Errata

p 3: *Table 1.1* The masses of the up and down quarks are inter-changed. The current estimates of the masses are:

$$m_{\mathrm{d}} \approx 5\,\mathrm{MeV} \quad \text{and} \quad m_{\mathrm{u}} \approx 2.5\,\mathrm{MeV}\,.$$

p 56: *Question 2.8*: The reaction should (of course) read:

$$\mathrm{p} + \overline{\mathrm{p}} \rightarrow \mathrm{p} + \mathrm{p} + \overline{\mathrm{p}} + \overline{\mathrm{p}}\,.$$

p 56: *Question 2.9*: The question should ask for the *minimum* opening angle; the maximum opening angle is (rather trivially) π.

p 57: the factor of $\frac{1}{4}$ in the last line of *Question 2.16* should be removed, *i.e.* Find the eigenvalue(s) of the operator $\hat{\mathbf{S}}^2 = (\hat{S}_x^2 + \hat{S}_y^2 + \hat{S}_z^2)$, and deduce that the eigenstates of $\hat{S}_z$ are a suitable representation of a spin-half particle.

p 78: the mass of the pion in *Question 3.1* should be 140 MeV, not 140 GeV.

p 94: in the equation below 4.44, $\sigma_x p_x + \sigma_x p_y + \sigma_x p_x$ should read $\sigma_x p_x + \sigma_y p_y + \sigma_z p_z$.

p146: In the matrix in the *footnote* $B_{22} \rightarrow B_{21}$.

p177: *Question 7.2* should be ignored. There was an error in my original solution, whereby finding a closed form was relatively straightforward - it isn't!

p184: In *Equation 8.11* there is a missing factor of x^2. It should read

$$\frac{\mathrm{d}^2\sigma}{\mathrm{d}x\,\mathrm{d}Q^2} = \frac{4\pi\alpha^2}{Q^4}\left[\left(1 - y - \frac{m_{\mathrm{p}}^2 x^2 y^2}{Q^2}\right)\frac{F_2(x,Q^2)}{x} + y^2 F_1(x,Q^2)\right],$$

and the start of the following paragraph should state $Q^2 \gg m_{\mathrm{p}}^2 x^2 y^2$.

p199: The total length of the HERA collider tunnel is 6.3 km.

p205: In *Question 8.7a* there is a missing factor of x. It should read

$$F_2^{\mathrm{ep}}(x) = \frac{4}{9}\,x\,[u(x) + \overline{u}(x)] + \frac{1}{9}\,x\left[d(x) + \overline{d}(x) + s(x) + \overline{s}(x)\right].$$

p231: there is a typo in the equation at the bottom of the page:

$$\tfrac{1}{2}\left[\mathbf{S}^2 - \mathbf{S_1}^2 - \mathbf{S_1}^2\right] \to \tfrac{1}{2}\left[\mathbf{S}^2 - \mathbf{S}_1^2 - \mathbf{S}_2^2\right].$$

p261: there is a typo in *Equation 10.20* - there is a missing factor of 3 in the denominator, it should read:

$$\sigma(\mathrm{e^+e^-} \to \text{ hadrons}) = \frac{4\pi\alpha^2}{3s} \times 3 \sum_{\text{flavours}} Q_\mathrm{q}^2 .$$

p312: In *Figure 12.5*, the arrows on the d and ν_μ are the wrong-way around, only left-handed chiral states participate in the weak charged-current.

p315: Line four contains a typo, the third reaction should read $\overline{\nu}_\mu \mathrm{u} \to \mu^+\mathrm{d}$

p341: There is a typo ($\mathrm{p}_1 \to \mathrm{p}_2$) in Equation (13.13), which should read

$$\Delta\phi_{12} = (E_1 - E_2)\left[T - \left(\frac{E_1 + E_2}{\mathrm{p}_1 + \mathrm{p}_2}\right)L\right] + \left(\frac{m_1^2 - m_2^2}{\mathrm{p}_1 + \mathrm{p}_2}\right)L .$$

This typo is repeated in *question 13.1*.

p347: In *Figure 13.16*, the bottom two diagrams should (of course) show a π^+.

p362: In *question 13.2*, there is a spurious 4 in the denominator of the argument of the $\sin^2(...)$ in the second equation, it should read

$$\sin^2(2\theta)\sin^2\left(\frac{\Delta m^2[\mathrm{GeV}^2]L[\mathrm{GeV}^{-1}]}{4E_\nu[\mathrm{GeV}]}\right) \;\to\; \sin^2(2\theta)\sin^2\left(1.27\frac{\Delta m^2[\mathrm{eV}^2]L[\mathrm{km}]}{E_\nu[\mathrm{GeV}]}\right).$$

The expression in the main text is correct.

p363: Part d) of *question 13.9* should be ignored - it is poorly worded. The intention was to get the student to consider the case where the decay products of the pion were close to being perpendicular to the direction of the boost. Close to $\theta^* \sim \pi/2$ the transverse momentum is approximately p^* and the longitudinal momentum is primarily due to the Lorentz boost.

p427: The last matrix element should read $\mathcal{M}_{LR}^2$ not $\mathcal{M}_{RR}^2$.

p438: *Figure 16.6* has the labels 2ν and 4ν reversed.

p458: *Question 16.7* should read $\mu^-\overline{\nu}_\mu \mathrm{u}\overline{\mathrm{d}}$.

p498: *Question 17.8* the expression for the fields should read:

$$A_\mu = \frac{g' W_\mu^{(3)} + g_\mathrm{W} B_\mu}{\sqrt{g_\mathrm{W}^2 + g'^2}} \quad \text{and} \quad Z_\mu = \frac{g_\mathrm{W} W_\mu^{(3)} - g' B_\mu}{\sqrt{g_\mathrm{W}^2 + g'^2}},$$

p541: *SM quartic gauge boson vertices:* it is incorrectly stated that there are three

quartic vertices, there are in fact four $W^+W^-W^+W^-$, W^+W^-ZZ, $W^+W^-\gamma\gamma$ and $W^+W^-Z\gamma$