8

Corrections and Updates to the first edition

Table 8.1: Corrections in Equations referring to the 1st Edition of this book [1]

Equation	page	comment
nn	72	typos in tadpole (1st item) calculation 2nd Eq. $d\alpha^{(1-d/2)} \to d\alpha\,\alpha^{(1-d/2)}$; last Eq. prefactor $m^2 \to -m^2$
next after (2.231)	111	factor N_{cf} missing in 1st term
(2.233)	111	wrong sign in 2nd term
(2.234)	111	2nd term $\pi \to 3\pi$ in denominator
next after (3.130)	189	in numerators $e(s)^2 \to e^2$ and $\alpha(s) \to \alpha$
(3.131)	189	$\alpha(s)^2 \to \lvert\alpha(s)\rvert^2$
(3.157)	198	$\frac{\alpha}{\pi} \to \frac{\alpha^2}{6\pi^2}$
(4.34)	228	$\ln \frac{m_H^2}{m_\mu^2} \to \ln \frac{m_H^2}{m_\mu^2}$
(4.34)	228	$1/(4\pi^2) \to 1/(8\pi^2)$
in footnote	232	all three Eqs. must have opposite sign
(4.75)	254	$\to$ (4.99) [see Erratum Ref. [3] in Sect. 3]
(4.76)	254	$\frac{56}{9} \to \frac{59}{6}$
(4.78)	255	(4.102) through (4.118) [see also [4]]
(5.21)	291	$(\alpha/\alpha(s))^2 \to \lvert\alpha/\alpha(s)\rvert^2$
(5.30)	297	$6\pi \to 6$ and $\left(1 - \frac{s}{m_\tau^2}\right) \to \left(1 - \frac{s}{m_\tau^2}\right)^2$
(5.32)	297	12π in denominator $\to 12$ without factor π
(5.105)	333	with $\tilde{f}_{\alpha\beta}$ the dual of $f_{\alpha\beta} = k_\alpha \varepsilon_\beta - k_\beta \varepsilon_\alpha$
a_e^{weak}	164	new corrected estimate of (4.136)
footnote 10	385	$\Delta\rho \approx \frac{\sqrt{2}G_\mu}{16\pi^2}\, 3\lvert m_t^2 - m_b^2\rvert$ should correctly read as Eq. (4.40)

Table 8.2: Update Table: listed are numbers which change because of more precise input parameters $\alpha^{-1}(a_e)$ and new lepton masses/ratios, as well as improved eight order QED calculations and the new tenth order QED calculations

Contribution	result	Eq.	Review [2]	Book [1]
$\alpha^{-1}(a_e)$	137.035 999 139(31) [0.25 ppb]	(3.29)	(43)	(3.28)
$m_\ell\,(\ell = e,\mu,\tau)$	new masses/ratios	(3.30)	(44)	(3.29)
$A_{1\,\mathrm{uni}}^{(4)}$	$-0.328\,478\,965\,579\,193\,78\ldots$	(3.45,4.5)	(50)	(4.4)
$A_{1\,\mathrm{uni}}^{(6)}$	$+1.181\,241\,456\,587\ldots$	(3.45,3.44)	(51)	(3.43)
$A_{1\,\mathrm{uni}}^{(8)}$	$-1.9122457649\ldots$	(3.45,4.23)	(52)	(4.17)
$A_1^{(10)}$	+7.795(336)	(3.45,4.28)	(53)	(4.23)
a_ℓ^{uni}	0.001 159 652 176 42(26)(4)[26]	(3.45)	(54)	(3.43)
$a_e(\mu)$, $a_e(\tau)$, $a_e(\mu,\tau)$		(3.64)	(57)	(3.61)
a_e^{QED}	$\frac{\alpha}{2\pi} - 0.328\,478\,444\,002\,54(33)\left(\frac{\alpha}{\pi}\right)^2$ $+1.181\,234\,016\,816(11)\left(\frac{\alpha}{\pi}\right)^3$ $-1.91134(182)\left(\frac{\alpha}{\pi}\right)^4$ $+7.791(580)\left(\frac{\alpha}{\pi}\right)^5$	(3.65)	(58)	(3.62)
$a_e^{\mathrm{SM}} = a_e^{\mathrm{QED}}[(3.65)] + 1.721(12)\times 10^{-12}$ (hadronic & weak)		(3.67)	(59)	(3.63)
a_e contributions	Tables	3.3	2	3.3
$a_\mu^{(4)}(\mathrm{vap},e)$	$5.90406006(4)\times 10^{-6}$	p. 167	(77)	p. 149
$a_\mu^{(4)}(\mathrm{vap},\mu)$	$8.464\,13319\times 10^{-8}$	(3.49)	(78)	(3.47)
$a_\mu^{(4)}(\mathrm{vap},\tau)$	$4.2127(8)\times 10^{-10}$	p. 169	(79)	p. 150
$a_\mu^{(4)\ \mathrm{QED}}$	$413217.627(9)\times 10^{-11}$	(4.9)	(80)	(4.8)
$a_\mu^{(6)}(\mathrm{lbl},e)$	$2.625\,351\,01(2)\times 10^{-7}$	p. 170	(81)	p. 151
$a_\mu^{(6)}(\mathrm{lbl},\mu)$	4.64971650×10^{-9}	(3.50)	(82)	(3.48)
$a_\mu^{(6)}(\mathrm{lbl},\tau)$	$2.68607(48)\times 10^{-11}$	p. 171	(83)	p. 152
$A_{2\,\mathrm{lbl}}^{(6)}(m_\mu/m_e)$	20.947 924 85(14)	(4.11)	(84)	(4.9)
$A_{2\,\mathrm{lbl}}^{(6)}(m_\mu/m_\tau)$	0.002 143 239(385)	(4.13)	(85)	(4.11)
$A_{2\,\mathrm{vap}}^{(6)}(m_\mu/m_e)$	1.920 455 123(28)	(4.12)	(86)	(4.10)
$A_{2\,\mathrm{vap}}^{(6)}(m_\mu/m_\tau)$	−0.001 782 611(270)	(4.14)	(87)	(4.12)
$A_{3\,\mathrm{vap}}^{(6)}(m_\mu/m_e, m_\mu/m_\tau)$	0.00052776(10)	(4.16)	(89)	(4.14)
$A_2^{(6)}(m_\mu/m_e)$	22.868 380 00(17)	(4.17)	(90)	(4.15)
$A_2^{(6)}(m_\mu/m_\tau)$	0.000 360 63(12)	(4.17)	(90)	(4.15)
$A_{3\,\mathrm{vap}}^{(6)}(m_\mu/m_e, m_\mu/m_\tau)$	0.000 527 76(10)	(4.17)	(90)	(4.15)
$a_\mu^{(6)\ \mathrm{QED}}$	$30141.9022(4)\times 10^{-11}$	(4.18)	(91)	(4.16)
$A_2^{(8)}(m_\mu/m_e)$	132.6852(60)	(4.23)	(92)	(4.18)
$A_3^{(8)}(m_\mu/m_e, m_\mu/m_\tau)$	0.062 72 (4)	(4.25)	(94)	(4.20)
$A_2^{(8)}(m_\mu/m_\tau)$	0.04234(12)	(4.26)	(95)	(4.21)
$a_\mu^{(8)\ \mathrm{QED}}$	$380.990(17)\times 10^{-11}$	(4.27)	(96)	(4.22)
$A_2^{(10)}(m_\mu/m_e)$	742.18 (87)	(4.28)	(97)	p. 222
$A_2^{(10)}(m_\mu/m_\tau)$	−0.068 (5)	(4.28)	–	–
$A_3^{(10)}(m_\mu/m_e, m_\mu/m_\tau)$	2.011 (10)	(4.28)	–	–
$a_\mu^{(10)\ \mathrm{QED}}$	$5.0845(63)\times 10^{-11}$	(4.29)	(98)	(4.24)
a_μ contributions	Tables	4.6	3	4.2
$a_\mu^{\mathrm{QED}} = 116\,584\,718.859(.026)(.009)(.017)(.006)[.034]\times 10^{-11}$		(4.30)	(99)	(4.25)

Table 8.3: Updated Table of QED contribution to a_μ

# n of loops	C_i $[(\alpha/\pi)^n]$	$a_\mu^{\rm QED} \times 10^{11}$
1	+0.5	116140973.242 (26)
2	+0.765 857 423(16)	413217.627 (9)
3	+24.050 509 82(28)	30141.9022 (4)
4	+130.8734(60)	380.990 (17)
5	+751.917(932)	5.0845 (63)
tot		116584718.859 (0.034)

Table 8.4: Update Table continued: listed are numbers which changes because we know the Higgs mass as well as improved and/or corrected hadronic evaluations. † Missing asymmetry factors (5.260) à la Landau-Yang in (5.259) (see Eq. (34) in [5]) concerning entries "axial vector MV" in Tables. * Equations to be corrected according to Table 8.1 above

Contribution	result	Eq.	Review [2]	Book [1]
$a_\mu^{(2)\rm EW}(W)$	$+388.71(0)\times10^{-11}$	(4.47)	(203)	(4.33)
$a_\mu^{(2)\rm EW}(Z)$	$-193.90(1)\times10^{-11}$	(4.47)	(203)	(4.33)
$a_\mu^{(2)\rm EW}(H)$	21.64×10^{-15} [$m_H \sim 125$ GeV]	(4.48)	(204)	(4.34)*
$a_\mu^{(2)\rm EW}$	$(194.81\pm0.01)\times10^{-11}$	(4.49)	(205)	(4.35)
$a_\mu^{(4)\rm EW}([\tau,b,t])$	$-8.19(10)\times10^{-11}$	(4.70)	(211)	(4.53)
$a_\mu^{(4)\rm EW}([e,u,d])$	$-2.30(20)\times10^{-11}$	(4.99)	(234)	(4.75)*
$a_\mu^{(4)\rm EW}([\mu,c,s])$	$-4.67(30)\times10^{-11}$	(4.100)	(235)	(4.76)*
$a_{\mu;\text{f-rem,no H}}^{(4)\rm EW}$	$-4.12(3)\times10^{-11}$	(4.102)	–	–
$a_{\mu;\text{f-rem,H}}^{(4)\rm EW}$	$-1.504(12)\times10^{-11}$	(4.109)	–	–
$a_{\mu;\text{f-rem,Z}}^{(4)\rm EW}$	$-0.2547(33)(16)$[37]	(4.116)	–	–
$a_{\mu;\text{f-rem,all}}^{(4)\rm EW}$	$-4.61(3)\times10^{-11}$	(4.118)	(237)	(4.78)
$a_{\mu;\text{bos}}^{(4)\rm EW}$	$(-19.97\pm0.3)\times10^{-11}$	(4.122)	(241)	(4.82)
$a_\mu^{(4)\rm EW}$	$(-41.23\pm0.22[m_H,m_t]\pm0.72[\text{had}])\times10^{-11}$	(4.124)	(243)	(4.83)
$a_\mu^{(6)\rm EW}$	$(0.16\pm0.2)\times10^{-11}$	(4.125)	(244)	(4.84)
$a_\mu^{\rm LL\ EW}$	$(153.42\pm0.72[\text{had}]\pm0.22[\text{m}_\text{H},\text{m}_\text{t},3-\text{loop}])\times10^{-11}$	(4.126)	(245)	(4.85)
$a_e^{(4)\rm EW}([e,u,d])$	$-1.86(16)\times10^{-15}$	(4.132)	(250)	(4.75)*
$a_e^{(4)\rm EW}([\mu,c,s])$	$-1.15(7)\times10^{-15}$	(4.133)	(251)	(4.76)*
$a_e^{(4)\rm EW}(\tau,t,b)$	$-1.91(2)$	Tab. 4.15	Tab. 15	
$a_e^{(4)\rm EW};\text{bos}$	$(-8.70\pm0.01)\times10^{-15}$	Tab. 4.15	Tab. 15	
$a_{e;\text{f-rem,H}}^{(4)\rm EW}$	$-0.35(0)$	Tab. 4.15	Tab. 15	
$a_{e;\text{f-rem,no H}}^{(4)\rm EW}$	$-1.06(1)$	Tab. 4.15	Tab. 15	
$a_e^{(4)\rm EW}$	$(-15.04\pm0.02[m_H,m_t]\pm0.23[\text{had}])\times10^{-15}$	(4.137)	(253)	–
$a_e^{\rm EW}$	$(30.53\pm0.02[m_H,m_t,3-\text{loop}]\pm0.23[\text{had}])\times10^{-15}$	(4.138)	(254)	–
$a_\mu^{\rm f,bL}(a_1,f_1,f_1')$	$(7.55[1.89+5.19+0.47]\pm2.71)\times10^{-11}$	(5.261)†	Tab. 9/13	Tab. 5.11

References

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