Corrections

Quantum Mechanics: Concepts and Applications

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Note: This list of corrections pertains to: N. Zettili, Quantum Mechanics: Concepts and Applications, (Chichester: John-Wiley, 2009); 2nd edition, ISBN: 978-0-470-02678-6 (Hardcover), 978-0-470-02679-3 (Paperback).

Chapter 2

- Page 151, replace Eq. (2.471) by

$$\begin{aligned}\hat{H}^2 &= \alpha^2 \left(|\,\phi_1\rangle\langle\phi_2\,| + |\,\phi_2\rangle\langle\phi_1\,|\right)\left(|\,\phi_1\rangle\langle\phi_2\,| + |\,\phi_2\rangle\langle\phi_1\,|\right)\\ &= \alpha^2 \left(|\,\phi_1\rangle\langle\phi_1\,| + |\,\phi_2\rangle\langle\phi_2\,|\right),\end{aligned}$$

- Page 8, Page 151, replace Eq. (2.472) by

$$\begin{aligned}(\alpha^{-2}\hat{H}^2)^2 &= \left(|\,\phi_1\rangle\langle\phi_1\,| + |\,\phi_2\rangle\langle\phi_2\,|\right)\left(|\,\phi_1\rangle\langle\phi_1\,| + |\,\phi_2\rangle\langle\phi_2\,|\right)\\ &= |\,\phi_1\rangle\langle\phi_1\,| + |\,\phi_2\rangle\langle\phi_2\,| = \alpha^{-2}\hat{H}^2.\end{aligned}$$

Chapter 3

- Replace Problem 3.5 and its solution on Page 196 by

  Problem 3.5
  Assuming that the system of Problem 3.4 is initially in the state $|\phi_3\rangle$, what values for the energy and the observable A will be obtained if we measure: (i)H first then A, (ii) A first then H?

  (b) Compare the results obtained in (i) and (ii) and infer whether $\hat{H}$ and $\hat{A}$ are compatible. Calculate $[\hat{H},\ \hat{A}]|\phi_3\rangle$.

  (c) Consider now an other operator $\hat{B}$ whose action on $|\phi_n\rangle$ is defined by $\hat{B}|\phi_n\rangle = nb_0|\phi_{n+1}\rangle$. Repeat Questions (a) and (b) for the operator $\hat{B}$.

  Solution

  (a) (i) The measurement of H first then A is represented by $\hat{A}\hat{H}|\phi_3\rangle$. Using the relations $\hat{H}|\phi_n\rangle = n^2\mathcal{E}_0|\phi_n\rangle$ and $\hat{A}|\phi_n\rangle = (n+1)a_0|\phi_n\rangle$, we have

$$\hat{A}\hat{H}|\phi_3\rangle = 9\mathcal{E}_0\hat{A}|\phi_3\rangle = 36\mathcal{E}_0 a_0|\phi_3\rangle. \tag{1}$$

(ii) Measuring A first and then H, we will obtain

$$\hat{H}\hat{A}|\phi_3\rangle = 4a_0\hat{H}|\phi_3\rangle = 36\mathcal{E}_0 a_0|\phi_3\rangle. \tag{2}$$

(b) Equations (1) and (2) show that the actions of $\hat{A}\hat{H}$ and $\hat{H}\hat{A}$ yield the same result. This means that $\hat{H}$ and $\hat{A}$ commute; hence they are compatible. We can thus write

$$[\hat{H},\ \hat{A}]|\phi_3\rangle = (36-36)\mathcal{E}_0 a_0|\phi_3\rangle = 0. \tag{3}$$

(c) (i) The measurement of H first then B is represented by $\hat{B}\hat{H}|\phi_3\rangle$. Using the relations $\hat{H}|\phi_n\rangle = n^2\mathcal{E}_0|\phi_n\rangle$ and $\hat{B}|\phi_n\rangle = nb_0|\phi_{n+1}\rangle$, we have

$$\hat{B}\hat{H}|\phi_3\rangle = 9\mathcal{E}_0\hat{B}|\phi_3\rangle = 27\mathcal{E}_0 b_0|\phi_4\rangle. \tag{4}$$

(ii) Measuring B first and then H, we will obtain

$$\hat{H}\hat{B}|\phi_3\rangle = 3b_0\hat{H}|\phi_4\rangle = 48\mathcal{E}_0 b_0|\phi_4\rangle. \tag{5}$$

Equations (4) and (5) show that the actions of $\hat{B}\hat{H}$ and $\hat{H}\hat{B}$ yield different results. This means that $\hat{H}$ and $\hat{B}$ do not commute; hence they are not compatible. We can thus write

$$[\hat{H},\ \hat{B}]|\phi_3\rangle = (48-27)\mathcal{E}_0 b_0|\phi_4\rangle = 17\mathcal{E}_0 b_0|\phi_4\rangle. \tag{6}$$

- Replace the first two lines of Problem 3.11 on Page 204 by:

  Consider a system whose initial state $|\psi(0)\rangle$ and Hamiltonian are given by

$$|\psi(0)\rangle = \frac{1}{5}\begin{pmatrix} 3 \\ 0 \\ 4 \end{pmatrix}, \qquad H = \epsilon\begin{pmatrix} 3 & 0 & 0 \\ 0 & 0 & 5 \\ 0 & 5 & 0 \end{pmatrix},$$

  where ϵ has the dimensions of an energy.

- Replace the third line from the bottom of Page 204 by:

  A measurement of the energy yields the values $E_1 = -5\epsilon$, $E_2 = 3\epsilon$, $E_3 = 5\epsilon$; the

- Replace Eq. (3.222) on Page 205 by:

$$|\psi(t)\rangle = \frac{2\sqrt{2}}{5}e^{-iE_1 t/\hbar}|\phi_1\rangle + \frac{3}{5}e^{-iE_2 t/\hbar}|\phi_2\rangle + \frac{2\sqrt{2}}{5}e^{-iE_3 t/\hbar}|\phi_3\rangle = \frac{1}{5}\begin{pmatrix} 3e^{-3i\epsilon t/\hbar} \\ -4i\sin(5\epsilon t/\hbar) \\ 4\cos(5\epsilon t/\hbar) \end{pmatrix}.$$

- Replace Eq. (3.223) on Page 205 by:

$$\begin{aligned} E(0) = \langle\psi(0)|\hat{H}|\psi(0)\rangle &= \frac{8}{25}\langle\phi_1|\hat{H}|\phi_1\rangle + \frac{9}{25}\langle\phi_2|\hat{H}|\phi_2\rangle + \frac{8}{25}\langle\phi_3|\hat{H}|\phi_3\rangle \\ &= \frac{8}{25}(-5)\epsilon + \frac{9}{25}(3)\epsilon + \frac{8}{25}(5)\epsilon = \frac{27}{25}\epsilon. \end{aligned}$$

- Replace Eq. (3.224) on Page 205 by:

$$E(0) = \langle\psi(0)|\hat{H}|\psi(0)\rangle = \frac{\epsilon}{25}\left(\begin{array}{ccc} 3 & 0 & 4 \end{array}\right)\left(\begin{array}{ccc} 3 & 0 & 0 \\ 0 & 0 & 5 \\ 0 & 5 & 0 \end{array}\right)\left(\begin{array}{c} 3 \\ 0 \\ 4 \end{array}\right) = \frac{27}{25}\epsilon.$$

- Replace Eq. (3.225) on Page 205 by:

$$E(0) = \sum_{n=1}^{2} P(E_n)E_n = \frac{8}{25}(-5)\epsilon + \frac{9}{25}(3)\epsilon + \frac{8}{25}(5) = \frac{27}{25}\epsilon.$$

- Replace Eq. (3.226) on Page 205 by:

$$E(t) = \langle\psi(t)|\hat{H}|\psi(t)\rangle = \frac{8}{25}e^{iE_1t/\hbar}e^{-iE_1t/\hbar}\langle\phi_1|\hat{H}|\phi_1\rangle + \frac{9}{25}e^{iE_2t/\hbar}e^{-iE_2t/\hbar}\langle\phi_2|\hat{H}|\phi_2\rangle$$
$$+\frac{8}{25}e^{iE_3t/\hbar}e^{-iE_3t/\hbar}\langle\phi_3|\hat{H}|\phi_3\rangle = \frac{8}{25}(-5)\epsilon + \frac{9}{25}(3)\epsilon + \frac{8}{25}(5)\epsilon = \frac{27}{25}\epsilon = E(0).$$