Corrections 1

Quantum Mechanics: Concepts and Applications

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Note: This list of corrections pertains to the first print that was produced in 2001.

Chapter 1

- Page 6, replace footnote # 3 by "Using a variable change $\beta = 1/(kT)$, we have $\langle E\rangle = -\frac{\partial}{\partial\beta}\ln\left(\int_0^\infty e^{-\beta E} dE\right) = -\frac{\partial}{\partial\beta}\ln(1/\beta) = 1/\beta \equiv kT$".
- Page 9 right after Eq. (1.17), insert "is" after "This" in the statement "This an enormous...".
- Page 15, in Eq. (1.37) replace $\Delta\lambda = \frac{4\hbar c}{m_e c^2}$ by $\Delta\lambda = \frac{4\pi\hbar c}{m_e c^2}$.
- Page 15, in Eq. (1.39) replace $E' = \frac{m_e c^2}{2}\left[1 + \frac{2m_e c^2}{E}\right]^{-1} \simeq \frac{m_e c^2}{2} - \frac{(m_e c^2)^2}{E} \simeq ...$ by $E' = \frac{m_e c^2}{2}\left[1 + \frac{m_e c^2}{2E}\right]^{-1} \simeq \frac{m_e c^2}{2} - \frac{(m_e c^2)^2}{4E} \simeq ....$
- Page 31, inside footnote # 14, replace $F_G/F_e = G m_e m_p/e^2 \simeq 9.9 \times 10^{-30}$ by $F_G/F_e = (4\pi\epsilon_0) G m_e m_p/e^2 \sim 10^{-40}$.
- Page 54, in the paragraph before **Problem 1.1**, replace $1/(4\pi\epsilon_0) = 8.9 \times 10^9$ by $1/(4\pi\epsilon_0) = 8.99 \times 10^9$ N m^2 C^{-2}.
- Page 60, at the end of the line before **Problem 1.10**, replace $1/(4\pi\epsilon_0) = 8.9 \times 10^9$ by $1/(4\pi\epsilon_0) = 8.99 \times 10^9$ N m^2 C^{-2}.
- Page 71, Exercise 1.4, replace "...temperatures are 8500 K, 8500 K, and ..." by "...temperatures are 8500 K, 850 K, and ...".

Chapter 2

- Page 92, last statement of Example 2.5, replace "In sum, the a state $|\psi >$ ..." by "In sum, if a state $|\psi >$ ...".
- Page 106, Example 2.10, replace "Calcualte inverse of the matrix $A = ...$" by "Calcualte the inverse of the matrix $A = ...$ ".

- Page 111, replace $|\psi_1\rangle$, $|\psi_2\rangle$, and $|\psi_3\rangle$ by $|\phi_1\rangle$, $|\phi_2\rangle$, and $|\phi_3\rangle$ in equation (2.215); this equation should now read

$$U = \begin{pmatrix} \langle \phi'_1 \mid \phi_1\rangle & \langle \phi'_1 \mid \phi_2\rangle & \langle \phi'_1 \mid \phi_3\rangle \\ \langle \phi'_2 \mid \phi_1\rangle & \langle \phi'_2 \mid \phi_2\rangle & \langle \phi'_2 \mid \phi_3\rangle \\ \langle \phi'_3 \mid \phi_1\rangle & \langle \phi'_3 \mid \phi_2\rangle & \langle \phi'_3 \mid \phi_3\rangle \end{pmatrix}.$$

- Page 116, replace the determinant in Eq. (2.248) by

$$\begin{vmatrix} 7-a & 0 & 0 \\ 0 & 1-a & -i \\ 0 & i & -1-a \end{vmatrix}$$

- Page 116, statement before Eq. (2.253), replace "corresponding to $a_1 = 7$ ..." by "corresponding to $a_2 = \sqrt{2}$ ...".
- Page 116, inside Eq. (2.253), replace the last element of the vector $-i(1+\sqrt{2})$ by $i(\sqrt{2}-1)y$.
- Page 122, insert a "-" sign after the equal sign in equation (2.290): i.e., replace "$= i\hbar\vec{\nabla}\langle \vec{r}\,' \mid \vec{r}\rangle$" by "$= -i\hbar\vec{\nabla}\langle \vec{r}\,' \mid \vec{r}\rangle$".
- Page 134, inside Eq. (2.372), replace $B\pi$ by $B^2\pi$.
- Page 150, part (b) of Exercise 2.18, replace "(b) Show that $A^2 + B^2 + C^2 = 4I$, ..." by "(b) Show that $A^2 + B^2 + 2C^2 = 4I$, ..."
- Page 152, part (e) of Exercise 2.23, replace "$\hat{U}$ being the matrix of eigenvectors of $\hat{B}$." by "$\hat{U}$ being the matrix of the normalized eigenvectors of $\hat{B}$."
- Page 152, part (f) of Exercise 2.23, replace "(f) Verify that $\hat{U}^{-1} = \hat{U}$" by "(f) Verify that $\hat{U}^{-1} = \hat{U}^\dagger$"
- Page 156, replace $[x,\ [\hat{A},\ \hat{X}]]$ in part (c) of Exercise 2.48 by $[\hat{X},\ [\hat{A},\ \hat{X}]]$.

Chapter 3

- Page 161, inside Eq. (3.13), replace $\left|\frac{\sqrt{2}}{3}\langle\phi_1|\phi_2\rangle\right|^2$ by $\left|\frac{2}{3}\langle\phi_2|\phi_2\rangle\right|^2$.
- Page 186, replace Eq. (3.159) by

$$\vec{J}(x,t) = \frac{i\hbar}{2m}\left(\psi(x,t)\frac{d\psi^*(x,t)}{dx} - \psi^*(x,t)\frac{d\psi(x,t)}{dx}\right)\vec{i}. \qquad (1)$$

- Page 187, replace equations (3.168) and (3.169) respectively by

$$P(E_1) = \left|\sqrt{\frac{2}{7}}\langle\phi_1|\phi_1\rangle\right|^2 = \frac{2}{7}, \qquad P(E_2) = \left|\sqrt{\frac{3}{7}}\langle\phi_2|\phi_2\rangle\right|^2 = \frac{3}{7},$$
$$P(E_3) = \left|\frac{1}{\sqrt{7}}\langle\phi_3|\phi_3\rangle\right|^2 = \frac{1}{7}, \qquad P(E_4) = \left|\frac{1}{\sqrt{7}}\langle\phi_4|\phi_4\rangle\right|^2 = \frac{1}{7}.$$

- Page 188, replace equations (3.171) and (3.172) respectively by

$$P(a_1) = \left|\sqrt{\frac{2}{7}}\langle\phi_1|\phi_1\rangle\right|^2 = \frac{2}{7}, \qquad P(a_2) = \left|\sqrt{\frac{3}{7}}\langle\phi_2|\phi_2\rangle\right|^2 = \frac{3}{7},$$
$$P(a_3) = \left|\frac{1}{\sqrt{7}}\langle\phi_3|\phi_3\rangle\right|^2 = \frac{1}{7}, \qquad P(a_4) = \left|\frac{1}{\sqrt{7}}\langle\phi_4|\phi_4\rangle\right|^2 = \frac{1}{7}.$$

- Page 200, replace $\Psi(x, 0)$ in Exercise 3.3 by

$$\Psi(x,0) = \sqrt{\frac{4}{7a}}\sin\left(\frac{\pi x}{a}\right) + \sqrt{\frac{2}{7a}}\sin\left(\frac{2\pi x}{a}\right) + \sqrt{\frac{8}{7a}}\sin\left(\frac{3\pi x}{a}\right).$$

- Page 204, cancel Exercise 3.26 and replace it with the following exercise: Consider a system whose initial state at $t = 0$ is given in terms of a complete and orthonormal set of four vectors $|\phi_1\rangle$, $|\phi_2\rangle$, $|\phi_3\rangle$, $|\phi_4\rangle$ as follows:

$$|\psi(0)\rangle = \frac{A}{\sqrt{6}}|\phi_1\rangle + \frac{1}{\sqrt{6}}|\phi_2\rangle + |\phi_3\rangle + \frac{1}{2}|\phi_4\rangle,$$

where A is a real constant.

(a) Find A so that $|\psi(0)\rangle$ is normalized.

(b) If the energies corresponding to $|\phi_1\rangle$, $|\phi_2\rangle$, $|\phi_3\rangle$, $|\phi_4\rangle$ are given by E_1, E_2, E_3, and E_4, respectively, write down the state of the system $|\psi(t)\rangle$ at any later time t.

(c) Determine the probability of finding the system at a time t in the state $|\phi_2\rangle$.

Chapter 4

- Page 212, replace $4\mathcal{K}^2$ by $4\mathcal{K}$ in the numerator of the expression of the transmission coefficient T in Eq. (4.27).

- Page 234, replace the matric of $\hat{N}$ in Eq. (4.158) by

$$\hat{N} = \begin{pmatrix} 0 & 0 & 0 & \cdots \\ 0 & 1 & 0 & \cdots \\ 0 & 0 & 2 & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}, \qquad (2)$$

- Page 236, replace Eq. (4.178) by

$$\psi_n'''' = \frac{d^2}{dx^2}(-k^2\psi)\bigg|_{x=x_n} = -\frac{(k^2\psi)_{n+1} - 2(k^2\psi)_n + (k^2\psi)_{n-1}}{h_0^2}.$$

- Page 237, replace the first line and Eq. (4.179) by: Using $\psi_n'' = -k_n^2\psi_n$ and substituting (4.178) into (4.177) we can show that

$$\psi_{n+1} = \frac{2\left(1 - \frac{5}{12}h_0^2k_n^2\right)\psi_n - \left(1 + \frac{1}{12}h_0^2k_{n-1}^2\right)\psi_{n-1}}{1 + \frac{1}{12}h_0^2k_{n+1}^2}.$$

- Page 238, remove the clause "; plot the corresponding wave functions" from the statement of part (b) of Example 4.3.

- Page 242, in the statement before Eq. (4.198), replace "(c) Equation (4.197) shows ..." by "(c) Equation (4.196) shows ...".

- Page 243, replace Eq. (4.201) by

$$P(E_1') = |\langle\psi_1|\phi_1\rangle|^2 = \left|\int_0^a \psi_1^*(x)\phi_1(x)dx\right|^2 = \frac{1}{a^2}\left|\int_0^a \sin\left(\frac{\pi x}{4a}\right)\sin\left(\frac{\pi x}{a}\right)dx\right|^2;$$

- Page 243, in the statement before Eq. (4.202), replace "Using the relation $\sin a \sin b = \frac{1}{2}\cos(a+b) - \frac{1}{2}\cos(a+b)$, we have $\sin(\pi x/4a)\sin(\pi x/a) = \frac{1}{2}\cos(5\pi x/4a) - \frac{1}{2}\cos(3\pi x/4a)$, hence" by "Using the relation $\sin a \sin b = \frac{1}{2}\cos(a-b) - \frac{1}{2}\cos(a+b)$, we have $\sin(\pi x/4a)\sin(\pi x/a) = \frac{1}{2}\cos(3\pi x/4a) - \frac{1}{2}\cos(5\pi x/4a)$, hence"

- Page 243, replace Eq. (4.202) by

$$\begin{aligned} P(E_1') &= \frac{1}{a^2}\left|\frac{1}{2}\int_0^a \cos\left(\frac{3\pi x}{4a}\right)dx - \frac{1}{2}\int_0^a \cos\left(\frac{5\pi x}{4a}\right)dx\right|^2 \\ &= \frac{128}{15^2\pi^2} = 0.058 = 5.8\%. \end{aligned}$$

- Page 243, replace Eq. (4.204) by

$$\begin{aligned} P(E_2') &= |\langle\psi_2|\phi_1\rangle|^2 = \left|\int_0^a \psi_2^*(x)\phi_1(x)dx\right|^2 = \frac{1}{a^2}\left|\int_0^a \sin\left(\frac{\pi x}{2a}\right)\sin\left(\frac{\pi x}{a}\right)dx\right|^2 \\ &= \frac{16}{9\pi^2} = 0.18 = 18\%. \end{aligned}$$

- Page 244, add "dx" inside the integral sign in the last line of Eq. (4.213).

- Page 252, replace Eq. (4.261) by

$$\tan\left(k\frac{a}{2}\right) = \frac{\hbar^2 k}{mV_0} \quad\Longrightarrow\quad \tan\left(\sqrt{\frac{ma^2|E|}{2\hbar^2}}\right) = \sqrt{\frac{2\hbar^2|E|}{mV_0^2}}.$$

- Page 263, replace E_0, E_1, and E_2 in part (b) of Exercise 4.1 by E_1, E_2, and E_3.

- Page 263, replace $P_1(x,t)$ and $P_2(x,t)$ in part (c) of Exercise 4.1 by $P_2(x,t)$ and $P_3(x,t)$.

- Page 263, replace $< X >_1$, $< X >_2$, $< P >_1$, and $< P >_2$ in part (d) of Exercise 4.1 by $< X >_2$, $< X >_3$, $< P >_2$, and $< P >_3$.

- Page 263, replace $\psi_1(x,t)$ and $\psi_2(x,t)$ in part (e) of Exercise 4.1 by $\psi_2(x,t)$ and $\psi_3(x,t)$.

- Page 263, replace $E_n = \pi^2 n^2/(2ma^2\hbar^2)$ in Exercise 4.2 by $E_n = \pi^2\hbar^2 n^2/(2ma^2)$.

- Page 265, Exercise 4.9, the statement before (a), replace "a harmonic oscillator of width a and energy $E_n = n\hbar(n + 1/2)$." by "a harmonic oscillator of energy $E_n = \hbar\omega(n + 1/2)$."
- Page 266, Exercise 4.17, replace the wave function by

$$\psi(x) = \begin{cases} Ax(a^2 - x^2) & 0 < x < a \\ 0 & \text{elsewhere} \end{cases} .$$

Chapter 5

- Page 285, replace twice the ket "$|j,\ m_s >$" by "$|s,\ m_s >$" in the statement before Eq. (5.105).
- Page 288, inside Eq. (5.135), replace "$Y_{lm}(\theta,\ \psi)$=" by "$Y_{lm}(\theta,\ \varphi) =$".

Chapter 6

- Page 368, remove the factor c^4 from Eq. (6.323).

Chapter 9

- Page 516, replace the ratios $\frac{8}{L^3}$ by $\sqrt{\frac{8}{L^3}}$ in equations (9.285) through (9.287).