Corrections of Principles of Nano-Optics (2nd. ed.)

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1. Page 24: In Equation (2.64) replace $\omega 0$ by ω_0

2. Page 25: Replace Equation (2.65) by

$$\bar{w_E}(\mathbf{r}) \;=\; \frac{\varepsilon_0}{4}\,\frac{d\,[\omega\,\varepsilon'(\omega)]}{d\omega}\bigg|_{\omega=\omega_0} |\mathbf{E}_0(\mathbf{r})|^2 \,. \tag{2.65}$$

3. Page 25: Replace Equation (2.67) by

$$\bar{W} \;=\; \left[\frac{\varepsilon_0}{2}\,\frac{d\,[\omega\,\varepsilon'(\omega)]}{d\omega}\,\Big\langle \mathbf{E}\cdot\mathbf{E}\Big\rangle \;+\; \frac{\mu_0}{2}\,\frac{d\,[\omega\,\mu'(\omega)]}{d\omega}\,\Big\langle \mathbf{H}\cdot\mathbf{H}\Big\rangle\right] \tag{2.67}$$

   Keep it shaded (highlighted).

4. Page 25: In the text following Equation (2.67) replace $\bar{W} = (1/2)\,[\varepsilon_o\varepsilon'|\mathbf{E}_0|^2 + \mu_o\mu'\,|\mathbf{H}_0|^2]$ by $\bar{W} = (1/4)\,[\varepsilon_o\varepsilon'|\mathbf{E}_0|^2 + \mu_o\mu'\,|\mathbf{H}_0|^2]$

5. Page 35: Equation (2.113) is wrong. It should read as

$$\langle\mathbf{S}\rangle_{\mathrm{x}} \;=\; \frac{1}{2}\sqrt{\frac{\varepsilon_0\varepsilon_2}{\mu_0\mu_2}}\,\frac{k_1}{k_2}\,\sin\theta_1\left(|t^{\mathrm{s}}|^2\left|\mathbf{E}_1^{(\mathrm{s})}\right|^2 + |t^{\mathrm{p}}|^2\left|\mathbf{E}_1^{(\mathrm{p})}\right|^2\right)\mathrm{e}^{-2\gamma z}\,. \tag{2.113}$$

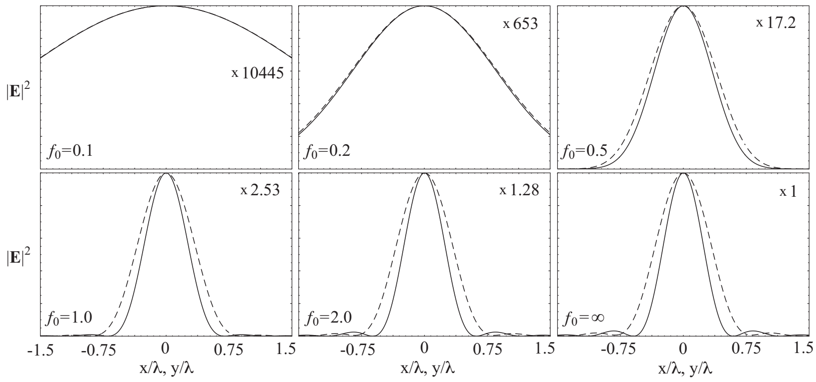
6. Page 45: After Equation (3.2) replace "also referred to as the *optical transfer function* (OTF) in free space" by "also referred to as the *free-space transfer function*"

7. Page 51: After Equation (3.20) replace "where E_x corresponds to the Gaussian beam profile defined in Eq. (3.8)" by "where we used the Gaussian beam profile (3.8) for E_x and approximated k_z by k"

8. Page 55: Before Equation (3.34), after the sentence ".. whereas the screen blocks all the field outside of the aperture." add the following footnote: "A purely transverse aperture field violates Maxwell's equations. The approximation is only reasonable in the paraxial limit, that is, for apertures much larger than the wavelength."

9. Page 63: The angle 68.96° should be changed to 67.26°.

10. Page 63: Scaling of horizontal axes is wrong in Fig. 3.10. Replace the figure by figasp12_rev.eps (file attached).



11. Page 66: Equations (3.74) and (3.75) are missing a factor of 4 before the integral sign. Replace as follows:

$$I_{\text{rad}} = I_{11} - I_{12} = 4 \int_0^{\theta_{\max}} f_w(\theta)\,(\cos\theta)^{3/2} \sin^2\theta\, J_1(k\rho\sin\theta)\,\mathrm{e}^{ikz\cos\theta}\,\mathrm{d}\theta \tag{3.74}$$

$$I_{\text{azm}} = I_{11} + 3I_{12} = 4 \int_0^{\theta_{\max}} f_w(\theta)\,(\cos\theta)^{1/2} \sin^2\theta\, J_1(k\rho\sin\theta)\,\mathrm{e}^{ikz\cos\theta}\,\mathrm{d}\theta \tag{3.75}$$

12. Page 96: After Equation (4.24) delete the sentence "where the multiplications between field vectors denote outer products."

13. Page 173: Replace the sentence "The power transmission of aperture probes with $D_{\text{a}} = 100$ nm, 50 nm and 20 nm therefore is approximately 10^{-3}, 10^{-6} and 2×10^{-12}, respectively." by "The power transmission of aperture probes with $D_{\text{a}} = 100$ nm, 50 nm and 20 nm therefore is approximately 10^{-3}, 10^{-6} and 10^{-11}, respectively."

14. Page 179: Replace the last sentence "Bethe and Bouwkamp show that the far-field of a small aperture is equivalent to the far-field of a radiating magnetic dipole located in the aperture and with axis along the negative y-direction, i.e. opposite to the magnetic field vector of the incident plane wave." by "Bethe and Bouwkamp show that the far-field of a small aperture is equivalent to the far-field of a radiating magnetic dipole located in the aperture and with axis along the y-direction."

15. Page 180: Replace the factor '8/3' in Equation (6.19) by '16/3'.

16. Page 180: Just before Equation (6.20) replace reference [23] by [22].

17. Page 180: Replace Equation (6.20) by

$$\mathbf{p} = -\frac{8}{3}\varepsilon_0 a_0^3\,[\mathbf{E}_0 \cdot \mathbf{n}_z]\,\mathbf{n}_z, \qquad \mathbf{m} = -\frac{16}{3} a_0^3\,[\mathbf{n}_z \times (\mathbf{H}_0 \times \mathbf{n}_z)]\,, \tag{6.20}$$

18. Page 102: In Equation (4.42) ε_0^z should read ε_0^2.

19. Page 103: In Equation (4.45) $\sqrt{n'/n}$ should be moved out of the brackets, that is, it should apply to all components of $\mathbf{p}_{\mathrm{n}}$.

20. Page 207: Remove the 'π' in the denominator of the last term in the expression for H_y/H_0.

21. Page 229: Replace the last expression in Equation (8.26) by

$$-q\left[\frac{\partial A_x}{\partial t} + \dot{x}\frac{\partial A_x}{\partial x} + \dot{y}\frac{\partial A_x}{\partial y} + \dot{z}\frac{\partial A_x}{\partial z}\right] \tag{8.26}$$

22. Page 232: Replace the last sentence by "The multipolar interaction Hamiltonian can be converted to an operator form by replacing the fields **E** and **B** by corresponding electric and magnetic field operators."

23. Page 238: In Equation (8.71) replace $\bar{P}$ by P_0.

24. Page 238: In the text, just before Equation (8.72) replace $\bar{P}$ by P_0.

25. Page 238: In Equation (8.72) replace $\bar{P}$ by P_0 and $\bar{P}(\vartheta,\varphi)$ by $P_0(\vartheta,\varphi)$.

26. Page 239: After Equation (8.74) replace "where the field **E** is evaluated at the dipole's origin $\mathbf{r}_0$. This equation can be rewritten in terms of the Green function by using Eq. (8.52) as" by "To calculate the radiated power ($P_0 = dW/dt$) we have to evaluate the dipole's field **E** at its origin $\mathbf{r}_0$. In terms of the Green function (c.f. Eq. 8.52) we then obtain"

27. Page 239: Replace Equation (8.75) by

$$P_0 \;=\; \frac{\omega^3\,|\mathbf{p}|^2}{2\,c^2\varepsilon_0\varepsilon}\left[\mathbf{n}_{\mathrm{p}}\cdot \mathrm{Im}\left\{\overleftrightarrow{\mathbf{G}}(\mathbf{r}_0,\mathbf{r}_0)\right\}\mathbf{n}_{\mathrm{p}}\right] \;. \tag{8.75}$$

28. Page 239: Replace Equation (8.77) by

$$\begin{aligned} P_0 \;&=\; \lim_{R\to 0}\left[\frac{\omega}{2}\,|\mathbf{p}|\;\mathrm{Im}\{E_z\}\right] \;=\; \frac{\omega\,|\mathbf{p}|^2}{8\pi\varepsilon_0\varepsilon}\,\lim_{R\to 0}\left\{\frac{2}{3}k^3 + R^2(\ldots)+\ldots\right\} \\ &=\; \frac{|\mathbf{p}|^2}{12\,\pi}\,\frac{\omega}{\varepsilon_0\varepsilon}\,k^3, \end{aligned} \tag{8.77}$$

29. Page 239, after Equation (8.77): Replace the sentence "Thus, Eq. (8.74) leads to the correct result despite the apparent singularity at $R = 0$." by "We thus find that Eq. (8.74) leads to the correct result for the radiated power despite the apparent singularity at $R = 0$."

30. Page 245: In Equation (8.103), in the expression for γ, replace ω by ω_0.

31. Page 249: In Equation (8.123) there should be a minus sign in the exponent of the last term, i.e. $\mathrm{e}^{-\gamma_0 t/2}$.

32. Page 250: In Equations (8.128) and (8.129) replace q_i by q_i^{-1}

33. Page 250: Replace the sentence "The quantum mechanical analog of the decay rate (cf. Eq.(8.121)) can be arrived at by replacing the oscillator's initial average energy $m\omega_0^2|\mathbf{p}_0|^2/(2q^2)$ by the energy quantum $\hbar\omega_0$." by "The quantum mechanical analog of the decay rate (cf. Eq.(8.121)) can be arrived at by replacing the oscillator's initial average energy $m\omega_0^2|\mathbf{p}_0|^2/(2q^2)$ by $\hbar\omega_0/4$."

34. Page 251: In Equation (8.134) the ω_0^2 should be changed to ω_0^4, that is, Equation (8.134) should read as

$$\frac{\mathrm{d}W}{\mathrm{d}\Omega\,\mathrm{d}\omega} = \frac{1}{4\pi\varepsilon_0}\frac{|\mathbf{p}|^2\sin^2\!\vartheta\,\omega_0^4}{4\pi^2c^3\gamma_0^2}\left[\frac{\gamma_0^2/4}{(\omega-\omega_0)^2+\gamma_0^2/4}\right] \qquad (8.134)$$

35. Page 258: In Equation (8.152) remove the minus sign on the right hand side.

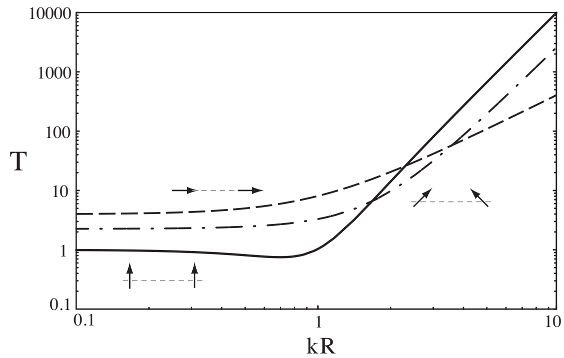
36. Page 258: Before Equation (8.152) change "(c.f. Eq. (8.73))" to "(c.f. Eq. (2.58))".

37. Page 259: Change Equation (8.153) as follows:

$$P_{\mathrm{D}\to\mathrm{A}} = \frac{\omega_0}{2}\,\mathrm{Im}\{\mathbf{p}_\mathrm{A}\cdot\mathbf{E}_\mathrm{D}^*(\mathbf{r}_\mathrm{A})\}\;. \qquad (8.153)$$

38. Page 294: Include a footnote in the text just before Equation (9.3) [after ".. is given by (c.f. Chapter 8)"]. The footnote should read: "Strictly speaking, **E** is the total electric field consisting of the sum of incident field and self-field. The latter gives rise to scattering through radiation reaction. However, **E** can be regarded as the incident field if we only account for absorption in $\mathrm{Im}\{\alpha\}$.

39. Page 261: Replace Figure 8.13 by figdip18_rev.eps (file attached)



40. Page 272: After Equation (8.193) replace "To determine the eigenstates .." by "To determine the eigenvalues .."

41. Page 274: The minus sign inside the first square brackets of Equation (8.205) should be a plus sign

42. Page 274: In Equation (8.209) change W_{A^*B} to W_{AB^*}.

43. Page 278: Change the last sentence of Problem 8.5 to "The inconsistency of the quasi-static polarizability is also discussed in Problem 16.4."

44. Page 295: Remove the minus sign on the right hand side of Equation (9.5)

45. Page 310: In Problem 9.2 replace $P_{\rm abs}(\omega) = (\omega/2)\,{\rm Im}\,[\mathbf{p}\cdot\mathbf{E}(\omega)]$ by $P_{\rm abs}(\omega) = (\omega/2)\,{\rm Im}\,[\mathbf{p}\cdot\mathbf{E}^*(\omega)]$, that is, add a * to $\mathbf{E}$.

46. Page 317: In Equation (10.13) replace k^2 by k_1^2.

47. Page 324: Factor 2π is missing in (10.28).
Replace '$-{\rm i}ks_z$' by '$-2\pi{\rm i}ks_z$'.

48. Page 325: Eq. (10.32) uses wrong symbol for dipole.
Replace μ_x by p_x, μ_y by p_y, and μ_z by p_z.

49. Page 325: In Eq. (10.37), remove the negative sign in front of the expression for $\Phi_n^{(2)}$.

50. Page 332: In Equation (10.53), replace the last term in brackets ($\mu\mathbf{m}$) by $\mu_0\mu\mathbf{m}$

51. Page 339: The opening bracket is missing in the exponent of Equation (11.2). Change to

$$\text{TM}: \quad \mathbf{H}(\mathbf{r}) = H(z)\,{\rm e}^{{\rm i}(k_x x + k_y y)}\,\mathbf{n}_x\,. \tag{11.2}$$

52. Page 358: The derivation on this page is wrong!! Replace Eq. (11.49) and following text by:

$$\int_{\partial V}\left[\mathbf{H}\cdot(\mathbf{n}\times\mathbf{E}_0^*) \,+\, \mathbf{H}_0^*\cdot(\mathbf{n}\times\mathbf{E})\right] da \;=\; \frac{2}{Z_0}\int_{\partial V}\mathbf{E}_0^*\cdot\mathbf{E}\;da \tag{11.49}$$

where $\mathbf{n}$ is a unit vector normal to the surface ∂V, and Z_0 is the wave impedance of the surrounding medium. We made use of the fact, that in the far field $\mathbf{H}_0 = (1/Z_0)(\mathbf{n}\times\mathbf{E}_0)$ and $\mathbf{H} = (1/Z_0)(\mathbf{n}\times\mathbf{E})$. For a small perturbation, we have $\mathbf{E}_0^*\cdot\mathbf{E} \approx |\mathbf{E}|^2$ and the above integral gives $4\bar{P}_0$, with $\bar{P}_0$ being the power radiated by the resonator.

For a resonator, the energy associated with radiation is much smaller than the stored energy and hence we neglect the term in Eq. (11.49). We thus arrive at the equation

$$\frac{\omega-\omega_0}{\omega} \;=\; -\frac{\int_V\left[\mathbf{E}_0^*\varepsilon_0\boldsymbol{\Delta}\varepsilon(\mathbf{r})\mathbf{E} \,+\, \mathbf{H}_0^*\mu_0\boldsymbol{\Delta}\mu(\mathbf{r})\mathbf{H}\right]dV}{\int_V\left[\varepsilon_0\varepsilon(\mathbf{r})\mathbf{E}_0^*\cdot\mathbf{E} \,+\, \mu_0\,\mu(\mathbf{r})\mathbf{H}_0^*\cdot\mathbf{H}\right]\,dV}\,, \tag{11.50}$$

which is known as the Bethe-Schwinger cavity perturbation formula [31,32]. It is also known as Waldron's formula. In the absence of radiation losses, Eq. (11.50) is an exact formula, but because $\mathbf{E}$ and $\mathbf{H}$ are not known the equation cannot be used in its form. Notice that because $\boldsymbol{\Delta}\varepsilon$ and $\boldsymbol{\Delta}\mu$ are zero outside of the volume occupied by the perturbation the integral in the numerator runs only over the volume of the perturbation ΔV.

We assume that the perturbation has a small effect on the cavity. Therefore we write as a first-order approximation $\mathbf{E} = \mathbf{E}_o$ and $\mathbf{H} = \mathbf{H}_o$. After performing these substitutions in Eq. (11.50) we find ...

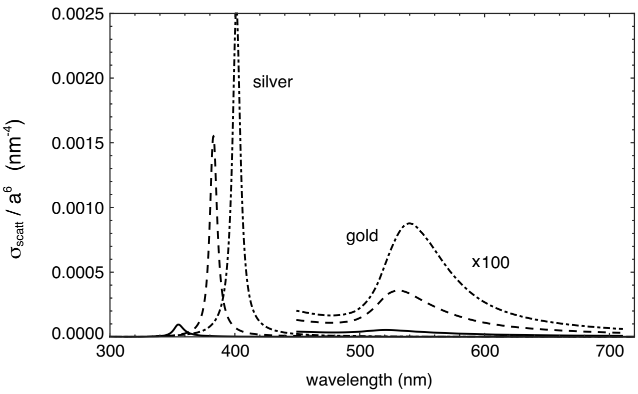
53. Page 359: The second-to-last sentence of section 11.3 should be corrected as "Making use of the quasi-static solution for a small spherical particle we write $\mathbf{E} = 3\mathbf{E}_0/(3+\Delta\varepsilon)$ and obtain a frequency shift of $(\omega-\omega_0)/\omega = -[3\Delta\varepsilon/(3+\Delta\varepsilon)]\,\Delta V/V$. "

54. Page 382: Add a footnote after the sentence "It is the condition that makes the Fresnel reflection coefficient r^{p} go to infinity or, in other words, it is the pole of r^{p} (c.f. Eq. 2.51)." The footnote should read: "A mode is a solution for which the incident field is zero, that is, $E_{\mathrm{in}}^{\mathrm{p}} = 0$. Since $r^{\mathrm{p}} = E_{\mathrm{ref}}^{\mathrm{p}}/E_{\mathrm{in}}^{\mathrm{p}}$, the reflection coefficient goes to infinity as $E_{\mathrm{in}}^{\mathrm{p}} \to 0$."

55. Page 399: In footnote #4, change 'vacuum permeability' to 'vacuum permittivity'

56. Page 399: Just before Equation (12.62) replace "polarizability" by "quasi-static polarizability"

57. Page 400: Replace Figure 12.22 by resonances_rev.eps (file attached)



58. Page 401: Reference [4] just before Equation (12.65) should be changed to [3].

59. Page 410: In Problem 12.6 replace $\mathrm{e}^{\mathrm{i}\omega t}$ by $\mathrm{e}^{-\mathrm{i}\omega t}$.

60. Page 411: In Ref [13] replace "Oberflachenplasmaschuingungen" by "Oberflaechenplasmaschwingungen

61. Page 425: Replace section title "The Chu limit" by "The Wheeler-Chu limit"

62. Page 425: Replace the last two sentences after Eq. (13.20) by
"This limit goes back to the work of H. A. Wheeler and L. G. Chu in 1947 and 1948 and is based on ideal conductors [14]. The theory has later been expanded and generalized

by Gustafsson and co-workers [15]."

Also, on page 445 modify reference [14] as follows:

[14] H. A. Wheeler, "Fundamental limitations of small antennas," *Proc. I.R.E.* **35**, 1479–1484 (1947); L. J. Chu, "Physical limitations of omni-directional antennas, *Appl. Phys.* **19**, 1163–1175 (1948).

63. Page 457: After Equation (14.42) replace "absorption cross-section" by "extinction cross-section"

64. Page 458: In Equation (14.46) replace $\langle|\mathbf{E}|^2\rangle$ by $\langle\mathbf{E}^2\rangle$

65. Page 458: In Equation (14.47) replace $\langle|\mathbf{E}|^2\rangle$ by $\langle\mathbf{E}^2\rangle$

66. Page 458: In the text, just below Equation (14.47), remove the sentence "where $|\mathbf{E}|$ denotes the time-dependent magnitude of the electric field vector."

67. Page 459: In Equation (14.49) the term $i\gamma^2/4$ in the denominator should be changed to $\gamma^2/4$, i.e. remove the 'i'. Also, the term ω_o in the numerator should be ω_0.

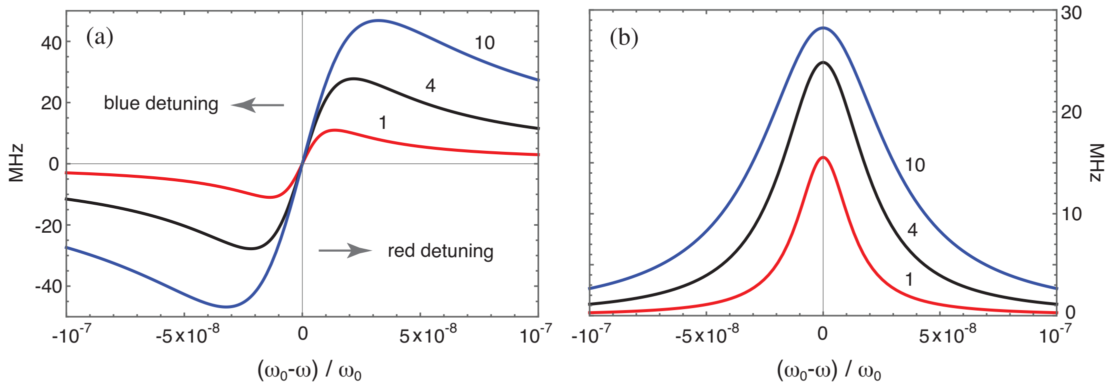
68. Page 459: In Equation (14.50) replace $(\omega - \omega_0)$ by $(\omega_0 - \omega)$.

69. Page 459: In Equation (14.51) replace $(\omega - \omega_0)^2$ by $(\omega_0 - \omega)^2$.

70. Page 459: After Equation (14.50) delete the statement "where we used $\gamma \ll \omega_0$." Replace the comma after (14.50) by a full stop (period).

71. Page 460: In Equation (14.53) replace $(\omega - \omega_0)$ by $(\omega_0 - \omega)$.

72. Page 460: Replace Figure 14.4 by figf12_rev.eps (file attached)



73. Page 460: Replace the text in the caption of Figure 14.4 by the following: "Frequency dependence of (a) the dipole force and (b) the scattering force evaluated for sodium atoms ($1/\gamma = 16.1ns$, $\lambda_o = 590nm$). (a) shows $(\omega_0 - \omega)p/(1+p)$. (b) shows $(\gamma/2)p/(1+p)$. The numbers in the figures indicate the value of I/I_{sat}."

74. Page 460: Replace "For frequencies $\omega < \omega_0$ (red detuning) the dipole force is proportional to $-\nabla E_0$ causing an atom to be attracted towards regions of high intensity. On the other hand, for frequencies $\omega > \omega_0$ (blue detuning) atoms are repelled from regions of high intensity because the dipole force is proportional to ∇E_0. The dipole force vanishes for exact resonance. Fig. 14.4 shows qualitatively the frequency behavior of the dipole and scattering force for different excitation intensities."
by
"Fig. 14.4 shows the frequency dependence of the dipole force and the scattering force for different excitation intensities. For frequencies $\omega < \omega_0$ (red detuning) the dipole force is proportional to $+E_0 \nabla E_0$ causing an atom to be attracted towards regions of high intensity. On the other hand, for frequencies $\omega > \omega_0$ (blue detuning) atoms are repelled from regions of high intensity because the dipole force is proportional to $-E_0 \nabla E_0$. The dipole force vanishes for exact resonance."

75. Page 467: Replace Equation (14.64) by

$$\langle \mathbf{F} \rangle = (\alpha'/2)\, \nabla \langle \mathbf{E}^2 \rangle = (\alpha'/4)\, \nabla (\underline{\mathbf{E}} \cdot \underline{\mathbf{E}}^*)\,, \tag{14.64}$$

76. Page 469: Replace 'r^6' in the denominator of Eq. (14.67) by 'r^8'.

77. Page 469: In the text following Eq. (14.67) change 'tip radius a_t' to 'tip radius r_t'

78. Page 469: Equation (14.67) replace '$4\, r^6$' in the denominator by '$8\, r^6$'

79. Page 469: Equation (14.69) replace '$8\, r^6$' in the denominator by '$16\, r^6$'

80. Page 470: Equation (14.70) replace '$4\pi\sqrt{\varepsilon_s}$' in the denominator by '$2\pi\sqrt{\varepsilon_s}$'

81. Page 470: In the sentence just before Equation (14.71) replace "With **E** being the field of the .." by "With $\underline{\mathbf{E}}$ being the complex field of the .."

82. Page 470: Replace Equation (14.71) by

$$V_{\text{pot}}(\mathbf{r}) \;=\; -\frac{1}{4}\,\text{Re}\,\{\mathbf{p} \cdot \underline{\mathbf{E}}^*(\mathbf{r})\} \;=\; -(\alpha'/4)\, |\underline{\mathbf{E}}(\mathbf{r})|^2\,, \tag{14.71}$$

83. Page 471: In the text below Equation (14.71) replace "A comparison shows that the forces calculated here are off by a factor $\approx 2-3$. Nevertheless, we find that moderate laser powers are needed to trap a nanoparticle at the end of a gold tip in an aqueous environment." by "We find that moderate laser powers are needed to trap a nanoparticle at the end of a gold tip in an aqueous environment."

84. Page 514: Add a footnote just before Equation (16.50) with the following text: "Note that this definition is different from Eq. (12.62) where $\mathbf{p} = \varepsilon_{\text{ref}} \alpha \mathbf{E}$. Here we incorporate ε_{ref} in α in order to simplify the notation."

85. Page 516: Before Equation (16.62), after ".. one obtains", add a footnote with the following text:
"In the isotropic case we obtain to third-order $\alpha = \alpha_0 \left[1 - \frac{ik^3\alpha_0}{6\pi\varepsilon_0\varepsilon_{\rm ref}} - \frac{k^2\alpha_0}{4\pi a\varepsilon_0\varepsilon}\right]^{-1}$, which is referred to as the Modified Long-Wavelength Approximation (MLWA) [28]."

86. Page 518: Add the following paragraph to the end of section 16.3:
Substituting $\mathbf{p} = \alpha_{eff}\mathbf{E}_0$ into (16.67) on the left hand side, together with $\mathbf{p}_0 = \alpha\mathbf{E}_0$ on the right hand side, yields

$$\alpha_{\rm eff} \;-\; \frac{\omega^2}{\varepsilon_0 c^2}\,\alpha(\omega)\,G_{\rm s}(\mathbf{r}_0,\mathbf{r}_0)\,\alpha_{\rm eff} \;=\; \alpha(\omega) \tag{14.72}$$

Solving for $\alpha_{\rm eff}$ gives

$$\alpha_{\rm eff} \;=\; \alpha(\omega)\;\left[I \;-\; \frac{\omega^2}{\varepsilon_0 c^2}\,\alpha(\omega)\,G_{\rm s}(\mathbf{r}_0,\mathbf{r}_0)\right]^{-1} \tag{14.73}$$

The eigenmodes of the emitter in the inhomogeneous environment are defined by the singularities of $\alpha_{\rm eff}$, that is, by the zeroes of the expression in brackets

$$I \;=\; \frac{\omega^2}{\varepsilon_0 c^2}\,\alpha(\omega)\,G_{\rm s}(\mathbf{r}_0,\mathbf{r}_0) \tag{14.74}$$

87. Page 522: Add the reference: [28] K. L. Kelly, E. Coronado, L. L. Zhao, and G. C. Schatz, "The optical properties of metal nanoparticles: The influence of size, shape, and dielectric environment," *J. Phys. Chem. B* **107**, 668–677 (2203).