Foundations of Quantum Physics KNOWN ERRORS AND OTHER UNDESIRABLES

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ERRATA

Thanks are due to Johannes Deutsch for his many contributions to these errata.

Chapter 1

•(p1) Section 1.1.1. Gustov Ludwig Hertz should be Heinrich Rudolf Hertz.

•(p4) Section 1.1.2. Before the sentence that begins "The citation for the 1925 prize reads:.." insert the following sentence: Gustav Ludwig Hertz was the nephew of Heinrich Rudolf Hertz.

•(p11) Section 1.2.1 Equation (1.22) is missing $(4\pi\epsilon_0)$. It should read

$$\tau = (4\pi\epsilon_0)\frac{m_e^2 c^3 R^3}{4e^4} \tag{1.22}$$

•(p16)Section 1.2.1 Equation (1.39). Second line $n^2 \rightarrow n$. It should read

$$\begin{aligned} v_n &= \sqrt{\frac{1}{m_e}\left(\frac{e^2}{4\pi\epsilon_0}\right)\frac{1}{n^2 a_0}} \\ &= \frac{1}{m_e}\frac{\hbar}{n a_0} \end{aligned} \tag{1.39}$$

Chapter 2

•(p29) Section 2.4 Remove the ö in the section head.

•(p33) Sentence after Equation 2.18: insert commas "...using the TDSE, Equation 2.17, and..."

•(p33) Equation (2.19): Insert minus sign before $\dfrac{\partial}{\partial x}$ on the rhs.

•(p33) Sentence before Equation 2.22: remove "equation" after TDSE.

•(p33) Section 2.6 Equation (2.23): There is a $1/T(t)$ missing from the rhs. It should read:

$$\frac{1}{\psi(x)}\left[-\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + U(x)\right]\psi(x) = -\frac{\hbar}{i}\frac{1}{T(t)}\frac{dT(t)}{dt} \tag{2.23}$$

•Section 2.6 (p35): Last sentence of the section.
Change eigenfunctions→eigenvalues

Chapter 3

• (p50) First sentence under "Information Obtained from the Eigenfunctions" at the bottom of the page. Change eigenunctions→eigenfunctions.

• (p51) First complete paragraph. The one that begins with "Clearly the sinusoidal..." Change eigenunctions→eigenfunctions.

•(p54) Equation 3.12: the limits of integration in the middle line should be $0 \rightarrow L$.

•(p60) Equation 3.33: the first term should be the second derivative.

(p65) The 2nd paragraph after Table 3.3 that begins with "The zero of these functions....". About halfway down there is an errant "y" before "Because".

•(p69) Second paragraph under Figure 3.12 the paragraph: "Before leaving the discussion of the nature of the harmonic oscillator eigenfunctions, let us examine one of them, $\psi_3(x)$, in more detail. In particular, we wish to see how the harmonic oscillator eigenfunctions conform with the general characteristics of eigenfunctions laid out at the beginning of this chapter. The eigenfunctions for the particle-in-a-box do indeed conform, but, as noted previously, the infinite step in the potential energy and zero potential energy in the box introduced features and peculiarities in the wave function that are not present when the potential energy is a smooth ..."

The large print part of this paragraph above is incorrect because "characteristics of the eigenfunctions" was laid out in the previous chapter, not this one.

•(p78)Problem 3.10: First sentence. Change "For an L-box"→"For a particle of mass m in an arbitrary eigenstate of an L-box".

•(p80)Problem 3.21: Second sentence. Change "Problems"→"Problem".

•(p81)Problem 22. Second line. Add x^2 to $U(x)$ so $U(x) = \frac{1}{2}m\omega^2 \rightarrow U(x) = \frac{1}{2}m\omega^2 x^2$.

Chapter 4

•(p83) Equation 4.2: the second term in the first line has an extra $\dfrac{\partial\Psi(x,t)}{\partial t}$ in it. The one in the middle should be removed so the first line of this equation reads

$$\frac{d}{dt}\langle x\rangle = \int_{-\infty}^{\infty}\frac{\partial\Psi^*(x,t)}{\partial t}x\Psi(x,t)\,dx + \int_{-\infty}^{\infty}\Psi^*(x,t)\,x\frac{\partial\Psi(x,t)}{\partial t}dx \quad (4.2)$$

•(p90) Equation (4.32): Insert $\psi(x)$ in the integrand.

•(p91) Sentence above Equation (4.39). Replace $\phi(k) \rightarrow A(k)$.

•(p92) Second sentence of the first full paragraph following Equation 4.41: "Three of the most important properties of the δ-function are listed in Table 4.1." *There are **four** of the most important properties in the table, not three.*

•(p96) Equations 4.56 and 4.57 right before Section 4.5: *There are two equation numbers.*

•(p97) Equation (4.59). The equation should read

$$\Phi(p,0) = \frac{1}{\pi^{1/4}\sqrt{\beta\hbar}}e^{-(p-p_0)^2/2\beta^2\hbar^2}\cdot e^{-i(p-p_0)x_0/\hbar} \quad (4.59)$$

That is, in the last term $e^{-ipx_0/\hbar} \rightarrow e^{-i(p-p_0)x_0/\hbar}$.

•(p99) Equation (4.61). This is the same correction as the correction to Equation (4.59) (gaussianp). The equation should read

$$\Phi(p,0) = \frac{1}{\pi^{1/4}}\left(\frac{1}{2^{1/4}\sqrt{\Delta p_0}}\right) e^{-(p-p_0)^2/4\Delta p_0^2} \cdot e^{-i(p-p_0)x_0/\hbar} \tag{4.69}$$

So, in the last term $e^{-ipx_0/\hbar} \rightarrow e^{-i(p-p_0)x_0/\hbar}$.

The changes in these two equations have no consequences on succeeding work.

•(p110) Problem 4.14: "Use Equation 2.2 to write ..." should be "Use Equation 4.38 to write ..."

Chapter 5

•(p114) Second sentence under Fig. 5.1. Change $k \rightarrow \hbar k$.

•p(122) Equation (1.22). Last line: Change $x > -a \rightarrow x > a$.

•(p156) Line under Equation 5.148: Insert the words "*integral on the*" so it reads "where the **integral on the** left-hand side is zero. Equation 5.148 ..."

•(p166) Problem 5.3: Top line of the equations: $U(x) = 0$, not ∞.

•(p166) Problem 5.3: Last line of equations. Change $x > -a \rightarrow x > a$

Chapter 6

•(p182) Line below Equation (6.56). Change $a_j \rightarrow \alpha_j$.

•(p183) Equation (6.60). Should read (note the changes in lines 3 and 4 of the equation):

$$\begin{aligned}
\left(|\alpha_i\rangle\langle\alpha_i|\right)|\psi\rangle &= \left(|\alpha_i\rangle\langle\alpha_i|\right)\sum_{j=1}^{N}\alpha_j|\alpha_j\rangle \\
&= |\alpha_i\rangle\left(\langle\alpha_i|\sum_{j=1}^{N}\alpha_j|\alpha_j\rangle\right) \\
&= |\alpha_i\rangle\left(\sum_{j=1}^{N}\alpha_j\langle\alpha_i|\alpha_j\rangle\right) \\
&= |\alpha_i\rangle\left(\sum_{j=1}^{N}\alpha_j\delta_{ij}\right) \\
&= \alpha_i|\alpha_i\rangle
\end{aligned} \tag{6.60}$$

Chapter 7

•(p222) Second sentence under Equation 7.16: Change "...second, its eigenfunction is $(n-1)$."→"second, its eigenvalue is $(n-1)$."

so that "eigenfunction"→"eigenvalue"

Chapter 8

•(p289) Last sentence in paragraph under Equation (8.187). Change "...an antisymmetric..."→"...a symmetric...".

•(p289) Section: Example: Two noninteracting fermions: The line above the first equation of the example "...by integers $0, 1, 2 \ldots$ the state kets....". Remove the 0 so it reads "...by integers $1, 2 \ldots$ the state kets....".

•(p296) Problem 16: Remove everything after "...the second SGz apparatus?" [This is actually the final answer to the problem.]

Chapter 9

•(p308) Section 9.3: The Infinite Spherical Square Well. Second equation, Equation (9.35), second line should be $r > a$, not $r < a$.

•(p316) Section 9.5: The Isotropic Harmonic Oscillator. First equation, Equation (9.60). Insert comma, i.e. $U(x, y.z) \rightarrow U(x, y, z)$.

•(p322) Line above boldface **Energy eigenvalues**. Insert [ ] at the end of the sentence "quantity $(\ell + 1)$ [see Equation (9.71)].

•(p346) Last sentence of Problem 13. Add "Chapter 7" to this sentence so it reads: "The result of Problem 7, Chapter 7, will be helpful."

Chapter 10

•(p351) Equation 10.14. The entire expression should = 0. The equation should read:

$$\sum_{j=0}^{\infty} \left\{ \left[j(j+1) + 2(\ell+1)(j+1) \right] a_{j+1} + (\lambda - \ell - 1 - j)\, a_j \right\} \rho^j = 0 \tag{10.14}$$

•(p357) Table 10.3: The 4th entry, $R_{30}(r)$. The exponential should be $e^{-Zr/3a_0}$, not $e^{-Zr/2a_0}$.

Chapter 12

•(p403) Second sentence after Equation (12.69). "if we we ..."→"if we were..."

Chapter 13

•(p428) Problem 2. The first line of the equation. Eliminate $\hbar^2$ in the denominator and insert e^2 in the numerator so it reads:

$$\begin{aligned} \left\langle \hat{H}_{SO} \right\rangle &= \frac{1}{2m_e^2 c^2} \left(\frac{e^2}{4\pi\epsilon_0} \right) \left\langle \frac{1}{r^3} \right\rangle \left\langle \hat{\boldsymbol{L}} \bullet \hat{\boldsymbol{S}} \right\rangle \\ &= -\frac{1}{n} \alpha^2 E_n^{(0)} \frac{1}{\left[\ell \left(\ell + \frac{1}{2} \right) (\ell + 1) \right]} \frac{\left\langle \hat{\boldsymbol{L}} \bullet \hat{\boldsymbol{S}} \right\rangle}{\hbar^2} \end{aligned}$$

The second line of the equation is OK.

Appendix A

•(p493) Chapter 10, Problem 17, part (b). $\left\langle \hat{L}^2 \right\rangle \neq \frac{13}{3}\hbar^2$. Should be $\left\langle \hat{L}^2 \right\rangle = \frac{10}{3}\hbar^2$.