Corrections for LASERS

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Front pages

The 1971 Nobel Laureate in Chemistry is **Gerhard** Herzberg, not George Herzberg.

UNITS AND NOTATION (p. xv)

LIST OF SYMBOLS (p. xvii

The symbol ϵ, which I have referred to as the *dielectric permeability* throughout the book, seems to be referred to more commonly in electromagnetic theory texts as the *dielectric permittivity*.

Page xix: In the entry for $\Delta\omega_a$, change "(FWHM)nin" to "(FWHM) in".

CHAPTER 1 An Introduction to Lasers

Section 1.3 Stimulated Atomic Transitions

Page 27: I don't seem to have given a numerical value for Boltzmann's constant anywhere in the text; its value is $k = 1.38 \times 10^{-23}$ joule/K in mks units, or 8.63×10^{-5} eV/K in more convenient units.

Page 27, Eq. 1-14: Delete the unmatched parenthesis in the exponent $\hbar\omega/kT)$ of the final term.

Page 30: The volume number in the final reference may be incorrect and should be changed to *Phys. Rev.* **99** rather than *Phys. Rev.* **18** (need to check this)

Section 1.8 A Few Practical Examples

Page 65, 2nd paragraph: "gain per meter" should be "gain per centimeter".

Section 1.11 Additional Problems for Chapter 1

Page 78, Problem 7: In first line of second paragraph, change "Ne-Ne" to "He-Ne".

CHAPTER 2 Stimulated Transitions: The Classical Oscillator Model

Section 2.1 The Classical Electron Oscillator

Page 83, Eq. (4): It should be indicated, either in the text or by modifying this equation, that the real displacement $x(t)$ will actually be given by the real part of the right-hand side (including the possibility of an arbitrary phase shift).

Page 84, Eq. (7): Put absolute value signs around the term $(1/U_a)(dU_a/dt)$.

Page 86: The second line of Eq. (11) should read

$$\mathbf{b}(\mathbf{r}, t) = \mu_0(\mathbf{h}(\mathbf{r}, t) + \mathbf{m}(\mathbf{r}, t))$$

Section 2.2 Collisions and Dephasing Processes

Page 94, Eq. (21): Should be $\cos\omega_a t$, not $\cos\omega_{at}$.

Page 97: The mathematical expression in the line following Eq. 29 should read $\tilde{\mu}_{ss} \equiv -j(e^2/m\omega_a\gamma)E_1$.

Section 2.3 More on Atomic Dynamics and Dephasing

Page 98: In the last paragraph above the subsection heading, change "these system" to "these systems".

Page 101: Heading on top of page is not correct—should still be 2.3, not 2.4.

Section 2.4 Steady-State Response: The Atomic Susceptibility

Page 105, Eq. (49): Final E should be $\tilde{E}$.

Page 105, 4th line from bottom: Should be 10% (not l0%).

Page 106: The $\Delta\omega$ factors in the denominators of the second and third terms of Eq. (53) should be $\Delta\omega_a$.

Page 107: The factor of $\pm\Delta\omega_a$ in the half-line of text immediately preceding Eq. (60) should be replaced by $\pm\Delta\omega_a/2$.

Section 2.5 Conversion to Real Atomic Transitions

Page 112, 2nd line of penultimate paragraph: "slowl" should be "slow".

Page 116: Problem 2 should refer to Problem 1.

CHAPTER 3 Electric Dipole Transitions in Real Atoms

Section 3.2 Line Broadening Mechanisms in Real Atoms

Page 128: Last sentence of first paragraph: change "Einsten" to "Einstein".

Page 129, last line: "$C0_2$" should read "CO_2" (cap O, not zero).

Section 3.3 Polarization Properties of Real Atoms

Page 138, Eq. (22): The right-hand side of this equation should be multiplied by a factor of two (preferably just inside the square brackets).

Section 3.6 Degenerate Energy Levels and Degeneracy Factors

Page 146: The third section of Eq. (34) should read

$$\text{const} \times \begin{bmatrix} \tilde{\mu}_x \\ \tilde{\mu}_y \\ \tilde{\mu}_z \end{bmatrix} \times [\,\tilde{\mu}_x^* \quad \tilde{\mu}_y^* \quad \tilde{\mu}_z^*\,]$$

just as in Eq. (33), and Eq. (37) should have the form

$$\mathbf{T} = \frac{3}{2} \times \begin{bmatrix} 1 \\ -j \\ 0 \end{bmatrix} \times [\,1 \quad j \quad 0\,] = \frac{3}{2} \times \begin{bmatrix} 1 & -j & 0 \\ j & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}. \tag{37}$$

Page 146, Eq. (35): The first term in Eq. (35) should be $\tilde{P}(\omega)$, not $\tilde{p}(\omega)$.

Page 154, Eq. (47): Remove the extra ")" from the numerator on the right-hand side of the equation.

Section 3.7 Inhomogeneous Line Broadening

Page 161, Fig. 3.15: The denominator in the figure legend should be $\Delta\omega_d$, not $\Delta\omega_a$.

Page 161: The words "rms spread" in the first line of text should be replaced by "mean-square spread or variance".

Page 165, second line: Remove ";" from "Equation".

Pages 165–167: I can't spell "Gouy" correctly, and I can't spell "Voigt" correctly. In the subheading and the following two paragraphs on page 165, change "Voight" to "Voigt"; also on the following two pages and on pages 173, 175 and in the Index.

Page 166, 4th line: Should read "to a numerically computed Voigt profile…".

Page 174, Prob. 2: The second paragraph should ask for an explicit expression and a plot versus $(\omega - \omega_{a0})/\Delta\omega_a$, not $(\omega - \omega_a)/\Delta\omega_a$.

Pages 173–175: See correction for page 165 above.

CHAPTER 4 Atomic Rate Equations

Section 4.1 Power Transfer from Signals to Atoms

Page 179: Eq. (11) is not laid out correctly. It should look like

$$\begin{aligned}\int_S (\mathcal{E} \times \mathbf{h}) \cdot d\mathbf{S} =& \frac{d}{dt} \int_V \left(\frac{1}{2}\epsilon_0 |\mathcal{E}|^2 + \frac{1}{2}\mu_0 |\mathbf{h}|^2 \right) dV \\ &+ \int_V (\mathcal{E} \cdot j)\, dV \\ &+ \int_V \left(\mathcal{E} \cdot \frac{d\mathbf{p}}{dt} + \mu_0 \mathbf{h} \cdot \frac{dm}{dt} \right) dV.\end{aligned}$$

Page 180, second line: Change "$\mathcal{E}(t)$ and $\mathbf{p}(t)$ will be 90° out of time-phase, and…" to read "$\mathcal{E}(t)$ and $\mathbf{p}(t)$ will be in phase with each other, and hence…".

Page 180, Eq. (14): The numerator of the second term should be "rate of energy dissipation" rather than "energy dissipated".

Page 181: The hermitian and antihermitian parts of χ are not properly defined. If we want the hermitian part to be defined by $\chi_h^\dagger = \chi_h$ and the antihermitian part by $\chi_{ah}^\dagger = -\chi_{ah}$, then Eq. (17) should be changed to $\chi \equiv \chi_h + \chi_{ah}$ and Eq. (18) should be changed to

$$\chi_h \equiv (1/2)\,(\chi + \chi^\dagger) \qquad \text{and} \qquad \chi_{ah} \equiv (1/2)\,(\chi - \chi^\dagger) \tag{18}$$

The initial factor in Eq. (19) should then be $+(j/2)$ rather than $-(1/2)$.

Section 4.3 Blackbody Radiation and Radiative Relaxatio

Page 184: Add a right parenthesis ")" after the ω_a in the denominator of Eq. (27).

Page 188, Eq. (35): First term on the right-hand side should be $16\pi/\epsilon\lambda^3$ rather than just $16\pi/\lambda^3$.

Section 4.3 Blackbody Radiation and Radiative Relaxation

Page 194, References: The journal article by Tolman cited here appeared in *Phys. Rev.*, not *Rev. Mod. Phys.*; the rest of the citation is correct.

Section 4.4 Nonradiative Relaxation

Page 200, 3rd paragraph, line 1: Delete dot or period between the two words "arguments as".

Page 200, 3rd paragraph, line 2: "produced" should read "produce".

Section 4.5 Two-Level Rate Equations and Saturation

Page 204: Labels on downward and upward arrows should be $W_{21} + w_{21}$ and $W_{12} + w_{12}$ instead of just W_{21} and W_{12}.

Page 206: Need a better figure in place of Figure 4.12.

Page 208, Eq. (71): The denominator in the final term should be $g_1/g_2 + exp[-\hbar\omega_a/kT]$.

Page 210, last line of page (in Prob. 2–10): Delete the extraneous comma at the beginning of this line.

Section 4.6 Multilevel Rate Equations

Page216: In the fourth line of the paragraph following Eq. (82) change $W_{1j,sat}$ to $W_{sat,ij}$.

CHAPTER 5 The Rabi Frequency

Section 5.1 Validity of the Rate Equation Model

Page 222: In the last line before Eq. (3) change “cosinusoidal” to “sinusoidal”.

Page 225: The right-hand side of Eq. (10) should have a + rather than a − sign in front.

Page 227, 4th line after “Saturation Condition” subheading: Change “for eample” to “for example”.

Section 5.2 Strong Signal Behavior: The Rabi Frequency

Page 232, 5th line of text: Change “rasther” to “rather”.

Page 235: Line above Eq. (37) should read, “in this limit may be written as”.

CHAPTER 6 Laser Pumping and Population Inversion

Section 6.1 Steady-State Laser Pumping and Population Inversion

Page 246, Figure 6–3: The decay rates γ_{32}, γ_{21}, and γ_{10} should be written γ_{43}, γ_{32}, and γ_{21} instead.

Page 248, Eq. (12): The quantum efficiency η could be left in front of both of the $W_p\tau_{\text{rad}}$ factors in the third part of this equation; or the third term could be interpreted as the optimum result sssuming both $\eta \to 1$ and $\beta \to 0$.

Page 250, line 5: Change “upper laser level 1” to “upper laser level 2”.

Page 251: Heading on top of page is not correct; should be 6.1, not 6.2. Macro must be incorrect.

Page 251, Problem 2, 2nd paragraph: Delete duplicate “to”.

Page 251, Problem 4: Text should read $W_{15} = W_{51} = W_p$, not $W_{15} = W_{51} + W_p$

Page 251: 6.2 in running head should be 6.1.

Section 6.2 Laser Gain Saturation

Page 258, line 6 of text: Change γ^2 in the exponent to γ_2.

CHAPTER 7 Laser Amplification

Section 7.1 Practical Aspects of Laser Amplifiers

Page 265: With the advent of fiber optic communications systems, the remarks in this section on “Lasers as Weak Signal Amplifiers” are entirely obsolete, as erbium-glass fiber amplifiers now promise to become of great importance in long-haul fiber communications systems. A good starting reference on this subject is the Special Issue on Optical Amplifiers, *J. Lightwave Technol.* **9**, 145–296 (February 1991).

Page 266: The first reference should be changed to David C. Brown, *High Peak Power Nd:Glass Laser Systems* (Springer-Verlag, 1991).

Section 7.2 Wave Propagation in an Atomic Medium

Page 268. first paragraph, line 5: Change "derivations" to "derivatives".

Page 271, last paragraph: The final sentence on this page is incorrect: the atomic phase shift in Fig. 7.3 corresponds to an atomic transition with an absorbing rather than an inverted or amplifying atomic population difference. The caption for Fig. 7.3 might note that this is an *absorbing* atomic transition.

Section 7.3 The Paraxial Wave Equation

Page 279, Problem 3: Change k to β in the first exponential.

Section 7.4 Single-Pass Laser Amplification

Page 279, end of first paragraph of section: Insert "." after "medium".

Page 285: Running head should be 7.4 not 7.5.

Section 7.5 Stimulated-Transition Cross Sections

Page 288: In the sixth line from the bottom the factor (g_i/g_j) should be changed to (g_j/g_i).

Page 291, Prob. 7.5–1: The title for this problem would be better written as "Practical expression for transition cross sections."

Section 7.6 Saturation Intensities in Laser Materials

Page 294, 14th line of text: The factor $\Delta\omega$ appearing in this line should be the atomic linewidth $\Delta\omega_a$.

Section 7.7 Homogeneous Saturation in Laser Amplifiers

Page 301, 7th line of last paragraph: Delete "/cm^2".

Page 304, Problem 4: Delete the TeX remnant "/item" in line 6 of the problem.

CHAPTER 8 More on Laser Amplification

Section 8.1 Transient Response of Laser Amplifier

Page 314, last paragraph, line 3: "Hopf" should read "Hoff".

Section 8.2 Spatial Hole Burning, and Standing-Wave Grating Effects

Page 321, Eq. (17): The exponent in the very last term of the equation should be $+j\beta z$ instead of $+2\beta z$.

CHAPTER 9 Linear Pulse Propagation

Section 9.1 Phase and Group Velocities

Page 334: Change the wording immediately above Eq. (13) to read

> Combining the preceding equations shows that the intensity profiles of the gaussian pulse in time and frequency have a *FWHM-based time-bandwidth product* given by

In the first sentence of the following paragraph change $\Delta f_{\text{rms}}\Delta t_{\text{rms}} \geq 1/2$ to $\Delta f_{\text{rms}}\Delta t_{\text{rms}} \geq 1/4\pi$, and replace the entire following sentence with

> The numerical difference between this result and Eq. (13) occurs because the FWHM width of a gaussian pulse is larger than the rms width by a factor of $\sqrt{8\ln 2} \approx 2.35$ (we will see later that a rule of thumb for a gaussian pulse is that the full width containing 99% of the pulse energy is close to 3 times the rms width of the same pulse).

Page 336: In the first line of text after Eq. (18) change β'' to $\beta'' z$.

Section 9.2 The Parabolic Equation

Page 340: Insert a factor of $e^{-j\beta_0 z}$ before the dt in the second line of Eq. (31).

Page 340: Change the $\omega_0 t'$ in the exponent of the final term of Eq. (32) to $(\omega_0 - \omega)t'$.

Page 340: In Eq. (35) there should be a $-$ sign in front of the middle term (i.e., after the $\equiv$ sign), and no $-$ sign in the final term (i.e., after the $=$ sign).

Page 341: In Eq. (37) insert $(-j)^n$ before the n-th derivative term on the RHS of the equation.

Correction: In Eq. (37) insert $(-1)^n$ before the n-th derivative term on the RHS of the equation.

Page 341: In the first line after Eq. (40) change $v_g(\omega_0)$ to $v_g^{-1}(\omega_0)$.

Page 343: In the third line the reference title should begin with "Nonstationary ..." rather than "Stationary ...".

Section 9.3 Group Velocity Dispersion and Pulse Compression

Page 347, Eq. (55): Insert the closing parenthesis on the $(t_1 - t_0)$ term in the denominator of the middle term.

Page 347, Eq. (57): To be consistent with the rest of this subsection the left-hand side of this equation should be $2\beta'' z$ instead of $2\beta'' L$.

Section 9.4 Phase and Group Velocities in Resonant Atomic Media

Page 352, Eq. (61): Numerator of the third term in the equation should be 1, not L.

Page 353, 2nd paragraph, last line: Add closing ")" before the period.

Section 9.5 Pulse Broadening and Gain Dispersion

Page 356: This is not an error, but Eq. (65) might be more clearly written as

$$\tau_p^2(z) \equiv \frac{2\ln 2}{a(z)} = \tau_{p0}^2 \left[1 + \frac{(4\ln 2)^2(\beta'' z)^2}{\tau_{p0}^4}\right] = \tau_{p0}^2 \left[1 + \left(\frac{z}{z_D}\right)^2\right]$$

Page 356: The denominator in the first term on the right-hand side of Equation (67) should be $8\pi \ln 2$ rather than $8 \ln 2$. Also, the numerical values of z_D in Equation (72) on the following page would be more like ≈ 2 cm, ≈ 200 cm, etc., if one assumes a value of $D = 0.1$ and a free-space wavelength of $\lambda_0 = 600$ nm.

Page 361, Problem 9.5-3: "The carrier frequency ω_a ..." should be changed to "The carrier frequency ω_0 ...".

CHAPTER 10 Nonlinear Optical Pulse Propagation

Section 10.1 Pulse Amplification With Homogeneous Gain Saturation

Page 367: In the second sentence after Eq. (16) change "essentially a 50% chance" to "has a probability equal to $1 - 1/e = 63.2\%$". (Readers may want to try to prove this, using for example Eq. (20) on the following page.)

Page 367, following sentence: Change $\sigma \approx 5 \times 10^{19}$ to $\sigma \approx 5 \times 10^{-19}$.

Section 10.2 Pulse Propagation in Nonlinear Dispersive Systems

Pages 383-384: If $\phi(t)$ is to be regarded as a time phase, used in the form $\exp[j(\omega t + \phi(t))]$, then strictly speaking Eqs. (36), (37) and (38) should have a minus sign in front of the right-hand side. Also, 4π should be changed to 8π in the third term of Eqs. (37) and (38), and 2π should be changed to 4π in Eqs. (39) and (40).

Page 386, above Eq. (42): The word "multipass" is unnecessary.

Section 10.5 Solitons in Optical Fibers

Page 396: Circulating mode-locked pulses which have all the physical characteristics of lowest or higher-order soliton pulses have now been definitely observed particularly in CPM (colliding-pulse mode-locked) dye lasers in which the pulsewidths are extremely short and the group velocity dispersion effects can be significant compared to the mode-locked pulsewidths. An early reference on this is by F. W. Wise, I. A. Walmsley, and C. L. Tang, "Simultaneous formation of solitons and dispersive waves in a femtosecond ring dye laser," *Opt. Lett.* **13**, 129–131 (February 1988).

CHAPTER 11 Laser Mirrors and Regenerative Feedback

Section 11.1 Laser Mirrors and Beam Splitters

Page 401, Eq. (6): $e^{-j\theta}$ in the numerator should be $e^{-2j\theta}$.

Page 405: The term $\tilde{t}_{12}\tilde{r}_{22}^*$ in third line of Eq. (14) should be $\tilde{t}_{21}\tilde{r}_{22}^*$.

Page 406, line 6 of text: Change "One the other hand..." to "On the other hand...".

Section 11.2 Interferometers and Resonant Optical Cavities

Page 411, third paragraph, line 1: "possible to set up" (not "possible set up").

Section 11.3 Resonance Properties of Passive Optical Cavities

Page 414, under Figure 11.9 (and after Eq. (17)): There should not be a paragraph break here.

Page 416: The labels on the horizontal axes in both parts of Figure 11.10 should be $\omega p/2\pi c$ instead of $\omega c/2\pi p$.

Page 418, Eqn. 11.24: numerator of right-hand side should be t_1^2 (or T_1) rather than $t_1 t_2$.

Page 420, line 3 of text: Delete the extra "in" in "Note that in in...".

Page 422, Eq. 11.29: The factor $t_1^2 r_2$ in the numerator of the middle term should be changed to $t_1^2 r_2 (r_3 \cdots)$

Page 422, following Eq. (30): The reflectivity can go to zero if r_1^2 (not r_1) equals the round-trip gain $\tilde{g}_{\text{rt}}$ at resonance.

Page 425, Figure 11.17(b): The phase angle curves for reflection from a resonant cavity plotted in Figure 11.17(b) are not correct. The corrected curves have a generally similar appearance but the individual curves for different values of R_1 and R_2 do not cross each other and the phase behavior is more complex. In general the curves have a discontinuous jump by a factor of 2π at each axial mode resonance in the over-coupled case $R_1 < R_2$; they jump by a factor of π for the matched case $R_1 = R_2$; and they round over somewhat as shown in the figure in the under-coupled case $R_1 > R_2$. A better picture of the phase behavior is obtained by making a parametric plot of the complex reflection coefficient in the complex plane and seeing how the reflection coefficient varies with frequency. (Thanks to Hans Moosmuller of the Desert Research Insitute, Reno NV, for comments.)

Page 427, Problem 11.3–1: The requirement for $\geq 99\%$ peak transmission and a finesse ≥ 30 is unrealistic. A somewhat more realistic target would be $\geq 90\%$ peak transmission at the same finesse.

Page 428, Problem 11.3–7: Should refer to Figure 11.12, not 11.11.

Section 11.5 Optical-Cavity Mode Frequencies

Page 435, Eq. (50): The first term in Eq. (50) should read $\Delta\nu_{\text{ax}}(\text{cm}^{-1})$, and the c_0^2 factors in the numerators of the two final terms should be deleted (changed to 1)..

Page 437, line 5: Should be $\Delta\beta_m$ (not $\Delta\beta_n$).

Section 11.6 Regenerative Laser Amplification

Page 447, Prob. 2: Change $\Delta beta_m$ to $\Delta\beta_m$.

Section 11.7 Approaching Threshold: The Highly Regenerative Limit

Page 451, 3rd paragraph, 4th line: "roundstrip" should read "round-trip".

Pages 452–454: The equivalent noise power dP_n at the input to a laser amplifier is correctly given by the inversion factor $N_2/(N_2 - N_1)$ times $\hbar\omega B$, i.e., a noise power spectral density of $\hbar\omega$ or one photon per second per unit bandwidth, times the bandwidth B in units of cycles/second or Hz. But since $\hbar\omega B \equiv (\hbar\omega/2\pi) \times (2\pi B) = (\hbar\omega/2\pi) \times d\omega$ where $d\omega = 2\pi B$ is the bandwidth in units of radians per second, Eq. (74) should be changed to

$$\frac{dP_n}{d\omega} = \frac{N_2}{N_2 - N_1} \times \frac{\hbar\omega}{2\pi}$$

The second line of Eq. (75) should then also be divided by 2π, and the Schawlow-Townes formula of Eq. (77) should be changed to

$$\Delta\omega_{\text{osc}} \approx (2) \times \frac{N_2}{N_2 - N_1} \times \frac{\hbar\omega\Delta\omega_c^2}{2P_{\text{osc}}}$$

Alternatively, Eq. (77) will become correct as it stands if each of the $\Delta\omega_{\text{osc}}$, $\Delta\omega_{3\text{ db}}$, and $\Delta\omega_c$ factors in the equation is changed to the corresponding Δf_{osc}, $\Delta f_{3\text{ db}}$, or Δf_c factor.

Page 455, References, 5th line: "He-He-" should read "He-Ne-".

Page 455, Problem 11.7–2: Next to last sentence should refer to a "single-pass laser amplifier," not a "round-trip laser amplifier."

CHAPTER 12 Fundamentals of Laser Oscillation

Section 12.1 Oscillation Threshold Conditions

Page 458: Delete the two unmatched right-hand] brackets in Eq. (5).

Page 458, first line after Eq. (7): "In order to achieve" (omit "have").

Page 461, 5th paragraph, 2nd to last line: "both for this reason" (not "or").

Section 12.2 Oscillation Frequency and Frequency Pulling

Page 463, Figure 12.2: Should be "…strongly inhomogeneously broadened…".

Page 465, first paragraph, 2nd line: "independent" should read "independently".

Page 470, first line after Eq. (21): Change ω_p to $\omega_a p$.

Page 472: The double quotation mark before the title of the first reference is backwards.

Page 472, Problem 12.2-1: In first line, change "lasers" to "laser."

Section 12.3 Laser Output Power

Page 479, first paragraph, line 7: Change "tranmission" to "transmission".

Page 479, Figure 12.15: The label "unsaturated" should be "unsaturated gain".

Section 12.4 The Large Output Coupling Case

Page 487, last paragraph: The phrase "any finite reflectivity R_1" might better be phrased as "any reflectivity $R_1 < 1$".

Page 488, last two lines: Delete the words "does not seem useful to discuss here"; and insert "and" before "an internal" in the following sentence.

CHAPTER 13 Oscillation Dynamics and Oscillation Threshold

Section 13.1 Laser Oscillation Buildup

Page 495, 2nd line: Definition of I_{ss} doesn't match (quite) to previous chapter.

Page 495, third line from bottom: Change "relation oscillation behavior" to "relaxation oscillation behavior".

Section 13.2 Derivation of the Cavity Rate Equation

Page 499, caption of Figure 13.4: "cvty" should read "cavity".

Section 13.3 Coupled Cavity and Atomic Rate Equations

Page 507, Eq. (40), 2nd line: γ_{12} should read γ_{21}

Page 507, line 7: "Section (13.32)" should be "Section (13.2)".

Page 507, Eq. (42): Delete one of double plus signs in both parts.

Page 510, Problem 5(a), line 2: "averaged" (not "averged").

Section 13.4 The Laser Threshold Region

Page 510: 2nd line of Section 13.4: Change "feature" to "features".

Page 513, top line: "Equation 13.47" should be "Equation 13.46".

Page 513: In the third term of Eq. (52), the second term of Eq. (53), and the lower line in Eq. (54), the ratio $\gamma_{\text{rad}}/\gamma_2$ should be inverted to become $\gamma_2/\gamma_{\text{rad}}$.

Page 514: Line 9 should read "as they fluoresce…".

Section 13.6 Unidirectional Ring-Laser Oscillators

Page 535: Exchange CCW for CW and vice versa for all three examples in the sentence beginning "If this cavity attempts to oscillator…".

Section 13.7 Bistable Optical Systems

Page 541: The coordinate axes in Figure 13.30 are not adequately labelled. This figure is not directly a plot of Eq. (67). Rather the horizontal axis plots the normalized amplitude $(2^* I_{\text{inc}}/2\delta_{m0} I_{\text{sat}})^{1/2}$ and the vertical axis plots $(2^* I_{\text{trans}}/2\delta_{m0} I_{\text{sat}})^{1/2}$. The successive curves in Figure 13.30 thus correspond to taking a cavity with a fixed unsaturated attenuation coefficient δ_{m0} and varying the input/output coupling factor $\delta_1 \equiv \delta_2$ to produce different values of the ratio $R \equiv \delta/(\delta_1 + \delta_2)$.

CHAPTER 14 Optical Beams and Resonators: An Introduction

14.3 Build-Up and Oscillation of Optical Resonator Modes

Page 574, Figure 14.8: This figure does not show the field amplitude at a fixed point on the mirror, relative to the amplitude at the same point on the preceding round trip, as stated in the text on the preceding page. Rather it shows the ratio of the field amplitude at a point halfway out on the mirror to the amplitude at the center of the mirror, plotted as a function of bounce number for repeated round trips in the Fox and Li calculation. Thus the limiting value which this ratio approaches at large n is not (except accidentally) the eigenvalue magnitude $|\gamma_0|$ as indicated in the plot, but rather depends on the shape of the lowest-order mode. The plot still provides a direct demonstration of transverse mode beating,however, and the eigenvalue for the next higher-order mode relative to the eigenvalue for the lowest-order mode can still be deduced from the rate at which this mode beating dies out.

CHAPTER 15 Ray Optis and Ray Matrices

Section 15.1 Paraxial Optical Rays and Ray Matrice

Page 585, Table 15.1: It should be noted that the ABCD matrix for a thin lens given in part (b) of this table is valid only when this lens is immersed in free space on both sides. In general it is not possible to obtain the ABCD matrix for a thin lens of free-space focal length f placed between two media having indexes n_1 on the left and n_2 on the right, with the media filling all the space right up to the surface of the lens on each side, in terms only of the two indexes and the focal length f; to determine this ABCD matrix one also needs to know the surface radii of curvature R_1 and $R-2$ of the two surfaces of the lens and the index n of the lens itself.

In part (c) of Table 15.1, however, if the medium to the left of the mirror with radius R has index of refraction n (in other words, the curved surface is formed directly on this medium, the C element of the ABCD matrix can be replaced by $-2n/R$ rather than just $-2/R$.

Page 586: There is a typographical error in the word "interface" in the header of part (e) of Table 15.1.

Page 589, Eq. (18): Delete the minus sign in front of the lower-left matrix element.

Page 592: Add new reference:

J. N. McMullin, "The *ABCD* matrix in arbitrarily tapered quadratic-index waveguides," *Appl. Opt.* **25**, 2184–2187 (July 1986).

Page 592, Problem 2: This is a quite difficult problem; students may require some assistance. The right-hand side N/d in the grating equation should be $n\lambda/d$; and the effective radius is

$$R_t \equiv R_1 \cos\theta_1 \cos\theta_2/(\cos\theta_1 + \cos\theta_2).$$

Section 15.2 Ray Propagation Through Cascaded Elements

Page 596, Eq. (32): Change the upper right term in the $ABCD$ matrix to $-C^{-1}$; and in the second following sentence, the apparent length is then $-C^{-1} = f$.

Section 15.3 Rays in Periodic Focusing Systems

Page 604, Eq. (51): Change the $\mathbf{s}$ on the right-hand side to $\mathbf{s}_0$.

CHAPTER 16 Wave Optics and Gaussian Beams

Section 16.1 The Paraxial Wave Equation

Page 629: In the middle term of Eq. (9) the sign before the $jkz(1-\cos\theta)$ term should by + instead of −.

Section 16.2 Huygens' Integral

Page 636: In the last sentence of text, change "Guoy" to "Gouy."

Section 16.3 Gaussian Spherical Waves

Page 637: First line on this page (in text of Problem 16.2-1) should read $I_z = A_0 P_0/(z\lambda)^2$ (add the A_0).

Page 641, Problem 1: Change "concave" to "convex" in part (c).

Section 16.4 Higher-Order Gaussian Modes

Page 642, Eq. (37): (a) The term $(k/2)^2$ at the beginning of this equation should be $(k/\tilde{q})^2$. (b) The large square brackets and the final $A(z)$ factor could just as well be deleted. (c) If this is done the following sentence could be modified to read, "The only way in which this equation can be satisfied for all x and y is to set the expressions before and after the central minus sign independently to zero."

Page 644, Eq. (46): $2q/A$ should be $2\tilde{q}/A$ (in two places). Also, in the second half of Eq. (46), the fractional term immediately following the = sign should be $\frac{2jn\tilde{q}}{k\tilde{p}^2}$ rather than $\frac{2jnk\tilde{p}^2}{\tilde{q}}$.

Pages 645–647: Change "Guoy" to "Gouy."

Page 646, Eq. (63): Change the integrand on the right-hand side from $\tilde{E}(x, y, z)$ to $\tilde{E}(x, y, z)\, e^{+jkz}$. The net result is that the mode coefficients c_{nm} will turn out to be independent of z, at least for paraxial beam propagation in free space.

Page 647, 2nd line from top: Change "to given" to "to give".

Page 647, Eq. (64): The normalization in this equation is incorrect. The factor of $(1+\delta_{0m})$ in the denominator of the square root on the right-hand side should be removed.

[Note: The 2 in the numerator of this square root would need to be changed to 4 and the factor of $(1+\delta_{0m})$ in the denominator retained if the $\exp[im\theta]$ variation were changed to $\cos m\theta$ or $\sin m\theta$ for $m \geq 1$, as is sometimes done; but if the $\exp[im\theta]$ variation is retained, then the $(1+\delta_{0m})$ is not needed.]

Also, all the factors of m on the right-hand side of this equation except for the final $jm\theta$ in the exponential should be changed to $|m|$ and the values of m should be confined to $0 \leq |m| \leq p$

Page 647: For consistency with the notation in the rest of the book, the factors $im\theta$ in the last term of Eq. (64) and also in the fourth line from the bottom of the page should be changed to $jm\theta$.

Page 647, final paragraph: The sentence reading "In either situation these modes have cylindrical symmetry, with modes having circles of constant intensity in the radial direction..." may be confusing. The final portion of the sentence might better read, "...with the modes having circles of constant intensity and an $e^{jm\theta}$ phase variation in the azimuthal direction."

Page 648: third line from bottom: "asI know" should read "as I know".

Section 16.6 Gaussian Beam Propagation in Ducts

Page 652: Equation (72) is in agreement with Table 15.1(h) and should be retained; but to be compatible with this, the parameter n_2 in Eqs. (73) and (74) should be changed to (n_2/n_0).

Page 653: As a consequence of the corrections to Eqs. (73) and (74), the final term in the exponent in Eq. (75) should be changed to $j\lambda z/(2\pi w_1^2)$, where λ is the wavelength *in the duct* (i.e., on axis); and Eq. (76) should be replaced by

$$w_1^2 = \frac{\lambda}{\pi}\sqrt{\frac{n_0}{n_2}} = \frac{\lambda_0}{\pi\sqrt{n_2}}$$

where λ is again the wavelength in the duct and λ_0 is the free-space wavelength.

Page 653 (again!): The preceding correction is incorrect: Eq. (76) should actually be replaced by

$$w_1^2 = \frac{\lambda}{\pi}\sqrt{\frac{n_0}{n_2}} = \frac{\lambda_0}{\pi\sqrt{n_0 n_2}}$$

Page 653: Change "Guoy" to "Gouy" in final sentence.

CHAPTER 17 Physical Properties of Gaussian Beams

Section 17.1 Gaussian Beam Propagation

Page 665: Change the sentence following Eq. (5) to read: "In other words, once we specify the absolute position of the waist, and the wavelength λ in the medium, the field pattern along the entire rest of the beam is characterized entirely by the single parameter w_0 (or z_R) at the beam waist."

Pages 668–669: The legends in Figures 17.6 and 17.7 may be somewhat confusing if compared with Figures 17.1 or 17.3. In Figure 17.6 the legend merely indicates that the two beams have gaussian parameters w_{01} and w_{02} at their respective waists. In Figure 17.7 the legends indicate that if the beam has gaussian spot size w_0 at the waist, the gaussian spot size increases to $\sqrt{2}w_0$ one Rayleigh range out in either direction.

Section 17.4 Axial Phase Shifts: The Guoy *(should be "Gouy")* Effect

Throughout this entire section the name "Guoy" should be spelled correctly as "Gouy."

Also in all of the text in this section concerning the Gouy phase shift, it might be semantically preferable to change "added" phase shift to "additional" phase shift, and change phrases such as "an extra π phase shift" to "an additional $\pm\pi$ phase shift". The equations in the section say mathematically what happens; putting this into words can be more confusing.

Page 685, 2nd line: Change $\psi(zz)$ to $\psi(z)$..

Page 685: In all the references (and elsewhere) change "Guoy" to "Gouy"; and in the first reference change "G. Guoy" to "L. G. Gouy" and the date (1981) to (1891).

Section 17.5 Higher-Order Gaussian Modes

Page 686: The factor $-jkz$ should be removed from the exponentials on the right-hand side of Eqs. (40) and (41). The total field associated with paraxial propagation of a single c_{nm} mode, including the on-axis or plane-wave factor, can then be written as $\tilde{E}(x, y.z) = c_{nm}\tilde{u}_n(x,z)\tilde{u}_m(y,z)\exp[-jkz]$ (and I've not been entirely consistent in using tildes for complex quantities here, since the coefficients are also complex-valued and should thus be written as $\tilde{c}_{nm}$.

Page 687: Change the $\sqrt{n}$ appearing on top of Figure 17.19 to $\sqrt{n+1/2}$.

Page 690: Remove the words "Let us use the peak of the outermost ripple..." in the first line of the final paragraph on this page and replace with:

One measure of the width of a gaussian beam is the standard deviation σ evaluated over the transverse intensity profile of the beam. The standard deviation of an $n = 0$ gaussian beam with spot size w is $\sigma_0 = w/2$ and the standard deviations of high-order Hermite-gaussian modes are given by

$$\sigma_n = \sqrt{2n+1}\sigma_0 = \sqrt{2n+1}\frac{w}{2}.$$

Alternatively we could use the peak of the outermost ripple...

Page 691: Change "form" in the fist line to "same form", and change $\sqrt{n}$ in Eq. (44) to $\sqrt{n+1/2}$.

CHAPTER 18 Beam Perturbation and Diffraction

Section 18.3 Aperture Diffraction: Rectangular Apertures

Page 716, Eq. (29): The square root in front of the integral should have $z - z_0$ rather than z in the denominator.

Page 725, Eq. (43): Change z_r to z_R (also elsewhere in this chapter as needed).

Section 18.4 Aperture Diffraction: Circular Apertures

Page 729, Eq. (54): The final term in this equation should be $(z_R/z)^2$ rather than $(z/z_R)^2$.

Page 729, Eq. (55): Change z_r to z_R (also elsewhere in this chapter as needed).

Page 732, Eq. (57): Insert a comma in $\tilde{u}(r, z)$.

CHAPTER 19 Stable Two-Mirror Resonators

Section 19.1 Stable Gaussian Resonator Mode

Page 747, Eq. (5): There should be a minus sign in front of the right-hand side of the expression for z_1.

Page 750, Problem 2, 3rd line: Change "in in" to "in".

Section 19.2 Important Stable Resonator Types

Page 753, Fig. 19.8: The gaussian spot size at the center of the resonator in this figure should be $\sqrt{L\lambda/2\pi}$ instead of $\sqrt{L\lambda/\pi}$.

Pages 755–756: In agreement with the topmost sketch in Figure 19.10, the mirror radii for the near-concentric stable resonator should satisfy $R_1 \approx R_2 \approx R$ and $L = R_1 + R_2 - \Delta L = 2R - \Delta L$ (so that ΔL will then represent a small inward axial displacement applied to either end mirror). With this notation the text in the second line above Eq. (13) should read "are given by $R_1 \approx R_2 \approx R = L/2 + \Delta L/2$ and $g_1 \approx g_2 = -1 + 2\Delta L/L$". Equation (13) is then correct as it stands, but Eq. (14) should be changed to

$$w_1^2 = w_2^2 \approx \frac{L\lambda}{\pi} \times \sqrt{\frac{L}{4\Delta L}} \qquad \text{for } \Delta L \ll L.$$

The vertical scale in the plot of w_1, w_2 and w_0 versus $\Delta L/L$ in Figure 19.10 may or may not be slightly off; I haven't checked.

Page 759, last paragraph of regular text: Change "take we either into" to "take us into either".

Section 19.3 Gaussian Transverse Mode Frequencies

Page 761: Throughout this entire section the name "Guoy" should be spelled correctly as "Gouy."

CHAPTER 20 Complex Paraxial Wave Optics

Section 20.2 Gaussian Beams and *ABCD* Matrices

Page 785: Just after Eq. (26), change "Guoy" to "Gouy."

Section 20.3 Gaussian Apertures and Complex *ABCD* Matrices

Page 791: The pointers back to Section 15.1 and Eqs. 15.15 and 15.18 near the bottom of this page might better be changed to point back to Section 15.5 and Eqs. 15.75 and 15.77.

Page 791, last line: Change "dust" to "duct".

Section 20.5 Complex Hermite-Gaussian modes

Page 802, Eq. (73): Remove the extra x in the numerator of the argument of the $H_n(\sqrt{2}x/\tilde{v})$ function.

Page 803, Eq. (78): For biorthogonal sets of functions such as the Hermite-gaussian functions considered in this section, where the eigenfunctions $\tilde{u}(x)$ are not power-orthogonal in the usual sense, it has since been realized that the coefficients c_n given by Eq. (78), when used in an eigenfunction expansion like Eq. (74), will not give a minimum-error expansion in the usual least-squares sense, and may not even give a convergent expansion. For a more complete explanation of this point see the publication by A. Kostenbauder, Y. Sun and A. E. Siegman, "Eigenmode expansions using biorthogonal eigenfunctions: complex-valued Hermite gaussians," *J. Opt. Soc. Am. A* **14**, 1780–1790 (August 1997).

Section 20.6 Coordinate Scaling with Huygens' Integrals

Page 806, Eq. (82): The factor in the exponent on the right-hand side should be $(D - 1/M)$ rather than $(D - M)$. Also, the λ's in Eqs. (81) through (93) should be the free-space wavelength λ_0.

Page 808, Eq. (85): The $1/M_2$ and $1/M_1$ terms in the lower left or 2,1 positions in the second and fourth matrices on the right-hand side of this equation should be moved to the lower right or 2,2 positions, and the lower left positions in both cases should contain 0 (zero).

CHAPTER 21 Generalized Paraxial Resonator Theory

Section 21.1 Complex Paraxial Resonator Analysis

Page 816, fifth line: Change "if it necessary" to "if it is necessary".

Page 817, Eq. (5): Change $\tilde{q}_1$ in the denominator of the second term to $\Delta\tilde{q}_1$.

Page 817, Eq. (6): Change the denominator of the square bracket in the middle term from $C\tilde{q}_{a,b} + B$ to $C\tilde{q}_{a,b} + D$; and the square bracketed factors in both the second and third terms should be squared (raised to the second power).

Section 21.3 Real and Geometrically Unstable Resonators

Page 823, Eq. (19): Change Rb to R_b in the final term of this equation.

Section 21.5 Other General Properties of Paraxial Resonators

Page 836: In the line following Equation (30), the result for Laguerre-gaussian modes should be $2p + m + 1$ rather than $p + m + 1$. (?????)

Also, in the line following Equation (31), the expression $\cos\theta = m$ should be replaced by $\cos\theta = (A + D)/2$.

In the middle paragraph and paragraph heading, change "Guoy" to "Gouy."

Page 839: The caption of Figure 21.10 should read "...the forward and reverse eigenvalues are the same, but the forward and reverse eigenfunctions are not." Also, the labels on the forward and reverse waves in the figure are reversed (assuming the "forward" wave is the wave traveling to the right).

CHAPTER 22 Unstable Optical Resonators

Section 22.2 Canonical Analysis for Unstable Resonators

Page 867, Equation (3): In the second line, the magnification for the negative-branch case should be $m - \sqrt{m^2 - 1}$, not $-m - \sqrt{m^2 - 1}$.

Page 875, Table 22.1: The reference plane in each case is just before the output mirror M_1 (not M_2), and the basic Fresnel number $N \equiv a^2/L\lambda$ is defined by $2a \equiv 2a_1$ (not $2a_2$). In parts (b) and (c) the mirror half-widths should be $a_1 = a, a_2 = \infty$, rather than the reverse. All other formulas then remain correct except that in part (b) the equivalent Fresnel number should be given by either of the two equivalent formulas

$$N_{eq} = \frac{M^2 - 1}{4Mg_2} N = \frac{M - 1}{M + 1} g_1 N$$

Section 22.3 Hard-Edged Unstable Resonators

Page 884: Between the fourth and fifth References delete the dangling words, "See also", and merge the two references into one paragraph.

CHAPTER 24 Laser Dynamics: The Laser Cavity Equations

Section 24.1 Derivation of the Laser Cavity Equations

Page 926, Figure 24.2: The labels $n = 0$, $n = 1$ and $n = 2$ on the figure should be reversed in order.

Section 24.2 External Signal Source

Page 933: In next to last line of first paragraph, change "this provides" to "thus provides".

Page 935, Figure 24.9: Remove the subscript a from p_a in the upper part of the figure.

Page 940, Problem 3: In the second paragraph, $\tilde{g}_{Rt}$ should be $\tilde{g}_{rt}$. Also, one must distinguish between the time t and the voltage transmission t of the partial mirror, which might be better written as t_1, so that one would have, for example, $jt_1\tilde{E}_e(t)$ for the incident wave amplitude inside the cavity.

Section 24.3 Coupled Cavity-Atom Equations

Page 941: Multiply the right-hand side of Eq. (43) by κ (just as on the left-hand side).

Page 942: The first term of Eq. (48) should be $\partial \Delta N(\mathbf{r}, t)/\partial t$ rather than $d\Delta N(\mathbf{r}, t)/dt$.

Section 24.4 Alternative Formulations of the Laser Equations

Page 945, Eq. (52): Delete the subscript n on $P_n(t)$.

Page 945, preceding Eq. (53): Delete the phrase, "with the extended signal left off for simplicity."

Page 945, Eq. (53): Last term should read $j\omega\tilde{E}_e(t)$ (subscript on $\tilde{E}$).

Page 946, Eqs. (56): The $-j$ on the right-hand side of the last equation should be changed to $+j$.

Page 948: Change $-\kappa/2$ to $+\kappa/2\omega$ on the right-hand side of the second line in Eq. (63).

Page 949, Problem 24.4-3: Second sentence should read, "Using Lamb's phase-amplitude equations,...". [Word "equations" is missing.]

Section 24.5 Cavity and Atomic Rate Equations

Page 950, Eq. (68): The $-$ sign on the right-hand side should be changed to a $+$ sign.

Page 951, second line of second paragraph: $Ptilde(t)$ should read $\tilde{P}(t)$.

Page 951, Eqs. (69): The factor on the right-hand side of this equation which is written as $2\kappa/\Delta\omega_a$ should be changed to $\kappa/\omega_a\Delta\omega_a$.

Page 953, second paragraph, line 2: "Bloemberge" should read "Bloembergen".

Page 953, Problem 1: The reference to Section 24.5 should be changed to Section 24.4.

CHAPTER 25 Laser Spiking and Mode Competition

Section 25.1 Laser Spiking and Relaxation Oscillations

Page 958, 5 lines from bottom: Remove extra "," .

Page 962, 2nd paragraph: Change "recall" to "note".

Page 963, Eq. (10): Lower half should read $-[(r-1)/r]\gamma_c$ (i.e, insert "-").

Page 965, first line of last paragraph: Change "GasAs" to "GaAs".

Page 969, line 1 of final reference: Remove both commas.

Section 25.2 Laser Amplitude Modulation

Page 975, third paragraph, line 7: Delete the inverted exclamation point and question mark.

Page 976, 16 lines from end: Change "an especially" to "a specially".

Section 25.4 Laser Mode Competition

Page 993: In the text between Eqs. (45) and (46) change 0_3 to O_3.

Page 996, Eq. (49): Denominator of the final terms should be β_1 rather than β_2.

Page 998, Eq. (57): Change $s\beta_2$ to $s + \beta_2$ int he lower right-hand term of the determinant.

CHAPTER 26 Laser Q-Switching

Section 26.1 Laser Q-Switching: General Description

Pages 1004, third line of Section 26.1: Change "artifically" to "artificially".

Section 26.2 Active Q-Switching: Rate-Equation Analysis

Pages 1013, third line: Remove the hyphen from "pulse-output" .

Page 1019, Eq. 24: This equation is formally correct, but the integrand on the right-hand side has a nonintegrable singularity at its lower limit $y = 1$. In order to use this integral for numerical calculations of the pulse shape, it should be integrated forward and backward starting from the pulse peak, i.e. the numerator on the left-hand side should be $t - t_p$ rather than t, where t_p is the time at which the Q-switched pulsed reaches its peak, and the lower limit for the integral on the right-hand side should be $y = 1/r$ instead of $y = 1$.

Page 1022, Prob. 2, third line from end: Change "on" to "of".

Section 26.3 Passive (Saturable Absorber) Q-Switching

Pages 1027–1028: There are several cumulative algebraic errors in Equations (36) through (40) on these pages.

Section 26.4 Repetitive Laser Q-Switching

Page 1031: The exponential on the right-hand side of Eq. (45) should be $e^{-w_{\text{out}}}$ and not $e^{-u_{\text{out}}}$.

Section 26.5 Mode Selection in Q-Switched Lasers

Page 1038, first line: Change "round" to "round trips".

Section 26.6

Page 1040, end of first paragraph: Delete "FLAG" (inserted by fussy editor worried about the split infinitive that precedes it!).

Page 1040, line 3 of 2nd paragraph: Delete extra "for".

CHAPTER 27 Active Laser Mode Coupling

Section 27.1 Optical Signals: Time and Frequency Description

Page 1045, fourth line above Eq. (8): Change "single- mode" to "single-mode".

Page 1046, first line: Change "understood" to "important".

Page 1050, third line from bottom. "Figure 27.8" should read "Figure 27.7".

Page 1054, last line of page: In text of Problem 1 change "pulsewdith" to "pulsewidth".

Section 27.2 Mode-Locked Lasers: An Overview

Page 1056, last paragraph: The figure reference in this paragraph should be to Figure 27.9, not Figure 27.10.

Page 1058, third paragraph, line 7: Should read "As a result, passive mode…" (i.e., insert "s" in "pasive").

Page 1059, Eq. (12): Denominator of the final term should be $N_0 f_m$ rather than $N_0 \Delta f_m$.

Page 1061, 4th line from the bottom: Capitalize "We".

Section 27.3 Time-Domain Analysis: Homogeneous Active Mode Locking

Page 1063: The first line after Eq. (17) should read $\omega_{\text{ax}} = 2\pi c/p$ and not $\omega_{\text{ax}} = 2\pi p/c$.

Page 1065: If the modulation frequency of the AM modulator in Fig. 27.11 is to be ω_m, then the alternative form of the AM transmission function given in the third line under the figure should be written as $\tilde{t}_{am} = \cos(\theta_m \sin(\omega_m t/2))$.

The modulation index Δ_m as defined in Eq. (24) will then be given by $\Delta_m = (\theta_m/2)^2$. Note that this alternative form for the transmission function corresponds closely to the amplitude transmission of a simple acoustooptic modulator; and that such a modulator must in fact be driven with a radio-frequency source at half the desired mode-locking frequency, i.e. at $\omega_m/2$, in order to get a mode-locking frequency of ω_m.

Page 1068: In the fifth line of text, change Δf_m to just f_m, and in the following line change "axial modes" to "axial mode spacings" for added clarity. In the final term of Eq. (36), change $N^{1/2}$ to $N_0^{1/2}$.

Page 1071, Figure 27.15: There is confusion in this figure (and also in Fig. 27.19 on page 1078) between the modulation index δ_m as defined in Section 27.3 and the same symbol as used in earlier Kuizenga and Siegman publications on active mode locking. The 1/2 power exponents in the figure should either be changed to 1/4 power exponents, or δ_m should be replaced by the quantity θ_m as described at the top of p. 1065.

Page 1075: Addendum to text of Problem 27.3-4

> Suggestion: Assume the mode-locked spectrum has the usual gaussian form, multiplied by a simple cosinusoidal amplitude variation with peak-to-peak amplitude variation 2Δ and etalon period (in frequency) of ω_e, and ignore any chirp or phase-distortion effects that might be introduced by the etalon modulation of the spectrum.

Section 27.4 Transient and Detuning Effects

Page 1077: In the second line after Eq. (39), change $\Delta\omega_{a2}$ to $\Delta\omega_a^2$.

Page 1078, Figure 27.19: See notes for p. 1071.

Section 27.5 Frequency-Domain Analysis: The Coupled Mode Equations

Page 1089, Eq. (54): Change $T(t)$ on the left-hand side to $\tilde{t}_{am}(t)$.

Page 1092, References: The reference by DiDomenico should be dated 1964, not 1954.

Section 27.6 Active Mode Locking: The Modulator Polarization Term

Page 1095, fourth line of problem 26.6-1: $\langle \mathcal{E}^2(t) \rangle$ should read $\langle \mathcal{E}^2(z) \rangle$.

Section 27.7 FM Laser Operation: Coupled-Mode Analysis

Page 1097, Eq. (78): Delete an extra ")" in the denominator of the first term.

Page 1103, first line: Delete repeated phrase "useful tool for".

CHAPTER 28 Passive Mode Locking

Section 28.1 Pulse Shortening in Saturable Absorbers

Page 1105, third line of text: Change τ_p to T_1.

Section 28.3 Passive Mode Locking in CW Lasers

Page 1121, Eq. (8): Delete subscript 1 on $q_1(t)$.

CHAPTER 29 Laser Injection Locking

Page 1129:

Since Christiaan Huygens lived from 1629-1695, the date in the first line of text should evidently be 1665, not 1865.

Also, on closer examination the type of injection locking involved in Huygens' clock mechanism may have been closer to a kind of "triggered" synchronism of two oscillators, rather than the kind of small-signal oscillator injection locking discussed in this chapter.

Section 29.1 Injection Locking of Oscillators

Page 1145:

The middle term in Eq. (36) should be

$$\frac{(r-1)(E^2 - E_0^2)}{(r-1)E^2 + E_0^2}$$

(i.e., missing brackets around $(E^2 - E_0^2)$ in the numerator.

CHAPTER 30 Hole Burning and Saturation Spectroscopy

Section 30.1 Inhomogeneous Saturation and "Hole Burning" Effects

Page 1174, 2nd line from bottom: Should read "…photochemical holes can be erased …".

Section 30.2 Elementary Analysis of Inhomogeneous Hole Burning

Page 1179: The $(\omega - \omega_a)$ in the second (but not the third) line of Eq. (8) should be changed to $(\omega_1 - \omega_a)$.

Section 30.6 Inhomogeneous Laser Oscillation: Lamb Dips

Page 1200, Figure 30.23: This figure actually shows the Lamb dip in the output not of a He-Ne laser but of a low-power single-mode CW HF/DF chemical laser operating near 2.8 μm, and comes from Fig. 2 of a publication by J. Munch, M. A. Kolpin, and J. Levine, "Frequency stability and stabilization of a chemical lasers," *IEEE J. Quantum Electron.* **QE–14**, 17–22 (January 1978).

Page 1200, 3rd and 4th lines of the last paragraph: Should read "…resonance detuned from atomic line center by several homogeneous linewidths…".

Page 1207, Eq. (46): Wrong typeface in numerator; try $\frac{1}{2}$.

Page 1211, Problem 30.6-1, 7th line: The period after "800 Mhz" is pushed over to the next line.

Page 1212: Change "The opening section of this chapter has a problem which asks for…" to "Problem 30.2-3 asks you for…".

CHAPTER 31 Magnetic-Dipole Transitions

Section 31.3 The Classical Magnetic Top Model

Page 1231: Change the factor $g\hbar\beta$ in the middle term of Eq. (17) to be $(\hbar/g\beta)$.

Page 1234, last line: $\theta_0 = o^\circ$ should read $\theta_0 = 0^\circ$.

Section 31.4 The Bloch Equations

Page 1241, Eq. (42):

The third term in the equation should be $-\Delta N_0 g\beta B_0/2$.

Section 31.5 Transverse Response: The AC Susceptibility

Page 1243, 2nd line after Eq. (46): "resonance in dddddsame year" should read "resonance in the same year".

Page 1244, Eq. (51): The first term in the second line should be $-\omega_a\tilde{M}_x$ rather than $j\omega_a\tilde{M}_x$, and the signs in front of the right-hand sides of both lines should be reversed.

Pages 1245–1247: Change all factors of $ge/2m$ to $ge/4m$ and $ge\mu_0/2m$ to $ge\mu_0/4m$ in Eqs. (52), (53), (54), (55), (60) and (61).

Page 1246: The denominator in the second line of Eq. (59) needs a closing ")".

Page 1246: The denominator in the second line of Eq. (59) needs a closing ")".

Page 1246: Change $(\omega - \omega_a)\Delta\omega_a$ to $(\omega - \omega_a)/\Delta\omega_a$ (add the slash) in the denominator of Eq. (60).

Page 1247: Near the bottom of this page, the first "bullet" should be eliminated.

Section 31.6 Longitudinal Response: Rate Equation

Page 1250, Eq. (65): The factor $j(ge/2m)$ on the right-hand side should be $-j(ge/4m)$.

Page 1251: The right-hand parenthesis after the $(\omega - \omega_a)$ term in the denominator of Eq. (71) is missing.

Section 31.7 Large-Signal and Coherent-Transient Effects

Pages 1252: Change $ge/2m$ to $ge/4m$ in Eq. (73).

Page 1259, Eq. (84): The right-hand side should have an initial + rather than − sign.

Page 1259, Eq. (85): Change $-\Delta\omega M_1(t)$ in the second line to $+\Delta\omega M_1(t)$.

Page 1264: 4th paragraph should begin "By continuing…" (not "By containing…").