# Errata for Quantum Mechanics

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Mistakes Discovered after October 1, 2006

## Chapter I

- Page 10, First line of text, replace "vectors" with "vector":

  Examples of vector observables are **r**, **p**, and **L**.
  [Thanks to E. Angle, 12/06/2006]

- Page 6, Equation (1.33): In the second line replace the outer parentheses with brackets, and the inner parentheses with bigger ones:

$$= q\left[E_k + \left(\frac{\mathbf{v}}{c} \times \mathbf{B}\right)_k\right] \tag{1.33}$$

  [Thanks to E. Angle, 11/22/2006]

- Page 9, just above Equation (1.36), delete the period:

  Rotations about the $z$-axis have the form
  [Thanks to E. Angle, 12/06/2006]

## Chapter II

- Page 20, Figure 2.2 caption: Delete the space between the first dash and "or":

  Photons—or electrons—pass through two open slits.
  [Thanks to E. Angle, 12/10/2006]

- Page 25. at the end of the note just above Equation (2.8), change "as" to "is":

  A general position vector is
  [Thanks to E. Angle, 12/09/2006]

- Page 31, Equation (2.52): In the third row of both equations, on the left, change the subsctipt from 2 to 3:

$$|\alpha\rangle = \begin{pmatrix}\alpha_1\\ \alpha_2\\ \alpha_3\\ \cdots\\ \alpha_n\end{pmatrix} \qquad |\beta\rangle = \begin{pmatrix}\beta_1\\ \beta_2\\ \beta_3\\ \cdots\\ \beta_n\end{pmatrix} \tag{2.52}$$

  [Thanks to G. Marcus, 10/17/2006]

- Page 36, twice in the paragraph below Equation (2.85), for consistency $\langle\psi|\ x\rangle$ should read $\langle\psi|\ \psi_x\rangle$.

  $|\langle\psi|\ \psi_x\rangle|^2$ is a probability density....
  [Thanks to G. Marcus, 10/27/2006]

- Page 44. Equation (2.130): Change 1.054887 to 1.054572.

$$\boxed{\hbar = 1.054572\ldots \times 10^{-27}\,\text{erg-sec}} \tag{2.130}$$

[Thanks to G. Marcus, 10/17/2006]

- Page 52, Equations (2.197), (2.198), and (2.199): Change $\Psi$ to $\psi$ everywhere

$$\langle\psi|\, x^2 \,|\psi\rangle = \frac{a}{\sqrt{\pi}}\int_{-\infty}^{\infty} x^2 e^{-a^2x^2}\, dx = \frac{1}{2a^2} \tag{2.197}$$

and similarly

$$\langle\psi|\, p^2 \,|\psi\rangle = \int_{-\infty}^{\infty} p^2|\Phi(p)|^2\, dp = \frac{1}{2}a^2\hbar^2 \tag{2.198}$$

so that

$$\langle\psi|\, x^2 \,|\psi\rangle\langle\Psi|\, p^2 \,|\psi\rangle = \frac{1}{4}\hbar^2 \tag{2.199}$$

[Thanks to E. Angle, 11/22/2006]

- Page 58: Problem 2.6, part (b): The subscript on the summation symbol should read "$n = 0$":

$$\bar{R}(\hat{\boldsymbol{n}}_z, \theta) = \exp\left(-i\theta\bar{J}_z\right) = \sum_{n=0}^{\infty}\frac{1}{n!}\left(-i\theta\bar{J}_z\right)^n$$

[Thanks to T. Arlen, 10/17/2006]

**Chapter III**

- Page 68, Equation (3.28): The last factor should be "$\Theta\,(a - |x|)$":

$$\psi_1^+(x) = \frac{1}{\sqrt{a}}\cos(\pi x/2a)\,\Theta\,(a - |x|) \tag{3.28}$$

[Thanks to E. Angle, 12/13/2006]

- Page 69, line below Equation (3.36) change "equation (3.36)" to "equation (3.35)":

Since the spectrum of $H$ can be found from equation (3.35)
[Thanks to E. Perlmutter, 11/16/2006]

- Page 72, in the third sentence after Equation (3.62), change "be is zero" to "be zero."

the potential energy was chosen to be zero when $x = 0$
[Thanks to G. Marcus, 11/07/2006]

- Page 87, second line: Insert "each" before "other":

... and they commute with each other. That...

[Thanks to G. Marcus, 11/15/2006]

- Page 94, Problem 3.8, part (a), first line: Delete "Hermitean".

  Let $A$ be any well-defined operator, and
  [Thanks to A. Kao, 11/08/2006]

**Chapter IV**

- Page 125, Equation (4.126) and 4.129) : A comma is missing in one of the subscripts in each of these two equations:

$$\left|\phi_{\frac{3}{2},\frac{1}{2}}\right\rangle = \frac{1}{\sqrt{3}}\left[\sqrt{2}\left|\psi_{0,\frac{1}{2}}\right\rangle + \left|\psi_{1,-\frac{1}{2}}\right\rangle\right] \tag{4.126}$$

....

$$\left|\phi_{\frac{1}{2},\frac{1}{2}}\right\rangle = \frac{1}{\sqrt{3}}\left[\sqrt{2}\left|\psi_{1,-\frac{1}{2}}\right\rangle - \left|\psi_{0,\frac{1}{2}}\right\rangle\right] \tag{4.129}$$

[Thanks to E. Angle and E. Perlmutter, 12/09/2006]

**Chapter VI**

- Page 171, Section 6.1.1, Second paragraph, fourth line: Replcace "indicate" with "indicates"

  dimensional analysis only indicates...
  [Thanks to E. Angle, 3/27/2007]

- Page 177, Equation (6.43): The first $\mu$ should be in boldface:

$$\boldsymbol{\mu} = -\mu_B(\mathbf{L} + 2\mathbf{s}) = -\mu_B(\mathbf{L} + \boldsymbol{\sigma}) \tag{6.43}$$

[Thanks to E. Perlmutter, 2/01/2007]

- Page 186, fourth line: Replace "$10^{-15}$" with "$10^{15}$":

  with only one chance in $10^{15}$ that it interacts at all.
  [Thanks to A. Teymourian, 4/10/2007]

- Page 195, Footnote 14: "Apsect" should be "Aspect":

  See Aspect, Grangier, and Roger [11,12]...
  [Thanks to E. Perlmutter, 2/01/2007]

**Chapter VII**

- Page 212, fifth line from the bottom: Change the period after $\mathbf{p}^2$ to a comma:

  $\mathbf{r}^2$, $\mathbf{p}^2$, $\mathbf{L}^2$, and $\mathbf{L}\cdot\mathbf{s}$.
  [Thanks to E. Perlmutter, 2/01/2007]

- Page 219, Equation (7.95): The first "$s_p$" should be boldface:

$$= \frac{ge}{2m}\frac{g_p e}{2M}\left[(\mathbf{s}_p\cdot\boldsymbol{\nabla})\,(\mathbf{s}\cdot\boldsymbol{\nabla})\,\frac{1}{r} - \mathbf{s}_p\cdot\mathbf{s}\boldsymbol{\nabla}^2\frac{1}{r}\right] = \frac{gg_p\alpha}{4mM}\sum_{ij} s_{e\,i}s_{p\,j}T_{ij}(\mathbf{r}) \tag{7.95}$$

  [Thanks to E. Perlmutter, 2/01/2007]

- Page 222, at the end of the second complete paragraph in Subsection 7.4.2, "ev" should be eV:

  the Coulomb potential of a single proton, about -13.6 eV.
  [Thanks to E. Perlmutter, 2/01/2007]

**Chapter VIII**

- Pages 272 and 273, Equations (8.52), (8.54), (8.55), and (8.56): Delete the small parentheses around the fractions:

$$0 = \text{Im}\int\left[\phi^*\frac{\partial\chi}{\partial r} + \chi^*\frac{\partial\phi}{\partial r} + \chi^*\frac{\partial\chi}{\partial r}\right]r^2 d\Omega \tag{8.52}$$

$$\int\chi^*\frac{\partial\chi}{\partial r}r^2 d\Omega \to \frac{ik}{(2\pi)^3}\int|f(\theta,\phi)|^2 d\Omega = \frac{ik\sigma_{tot}}{(2\pi)^3} \tag{8.54}$$

$$\text{Im}\,\psi^*\frac{\partial\phi}{\partial r} = -\text{Im}\,\psi\frac{\partial\phi^*}{\partial r} \tag{8.55}$$

$$\begin{aligned}\frac{k\sigma_{tot}}{(2\pi)^3} &= -\text{Im}\int\left(\phi^*\frac{\partial\chi}{\partial r} + \chi^*\frac{\partial\phi}{\partial r}\right)r^2 d\Omega \\ &= -\text{Im}\int\left(\phi^*\frac{\partial\chi}{\partial r}) - \chi\frac{\partial\phi^*}{\partial r}\right)r^2 d\Omega \\ &= -\text{Im}\int\left(\phi^*\frac{\partial\psi}{\partial r} - \psi\frac{\partial\phi^*}{\partial r}\right)r^2 d\Omega\end{aligned} \tag{8.56}$$

  [Thanks to E. Angle, 3/27/2007]

- Page 284, Equation (8.126). The brackets on the left should be larger. And in the next equation, replace the outer parentheses with brackets:

$$h_1(r) = -\left(\frac{1}{\rho} + \frac{i}{\rho^2}\right)e^{i\rho} = -\frac{1}{\rho^2}(\rho + i)e^{i\rho} \tag{8.126}$$

$$\delta_1 = -ka + \frac{1}{2}\arctan\left[\frac{2ka}{1-(ka)^2}\right] = -ka + \arctan(ka) \tag{8.127}$$

  [Thanks to E. Angle, 3/27/2007]

**Chapter X**

- Page 324, Equation (10.3): Replace $t$ by $t_a$ (twice):

$$t_o = t_a \qquad t_{N+1} = t_a + (N+1)\epsilon = t_b \qquad t_n = t_a + n\epsilon \tag{10.3}$$

[5/30/2007]

**Chapter XI**

- Page 363, Equation 11.42: Replace $p_\beta(\mathbf{k}')$ with $p_\beta(\mathbf{k}', t)$

$$\left[H, x_\beta(\mathbf{k}', t)\right] = -ip_\beta(\mathbf{k}', t) = -i\frac{\partial x_\beta(\mathbf{k}', t)}{\partial t} \tag{11.42}$$

[4/09/2007]

- Page 370, Equation (11.81): $\mathbf{A}$ and $\mathbf{B}$ should be functions of $\mathbf{r}$ only:

$$H'_{fi} = \left\langle \psi_f; \alpha, \mathbf{k} \left| \frac{e}{m}\mathbf{A}(\mathbf{r})\cdot\mathbf{p} + \frac{e^2}{2m}\mathbf{A}(\mathbf{r})^2 + \frac{e}{2m}\boldsymbol{\sigma}\cdot\mathbf{B}(\mathbf{r}) \right| \psi_i \right\rangle \tag{11.79}$$

[4/09/2007]

- Page 385, In the paragraph between Equations (11.167) and (11.168) delete ". Therefore":

Because ${k_f}^2/2m \gg |E_o|$, ${k_f}^2 \gg 1/a^2$...
[2/18/2007]

**Appendix**

- Page 484, Equation (A.109): There should be a factor $1/2^l l!$ in front of the last two terms:

$$\frac{d^2}{d\rho^2}\left[\rho h_l^{(1)}(\rho)\right] = \left[\frac{l(l+1)}{\rho^2} - 1\right]\rho h_l^{(1)}(\rho) + 2i(l+1)\frac{\rho^l}{2^l l!}\int_1^{1+i\infty} z e^{i\rho z}(1-z^2)^l dz + \frac{\rho^{l+1}}{2^l l!}\int_1^{1+i\infty} e^{i\rho z}(1-z^2)^{l+1} dz \tag{A.111}$$

[Thanks to E. Brown, 2/13/2007]

- Page 499, first line. $\mathbf{R}/2$ should be $\pm\mathbf{R}/2$:

The surfaces of constant $u$ are ellipsoids with foci at $\pm\mathbf{R}/2$
[Thanks to J. Landy, 2/13/2007]

- Page 500, first line of section B.1.1: $Y_m^l$ should be $Y_l^m$:

There are some relations between the spherical harmonics $Y_l^m(\theta, \phi)$ and the...
[Thanks to E. Perlmutter, 11/16/2006]