" in the last term should be "$+\xi\, m_A{}^2$"

p. 590, Eq. (29.27): The 1/v should be v.

p. 591, Eq. (29.28): "v^2" on the right should be "½ v^2".

p. 591, Eq (29.32): The "$(t-m_h{}^2)$" term in the denominator on the far right-hand side should not be squared.

p. 593, Eq. (29.36): The "g" on the far right on the first line, multiplying "$Y_L\, B$" should be a "g'".

p. 600, Above Eq. (29.64): The expression for "ψ_R" should have a minus sign in the top component: "$\psi_R = (-i\sigma_2\, \nu_R\, , \nu_R)$".

p. 605, Eq. (29.81): T_3 was not applied. Correction as follows:

Reads in third printing:

$$
\begin{aligned}
J^3_\mu = \bar{u}\gamma^\mu u + (\cos\theta_c \bar{d} + \sin\theta_c \bar{s})\gamma^\mu(\cos\theta_c d + \sin\theta_c s) \\
+ \bar{c}\gamma^\mu c + \big(\cos\theta_c \bar{s} - \sin\theta_c \bar{d}\big)\gamma^\mu(\cos\theta_c d - \sin\theta_c s) \\
= \bar{u}\gamma^\mu u + \bar{c}\gamma^\mu c + \bar{d}\gamma^\mu d + \bar{s}\gamma^\mu s,
\end{aligned}
$$

Should read:

$$
\begin{aligned}
J^3_\mu = \frac{1}{2}\bar{u}\gamma^\mu u - \frac{1}{2}(\cos\theta_c \bar{d} + \sin\theta_c \bar{s})\gamma^\mu(\cos\theta_c d + \sin\theta_c s) \\
+ \frac{1}{2}\bar{c}\gamma^\mu c - \frac{1}{2}\big(\cos\theta_c \bar{s} - \sin\theta_c \bar{d}\big)\gamma^\mu(\cos\theta_c s - \sin\theta_c d) \\
= \frac{1}{2}\bar{u}\gamma^\mu u - \frac{1}{2}\bar{c}\gamma^\mu c + \frac{1}{2}\bar{d}\gamma^\mu d - \frac{1}{2}\bar{s}\gamma^\mu s,
\end{aligned}
$$

p. 612, Eq. (29.109): The middle expression is incorrect. Instead of the factor of "2 m_s" in the numerator, there should be a factor of "$(2m_s - m_u - m_d)$" in the denominator.

p. 636, paragraph after Eq. (30.89), next to last line: The current experimental bound on the strong CP phase is "$\theta < 10^{-10}$", not "$\theta < 10^{-12}$".

p. 832, Eq. (B.60): In the second line of this equation, the denominators should have + signs, not - signs. That is, they should be "$(k_E{}^2 + m^2)^2$" and "$(k_E{}^2 + \Lambda^2)^2$".

Typos (Superficial formatting issues)

p. 136, Eq. (8.139): The "v" on the second line should be a "ν".

p. 160, Eq. (10.13): The summation symbol should be outside the square brackets.

p. 180, Eq. (10.133): The "a" in "$\varepsilon^{a\beta}$" should be an "α".

p. 182, Problem 10.1(f): There should be no arrow on top of H on the first line of the page.

p. 182, Problem 10.1(h), 4th line: "... are all m_e times powers ..." should be "... are all $m_e{}^{-1}$ times powers ...". Also "time-dependent" should be "time-independent".

p. 191. Eq. (11.32): The * on the first epsilon should be removed.

p. 183, Table 10.1: "describing" is misspelt.

p. 200, Eq. (11.83): The bar over the x on the left hand side should be an arrow.

p. 201, Eq. (11.91): The last term ($\psi\sigma_{\mu\nu}\psi F_{\mu\nu}$) should not have an "i".

p. 202, Problem 11.6. This problem has generated some confusion. A cleaner version would be: (a) Use the left and right chirality projection operators to show that the QED vertex vanishes unless ψ and its conjugate are both left-handed or both right-handed. And (d) Suppose we take a spin-up electron going in the +z direction and turn it around carefully with electric fields so that now it goes in the -z direction but is still spin up. Has its helicity or chirality flipped (or both)? How is your answer consistent with part (a)?

p. 218, Eqs. (12.66), (12.67) and (12.68): The “d^3q” should be replaced by “d^3p”.

p. 249, Problem 13.6(d): Ni^{59} should be Ni^{60} in two places (as in Problem 11.6(f) on p. 202). Also, C (Carbon) should be Co (Cobalt).

p. 280, Eq. (14.146), The “p” in the argument of M on the left hand side should be omitted.

p. 310, First line of Section 16.3.1: “$|p^2| << m$” should be “$|p^2| << m^2$”.

p. 315, above Eq. (17.2): Missing parenthesis. "i Dslash - m)" should be "(i Dslash - m)".

p. 321, Problem 17.1 (b): The values for (g-2)/2 have the decimal place in the wrong spot. 0.0011659208 and 0.0011659182 for the experiment and theory values, respectively. The uncertainties are correct.

p. 329, Below Eq. (18.14): Reference to Chapter 9 should be a reference to Chapter 16.

p. 332, Line below Eq. (18.42): Only condition (18.40) is required to define the pole mass.

p. 339, Third paragraph: reference to Chapter 15 should be to Chapter 16.

p. 339, Eq. (19.1): The first ψ should have a bar over it.

p. 345, Five lines before Eq. (19.39): δ_3 should be δ_1.

p. 353, Below Eq. (19.82): F_1 (0) = 1 sets δ_1 and Σ' (m_R)=0 sets δ_2, not vice versa as written.

p. 413, Eq. (22.59): m and M should be switched in the denominators on the second line.

p. 460, Eq. (24.44): The μ and ν indices on the final two p’s should be should be interchanged. Also, the sum on the left hand side should be over i and the second epsilon should have a ν index.

p. 502, Second line below Eq. (25.120): It should read “$r^\mu \Pi^{\mu\nu ab}{}_{axial} = 0$”. The “=0” is missing.

p. 566, Eq. (28.15): The variation should be $\partial L/ \partial(\partial_\mu \pi)$ instead of just $\partial L/\partial_\mu \pi$.

p. 571, Eq. (28.33) and the line above Eq. (28.33): It should be “$\pi \to \mu\, \nu_\mu$” not “$\pi \to \mu\, \nu_e$” in both cases (as in Eq. (23.34)).

p. 582, 5th line from bottom: “E>> m^2” should be “E>> m”.

p. 602, Third paragraph: Reactor neutrinos are mostly electron anti-neutrinos and accelerator neutrinos are mostly muon neutrinos (not the other way around, as written).

p. 612, line after Eq. (29.111): There is an extra $|d_N|$. That is, “$|d_N| < |d_N| < 2.9 \times 10^{-26}$ ...” should be simply “$|d_N| < 2.9 \times 10^{-26}$ ...”.

p. 633, Eq. (30.79): The “$A(R)d^{abc}$” on the right hand side should be “½ $A(R)d^{abc}$”.
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Credits

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Minor correction on p. 138, Thanks to Stefano.
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