Appendix G
Errata

Here is a list of known errata to "The Standard Model: a Primer" by Burgess and Moore. If you know of an error in the manuscript which does not appear here, please e-mail it to `guymoore@physics.mcgill.ca` so that it may be included in this errata list.

- Page xiv: $Z_{\mu\nu}$ should read $\eta_{\mu\nu}$, and "conversion tasle" should read "conversion table"
- Page 1, Eq.(1.1) the $\otimes$ symbols should be $\oplus$.
- Page 5, two lines below Eq. (1.15), "$p^2 \equiv Z_{\mu\nu}p^\mu p^\nu$" should read "$p^2 \equiv \eta_{\mu\nu}p^\mu p^\nu$".
- Page 7, between Eq. (1.25) and Eq. (1.26), "must be Hermitia:" should read "must be Hermitian:"
- Page 12, between Eq. (1.37) and item (i), s should be S.
- Page 21, in Eq. (1.82) the round parenthesis should not be there.
- Page 23, right after Eq. (1.100), it should say s^μ is the spin AXIAL 4-vector. Page 24, Eq (1.106) should read

$$\mathcal{L}_0 = -\frac{1}{2}\left[(A + \mathrm{i}B)_{mn}\bar{\psi}^m P_L \not{\partial}\psi^n + (C + \mathrm{i}D)_{mn}\bar{\psi}^m P_L \psi^n\right] + \text{h.c.} - E$$

  and Eq. (1.107) should read

$$\mathcal{L}_0 = -\frac{1}{2}[(\mathcal{V}^T\mathcal{A}\mathcal{V}^*)_{mn}\overline{\psi}'^m P_L \not{\partial}\psi'^n - (\mathcal{V}^T\mathcal{C}\mathcal{V})_{mn}\overline{\psi}'^m P_L \psi'^n] + \text{h.c.} - E$$

- Page 25, Eq. (1.116) the $\bar{a}_{\mathbf{p}\lambda}$ should be $a^*_{\mathbf{p}\lambda}$.
- Page 31, last line should read

$$\frac{dQ_a}{dt} = \int d^3x\, \frac{\partial j^0}{\partial t} = -\int d^3x\, \nabla\cdot\vec{j} = \oint d^2x\, \vec{n}\cdot\vec{j} = 0\,.$$

- Page 35, Eq. (1.158) line 2 should read

$$= -\frac{1}{2}\partial_\mu\phi^i\partial^\mu\phi^i - \rho - v_i\phi^i - \frac{1}{2}\mu_{ij}^2\phi^i\phi^j - \frac{1}{3!}\xi_{ijk}\phi^i\phi^j\phi^k$$

  (extra j index on μ_{ij})
- Page 38, Eq. (1.171) should read

$$F^a_{\mu\nu} \equiv \partial_\mu A^a_\nu - \partial_\nu A^a_\mu + g f^a{}_{bc} A^b_\mu A^c_\nu$$

  (extra g in front of $f^a{}_{bc}$)
- Page 41, the first line under Eq. (1.181) should read "Here $E_i = F_{i0}$ and $B_i = \frac{\epsilon_{ijk}}{2}F^{jk}$."
- Page 43, in Eq. (1.184), the last expression should have a $-$ sign in front.
- Page 44, the D in Eq. (1.188) should be Roman script, $\mathrm{D}_\mu = \partial_\mu - \mathrm{i}g_3 G^\alpha_\mu \frac{\lambda_a}{2}$. The same applies to $\not{D}$ in Eq. (1.194). But the i in Eq.(1.187) and Eq.(1.188) should be Roman font.
- Page 45, Eq. (1.190) should have a terminating u field operator. Immediately before Eq. (1.192), the words "(Eq. (1.171)) compare with" should read "(compare with Eq. (1.171))"
- Page 46, problem [1.1], the reference to using Eq. (1.90) should refer to Eqs. (1.89,1.91).
- Page 48, at the end of [1.2] (ii), the reference to (A) and (B) should be to (a) and (b). In (iii), the + superscripts should be † superscripts.
- Page 50, problem [1.5], "s^μ is a four-vector" should say "s^μ is a four-pseudovector". Also "Since $E_{\mathbf{p}} u\overline{u}$ transforms" should read "Since $u\overline{u}$ transforms".
- Page 58, last line of Eq.(2.13), the $\overline{Q}$, $\overline{U}$, $\overline{D}$ should be in italic, not Roman, font.
- Page 59, Eq. (2.20) and (2.21), the covariant derivatives D_μ should be in Roman font, D_μ. This also applies for D_μ and D^μ in Eq. (2.25) on page 60, D_μ in Eq. (2.28) on page 61, and 3 more occurrences in Eq. (2.32), (2.33) on page 62.
- Page 59, equation before Eq. (2.22), the double dash in the subscript "would−−be" should be a hyphen "would–be".
- Page 59, "The combination $\bar{E}P_L E$ is hypercharge –2 and is also not allowed" should read "The combination $\bar{E}P_L E$ is hypercharge +2 and is also not allowed".
- Page 62, Eq. (2.33), in the last parenthesis $W_{3\mu}$ should be W^3_μ.
- Page 66, Eq. (2.51), in the pair of expressions for $W^\pm$ in terms of $W^{1,2}$, the second expression is for W^- (they are not both for W^+).

- Page 63, Eq. (2.36), there should be a transpose on the column vector containing $\bar{\mathcal{U}}$ and $\bar{\mathcal{D}}$.
- Page 67, below (2.54) it should read $m^2 = \pm|M_0 M_3|$, that is, m^2 can be negative – and is in the standard model. In (2.55) $-\sin\theta_W$ should be $\mp\sin\theta_W$ and in (2.56) it should again be $\pm m^2$.
- Page 71, "hadran" should read "hadron"
- Page 77, "$W^{\pm}_{\mu\nu} = \partial_\mu W^{\pm}_\nu - \partial\nu W^{\pm}_\mu$." should read "$W^{\pm}_{\mu\nu} = \partial_\mu W^{\pm}_\nu - \partial_\nu W^{\pm}_\mu$."
- Also on page 77, in Eq. (2.79), X should read W^3.
- Page 78 Eq. (2.85), the γ_μ in the first line should be γ^μ.
- Page 79 Eq. (2.88), the subscript on ν' in the second line should be m not $1n$.
- Page 82 Eq. (2.96) the Z_μ should be removed.
- Page 82 Eq. (2.97), in the first 3 lines A^3_μ should be W^3_μ.
- Page 102, in Eq.(2.133) the first line should have coefficients $6, 3, 3$ rather than $18, 9, 9$; the next-to-last line should be $\sum_{\rm all} 2B^3 = 2(36-18-18)/27$. In both cases the answer remains zero.
- Page 105 first line (problem [2.1]), "exactly -1/2" should be "exactly +1/2".
- Page 105, Problem [2.3], in the equation all letters after $\not{\rm D}$ should be in math italic (not Roman) font.
- On page 109, Problem 2.7 contains errors.

  One fix is to delete the first two of the three listed possible Yukawa interactions (which are not gauge singlets!) and the sentence following that equation, and to strike the first two sentences of subproblem [2.7.4].

  An alternative (and more interesting!) fix is to rewrite the problem in terms of a field $\tilde{D}$ in the $(\mathbf{3}, \mathbf{1}, \frac{-1}{3})$ representation. Its conjugate $\tilde{D}^*$ is in the $(\bar{\mathbf{3}}, \mathbf{1}, \frac{1}{3})$ representation, and there are the associated changes to the covariant derivatives and transformation rules. The interaction terms are the same except for the Yukawa terms, which should read

$$-x_{mn}\bar{Q}_m P_R\, L_n \tilde{D} - y_{mn}\epsilon_{rst}\bar{U}^r_m P_R\, D^s_n\, \tilde{D}^t - z_{mn}\bar{U}_m P_L\, E_n \tilde{D}$$

  in which case the first two sentences of [2.7.4] are correct.
- Page 110, the last line of problem [2.8] should contain P_R not P_L.
- Page 117, Eq. (3.26) the second term should have $(-\mathrm{i})$ rather than $(-\mathrm{i})^2$. This error is repeated on page 127, Eq.(4.1) and page 155, Eq.(5.2).
- Page 120, in Eq. (3.37) and (3.38) the leading $1/\Omega$ and $1/(\Omega T)$ should be removed.
- Page 121, Eq. (3.39), in the next-to-last line the δ^4 should have the ΩT subscript and the square on $\mathcal{M}$ should be outside the absolute values. In the last line, P should be p.

- Page 122, last line in subsection 3.3.2.1, $1/(2E\alpha)$ should read $1/(2E_\alpha)$
- Page 129, Eq. (4.9) is the expression for $2E_{\mathbf{k}}d\Gamma$, not $d\Gamma$ as it says.
- Page 134, just before Eq. (4.30) $\bar{\mu}^2$ and $|\mu|^2$ should read $\bar{\mathcal{M}}^2$ and $|\mathcal{M}|^2$.
- Page 135, Eq. (4.35) is missing a factor of e_Z^2.
- Page 140 and 141, references to Eq. (4.41) should be to Eq. (4.42). Page 142, a reference to Eq. (4.42) should be to (4.41).
- Page 143 in Eq. (4.43) the subscript on the neutrino in the last line should be ν_m not ν_{1n} as written.
- Page 147 Eq. (4.56) in the last line it should read $\bar{u}(\mathbf{p},\sigma)v(\mathbf{q},\zeta)$ rather than $\bar{v}(\mathbf{q},\zeta)u(\mathbf{p},\sigma)$.
- Page 162 Eq. (5.17) and page 163 Eq. (5.18) have M_Z^2 where it should read M_W^2.
- Page 167 below Eq. (5.36) the text contains $\Theta(-w^2)$ which should instead read $\theta(-w^2)$.
- Page 183, in Eq. (5.79) in the second line, m^2 in the denominator should be M_W^2.
- Page 184, in problem [5.2.1] the first line should have an extra factor of $16m_n^2$ in the denominator. [5.2.4] should specify that $g_V = 1$.
- Page 194, Eq.(6.17) should have a factor of $\frac{1}{4}$ on the second line, and there should be a $\sum_{\text{spins}}$ on the righthand side of the first lines of Eq.(6.18) and Eq.(6.19).
- On page 207, in Eq.(6.53) the second expression on the right should read

$$\frac{\frac{1}{4} - \sin^2\theta_W}{\frac{1}{4} - \sin^2\theta_W + \sin\theta_W^4}$$

  the signs on $\sin^2\theta_W$ were backwards.
- On page 213, in Eq. (6.68) the subscripts RR should be in a smaller typeface.
- Page 219, the second and third lines of Eq.(6.83) should read

$$\begin{aligned} &= \frac{-e^2}{(2p\cdot l)^2}\sum_\lambda (-\mathrm{i}\not{p} + \mathrm{i}\not{l} + m)\Big\{\epsilon\cdot\epsilon^*(\mathrm{i}\not{p}+m) - 2\mathrm{i}\epsilon\cdot p\not{\epsilon}^*\Big\}(-\mathrm{i}\not{p}+\mathrm{i}\not{l}+m) \\ &= \frac{-e^2}{(2p\cdot l)^2}\sum_\lambda [-2\mathrm{i}\epsilon\cdot\epsilon^* l\cdot p\not{l} \;-\; 2\mathrm{i}\epsilon\cdot p\,(-\mathrm{i}\not{p}+\mathrm{i}\not{l}+m)\not{\epsilon}^*(-\mathrm{i}\not{p}+\mathrm{i}\not{l}+m)] \end{aligned}$$

- Page 224: "Nuclear Physics 166" should read "Nuclear Physics **A** 166".
- Page 227, problem [6.3.9], the expression for $d\sigma/d(\cos\theta)$ is missing a factor of $|V_{ud}|^2$.
- Page 228, end of problem [6.3], for a proton $k_A = \frac{1}{2}$ and for a neutron $k_A = -\frac{1}{2}$.

- On page 231 in the second paragraph, "weak decays of a light meson" should read "weak decays of a light lepton"
- On page 235, Eq.(7.10) W_μ should read W_μ^-.
- Page 245, first paragraph, "$\Lambda \to \alpha$" should read $\Lambda \to \infty$. In the last paragraph, "correction loop had $p = 0$ and has..." should read "correction loop had P=0 and has ...". Also "forum" should be "form."
- Page 254,, next to last paragraph, "diverges at large L" should read "diverges at large l"
- On page 257, Eq. (7.60) is mangled and should read

$$\Pi(q^2) = -\frac{e^2}{2\pi^2}\left(\frac{1}{\epsilon} - \gamma_E + \ln 4\pi + \ln\frac{\mu^2}{m^2} + 6\int_0^1 dx\, x(1-x)\ln\frac{m^2}{m^2 + x(1-x)q^2}\right)$$

  and the text just above Eq. (7.61), reading "absorbing the $[1/\epsilon+\gamma_{\rm E}+\ln 4_\pi]$ into e_0^2" should read "absorbing the $[1/\epsilon - \gamma_E + \ln 4\pi]$ into e_0^2".
- On page 311, halfway down the page, "Eq. (8.23) and Eq. (8.23)" should read "Eq. (8.22) and Eq. (8.23)".
- On page 322, in Eq. (9.1) $\not{D}$ and D_μ should be Roman font, $\not{\rm D}$, $\rm D_\mu$. Similarly, on page 328 in Eq. (9.22), $D_\mu D^\mu$ should read $\rm D_\mu D^\mu$.
- On page 325, below Eq.(9.17) the vector charges are written with a factor 2 different normalization than in the rest of the text, and should be $\frac{1}{2}T_3 - \sin^2\theta_W$ which is $g_{V,\rm p} = \frac{1}{4} - \sin^2\theta_W$ for a proton and $-\frac{1}{4}$ for a neutron.
- On page 342, the first line in Eq. (9.64) should read

$$\hat{\sigma}(q\bar{q} \to q'\bar{q}') = \frac{4\pi\alpha_3^2}{27\hat{s}}(2+z)\sqrt{1-z}$$

- On page 349, a garbage piece of text appears on the righthand figure.
- The section on D meson mixing on page 386 is over-strong and out of date. The estimate $\lambda^2 m_s^2/m_c^2$ is probably correct but may be numerically more important than we said, up to a 10^{-2} effect; and the experimental situation has evolved and there is now evidence for nonzero mass splitting and decay differences in the D_0 system.
- On page 397, the words "Chiral perturbation theory" should be CPT, standing for the discrete symmetry transformation.
- On page 412, in Eq.(10.32), W_μ should be W_μ^- and the symbol γ_L should be P_L.
- On page 415, "Successfuldescription" should read "Successful description"

- On page 430, Eq.(10.50) is not the most general Lagrangian containing the field Φ, as it is missing several potential terms (which are irrelevant for the subsequent discussion). Writing $\Phi = \Phi^a \tau^a$, the most general potential should read

$$\begin{aligned} 2\mathcal{L}_\Phi \;=\; & -\,\mathrm{tr}\;\mathrm{D}_\mu\Phi^*\mathrm{D}^\mu\Phi - M_\Phi^2\,\mathrm{tr}\;\Phi^*\Phi - \lambda_1\,\mathrm{tr}\;\Phi^*\Phi\Phi^*\Phi - \lambda_2(\mathrm{tr}\;\Phi^*\Phi)^2 \\ & -\lambda_3\phi^\dagger\phi\,\mathrm{tr}\;\Phi^*\Phi - \lambda_4\phi^\dagger\Phi\Phi^*\phi - 2\Big[y_{mn}\bar{L}_m\Phi\epsilon P_R L_n + c\phi^\dagger\Phi^*\tilde{\phi} + \mathrm{h.c.}\Big] \end{aligned}$$

  The λ_1 and λ_4 terms were missing in the text.
- On page 431, in Eq.(10.51) the second appearance of Φ_3^* (lower right element) should have a $-$ sign.
- On page 457, Eq. (11.22) the last term should read $-(7/2)g_3^3$ rather than $-(7/2)g_3^2$; and in Eq. (11.23) the coefficient on g_1^2 should be $-15/4$, not $-9/4$ as written.
- On page 458, Eq. (11.26) has some typos in the second line, and should read

$$\begin{aligned} 16\pi^2\,\mu^2\frac{d\lambda}{d\mu^2} \;=\; & \left(-\frac{9g_2^2}{2} - \frac{3g_1^2}{2} + 6h_{mn}h^*_{mn} + 6g_{mn}g^*_{mn} + 2f_{mn}f^*_{mn}\right)\lambda \\ & + 12\lambda^2 + \frac{3}{8}g_2^4 + \frac{3}{16}(g_2^2+g_1^2)^2 - 3h_{mn}h^*_{pn}h_{pq}h^*_{mq} \\ & - 3g_{mn}g^*_{pn}g_{pq}g^*_{mq} - f_{mn}f^*_{pn}f_{pq}f^*_{mq}\,. \end{aligned}$$

- On page 465, in both Eq.(11.40) and Eq.(11.41), δ_n should be d_n.
- In appendix C, our careful typesetting of indices on $\Lambda^\mu{}_\nu$ was destroyed between the galley proofs and the printed book. The errors are so extensive that we are attaching a correct Appendix C as a separate file.
- On page 521, the top line of Table E.1 should involve the anticommutator $\left\{\gamma^\mu\,,\,\gamma^\nu\right\}$ (not the commutator as written).
- It was our intention that the two pages on the inside of the back cover be in the opposite order.

This list is almost surely incomplete. However, we are not aware of any errata needed for the above list of errata.