

CORRECTIONS TO "RELATIVITY, GRAVITATION..." by CHENG

- p.vii, Insert new paragraph above the line ‘St. Louis T.P.C.’ to read: “**Additional acknowledgment:** I would like to express my gratitude to Professor Eric Sheldon. He was kind enough to read over the entire book and made numerous suggestions for editorial improvements, which were adopted in the new printings of this book.”
- p. 6, left sidebar 3, l. 3 & l. 5: Accent ‘e’ as ‘é’ in ‘Poincaré’
- p.11, l. 9: Change ‘ditty’ to ‘aphorism’ to read: "... nicely captured in an aphorism ..."
- p.14, Section 2.1, l. 3: Insert sidebar number ‘1’ to read: “(i.e., they are "covariant")¹. Here we shall ...” and add the new sidebar: “¹Under a transformation, an “invariant” quantity does not change; a “covariant” quantity ‘changes in the same way’. Thus, if all terms in an equation are covariant, their relation, hence the equation, is unchanged. The equation is said to be "covariant under the transformation." [Renumber all subsequent sidebars in this chapter accordingly.]
- p.17, 6 lines above Eq. (2.13): Accent ‘e’ as ‘é’ in ‘Poincaré’
- p.18, sidebar, last line: Change $\sqrt{\epsilon_0}$ to $\sqrt{1/\epsilon_0}$ to read: “ $\sqrt{1/\epsilon_0}(\rho, \mathbf{j}) \longrightarrow (\rho, \mathbf{j})$ ”
- p.19, line 1 above Eq (2.24): Change ‘ $u = u_x$ and $u' = u'_x$ ’ to ‘ $u_x = u$ and $u_y = u_z = 0$ ’ to read: "... parallel to the velocity under study: $u_x = u$ and $u_y = u_z = 0$, we have"
- p.19, line 1 below Eq (2.24): Insert ‘($u'_y = u'_z = 0$)’ after the word ‘unchanged’ to read: "... while the y and z components remain unchanged ($u'_y = u'_z = 0$). Namely, ..."
- p.19, Section 2.2, l. 3: Accent ‘e’ as ‘é’ in ‘Poincaré’
- p.20, Section 2.2.1, title: Change ‘congruity’ to ‘equilocality’ to read: "Relativity of spatial equilocality"
- p.20, Section 2.2.1, line 4-5: Change ‘spatially congruent’ to ‘equilocal’ to read: "...are termed to be "equilocal.""
- p.20, Section 2.2.1, l. 6: Change ‘spatial congruity’ to ‘equilocality’ to read; "... $\Delta t = t_2 - t_1 \neq 0$, equilocality for these two events..."
- p.20, 3 lines below Eq. (2.25): Change ‘congruous’ to ‘equilocal’ to read : "...two events are spatially equilocal but not simultaneous."
- p.20, 3rd and 4th lines below Eq. (2.25): Change ‘spatial congruity’ to ‘equilocality’ to read : "Clearly this equilocality is a relative ..."

- p. 26, Eqs (2.39) to (2.44): The upper and lower indices on $[\mathbf{R}]$ should not be along the same vertical line. Instead of $[\mathbf{R}]_j^i$, it should be $[\mathbf{R}]_j^i$. (namely, the index i comes ahead of the index j). Thus correct this for the $[\mathbf{R}]_j^i$ factor on line 1 above Eq (2.39), which should also read:

$$V'^i = [\mathbf{R}]_j^i V^j, \quad V^i = [\bar{\mathbf{R}}]_j^i V'^j,$$

and Eq (2.41) should read:

$$g_{ij} [\bar{\mathbf{R}}]_k^i [\bar{\mathbf{R}}]_l^j V'^k U'^l = g'_{kl} V'^k U'^l.$$

and Eq (2.42) should read

$$g_{ij} [\bar{\mathbf{R}}]_k^i [\bar{\mathbf{R}}]_l^j = g'_{kl}$$

and Eq (2.43) should read:

$$g_{ij} [\bar{\mathbf{R}}]_l^j = ([\mathbf{g}] [\bar{\mathbf{R}}])_{il},$$

and finally Eq (2.44) should read:

$$g_{ij} [\bar{\mathbf{R}}]_k^i = [\bar{\mathbf{R}}]_k^i g_{ij} = [\bar{\mathbf{R}}^\top]_k^i g_{ij}$$

Note in particular that for the first two $[\bar{\mathbf{R}}]'$ s the index i comes ahead of the index k , while for the last $[\bar{\mathbf{R}}^\top]$ the index i comes after.

- p. 28, between Eqs (2.52) and (2.53): Insert a phrase: "with Eq. (2.51) written out as" to read:

$$\begin{pmatrix} dx' \\ dy' \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} dx \\ dy \end{pmatrix}, \quad (2.52)$$

with Eq. (2.51) written out as

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} a & c \\ b & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}. \quad (2.53)$$

- p.34, l. 3: Change 'moving frame' to 'O-system,' to read: "... simultaneous measurements in the O-system, $\Delta t = 0$."
- p.34, l. 5: Change 'rest frame' to 'O'-system,' to read: "O'-system, $\Delta t' = \gamma(\Delta t - (v/c^2)\Delta x) \neq 0$."
- p.34, l. 10: Insert 'observed from the O-system,' to read: "Length contraction, observed from the O-system, is only in the direction ..."
- p.34, l. 11: Insert a colon after 'contraction' to read: "... same as length contraction: $V = \gamma^{-1}V'$, and ..."

- p.34, line below Eq. (2.71): Insert parentheses to read: "the $(\Delta x - v\Delta t)$ factor is ..."
- p.34, 4th line below Eq. (2.71): Change the sentence after 'says that' to read: "says that the O-system length Δx is shorter than the O'-system length $\Delta x'$ by a factor of γ ."
- p.34, 2nd & 3rd line below Eq. (2.72): Change sentence after 'in the' to read: "in the O'-system with $\Delta t'$ being the proper time interval; the second term is the amount of nonsynchronization that has developed in the O-system between two clocks, ..."
- p.39, l. 1: Delete the first 'the' to read: "... equivalently stated as Gauss's law for the"
- p.39, l. 3: Ditto, to read: "distribution, as Gauss's law for the gravitational field:"
- p.39, Eq. (3.6): Align horizontally.
- p.39, 1st line below Eq. (3.6): Insert 'the' to read: "To obtain the gravitational equation ..."
- p.39, 1st line below Eq. (3.7): Insert 'of' to read: "... outstanding feature of being totally ..."
- p.39, 5th line below Eq. (3.8): Insert a comma, to read: "... not complete, as the effects of .."
- p.47, following the title **Gravitational time dilation**: Change 'On the surface, ..' to 'At first sight, ...'
- p.47, 3rd line following the title **Gravitational time dilation**: Change '...that which is emitted?' to '... the emitted rate?'
- p.47, 6th line below Eq. (3.33): Insert 's' to read: "... each observer sees the ..."
- p.47, 11th line below Eq. (3.33): Change the first 'and' to 'the' to read: "combine the gravitational and relative motion ..."
- p.52, **The various results called "Newtonian"**, 3rd paragraph, 1st line: Change 'beware' to 'aware' to read: "However, one should be aware of the ..."
- p.52, Section 3.3.4, l. 2: Delete 'the' to read: "... underlying Einstein's formulation of ..."
- p.53, left column, l. -3: Change 'fasten' to 'fastened' to read: "... bowl is fastened to ..."

- p.54, left column, l. -6: Insert ‘displays’ to read: “their time displays are remotely ...”
- p.54, right column, bottom line: Insert ‘do’ to read: “direction, or do they tend ...”
- p.62, Box 4.1, l. 4: Change the second ‘the’ to ‘that’ to read: “... the fact that any surface ..”
- p.63, Section 4.3 Curvature, l. 5: Change ‘equals’ to ‘equates’ to read: “equates to the flat“
- p.63, Section 4.3.1 Gaussian curvature, l. 9: Change ‘exit’ to ‘exist’ to read: “... do not exist in the case of ...”
- p.64, Section 4.3.2 Spaces with constant curvature, bottom line: Insert ‘of’ to read: “of this result to 3D space ...”
- p.65, Eq. (4.39a), RHS bottom term: Should read: “ $\sinh^2(r/R)$ ”
- p.68, 2nd & 3rd line below Eq. (4.55): The period at the end of line 2 should be changed to a comma and the next word should be in lower case as ‘it’ to read: “... arbitrary spherical triangle, it is not difficult to prove ...”
- p.69, left column, Problem (4.4), 2nd line: Change ‘conform’ to ‘confirm’ to read: “Eq. (4.30) to confirm the familiar results ...”
- p.75, l. 6: Delete last word ‘it’ to read: “Or, put more strongly, EP ...”
- p.75, l. 9: Insert ‘a’ to read: “... to represent a gravitational field ...”
- p.75, l. 14: Delete ‘the’ to read: “... attribute this to some attractive force ...”
- p.75, l. 15: Insert comma after ‘say’ to read: “That is to say, this phenomenon ...”
- p.75, l. 16: Delete ‘as’ to read: “... can be thought of either as resulting ...”
- p.75, 5th line below schematic: Insert ‘the’ to read: “The GR field equation is the Einstein ..”
- p. 76, line 3 below Eq (5.7): Change section number (12.2.2) to read (11.2.2)
- p.76, 2nd line below (5.10): Delete ‘s’ to read: “... Christoffel symbol (also known ...”
- p.76, 3rd line below (5.10): Change ‘shall’ to ‘will’ to read: “... this quantity will be studied”

- p.77, 1 line above (5.15): Delete ‘s’ to read: “symbol is of order ...”
- p.77, 1 line below (5.18): Insert a space between superscripts ^{‘02’} to read: “... $d^2x^i/dx^{0\ 2}$...”
- p.78, l. -1: Change ‘this’ to ‘the’ to read: “spacetime has the result (5.20) in ...”
- p.80, l. 7: Insert ‘s’ to read: “relations are always ...”
- p.80, Section **5.3.1**, l. 2: Insert ‘the’ to read: “physics is the same as that ...”
- p.80, Section **5.3.1**, l. 9: Insert ‘and vice versa’ to read: “... free fall toward the moon and vice versa, there is still a detectable ...”
- p.80, 5th line above (5.27): Replace ‘remainder’ by ‘remnant’ to read: “remnant tidal ...”
- p.81, l. -1: Change ‘has’ to ‘have’ to read: “... same time have a separation ...”
- p. 82, line -3 to -1: Insert close-parenthesis ‘)’ after ‘the Riemann curvature tensor’ and open parenthesis ‘(’ before ‘cf. previous discussion...’ to read: "... the spacetime (the Riemann curvature tensor). In this geometric language ... is attributed to the curvature (cf. previous discussion in Section 5.1.2)."
- p.83, Eq. (5.36) and 1st line below (5.36): Align ‘ $\nabla^2\Phi$ ’ horizontally on line.
- p.83, Item 1., l. 6: Delete ‘s’ and change ‘includes 1’ to ‘include one’
- p.83, l. -1: Change ‘being a proportional’ to ‘is a proportionality’ to read: “where κ is a proportionality constant.”
- p.85, Question 1., l. 2: Change ‘Using’ to ‘Use’ to read: “Use the distance measurements ...”
- p.85, Question 9., l. 1: Insert ‘the’ to read: “... description of the GR field equation.”
- p.85, Question 10., l. 1: Insert ‘s’ to read: “... three motivations for ...”
- p.85, Problem (5.1), l. 2: Insert a space after ‘proper’ to read: “and proper time,”
- p.85, Problem (5.3), l. 5: Insert ‘the’ to read: “... violation of the Euclidean”
- p.85, Problem (5.4), l. 3: Delete ‘s’ from ‘symbols’ to read: “... Christoffel symbol and”

- p.85, Problem (5.5), l. 2: Delete ‘the’ and change ‘Huygen’s’ to ‘Huygens’
‘ to read: “... equation, rather than Huygens’ principle, to”
- p.87, 1st line below (6.1): Align ‘ ’ horizontally on line.
- p.91, 5th line below (6.22): Insert ‘a’ to read; “... only gradually was such
a possibility ...”
- p.91, 8th line below (6.22): Insert ‘r’ to read: “... In fact a stellar-mass
black hole ...”
- p.91, 7th line above (6.23): Insert ‘a’ to read: “... like to have a way to
visualize ...”
- p.92, l. 9: Insert ‘is’ to read: “... problem, and is not affected ...”
- p.92, l. 13: Change ‘are’ to ‘is’ to read: “... that there is only dipole,
...”
- p.92, Section 6.2, l. 2: Change ‘glazing’ to ‘grazing’ to read: “... star
light grazing”
- p.92, 3rd line below (6.24): Insert a comma, to read: “... spatial direction
as well, grr ...”
- p.92, 5th line below (6.24): Insert ‘l’ to read: “of the deflection angle.”
- p.93, 6th line below (6.26): Insert ‘that’ to read: “... (6.17) informs us
that $g_{00} = \dots$ ”
- p.93, 9th line below (6.26): Insert ‘large as’ to read: “as large as that
when ...”
- p.93, 1st line below (6.29): Replace ‘glazing pass’ by ‘grazing past’ to read:
“... light ray grazing past the sun.”
- p.93, 4th line below (6.29): Replace ‘in’ with ‘against’ to read: “eclipse
against the background ...”
- p.93, 5th line below (6.29): Insert ‘angular’ to read: “The angular position
of a star ...”
- p.93, 5th line below (6.29): Replace ‘glazing pass’ by ‘grazing past’ to
read: “... light grazing past the (eclipsed)”
- p.94, l. 1: Replace ‘lens’ by ‘lenses’ to read: “... at a point, gravitational
lenses “focus” ”
- p.94, l. 7: Change ‘deflecting’ by ‘deflection’ to read: “Solar deflection
has been shown ...”

- p.94, sidebar ², l. 2: Insert ‘mean’ to read: “is the mean distance from earth ...”
- p.94, 8th line above (6.30): Insert ‘that’ to read: “To the extent that we can approximate ...”
- p.95, 1st line above (6.33): Instead of ‘Eq.’ write out ‘equation’ to read: “equation (6.31) ...”
- p.96, **Box 6.2**, l. 4: Insert ‘of’ to read: “... because of the overlap of images,”
- p.96, l. 8: Change ‘are’ to ‘is’ to read: “Thus their flux is”
- p.96, l. 10: Change ‘being’ to ‘is’ to read: “magnification is the ratio of ...”
- p.96, 3rd line above (6.36): Insert a comma, to read: “... width is unchanged, $d\phi = \dots$ ”
- p.97, Section **6.3**, l. 2: Delete ‘of’ to read: “... from its Newtonian”
- p.97, Section **6.3**, l. 14: Insert a hyphen to read: “... arc-second/century”
- p.98, 2nd line below (6.40): Insert ‘a’ and ‘do’ to read: “... only for a massive particle do we”
- p.98, 1st line below (6.42): Insert ‘a’ to read: “... orbit, as a small correction ...”
- p.98, 1st line below (6.45): Insert ‘by’ to read: “After multiplying by $\frac{1}{2}m(1-\dots$ ”
- p.99, 1st line above (6.55): Replace ‘being’ with ‘as’ to read: “of the advance as”
- p.99, Eq. (6.55): Delete the period at the end and continue the sentence to read: "

$$\delta\phi = 5 \times 10^{-7} \text{ radian/revolution} \quad (6.55)$$
 or, $5 \times 10^{-7} \times 180/\pi \times 60 \times 60 = 0.103$ arc-seconds per revolution. In terms”
- p.99, l. -3: Insert ‘planet’ to read: “... advance of the planet Mercury ...”
- p.99, l. -2: Add ‘s’ to ‘principle’ to read: “first principles, and the correct ...”
- p.100, l. 3: Insert ‘the’ to read: “... has been out of the question. ...”
- p.100, **Box 6.4**, l. 1: Write out ‘Eq.’ as ‘equation’ to read: “... energy equation (6.41) as a ..”

- p.100, **Box 6.4**, l. 5: Write out ‘Eqs’ to read: "... momentum equations (6.44) and (6.48):"
- p.100, 1st line above Eq. (6.60): Change ‘divide’ to ‘dividing’ to read: "and dividing the ..."
- p.101, 1st line above (6.67): Change ‘Plug’ to ‘Plugging’ to read: "Plugging this into ..."
- p.102, 6th line below (6.70): Delete ‘in’ to read: "... surprising as the Newtonian ..."
- p.102, 17th line below (6.70): Insert ‘of’ to read: "... helpful to think of the scenario ..."
- p.103, 4th line above (6.71): Insert a hyphen in ‘central force’ to read: "... generalized central-force energy equation (6.41)."
- p.104, l. -2: Insert a ‘t’ to read: "... it is tempting to attribute ..."
- p.104, l. -2: Insert ‘a’ to read: "... the behaviour of a light ray in a gravitational field ..."
- p.104, sidebar 8, line 2: Insert ‘a’ to read: "... we are now considering a lightlike"
- p.105, **Fig. 6.9**: The middle drawn curved arrow indicating ‘Outgoing light’ should extend further leftward, to terminate on the next curve, which is running right-leaning upward from the right of r^* .
- p.106, l. 16: Insert a comma, to read: "... Schwarzschild coordinates, while appropriate ..."
- p.106, l. 17: Insert a comma, to read: "source, are not convenient ..."
- p.106, l. 18: Replace ‘using the’ by ‘the use of’ to read: "... in Fig. 6.9 the use of Schwarzschild coordinates ..."
- p.106, l. 19: Delete ‘of’ to read: "... is suspect as the effect ..."
- p.106, l. 21: Replace ‘has been discovered’ by ‘is employed’ to read: "... another coordinate system is employed. In the Eddington-Finkelstein ..."
- p.106, l. 24: Insert a comma, to read: "... coordinate singularity, as it is absent ..."
- p.107, top line: Delete ‘on’ to read: "Differentiating both sides,"
- p.107, 1st line below (6.87): Delete ‘it’ to read: "and substituting into the Schwarzschild ..."

- p.107, 3rd line above (6.89): Replace ‘did one find’ by ‘one found’ to read: “How one found such a set ...”
- p.108, 2nd line below (6.94): Change ‘a’ to ‘as’ to read: “... situations such as planet ...”
- p.108, 1st line below (6.98): Remove hyphen and close up to read: “so that the innermost stable orbit ...”
- p.109, 2nd bulleted para., l. 8: Replace ‘a neutron which’ by ‘the neutron, which’ to read: “... discovered the neutron, which is also a fermion...”
- p.109, l. -12: Delete ‘into’ to read: “How to take account of the realistic ...”
- p.110, **Observational evidence of black holes**, l. 2: Delete ‘into’ to read: “But by taking account of ...”
- p.110, Item 1., l. 6: Change ‘flair’ to ‘flares’ to read: “... the case of solar flares), the infall ...”
- p.110, Item 1., l. 8: Delete ‘the’ to read: “A notable example is Cygnus X-1, which ...”
- p.110, Item 2., l. 7: Change ‘pass’ to ‘past’ to read: “... past each other...”
- p.110, Item 2., l. 11: Change ‘amount’ to ‘amounts’ to read: “amounts of X-rays and ...”
- p.111, top line: Insert ‘to’ to read: “... energy as alluded to above, another ...”
- p.111, l. 6: Insert ‘a’ to read: “... fusion is a much more efficient ...”
- p.111, 1st line below displayed equation: Close up ‘inner most’ to read: “For the innermost stable circular orbit ...”
- p.111, Question 6., l. 2: Change ‘procession’ to ‘precession’ to read: “... calculating the precession of ...”
- p.111, Question 7., l. 1: Replace ‘when’ with ‘by’ to read: “... does one mean by saying ...”
- p.112, Problem (6.2), l. 1: Change “Huygen’s” to “Huygens’ ”
- p.115, Below the Box, l. 2: Replace ‘are they’ by ‘is this content’ to read: “How is this content organized?”
- p.116, l. 1: Insert ‘(cf. Eq. (6.22))’ to read: “... = $O(10^{-6})$ for the sun (cf. Eq. (6.22))”

- p.116, Section 7.1.1, l. 1: Insert ‘the’ to read: “... astronomy is the parsec (pc).”
- p.116, l. -2: Delete ‘a’ to read: “... until less than 100 years ago ...”
- p.118, line above Eq. (7.6): insert sidebar number ‘1’ to read: “Doppler interpretation¹ of (7.4),” and add the new sidebar: “¹ A Doppler redshift comes about because of the increase in the distance between the emitter and the receiver of a light signal. In the familiar situation, this is due to the relative motion of the emitter and the receiver. This language is being used here in our initial discussion of the Hubble’s law. However, as we shall show in Sec 7.3, especially Eq. (7.53), the proper description of this enlargement of the cosmic distance as reflecting the expansion of the space itself, rather than the motion of the emitter in a static space.” [Renumber all subsequent sidebars in this chapter accordingly.]
- p.119, line below Eq. (7.8): Insert ‘O’ to read: “...seen by us (at the origin O) to recede...”
- p.119, l. -16: Insert ‘redshifts’ and change ‘at one time’ to ‘simultaneously’ to read: “measure redshifts for hundreds of galaxies simultaneously. This made ...”
- p.120, 4th line below Eq. (7.11): Change ‘are’ to ‘is’ to read: “...time: there is matter”
- p.121, l. 4: Add ‘s’ to ‘model’ to read: “... based on established models”
- p.121, Section 7.1.4, l. 2-3: Delete ‘luminous as well as’ and change sentence to read: “..., in the universe we have **dark matter** as well as luminous. The mass density ...”
- p.121, 2nd line below Eq. (7.14): Delete ‘s’ to read: “... given by the Hubble constant H.”
- p.121, 3rd line below Eq. (7.14): Insert ‘s’ to read: “..., has the units of mass”
- p.121, line above Eq. (7.15): Change ‘For a particular’ to ‘With an appropriate choice of ’ to read: “density. With an appropriate choice of coefficient, we have the value of ...”
- p.121, line above Eq. (7.19): Insert sidebar number ‘4’ to read: “or equivalently a critical energy density⁴ of” and add new sidebar: “⁴ In the natural unit system of quantum field theory, this energy per unit volume is approximately $(2.5 \times 10^{-3} eV)^4 / (\hbar c)^3$, where \hbar is Planck’s constant (over 2π) with $\hbar c \approx 2 \times 10^{-5} eV \cdot cm$.” [Renumber all subsequent sidebars in this chapter accordingly.]

- p.122, l. 7: Insert “to” to read: ‘... general idea as to how cosmological ...’
- p.123, l. 5: Insert parenthesis “(” to read: ‘et al., (1980 ...’
- p.123, l. 6: Change ‘are’ to ‘is’ to read: “... nonluminous matter is believed ...”
- p.123, l. 7: Change “halos” to “haloes” to read: ‘form spherical haloes with dimensions ...’
- p.123, l. 9: Insert “of” to read: ‘We can think of the halo as a sphere ...’
- p.123, l. 9: Change “decreases” to “decreasing” to read: ‘... mass density decreasing as ...’
- p.123, l. 10: Add an “s” to “Measurement” to read: ‘Measurements of the rotational ...’
- p.123, 2nd Section, l. 2: Change “strong” to “strongly” to read: ‘... for strongly interacting ‘
- p.123, 2nd Section, l. 6: Insert a comma after “molecules” to read: ‘... to form atoms and molecules, leading to large’
- p.123, 2nd Section, l. 8: Change “they are” to “this is” to read: ‘... shine — this is the’
- p.123, 3rd line below Eq. (7.24): Change “thermal nuclear” to “thermonuclear” to read: ‘... trigger the thermonuclear’
- p.123, right margin, note ³, l. 4: Insert “n” to read: ‘... known elementary particle ...’
- p.124, 4th line above Eq.(7.28): Insert “al” to read: ‘... the **virial theorem** of statistical’
- p.124, 13th line above Eq. (7.29): Insert “the combined mass of” to read: ‘Zwicky noted that the combined mass of the visible stars ...’
- p.124, 9th line above Eq. (7.29): Insert ‘W.’ before ‘Kent’ to read: “Vera Rubin and W. Kent”
- p.124, 2nd line above Eq. (7.29): Add “s” to “supercluster” to read: ‘... galaxy superclusters ‘
- p.125, l. 3: Add “al” to “Observation” to read: ‘... protons and neutrons. Observational’
- p.125, line above Eq. (7.31): End the line with a colon to read: ‘must be exotic:’

- p.125, 3rd line below Eq. (7.31): Add an “s” to “cloud” to read: ‘... matter is clouds of ...’
- p.125, line above Eq. (7.34): End the line with a colon to read: ‘... of exotic particles:’
- p.126, l. 17: Change “is” to “was” to read: ‘... Thus CP was invoked in the study ...’
- p.126, l. 26: Set “cosmic inflationary epoch” in boldface sans-serif font, to read: ‘... rapid expansion, the “**cosmic inflationary epoch**.”’
- p.127, 2nd Section, l. 1: Change “Cosmological” to “The cosmological” to read: ‘The cosmological principle ...’
- p.127, 2nd Section, l. 6: Insert “a” to read: ‘..., which has a Robertson-Walker metric ...’
- p.127, l. -1: Insert a comma after “rest” to read: ‘Being at rest, $dx^i = 0$ with ...’
- p.128, 8th line above Eq. (7.42): Delete the second “the” in the “the the” combination to read: ‘a(t) is the size of the grids and is independent ...’
- p.128, 5th line above Eq. (7.42): Insert “The” to read: ‘The Robertson-Walker metric is for ..’
- p.128, l. -1: Change “value” to “the values” to read: ‘... can take on the values $\pm 1, 0$ with..!’
- p.128, **Fig. 7.6** caption, l. 2: Change “ x_i tilde” to “ x_i circumflex” as in text.
- p.129, l. 2: Change ‘calculation’ to ‘evaluation’ to read: “evaluation, were also ...”
- p.129, line below Eq. (7.47): Delete the first ‘the’ to read: “This is just Hubble’s law with the Hubble constant ...”
- p.129, l. -8: Change ‘that’ to ‘which’ to read: “... dynamical universe which satisfies the cosmological”
- p.130, top line: Insert a comma at end, to read: “... along a radial path,”
- p.130, 2nd line below Eq. (7.49): Change ‘in’ to ‘into’ to read: “... can be put into more ...”
- p.130, line above Eq. (7.54): Insert ‘d’ to change ‘receive’ to ‘received’ to read: “Since the “received time” is at ...”
- p.130, line below Eq. (7.54): Change ‘that of’ to ‘as large as at’ to read: “... size half as large as at the present one.”

- p.131, l. 2: Insert a colon at the end of the line, to read: "... redshift in the Robertson-Walker spacetime:"
- p.131, line below Eq. (7.55): Transpose words, and insert commas, to read: "... distance on the redshift is, of course, the Hubble"
- p.131, 2nd line below Eq. (7.55): Insert 'a' to read: "... models having a Hubble constant ..."
- p.131, 3rd line below Eq. (7.55): Insert 'a' and delete 's' from 'relations' to read: "... yield a different distance-redshift relation. Thus the Hubble"
- p.131, 4th line below Eq. (7.55): Change 'discriminate' to 'distinguish' to read: "... can be used to distinguish between different ..."
- p.131, 8th line below Eq. (7.55): Change 'go' to 'proceed' to read: "... expansion to proceed at an ever"
- p.131, 2nd Section, l. 5: Delete 'the' to read: "... properties are called "standard candles.""
- p.131, 2nd Section, l. 9: Insert a comma after 'Clearly' to read: "Clearly, the reliability ..."
- p.131, line above Eq. (7.57): Delete 'to' to read: "... distance equals the proper distance ..."
- p.132, 3rd line below Eq. (7.58): Insert 'by' to read: "increased by $\delta t_0 = \delta t_{em}(1+z), \dots$ "
- p.132, 4th line below Eq. (7.58): Replace period by a colon at end of line, to read: "another power of $(1+z)$:"
- p.132, 4th line above Eq. (7.62): Delete 's' to change 'eyes' to 'eye' to read: "... stars visible to the naked eye — the brighter a star"
- p.132, 3rd line above Eq. (7.62): Insert a comma after 'is' to read: "is, the smaller its magnitude. Since ..."
- p.133, line above Eq. (7.64): Change period to a colon to read: "... away to have a flux f_0 : "
- p.133, line above Eq. (7.65): Insert a colon at end of line, to read: "... luminosity ratio: "
- p.134, Question 8, l. 3: Change 'Hubble's' to 'Hubble' to read: "the epoch-dependent Hubble constant $H(t)$ related to the"
- p.134, Problem (7.5), l. 7: Change 'star lights' to 'starlight' to read: "to starlight. Compare your result ..."

- p.134, Problem (7.7), l. 4: Insert ‘a’ to read: “calculation (and obtain a similar result) for a point ...”
- p.134, Problem (7.9), l. 5: Change ‘be’ to ‘have been’ to read: “... means that all objects must have been closer ...”
- p.134, line 3 in Problem (7.6): Change ‘ $V_n ar_n^{-1}$ ’ to ‘ $V_n \propto r_n^{-1}$ ’
- p.134, Problem (7.9), l. 11: Capitalize ‘ssu’ to ‘SSU’ to read: “**steady-state universe** (SSU), was proposed ...”
- p.135, left column, l. 14: Change ‘ground’ to ‘grounds’ to read: “theoretical grounds — because it is ...”
- p.135, right column, l. 2: Insert ‘the’ to read: “of the number of hydrogen ...”
- p.135, right column, l. -3: Replace ‘To arrive at’ by ‘Deduce’ to read: “(c) Deduce the claimed result of (7.68) ...”
- p.137, l. 2: Insert ‘by’ to read: “... support, notably by the following ...”
- p.137, l. 13: Delete the hyphen in ‘dark-energy’ and insert a comma, to read: ““dark energy,” which exerts ...”
- p.137, 13th line above Eq. (8.1): Delete ‘to’ to read: “... energy-momentum tensor $T_{\mu\nu}$ take on the form ...”
- p.138, line below Eq. (8.3): Insert ‘the’ to read: “... form of the first law ...”
- p.138, line below Eq. (8.6): Delete ‘the’ to read: “... expression of Hubble’s constant ...”
- p.140, l. -3: Delete ‘s’ from ‘corresponds’ and insert ‘s’ onto ‘value’ to read: “... of a center correspond to different values of r_0 and thus ...”
- p.140, sidebar ³, l. 1: Change ‘Homogeniety’ to ‘Homogeneity’ to read: “Homogeneity and isotropy ...”
- p.143, l. -6: Transpose to read: “... that is, assumption (8.27) is not applicable.”
- p.143, l. -1: Insert ‘in’ to read: “term in the Friedmann Eq. (8.1) is negligible ...”
- p.145, 2nd Section, l. 9: Transpose ‘big hot’ to read: “left behind by the hot big bang.”
- p.145, 2nd Section, l. 24: Insert ‘of’ to read: “us a flavour of how in principle ...”
- p.145, l. -2: Change to read: “where h is the Planck constant, and g the ...”
- p.146, line below Eq. (8.38): Add ‘s’ to ‘specie’ to read: “... of the i th species of boson ...”

- p.146, 2nd line below Eq. (8.38): Delete ‘s’ from ‘factors’ to read: “The 7/8 factor reflects ..”
- p.146, line below Eq. (8.40): Change ‘says’ by ‘expresses’ and ‘term’ by ‘terms’ to read: “This expresses, in precise scaling terms, our expectation...”
- p.146, l. -1: Insert a comma after ‘distance’ to read: “... proportional to distance, hence ...”
- p.147, line above Eq. (8.43): Insert ‘the’ after ‘by’ and a comma after ‘(8.36)’ to read: “by the Stefan-Boltzmann law of (8.36), leading to”
- p.148, line below Eq. (8.45): Delete ‘the’ to read: “where Hubble’s constant H measures ...”
- p.148, l. -10: Insert ‘a’ to read: “... cooled below a certain”
- p.148, l. -2: Insert ‘the’ to read: “Because the neutrino interaction”
- p.148, sidebar ⁷, l. 2: Insert ‘anti-’ to read: “electrons and anti-neutrinos) with ...”
- p.149, 2nd line below Eq. (8.48): Instead of ‘half’ write ‘just over $\frac{1}{2}$ ’ to read: “... positron being just over $\frac{1}{2}MeV$, when ...”
- p.149, 20th line below Eq. (8.48): Change ‘by’ to ‘via’ to read: “... can be deduced via cosmological”
- p.149, l. -3: Delete ‘in’ and delete ‘s’ from ‘hydrogens’ and add ‘of’ after ‘little’ to read: “When we look around our universe, we see mostly hydrogen, and very little of heavy elements. The abundance ...”
- p.150, l. 3: The ‘H’ should be in roman [not italic] font, to read: “. . . , and H-II regions of ...”
- p.150, 2nd line below Eq. (8.49): Delete ‘of’ and replace with a colon, to read: “the light elements: deuterium (D), ...”
- p.150, 3rd line below Eq. (8.49): Delete ‘ones’ to read: “... were the first to suggest, in ...”
- p.150, 5th line below Eq. (8.49): Delete ‘as’ to read: “... follow the path described below.”
- p.150, 2nd line above Eq. (8.50): Hyphenate ‘light nuclei’ to read: “... into light-nuclei ions ”
- p.150, line below Eq. (8.50): Expand the line to read: “where D+ is the deuteron (i.e., the singly-charged deuterium ion, comprising one proton and one neutron), an isotope of hydrogen, and γ denotes, as before, an energy-carrying photon. As the universe ...”

- p.150, 3rd line below Eq. (8.50): Change ‘deuterium’ to ‘deuteron’ to read: “... the deuteron (the reaction proceeding from the right ...”
- p.150, 4th line below Eq. (8.50): Change ‘and the deuterium accumulates.’ to ‘and thus deuterons accumulate.’
- p.150, l. -2: Transpose to read: “heavier elements ($A > 7$) because there is ...”
- p.150, l. -1: Delete ‘a’ to read: “(If beryllium-8 were formed ...”
- p.150, sidebar 10, l. 5: Change ‘deduce’ to ‘identify’ to read: “..., we can identify Z from ...”
- p.150, sidebar 10, l. -2: Insert ‘the’ to read: “distinctive names: the deuteron has ...”
- p.150, sidebar 10, l. -1: Insert ‘the’ and correct the spelling of ‘nucleus’ to read: “... D, and the tritium nucleus”
- p.151, line above Eq. (8.54): Delete ‘the’ to read: “bound into helium-4 nuclei, because ...”
- p.151, line below Eq. (8.54): Insert ‘be’ to read: “... for helium-4 must be equal to ...”
- p.151, l. -5: Delete ‘a’ to read: “efficient, trace amounts of ...”
- p.151, l. -3: Delete ‘a’ and add ‘s’ to read: “...; only small amounts of lithium-6 ...”
- p.151, l. -2: Insert ‘the’ to read: “were synthesized in the big bang.”
- p.152, l. 7: Add an ‘s’ to ‘purpose’ to read: “illustrative purposes only.”
- p.152, 6th and 5th lines above Eq. (8.59): Transpose the sentence to read: “... unknown exotic weakly interacting massive particles (WIMPs) ($\gg GeV/c^2$).”
- p.152, line above Eq. (8.59): Insert parentheses and end the line with a colon [not a period] to read: “(939 MeV) because these particles are nonrelativistic:”
- p.152, l. -6: Insert ‘of’ to read: “... hot big bang beginning of our universe, ...”
- p.152, l. -4: Change ‘nomenon’ to ‘nomena’ to read: “nomena on the cosmic scale.”
- p.152, l. -2: Insert ‘furnished’ and delete the commas, to read: “anisotropy has furnished and will continue to provide us with ...”
- p.153, line below Eq. (8.60): Change ‘stopped’ to ‘ceased’ to read: “ceased to proceed from ”

- p.154, 9th line below Eq. (8.63): Transpose to read: “What should the photon temperature be now ?”
- p.154, 1st Section, l. -4: Change ‘was’ to ‘had’ to read: “... big bang, when the universe had cooled sufficiently to”
- p.154, 1st Section, bottom line: Insert ‘of’ to read: “... temperature of about 3 K.”
- p.154, l. -13: Change ‘tells’ to ‘constitute’ to read: “... interpretation also constitute an ...”
- p.154, l. -10: Change ‘were’ to ‘was’ to read: “... apparatus, Dicke was”
- p.154, l. -6: Delete ‘n’ from ‘an’ to read: “... used in a trial satellite ...”
- p.154, l. -1: Insert ‘of’ to read: “... detection of a cosmic background radiation.”
- p.155, 3rd line above Eq. (8.64): Change ‘2’ to ‘0’ to read: “... (Smoot et al., 1990)”
- p.155, 2nd line above Eq. (8.64): Insert ‘the’ to read: “by the Cosmic Background ...”
- p.155, 5th line below Eq. (8.64): In ‘clumpy’ change the ‘y’ to ‘ing’ to read: “subsequent gravitational clumping, gave rise to ...”
- p.155, line above Eq. (8.65): Change the semicolon to a colon, to read: “... number density via (8.35): ”
- p.155, line below Eq. (8.65): Change ‘is’ to ‘are’ and change ‘the’ to ‘an’ to read: “Namely, there are now in the universe, on an average, 400 photons ...”
- p.155, 3rd line above Eq. (8.66): Change ‘nuclear synthesis’ to ‘nucleosynthesis’ to read: “... from the primordial nucleosynthesis theory, ...”
- p.155, 1st line above Eq. (8.66): Delete the comma, to read: “... abundance of light ...”
- p.155, l. -1: Change ‘is’ to ‘are’ to read: “... there are about 2 billion photons.”
- p.156, l. 2: Change ‘is so much less than’ to ‘fell so much below’ to read: “... thermal energy fell so much below this value?”
- p.156, l. 3: Insert ‘that’ to read: “... for every baryon that the blackbody thermal”
- p.156, l. 4: Insert a comma at the end of the line, to read: “... very high, ”
- p.156, l. 6: Change ‘were’ to ‘was a ‘ to read: “was a sufficient number ...”

- p.156, l. 9: Change ‘were’ to ‘was’ to read: “... not only was the number of free “
- p.156, l. 10: Change ‘because’ to ‘since’ to read: “baryon number, since all the ...”
- p.156, line above Eq. (8.68): Change the period to a colon to read: “... equal:”
- p.156, line below Eq. (8.68): Insert ‘is’ to read: “... equality is z_{RM} ...”
- p.156, 3rd line below Eq. (8.68): Change ‘means that’ to ‘yields’ to read: “yields scale factor and temperature ratios ...”
- p. 156, sidebar ¹³, l. 4: Delete ‘See Problem 8.4.’
- p.157, l. 1: Insert a comma and substitute parentheses for later commas, to read: “From that time on, gravity (less opposed by significant radiation pressure) began to grow ...”
- p.157, l. 4: Insert parentheses to read: “... ceased so long ago ($t_{RM} \ll t_0$) and if the ...”
- p.157, l. 6: Delete the second hyphen and insert ‘during the’ to read: “... of a matter-dominated universe because during the overwhelming part ...”
- p.157, l. 7: Insert ‘the’ to read: “... part of the universe’s history, ...”
- p.157, 4th line below Eq. (8.70): Insert ‘at’ to read: “... hinted at the possibility ...”
- p.157, 5th line below Eq. (8.70): Insert ‘some’ to read: “... there may be some other ...”
- p.157, 6th line above Eq. (8.71): Add a comma after ‘conservation’ to read: “... interpretation of energy conservation, ”
- p.157, 4th line above Eq. (8.71): Add a comma after ‘conserved’ to read: “... entropy is conserved, $dS = 0$. Holding ...”
- p.157, 5th line below Eq. (8.71): Change ‘followed by’ to ‘, there was’ to read: “... 3 MeV, second, there was photon decoupling ...”
- p. 157, 9th line below Eq. (8.71): Delete the first ‘of’ to read: “... into account the effect of positron ...”
- p.157, line above Eq. (8.72): Change the period to a colon, to read: “... discussed above:”
- p.158, line above Eq. (8.75): Insert ‘that’ to read: “condition $T_\gamma = T_\nu$ that prevailed ...”

- p.158, 2nd line below Eq. (8.76): Insert ‘(“flavors”)’ to read: “... include the three species (“flavors”) of neutrinos ...”
- p.158, l. -13: Add ‘s’ to ‘number’ to read: “equal numbers of baryons. ...”
- p.158, l. -10: Add ‘ing’ to ‘carry’ to read: “... (particles carrying negative baryon ...”
- p.158, l. -9: Change ‘is’ to ‘were’ to read: “... In fact, there were”
- p.158, l. -8: Insert ‘an’ to read: “just about an equal number ...”
- p.158, l. -6: Change ‘be an’ to ‘have been a slight’ to read: “must have been a slight excess of particles.”
- p.159, 7th line below Eq. (8.77): Delete ‘s’ in ‘particles’ to read: “... Model of particle physics)”
- p.159, 8th line below Eq. (8.77): Delete ‘s’ in ‘numbers’ to read: “conserve baryon number. Thus one had ...”
- p.159, 11th line below Eq. (8.77): Change ‘y’ to ‘ic’ to read: “... with a symmetric state (or “
- p.159, Section 8.5.4, l. 2: Insert ‘the’ to read: “... temperature — the CMB showed ...”
- p.159, Section 8.5.4, l. 4: Add ‘s’ to ‘ment’ and to ‘observation’ to read: “ments of COBE satellite observations was the detection of ...”
- p.159, Section 8.5.4, l. 7: Insert a comma after ‘which’ and ‘explain’ to read: “... level, which, as we shall explain, holds”
- p.159, line above Eq. (8.78): Insert ‘is’ after ‘half’ to read: “other half is slightly lower ...”
- p.159, l. -5: Insert ‘which is’ to read: “of the COBE satellite which is 371 km/s ...”
- p.159, l. -4: Insert ‘The’ to read: “... Problem 8.14). The Doppler effect changes ...”
- p.159, l. -3: Delete ‘s’ from ‘turns’ to read: “which in turn changes the energy ...”
- p.160, top line: Insert ‘and’ to read: “... 8 km/s), and the seasonal motion of”
- p.160, l. 2: Change ‘being’ to ‘is in fact’ to read: “... measured value is in fact the vector ”
- p.160, l. 3: Add ‘al’ to ‘orbit’ to read: “the orbital motion of the solar system ...”

- p.160, l. 6: Insert a comma after ‘last’ to read: “The last, being the peculiar”
- p.160, l. 8: Delete ‘it’ to read: “. . . part of the universe, reflects the gravitational . . .”
- p.160, l. 12: Insert ‘the’ to read: “frame in which the CMB is isotropic.”
- p.160, l. 16: Insert ‘the’ to read: “. . . such as the microwave background.”
- p.160, l. 19: Insert ‘that the’ to read: “extent that the CMB frame . . .”
- p.160, l. 20: Delete ‘the’ to read: “statement is called Mach’s principle (cf. Box 1.1).”
- p.160, l. 21: Insert ‘of’ after ‘explanation’ to read: “. . . definitive explanation of why the ”
- p.160, 3rd line below para. heading: Insert ‘e’ in ‘homogenous’ to read: “. . . hypothesis of a homogeneous”
- p.160, 7th line below para. heading: Insert ‘the’ after ‘in’ and insert ‘of’ after ‘form’ to read: “. . . must be reflected in the CMB in the form of small . . .”
- p.160, l. -12: Add ‘s’ to ‘region’ to read: “. . . less dense regions did less work”
- p.160, l. -9: Add ‘s’ to ‘variation’ and add ‘of’ after ‘variation’; also capitalize ‘k’ in ‘ μk ’ to read: “Small temperature variations of about $10 \mu K$ coming from . . .”
- p.160, l. -6: Insert ‘the’ to read: “. . . based on the observed structure of”
- p.160, l. -4: Change ‘y’ to ‘ies’ to read: “. . . further inhomogeneities not seen . . .”
- p.160, l. -1: Insert ‘the’ to read: “Here we present the basic formalism . . .”
- p.161, line below Eq. (8.84): Delete ‘ s ’ to read: “. . . is the Legendre polynomial, . . .”
- p.161, line above Eq. (8.85): End the line with a colon, to read: “by (8.83): ”
- p.162, 3rd line below Eq. (8.86): Change ‘and’ to ‘as is’ and insert ‘of the’ after ‘independent’ to read: “is Gaussian as is thus independent of the alms.”
- p.162, line above Eq. (8.89): Insert ‘the’ to read: “. . . square-root of the number of samples”
- p.163, Question 4, lines 3 & 4: Transpose and add parenthetical acronyms, to read: “factor $a(t)$ in a flat radiation-dominated universe (RDU) and in a flat matter-dominated universe (MDU) ?”

- p. 163, left column Question 4, last sentence: Replace the word ‘approximation’ by ‘natural expectation’, and insert the word ‘approximately’ after ‘...universe is’ to read: "Justify the natural expectation that the age of our universe is approximately two-thirds of the Hubble time."
- p.163, Question 5, l. 6: Insert ‘a’ before ‘decelerating’ and ‘an’ before ‘accelerating’ and ‘an’ before ‘empty’ to read: “regions corresponding to a decelerating universe, an accelerating universe, and an empty universe.”
- p.163, Problem (8.2): Insert ‘the’ before ‘second’ to read the title as: “(8.2) Newtonian interpretation of the second Friedmann ...”
- p.163, Problem (8.5): Insert ‘a’ in the title, to read: “(8.5) Hubble plot in a matter-dominated ...”
- p. 163, right column Question 11: Delete the parenthetical remark ‘(in terms of redshift)’.
- p.163, Problem (8.2): Insert ‘the’ before ‘second’ to read the title as: “(8.2) **Newtonian interpretation of the second Friedmann ...**”
- p.163, Problem (8.5): Insert ‘a’ in the title, to read: “(8.5) **Hubble plot in a matter-dominated ...**”
- p.164, Problem (8.8), Part (b), l. 1: Insert ‘the’ to read: “(b) From the Friedmann equation,”
- p.164, Problem (8.8), Part (b), l. 2: Delete ‘s’ to read: “Hubble constant $H(t)$ scales as”
- p.164, Problem (8.11), l. 2: Insert ‘show that’ to read: “... scales, show that we can also ...”
- p.164, Problem (8.11), l. 3: End with a colon [not a period] to read: “... at the present era.”
- p.164, Problem (8.12), lines 1 & 2: Transpose and insert ‘[cf. Eq. (7.40)]’ to read: “... Show that the radius R_0 of the universe [cf. Eq. (7.40)] with $\Omega_0 > 1$, is related...”
- p.164, Problem (8.12), l. 3: Insert ‘the’ and ‘ H_0 ’ to read: “... and the Hubble constant H_0 by”
- p.164, Problem (8.13), l. 2: The ‘b’ in ‘Baryonic’ should be lower case, to read: "parameter of non-baryonic dark matter”
- p. 165, line 1 below the box: Replace 7.3 by 7.1.3
- p.166, l. 8: Replace ‘being’ with ‘to be’ to read: “ of the universe to be equal to the critical ”

- p.166, 11th line above Eq. (9.1): Insert ‘the’ to read: “... brief discussion of the GR field ...”
- p.166, 6th line above Eq. (9.1): Replace ‘, so it would’ with ‘to make it’ to read: “field equation to make it contain a repulsion component.”
- p.166, 3rd line above Eq. (9.1): Change ‘to’ to ‘will’ to read: “As will be discussed ...”
- p.167, line below Eq. (9.3): Insert clause after ‘is negative’ to read: “is negative, corresponding to an equation-of-state parameter $w = -1$ as defined in Eq. (8.4).”
- p.167, 2nd Section, l. -1: Change ‘to’ to ‘the’ to read: “ must necessarily equal the negative ”
- p.168, line below Eq. (9.5): Insert commas twice to read: “... used (9.3), $p_\Lambda = -\rho_\Lambda c^2$, and set $p_M = 0$ because ...”
- p.168, line above Eq. (9.8): Change the period to a comma at the end, to read: “cosmological constant,”
- p.169, Box **9.1**, l. -14: Change and add an ‘s’ to ‘tribution’ to read: “tributions coming from ...”
- p.170, l. 18: Change ‘exit’ to ‘exist’ to read: “... forbidden, it must exist!) In fact,”
- p.170, l. -2: Change ‘instance’ to ‘instant’ to read: “... extremely short instant ...”
- p.170, Sidebar ², l. 2: Change ‘Planck’s’ to ‘Planck’ to read: “... comparable to the Planck time ...”
- p.171, l. 6: Insert ‘times’ to read: “... some 10^{-30} times smaller than that ...”
- p.171, 3rd line above Eq. (9.15): At end of line, insert ‘the’ to read: “Recall that the Friedmann equation can be written ...”
- p.171, 10th line below Eq. (9.15): Insert ‘that’ and change ‘be’ to ‘have been’ to read: “This means that Ω must have been extremely close ...”
- p.172, l. 1: Insert ‘the’ to read: “cosmology back to the big bang nucleosynthesis time ...”
- p.172, 7th line below Eq. (9.17): Change ‘a’ to ‘an’ to read: “requires such an unnatural ...”
- p.172, 2nd Section, l. 10: Insert ‘the’ to read: “our instrument to measure the CMB, ...”

- p.172, l. -4: Change ‘be’ to ‘have been’ to read: “... universe must have been very uniform”
- p.173, Section **9.2.2**, l. 5: Change ‘superluminary’ to ‘superluminal’ to read: “expansion rate could reach superluminal speed. If the expansion ...”
- p.173, Section **9.2.2**, l. 10: Insert a comma before and after ‘then’ to read: “... The question is, then, what kind of physics ...”
- p.173, l. -16: Add an ‘s’ to ‘interaction’ to read: “(i.e., all interactions behave similarly);”
- p.173, l. -7: Insert ‘a’ to read: “... is the existence of a certain spin-zero ...”
- p.174, l. 5: Change ‘It’ to ‘These’ to read: “These should not be confused ...”
- p.175, l. 4: Insert ‘as’ to read: “curvature signature as $k \approx 0$ (cf. (9.22))...”
- p.175, 4th line below Eq. (9.20): Insert ‘the’ and replace ‘more’ by ‘the greater’ to read: “... a constant, the more the space expands, the greater is the vacuum-energy ...”
- p.175, 6th line below Eq. (9.20): Insert ‘of’ to read: “think of this Λ repulsive force ...”
- p.175, l. -5: Replace ‘placed’ by ‘lodged’ to read: “... transition and thus lodged temporarily”
- p.176, 2nd line below para. heading: Replace ‘superluminary’ by ‘superluminal’ to read: “superluminal ($\dot{a}R_0 > c$) expansion as the rate ...”
- p.176, 6th line below para. heading: Replace ‘saying’ by ‘stipulating that’ to read: “there is no restriction stipulating that space itself ...”
- p.176, 7th line below para. heading: Replace ‘superluminary’ by ‘superluminal’ to read: “superluminal expansion rate, this inflationary scenario ...”
- p.176, 8th line below para. heading: Insert ‘a’ to read: “... points that are a large number ...”
- p.176, 9th line below para. heading: Insert ‘the’ to read: “... when the CMB was created) ...”
- p.176, 10th line below para. heading: Insert ‘the’ to read: “onset of the inflationary epoch ...”
- p.176, 12th line below para. heading: Change ‘superluminary’ to ‘superluminal’ to read: “... lengths due to the superluminal expansion.”
- p.177, The origin of matter/energy ..., l. 3: Delete ‘to’ at the beginning of the line, to read: “be present at the very beginning ...”

- p.177, l. -2: Replace ‘would’ by ‘will’ to read: “... scale-invariant, which will be discussed ”
- p.179, 2nd line below Eq. (9.24): Insert ‘the’ to read: “... presented in the conventional plot ”
- p.179, l. -8: Replace ‘of’ by ‘to’ to read: “... hence indifferent to their...”
- p.179, l. -6: Add an ‘s’ to ‘region’, insert ‘a’ before ‘large’ and close up ‘snap shot’ to read: “CMB from such regions underwent a large Doppler shift. In short, it is a snapshot”
- p.180, 5th line above Eq. (9.25): Add an ‘s’ to ‘fluctuation’ to read: “For fluctuations larger”
- p.180, 3rd line above Eq. (9.25): Close up ‘can not’ to read: “... sound waves cannot have ”
- p.180, 2nd line above Eq. (9.25): Insert ‘a’ to read: “... perturbation without a pressure ...”
- p.180, 2nd line below Eq. (9.26): Insert a comma at end of line, to read: “... scale of aL ,”
- p.181, line above Eq. (9.29): Insert a comma at end of line, to read: “... surface of last scattering,”
- p.182, l. -4 & -3: Replace 1900s by 1990s, and change ‘the balloon borne telescope’ to ‘high altitude’, and insert ‘e.g.’ after ‘observations,’ and change ‘TOCO’ to ‘MAT/TOCO’ and insert ‘and balloon borne telescopes:’ after ‘(Miller et al., 1999),’ to read: "In late 1990s a number of high altitude observations, e.g., MAT/TOCO (Miller et al., 1999), and balloon borne telescopes: Boomerang (de Bernardis et al., 2000)..."
- p.182, bottom line: Insert ‘a’ before ‘degree’ to read: “... to be about a degree wide ...”
- p.182, Fig. 9.5: The designation ‘ $d=R\theta$ ’ should be in *italics*, to read: “ $d = R\theta$ ”
- p.184, 2nd line above Eq. (9.35): Add an ‘s’ to ‘two-third’ to read: “... be two-thirds of”
- p.184, line above Eq. (9.35): Insert ‘the’ to read: “the Hubble time ...”
- p.184, **Possible resolution through a nonvanishing Λ** : Change ‘ Λ ’ to ‘dark energy’ and add sidebar number ⁵ in title to read: “**Possible resolution through a nonvanishing dark energy⁵**” and add the new sidebar: “⁵ A dark energy is defined as the “negative equation-of-state energy”, $w < 0$ in Eq. (8.4). It gives rise to a gravitational repulsion (cf. Sec 9.1.1). The simplest example of a dark energy is Einstein’s cosmological constant, with $w = -1$. NB: One should not confuse this with the energies of neutrinos, black holes, etc.,

which are also ‘dark’, but are counted as parts of the “dark matter” (cf. Sec 7.1.4), as the associated pressure is not negative.” [Renummer all subsequent sidebars in this chapter accordingly.]

- p.184, 3rd line above Eq. (9.36): Change ‘we’ to ‘it’ to read: “... size as the one it had ...”
- p.184, line above Eq. (9.36): Add an ‘s’ to ‘two-third’ to read: “about two-thirds of the ...”
- p.184, l. -7: Change ‘its’ to ‘their’ to read: “... pressure of their electrons) ...”
- p.185, sidebar ⁶ (sidebar ⁵ before renumbering on p.184): Change sidebar to read: “⁶ A Hubble curve (as in Fig 9.7) is a plot of the luminosity distance versus the redshift (measuring recession velocity). A straight Hubble curve means a cosmic expansion that is coasting. This can only happen in an empty universe (cf. Sec 7.1.3 and Fig 8.2). If the expansion is accelerating, the expansion rate H must be smaller in the past. From Eq. (7.5): $H \Delta r = z$, we see that, for a given redshift z , the distance Δr to the light-emitting supernova must be larger than that for an empty or decelerating universe.”
- p.185, line below Eq. (9.37): Insert ‘the’ to read: “where, using the Friedmann Eq. (8.1)...”
- p.185, 2nd line below Eq. (9.37): Delete ‘s’ in ‘Hubble’s’ to read: “Hubble constant in ...”
- p. 186, line 2 below Eq (9.40): Insert parenthetical reference ‘(cf. sidebar 5, p 184).’ at the end of the sentence to read: "... resided in this mysterious "dark energy" (cf. sidebar 5, p 184)."
- p.186, 4th line below Eq. (9.40): Insert ‘The’ and delete ‘s’ to read: “The Hubble constant, ”
- p.186, line below Eq. (9.41): Delete ‘s’ to read: “... scale-dependent Hubble constant, ”
- p.186, 2nd line below Eq. (9.41): Insert a colon at end of line to read: “... parameters:”
- p.188, 7th line below Eq. (9.47): Change ‘a’ to ‘the’ to read: “Thus, the conclusive evidence“
- p.188, 17th line below Eq. (9.47): Insert ‘the’ to read: “... recorded by the Hubble Space ...”
- p.189, l. 10 & 11: Insert parenthetical remark ‘(cf. sidebar 5, p. 184)’ after ‘expansion’ to read: “The dark energy driving the accelerating expansion (cf. sidebar 5, p. 184) is suggested to...”

- p.190, l. -7: Insert a comma after ‘ways’ and change ‘is’ to ‘are’ to read: “independent ways, arriving at a consistent set of results. These data are compatible”
- p.190, l. -6: Insert a comma after ‘flat’ to read: “... and spatially flat, having ...”
- p.190, l. -5: Insert a comma after ‘density’ to read: “... critical density, $\Omega_0 = 1$. The largest “
- p.191, Table 9.1, l. 4: Insert ‘,where’ after ‘text’ to read: “... part of the txt, where such ...”
- p.192, l. 9: Change ‘octopole’ to ‘octupole’ to read: “... and octupole term ($l = 3$) can”
- p.192, l. 10: Close up ‘May be’ to read: “...greater than 60° . Maybe ...”
- p.192, l. 12: Delete ‘in the’ to read: “... accommodate them. Our discussion above has ...”
- p.192, l. -6: Change ‘purposes to report’ to ‘purpose in reporting’ to read: “Our purpose in reporting this particular episode ...”
- p.193, l. 4: Insert ‘for a’ after ‘account’ and add an ‘s’ to ‘allow’ to read: “ability to account for a whole array ... ultimately allows us to”
- p.193, Question 1, l. 3: Change ‘must have’ to ‘requires’ and insert ‘to be’ after ‘density’ to read: “requires this density to be equal to the ...”
- p.193, Question 2, l. 1: Delete ‘the’ to read: “... system obey Newton’s”
- p.193, Question 3, l. 1: Write out ‘Equation’ in full, to read: “3. From the Friedmann Equation $[1 - \Omega(t)] \dots$ ”
- p.193, right column, l. 12: Insert Review Question 11: “11. What is a dark energy? How is it different from the dark matter? [Should renumber the subsequent question-numbers accordingly.]
- p.193, Problem (9.2) l. 3: Write out ‘Equation’ in full; and change ‘that’ to ‘the’ to read: “... to show the epoch dependence”
- p.194, Problem (9.5), l. 3: Insert ‘(“inflection”)’ after the word ‘transition’ to read: “... acceleration transition (“inflection”) time as the epoch ”
- p.197, bottom line of 1st Section: Insert ‘the’ to read: “under the local (position-dependent) “
- p.198, l. 5: Delete ‘that’ at end of line to read: “... is that the bases have subscript labels ...”
- p.198, line above Eq. (10.1): End the line with a colon, to read: “like (2.33):”

- p.198, 3rd line below Eq. (10.1): Add an ‘s’ to ‘vector’ to read: “... basis vectors in turn ...”
- p.198, 2nd line below Eq. (10.2): End the line with a colon, to read: “... metric functions:”
- p.198, line below Eq. (10.3): End the line with a comma, to read: “... inverse to each other,”
- p.198, line below Eq. (10.4): Delete ‘s’ to read: “... follow the **Einstein summation**”
- p.200, line below Eq. (10.17): Insert ‘as’ after ‘interpreted’ to read: “... can be interpreted as defining the metric ...”
- p.200, sidebar 1, l. 4: The ‘v’ in German ‘vierbein’ should be capitalized, to read: “a **Vierbein**.”
- p.202, 6th line above Eq. (10.28): Insert ‘a’ to read: “... have a rather complicated ...”
- p.202, 3rd line above Eq. (10.28): Replace ‘having’ by ‘satisfying’ to read: “... that to have a velocity satisfying simple Lorentz ...”
- p.202, line above Eq. (10.28): End the line with a colon [not a period] to read: “time τ , which is a Lorentz scalar:”
- p.202, 7th line below Eq. (10.32): Insert ‘a’ to read: “... parameter of a photon’s worldline; ”
- p.202, 8th line below Eq. (10.32): Insert ‘a’ to read: “a time coordinate is lost.”
- p.203, 4th line below Eq. (10.37): Change ‘equals’ to ‘is equal’ to read: “which is equal to ..”
- p.204, Box 10.1, l. 9: Replace the period by a comma, to read: “a Lorentz scalar,”
- p.204, line below Eq. (10.44): Insert ‘with reduced velocity $\beta = v/c$ ’ to read: “... Lorentz boost in the +x direction with reduced velocity $\beta = v/c$, we have”
- p.204, bottom line: Insert a comma, to read: “... nil invariant length, $k^\mu k_\mu = 0$.”
- p.205, sidebar ², l. 6: Change ‘result’ to ‘results’ and insert a colon after ‘sign’ to read: “results in a minus sign: ...”
- p.205, sidebar ², l. 9: Change ‘gotten’ to ‘obtained’ to read: “can be obtained by permutation”
- p.205, sidebar ², l. 11: Insert ‘the’ to read: “... used to express the cross-product”

- p.205, sidebar ², l. 12: Insert a comma, to read: “of vectors, $(\mathbf{A} \times \mathbf{B})_i = \dots$ ”
- p.207, line above Eq. (10.67): Change ‘term’ to ‘terms’ to read: “... tensor in terms of the ”
- p.207, 2nd line above Eq. (10.69): Insert ‘of’ after ‘because’ and delete ‘ ‘s’ at end of line to read: “... unique because of the relation (10.67), hence the Maxwell”
- p.207, line above Eq. (10.69): Delete the comma to read: “equations are invariant under ... ”
- p.208, line above Eq. (10.75): Insert a comma at end of line, to read: “... 4-velocity field,”
- p.208, line below Eq. (10.75): Set ‘bona fide’ in roman italic font rather than in sans-serif boldface, to read: “... scalar, j^μ is a *bona fide* 4-vector.”]
- p.209, 4th line below Eq. (10.78): Change ‘transformations’ to ‘transformation’ [delete ‘s’] to read: “... under a Lorentz transformation. That is, they ... ”
- p.209, line below Eq. (10.79): Insert ‘(symmetric)’ to read: “called the (symmetric) **energy-**”
- p.210, line above Eq. (10.88): Delete the first ‘the’ to read: “... (10.82)) in the (i, i) ... ”
- p.211, 2nd line above Eq. (10.90): Delete ‘the’ to read: “... , which is Euler’s equation of ... ”
- p.211, line above Eq. (10.91): Replace a period by a comma at the end of the sentence, to read: “volume dV ,”
- p.211, line above Eq. (10.92): Replace a period by a colon at the end of the sentence, to read: “on time as well as on the spatial position:”
- p.211, line below Eq. (10.92): Delete ‘the’ to read: “Namely, Euler’s Eq. (10.90) is just ... ”
- p.211, line above Eq. (10.93): Insert a comma after ‘mechanics’ to read: “mechanics,”
- p.212, line above Eq. (10.94): Insert ‘the’ after ‘that’ and ‘an’ after ‘for’, to read: “It can be shown⁵ that the energy-momentum tensor for an electromagnetic field is”
- p.212, line above Eq. (10.97): Replace a period by a comma, to read: “the charged particles,”
- p.214, Problem (10.10): Replace ‘correction’ by ‘correct’ and insert ‘by’ before (10.42) to read: “... does have the correct interpretation as...as required by (10.42).”

- p.214, Problem (10.13), l. 1: Substitute ‘the’ for ‘this’, to read: “Verify the solution ...”
- p.214, Problem (10.13), l. 2: Change ‘homogenous’ to ‘homogeneous’ and delete ‘s’ to read: “(10.67) of the homogeneous Maxwell equation, by”
- p. 215, 3rd bulleted item: Insert ‘Eq. (5.10)’ after the word ‘functions’ to read: “• The relation between ... and first derivatives of metric functions Eq. (5.10) is re-established.”

- p.216, text between Eqs (11.4) and (11.5): Move sentence ‘This defines... .. system.’ from just below (11.4) to just below (11.5). Immediately follow (11.4) should be the partial sentence ‘that leaves invariant an infinitesimal length.’ The text is to read: "transformation

$$\frac{\partial}{\partial x'^{\mu}} = [\mathbf{L}]_{\mu}^{\nu} \frac{\partial}{\partial x^{\nu}} \quad (11.4)$$

that leaves invariant an infinitesimal length:

$$ds^2 = g_{\mu\nu} dx^{\mu} dx^{\nu} \quad (11.5)$$

This defines the metric functions for a given coordinate system. Let us now recall the (chain-rule) ..."

- p.216, bottom line: Insert ‘a’ before ‘matrix’ to read: “can be written as a matrix of ...”
- p.217, 3rd line above Eq. (11.9): Delete an ‘s’ and the hyphen to read: “misidentifying”
- p.217, 2nd line above Eq. (11.9): Replace ‘that’ by a comma, to read: “... discussed in Chapter 10, the del operator ...”
- p.217, Eq. (11.9): Terminate the equation with a period and continue the text with a capitalized ‘T’ to read:

$$\frac{\partial}{\partial x'^{\mu}} = [\mathbf{L}]_{\mu}^{\nu} \frac{\partial}{\partial x^{\nu}} \quad (11.9)$$

The chain rule of differentiation ...”

- p.218, line above Eq. (11.15): Terminate with a comma, to read: “... does not transform properly,”
- p.218, line above Eq. (11.16): Terminate with a colon, to read: “both sides of (11.8):”
- p.218, 4th line above Eq. (11.19): Change ‘so’ to ‘such’ to read: “... must have tensor equations such”

- p.218, l. -1: Change ‘to’ to ‘will’ and insert ‘the’ before ‘RHS’ to read: “As will be demonstrated below, the first term on the RHS of (11.8) is just ...”
- p.219, line above Eq. (11.24): End with a colon, to read: “... we have been looking for:”
- p.220, l. 3: Insert ‘the’ before ‘covariant’ to read: “... structure of the covariant”
- p.220, l. 4: Replace ‘gotten’ by ‘gleaned’ to read: “derivative can be gleaned by invoking ...”
- p.220, 3rd line above Eq. (11.32): Insert a comma after ‘dependent’ to read: “... tensor is position-dependent, ...”
- p.220, 2nd line above Eq. (11.32): Insert a comma after ‘differentiation’ to read: “... covariant differentiation, $D[\mathbf{g}] = 0$ (we say ...”
- p.220, line above Eq. (11.34): Change ‘Writing’ to ‘Written’ to read: “Written in terms ...”
- p.220, 4th line below Eq. (11.34): Insert a comma after ‘(cf. Section 12.4.3)’ to read: “... as we shall see (cf. Section 12.4.3),”
- p.220, l. -1: Change ‘allows’ to ‘allowed’ to read: “... property allowed Einstein ...”
- p.220, bottom line: Delete ‘(cf. Section 12.4.3)’ to read: “... relativistic field equation.”
- p.221, l. 3: Change ‘of’ to ‘for’ to read: “... expression for Christoffel symbols, ...”
- p.222, RHS of 4th line below displayed equation: Change the ‘hollow square symbol’ to ‘solid square ■’. [“end-of-proof” symbol]
- p.222, 2nd line below Box: Insert ‘the’ before ‘LEF’ and change ‘exists’ to ‘exists’ to read: “the proof that the LEF exists (Box 11.1), we also have ...”
- p.222, 3rd line below Box: Insert ‘an’ before ‘LEF’ to read: “existence of an LEF proves ...”
- p.223, 3rd line above Eq. (11.43): Insert a comma before and after the ‘ $\mathbf{V} = \mathbf{V}$ ’ formula, to read: “change of the vector itself, $\mathbf{V}_{(2)} \neq \mathbf{V}_{(1)}$, and a coordinate ...”
- p.223, 8th line below Eq. (11.44): Change ‘are’ to ‘is’ to read: “... displacement is due to ...”
- p.223, **Fig. 11.1** caption, l. 2: Insert a comma after ‘position-2’ to read: “... to another position-2, $\mathbf{V}^{(2)} = \dots$ ”

- p.224, l. 11: Insert ‘the’ to read: “... as measured by the covariant differential) and ...”
- p.225, 8th line above Eq. (11.52): Change ‘a direction of’ to ‘its direction by’ to read: “... transported vector changes its direction by 90° , which is ...”
- p.225, 3rd line above Eq. (11.52): Delete ‘to’ to read: “... we can relate the angular”
- p.225, 2nd line above Eq. (11.52): Change ‘Substitute’ to ‘Substituting’ to read: “... = dV . Substituting this”
- p.225, line above Eq. (11.52): Insert a comma after ‘(11.51)’ to read: “into (11.51), we obtain”
- p.225, Fig. 11.3 caption, l. 5: Change ‘at’ to ‘to’ to read: “to the starting point ...”
- p.226, l. 3: Change ‘a’ to ‘an’ before ‘ n -dimensional’ to read: “... generalized to an n -dimensional space, ...”
- p.226, 2nd line above Eq. (11.54): Insert ‘a’ to read: “with a different number of ...”
- p.227, line above Eq. (11.62): Replace the period by a colon to read: “the point P: ”
- p.228, 5th line below Eq. (11.67): Insert ‘do’ after ‘only’ and insert a comma after ‘vanish’ to read: “... Namely, not only do the first derivatives vanish, $\partial g = 0$ ”
- p.228, 6th line below Eq. (11.67): Change the second ‘also’ to ‘likewise’ to read: “... , but also the second derivatives of the metric $\partial^2 g = 0$ likewise.”
- p.228, line above Eq. (11.69): Change the first ‘the’ to ‘that’ and replace the period by a colon, to read: “... , and that of the third and fourth indices, respectively: ”
- p.228, line above Eq. (11.71): Change the period to a colon, to read: “... fourth indices:”
- p.229, l.3: End with a comma, to read: “(Problem 11.9),”
- p.229, line above Eq. (11.76): End with a comma, to read: “which is a symmetric tensor,”
- p.229, l. -2: Change ‘homogenous’ to ‘homogeneous’ by inserting an ‘e’ and delete ‘s’ to read: “... resemblance to the homogeneous Maxwell equa-”
- p.230, line above Eq. (11.85): End with a comma, to read: “differentiation),”

- p.230, Question 3, l. 1: Change ‘being’ to ‘as’ to read: “... vector components as”
- p.231, Question 7, l. 1: Insert ‘As the’ and change ‘being’ to ‘is’ to read: “As the Christoffel symbol $\Gamma_{\alpha\beta}^{\mu}$ is not a tensor, how do we”
- p.231, Problem (11.2) (c), l. 1: Insert ‘a’ to read: “... divergence in a polar coordinate”
- p.231, Problem (11.2) (d), l. 1: Insert ‘a’ to read: “... in a polar”
- p.231, Problem (11.4), l. 2: Change wording to read: “... and (11.34), prove $D_{\lambda}g_{\mu\nu} = 0$ in other ways by using:”
- p.232, Problem (11.10) (a), l. 4: Change ‘tensor’ to ‘tensors’ to read: “of these tensors. First ”
- p.232, 3rd line above Eq. (11.88): Insert ‘the’ to read: “... transformation of the metric”
- p.232, 4th line below Eq. (11.88): Change ‘depends’ to ‘depend’ to read: “depend on the ...”
- p.232, Problem (11.15), l. 4: Insert ‘the’ before ‘Riemann’ to read: “... third indices of the Riemann tensor. This”
- p.233, Box, l. 14: Change ‘Relation’ to ‘The relation’ to read: “The relation of the cosmological Friedmann ...”
- p.233, l. -4: Change ‘geometry’ to ‘geometric formalisms’ to read: “... the geometric formalisms used in cosmology as discussed”
- p.234, 7th line above Eq. (12.2): Insert ‘a’ before ‘gravitational’ to read: “... in the presence of a gravitational field. ...”
- p.234, 3rd line above Eq. (12.2): Change ‘equation’ to ‘equations’ to read: “... into physics equations.”
- p.234, line above Eq. (12.2): Insert ‘set of’ and change ‘equation’ to ‘equations’ to read: “..., we have the set of GR equations in curved ...”
- p.235, top line: Insert ‘a’ at end of line to read: “... in the presence of a”
- p.235, l. -1: Insert ‘the’ to read: “... suggest that the GR equation of motion ...”
- p.236, 3rd line below Eq. (12.11): Delete ‘the’ to read: “... to Newton’s constant ...”
- p.236, 7th line below Eq. (12.11): Change ‘are’ to ‘is’ to read: “... is suggested by the fact ..”

- p.236, 9th line below Eq. (12.11): Insert a comma, to read: "... hold energy, with density ..."
- p.236, bottom line above box: Insert 'that the' to read: "The basic properties that the LHS of "
- p.237, line below Eq. (12.15): Insert a comma after 'tensor' to read: "... trace of the energy-momentum tensor, $T = \dots$ "
- p.238, line above Eq. (12.22): Change 'Substitute' to 'Substituting' to read: "Substituting this into (12.20) we have"
- p.238, line below Eq. (12.22): Insert 'the' and change the comma into a semi-colon, to read: "**Static limit.** The Newtonian limit also corresponds to a static situation; we can"
- p.238, sidebar ², bottom line: Insert 'the' to read: "definition of the Ricci tensor ..."
- p.239, line above Eq. (12.29): End the line with a colon to read: "in (9.4):"
- p. 239, Eq (12.29): Replace ϕ by the upper case Φ to read:

$$\nabla^2 \Phi = 4\pi G_N (\rho + 3\frac{p}{c^2}).$$

- p.239, 5th line above Eq. (12.20): Insert 'the' to read: "We now solve the Einstein equation "
- p.241, 3rd line above Eq. (12.39): Delete 'of' and change 'spherical' to 'spherically' to read: "... region outside a spherically symmetric"
- p.241, l. -1: Insert a comma after 'vanish' to read: "... terms vanish, ..."
- p.243, line below Eq. (12.54): Change '(12.54)' to '(6.18)' to read: "and is quoted in (6.18). The parameter ..."
- p.244, l. 8: Change 'unknown' to 'an' to read : "(of an illness)"
- p.244, l. 8: Insert 'the' to read: "... victims of the First World War."
- p.244, Section **12.4**, l. 6: Insert 'a' to read: "equation with a Robertson-Walker metric ..."
- p.245, 2nd line above Eq.(12.60): Delete 'of' and change the comma to a semi-colon, to read: "... function of ξ , be a constant; with some forethought we set ..."
- p.246, Section **12.4.2**, 1st line: Insert 'the' to read: "... relation between the Einstein and"

- p.247, 4th line above Eq.(12.71): Insert ‘a’ to read: “... to see, from a mathematical ...”
- p.247, 2nd line above Eq.(12.71): Change ‘gotten’ to ‘gleaned’ to read: “... more readily gleaned if we move”
- p.248, top line: Insert a comma, to read: “... take $\Lambda > 0$, so that”
- p.248, l. 2: Insert ‘, it implied’ to read: “ $\rho_\Lambda > 0$, it implied a **negative** vacuum pressure.”
- p.248, Problem (12.1), l. 2: Hyphenate ‘no force’ to read: “from the no-force condition ...”
- p.248, Problem (12.1), lines 3 & 4: Change ‘we can’ to ‘show how to’ to read: “... = mU^μ , show how to arrive at the geodesic ...”
- p.248, Problem (12.2) (a), l. 1: Insert ‘a’ to read: “(a) Show that a vanishing ...”
- p.248, Problem (12.4), l. 6: Insert ‘the’ to read: “to derive the Newtonian deviation ...”
- p.250, Box, l. 1: Hyphenate ‘weak field’ to read: “In the weak-field limit ...”
- p.250, l. -14: Insert ‘the’ to read: “... undisturbed from the inner”
- p.250, l. -12: Change ‘moment’ to ‘moments’ and insert ‘the’ to read: “earliest moments of the universe, etc. ...”
- p.251, 8th line above Eq. (13.1): Hyphenate ‘strong field’ to read: “... involves strong-field situations,”
- p.251, 4th line below Eq. (13.1): Hyphenate ‘weak field’ to read: “to use in the weak-field situation. We can ...”
- p.251, line below Eq. (13.2): Hyphenate ‘position independent’ to read: “... is the position-independent Lorentz transformation of ...”
- p.252, line below Eq. (13.10): Insert a colon after ‘NB’ and hyphenate ‘energy momentum’ to read: “NB: On the right-hand side (RHS) the energy-momentum tensor ...”
- p.252, 3rd line above Eq. (13.12): Change ‘the’ to ‘, collectively,’ to read: “is called, collectively, **gauge transformations** because of their close ...”
- p.252, line above Eq. (13.14): Change ‘gotten’ to ‘obtained’ to read: “obtained by differentiating (13.12):”
- p.253, 2nd line above Eq. (13.17): Change ‘term’ to ‘terms’ to read: “... sides in terms of ...”

- p.253, 3rd line above Eq. (13.18): Change ‘gravitation’ to ‘gravitational’ to read: “... formalism for gravitational waves.”
- p.253, lines below Eq. (13.22): Delete ‘the’ and hyphenate ‘energy momentum’ to read: “... because of energy-momentum conservation (13.11).”
- p.254, Section 13.2, l. 1: Insert ‘a’ to read: “... propagation of a gravitational wave ...”
- p.254, Section 13.2, l. 2: Change ‘thought as’ to ‘regarded as a’ to read: “... can always be regarded as a superposition of ...”
- p.254, line above Eq. (13.28): End the line with a colon, to read: “must be “transverse”.”
- p.254, 2nd line above Eq. (13.29): Insert ‘that’ and change ‘constraint’ to ‘constrained’ to read: “... requires that the associated ... be constrained”
- p.255, l. 2: End the line with a comma, to read: “... to be traceless,”
- p.256, 4th line above Eq. (13.37): Insert ‘the’ to read: “Consider the effect of a ...”
- p.256, 3rd line above Eq. (13.37): Insert ‘the’ twice, to read: “... rest: one at the origin and the other located ...”
- p.256, 2nd line above Eq. (13.37): Change ‘the infinitesimally’ to ‘at an infinitesimally small’ to read: “..., hence at an infinitesimally small separation ...”
- p.256, l. -2: Change ‘instead’ to ‘but instead of impinging’ to read: “... wave, but instead of impinging on two ...”
- p.256, l. -1: Insert ‘acting’ to read: “... discussed above, acting on a set of test ...”
- p.256, bottom line: Change ‘result’ to ‘outcome’ to read: “... center. The outcome”
- p.257, l. 1: Change ‘are’ to ‘is’ to read: “... and (13.38) is shown through ...”
- p.257, l. 4: Change ‘are respectively’ to ‘alters the proper separation as’ to read: “... alters the proper separation as $ds =$ ”
- p.257, l. 5: Change ‘Their’ to ‘The’ to read: “... The generalization to a circle ...”
- p.257, l. 12: Insert ‘has’ to read: “the graviton has spin 2 ...”
- p.257, Section 13.3.2, l. 1: Replace ‘as’ by ‘of as a’ and insert a comma in between ‘metric’ and ‘affecting’ to read: “... wave can be thought of as a propagating metric, affecting distance”

- p.257, Section 13.3.2, l. 5: Insert ‘energy-flux’ to read: “... using the two energy-flux results (13.55) and ...”
- p.257, Section 13.3.2, l. 11: Insert ‘the’ to read: “... separation by the second derivative ...”
- p.257, l. -1: Replace ‘are’ by ‘have been’ to read: “... interferometers have been set up ...”
- p.257, bottom line: Change ‘to detect’ to ‘of detecting’ to read: “of detecting gravitation ...”
- p.258, l. 6: Change ‘the’ to ‘that’ to read: “that spacetime is a very stiff ...”
- p.258, l. 17: Change ‘light’ to ‘light-beams’ to read: “return light-beams from the two arms ”
- p.258, l. 18: Insert a comma, to read: “... path length properly, the optical ...”
- p.259, l. 4: Use ‘Scottish’ instead of ‘Scotch’ to read: “... the German/Scottish GEO project”
- p.259, l. 6: Delete ‘s’ on ‘spacecrafts’ to read: “... launching of three spacecraft”
- p.259, l. 8: Delete ‘s’ on ‘spacecrafts’ to read: “spacecraft are located at ...”
- p.259, l. 10: Insert ‘a’ to read: “... to observe a gravitational wave ...”
- p.259, Section 13.4, l. 2: Insert ‘a’ to read: “... detection of a gravitational wave ...”
- p.259, Section 13.4, l. 5: Insert ‘a’ to read: “... generation of a gravitational wave ...”
- p.259, Section 13.4, l. 6: Insert ‘this’ after ‘and’ to read: “... loses energy and this results in a decrease. ...”
- p.260, line above Eq. (13.43): Insert ‘the’ to read: “on the RHS must ...”
- p.260, 4th line below Eq. (13.44): End the line with a comma, to read: “... Einstein Eq. (12.14) at this order,”
- p.260, line above Eq. (13.45): End the line with a colon, to read: “... Ricci tensor and scalar:”
- p.260, l. -10: Change ‘exit’ to ‘exist’ to read: “... does not exist. Namely, ...”
- p.260, l. -7: Insert two ‘the’s to read: “according to the EP, find ... where the gravity field”
- p.260, l. -5: Insert ‘the’ to read: “.. square of the potential’s first”

- p.260, l. -3: Change ‘vanished’ to ‘vanishes’ to read: “metric vanishes in the local inertial ...”
- p.260, l. -1: Change ‘to’ to ‘with’ to read: “tensor with the gravitational field ...”
- p.261, line above Eq. (13.51): End the line with a comma, to read: “... factors,”
- p.262, l. 2: Insert a comma, to read: “the energy flux, being related to ...”
- p.262, 3rd line below Eq. (13.55): Add an ‘s’ to ‘derivative’ to read: “... product of time-derivatives of the vector potentials.”
- p.262, 5th line below Eq. (13.55): Change ‘proportional’ to ‘proportionality’ and delete ‘being’ to read: “proportionality constant built out of ...”
- p.262, 6th line below Eq. (13.55): Change ‘unit’ to ‘units’ to read: “... right units (energy ...”
- p.262, 7th line above Eq. (13.56): Insert ‘a’ to read: “... approximation means a low velocity limit”
- p.263, line above Eq. (13.57): End the line with a colon, to read: “... source volume:”
- p.263, line below Eq. (13.59): Replace ‘two’ by ‘second-order’ to read: “... indicate second-order time-derivatives.”
- p.263, 4th line below Eq. (13.59): Insert ‘the’ to read: “... derivative of the dipole”
- p.263, line above Eq. (13.60): End the line with a comma, to read: “moment,”
- p.263, line below Eq. (13.60): Replace ‘and’ by a comma, to read: “... total force on the system, vanishes for an isolated ...”
- p.263, 3rd line above Eq. (13.61): Insert ‘the’ to read: “... suggests that the mass moment ...”
- p.263, line above Eq. (13.61): End the line with a colon, to read: “... which is traceless:”
- p.263, line above Eq. (13.62): Insert ‘that’ to read: “... and (13.54) implies that we calculate “
- p.264, 3rd line above Eq. (13.64): Insert ‘a’ before ‘wave’ to read: “... flux for a wave ...”
- p.264, line above Eq. (13.64): Replace the period by a colon at the end, to read: “... vector \mathbf{n} :”

- p.264, 3rd line below Eq. (13.66): Insert ‘the’ before ‘second’ to read: “... , which is the second derivative of ...”
- p.264, 6th line below Eq. (13.66): Change ‘ground’ to ‘grounds’ to read: “... on dimensional grounds. The detailed”
- p.265, l. 3: Change ‘wave’ to ‘waves’ to read: “gravitational waves as predicted ...”
- p.265, l. 6: Change ‘it’ to ‘these’ to read: “... and expressing these in terms”
- p.265, l. 11: Change ‘fixed’ to ‘deduced’ to read: “be deduced. In the following ...”
- p.266, l. 4: End the line with a comma, to read: “... according to (13.59),”
- p.266, l. 8: Ditto, to read: “... as defined in (13.61),”
- p.266, 2nd line above Eq. (13.68): Replace the comma by a semicolon, to read: “a factor of $2\omega_b$; together with the averages ...”
- p.266, line above Eq. (13.68): Replace the comma by a colon to read: “rate of energy loss:”
- p.267, line above Eq. (13.72): End the line with a colon, to read: “... using (13.70):”
- p.267, line below Eq. (13.72): Change ‘Plug’ to ‘Plugging’ to read: “Plugging this back ...”
- p.267, line below Eq. (13.73): Insert commas before and after the math relation and hyphenate ‘period decrease’ to read: “Through the relation, $dE/E = \dots$, so that the rate of period-decrease”
- p.267, line above Eq. (13.74): End the line with a colon, to read: “... energy loss rate:”
- p.267, line below Eq. (13.75): Insert ‘the’ to read: “That the orbit for PSR 1913+16 ...”
- p.267, bottom line: Insert a comma after ‘masses’ to read: “... different masses, $M_p \dots$ ”
- p.267, **Fig. 13.6** caption, l. 8: Change ‘observation’ to ‘observations are depicted’ to read: “and observations are depicted by data points...”
- p.268, line above Eq. (13.78): Change equation number (13.68) to (13.67))’ to read: “given in (13.67), we then have”
- p.268, l. -2: Change ‘previous opening of new’ to ‘pioneering efforts of fresh’ to read: “pioneering efforts of fresh ways to observe the universe, ...”

- p.268, Question 1, l. 2: Change ‘gravitation’ to ‘gravitational’ to read: “expect gravitational waves from ...”
- p.268, Question 6, l. 5 (at top of RHS): Transpose to read: “... of the wave? How would the relative displacement”
- p.268, Problem 8, l. 1: Insert ‘the’ before ‘Poynting’ to read: “... know of the Poynting ...”
- p.268, Problem 8, l. 2: Insert ‘an’ to read: “of an EM wave, ...”
- p.268, Problem 8, l. 2: Insert ‘the’ to read: “... in terms of the gravitational ...”
- p.268, Problem 8, l. 3: Change ‘proportional’ to ‘proportionality’ to read: “... should be the proportionality constant ...”
- p.268, Problem 8, l. 5: Change ‘fixed’ to ‘derived’ to read: “derived by detailed calculation)?”
- p.268, Problem 9, l. 2: Change ‘Where’ to ‘Why’ to read: “Why is there no monopole ...”
- p.268, Problem 10, l. 2: Capital ‘W’ in ‘what’ to read: “pulsar? What is being observed?...”
- p.268, Problem 10, l. 3: Change ‘wave’ to ‘waves’ to read: “... existence of gravitational waves as predicted”
- p.269, LHS column, bottom line: Change ‘so’ to ‘such’ to read: “... can be chosen such that ”
- p.271, 3rd line above Eq. (A.1): Delete ‘a’ to read: “... rocket-ship; and $\gamma = \dots$ ”
- p.271, line above Eq. (A.1): Replace the period by a colon, to read: “... SR time dilation:”
- p.271, line below Eq. (A.1): Delete ‘is’ to read: “... aging of the twins, while counter- ...”
- p.271, l. -5: Delete ‘of’ to read: “... journey following two separate ...”
- p.272, l. -11: Change ‘synchronicity’ to ‘synchronicity’ to read: “nonsynchronicity of clocks ”
- p.272, l. -10: Change ‘firework acts’ to ‘fireworks act’ to read: “that the fireworks act as ...”
- p.272, l. -8: Add an apostrophe to ‘15-years’ to read: “Namely, during the 15-years’ outward bound journey, ...”

- p.273, line above Eq. (A.3): End the line with a colon, to read: “clock to run slow:”
- p.273, line below Eq. (A.3): End the line with a colon, to read: “... observes Al’s clock to run slow:”
- p.273, line below Eq. (A.5): Change ‘time’ to ‘times’ to read: “... respective proper times of ”
- p.273, 8th line below Eq. (A.6): Insert a comma after ‘months’ to read: “received every 4 months, thus a total ...”
- p.273, 9th line below Eq. (A.6): Change ‘checks’ to ‘agrees’ to read: “This agrees with the ”
- p.273, l. -10: Change ‘to be’ to ‘as’ to read: “... while B stays as an inertial frame observer ”
- p.273, l. -4: Insert a comma after ‘above’ to read: “In the above, we have considered ...”
- p.273, bottom line: Close up ‘view point’ to read: “from the viewpoint of B, in ...”
- p.274, l. 7: Change to read: “Adding up, Bill ages a total of $OQ = 50$ years.”
- p.274, l. 10: Change ‘relates’ to ‘states:’ to read: “... The Lorentz transformation states:”
- p.274, l. -2: Insert ‘its’ to read: “... But P’ has its time coordinate”
- p.275, 3rd line below Eq. (A.7): Insert ‘the’ to read: “... 41 years in the O’ frame.”
- p.275, 7th line below Eq. (A.7): Change ‘frame’ to ‘frames’ to read: “... accelerating frames of reference. As we find”
- p.275, Subheading title: Insert an ‘s’ to read: “Schwarzschild black ...”
- p.275, l. -7: Insert an ‘s’ to read: “The Schwarzschild black ...”
- p.275, l. -3: Change ‘are’ to ‘is’ to read: “... set of solutions is characterized by ...”
- p.276, l. 2: Insert ‘its destiny’ to read: “... far enough along its destiny will end ...”
- p.276, 11th line above Eq. (A.8): Change ‘progress has’ to ‘advances have’ to read: “... impressive advances have been”
- p.276, 7th line above Eq. (A.8): Delete ‘the’ to read: “... discovery of Planck’s constant in”

- p.276, line below Eq. (A.9): Change ‘way’ to ‘vastly’ to read: “... scales are vastly beyond ”
- p.276, l. -6: Insert ‘a’ to read: “... rest energy of a nucleon ...”
- p.276, l. -4: Insert ‘an’ to read: “... reach such an extreme density ...”
- p.277, top line: Change ‘Black’ to ‘The black’ to read: “The black hole physics of ...”
- p.277, l. 3: Change ‘that’ to ‘with’ to read: “are familiar with the macroscopic ...”
- p.277, l. 12: Change ‘Schwarzschild’ to ‘Schwarzschild’ [i.e., insert an ‘s’] to read: “... background Schwarzschild geometry. Namely, ...”
- p.277, l. 15: Insert ‘(non-quantum)’ after ‘classical’ to read: “... described by the classical (non-quantum) theory of GR.”
- p.277, l. 16: Insert commas twice, to read: “... and time, $\Delta E \Delta t \geq \hbar/2$, implies”
- p.277, l. 17: Insert ‘a’ before ‘sufficiently’ and delete ‘s’ from ‘intervals’ to read: “in a sufficiently short time interval Δt . Such ...”
- p.277, 15th line above Eq. (A.10): Change ‘a pair of’ to ‘pair creation of a ’ to read: “into pair creation of a particle and ...”
- p.277, 13th line above Eq. (A.10): Insert a colon after ‘conservation’ to read: “... familiar form of energy conservation: $0 = E + \dots$ ”
- p. 278, line 1: Replace $c^5/\hbar G_N$ by $\hbar c^5/G_N$
- p.278, top line: Delete ‘the’ to read: “where k_B is Boltzmann’s constant, ...”
- p.278, 3rd line above Eq. (A.11): Insert ‘as’ to read: “thermodynamic formulae, as $dS = \dots$ ”
- p.278, line above Eq. (A.11): Change ‘unit’ to ‘units’ and end the line with a colon, to read: “hole in units of Boltzmann’s constant:”
- p.278, line above para. 1.: Change ‘hole’ to ‘holes’ to read: “holes. In this connection, ...”
- p.278, Para. 1., l. 4: Rearrange sentence to read: “In string theory, for example, W has been calculated and found to be in perfect agreement with ...”
- p.278, l. -2: Insert a space after ‘Gerard’ to read: “... by Gerard ‘t Hooft”
- p.279, Section A.3, l. 4: Change ‘as’ to ‘for’ to read: “... for a symmetric theory ...”

- p.279, l. 7: Insert ‘an’ to read: “... — an infinite number of theoretically ...”
- p.279, l. 13: Insert ‘of’ after ‘thought’ to read: “... can be thought of as a collection ...”
- p.279, bottom line: Change ‘ μ_1 and μ_2 ’ to ‘ \mathcal{M}_1 and \mathcal{M}_2 ’ (capitalized calligraphic font as in **Fig. A.3**) to read: “ \mathcal{M}_1 and \mathcal{M}_2 .) However, for subcritical ...”
- p. 280, Section A.4 title: Interchange the positions of ‘ Λ ’ and ‘**quantum vacuum energy**’ to read: “**A.4 The Problem of quantum vacuum energy as Λ (Section 9.4)**” [Make corresponding change in the Table of Contents.]
- p.280, l. 1 & 2 below the section title, **A.4 The Problem...** : Change ‘associate’ to ‘identify’, delete ‘the constant vacuum energy, hence’, and insert parenthetical remark ‘(the simplest form of the dark energy)’ to read: “It is natural to identify the zero-point energy of the quantum fields as the cosmological constant Λ (the simplest form of the dark energy). Here...”
- p.280, l. -1: Change ‘is’ to ‘are’ to read: “... of a field are simply a set”
- p.281, 2 lines above Eq. (A.15): Transpose ‘discussion later’ to read: “See later discussion.”
- p.281, line below Eq. (A.15): Change ‘numerous’ to ‘abundant’ to read: “..., there is abundant empirical evidence for”
- p.281, 3rd line below Eq. (A.15): Delete ‘e’ to change ‘Casimier’ to ‘Casimir’ and add sidebar number ‘6’ to read: “... zero point energy is the Casimir effect⁶, which has ..” and add the new sidebar: “⁶ The summation of the modes in Eq. (A.15) involves the enumeration of the phase space volume in units of Planck’s constant $\int d^3\mathbf{x}d^3\mathbf{p}(2\pi\hbar)^{-3}$, cf. Eq. (A.16). Since the zero-point energy has no dependence on position, one obtains a simple volume factor $\int d^3\mathbf{x} = V$ and the result that the corresponding energy per unit volume $E_\Lambda V^{-1}$ is a constant with respect to changes in volume. As explained in Sec 9.1, this constant energy density implies a $-\partial E/\partial x$ force that is attractive, pulling-in the piston in Fig 9.1. This is the key property of the cosmological constant and is the origin of the Casimir effect — an attractive force between two parallel conducting plates.”
- p.281, Subsection heading: Insert ‘fold’ to read: “... **vacuum energy is 10^{120} -fold too large for Λ** ”
- p.281, Eq. (A.18): In the first denominator, change ‘ c^2 ’ to just ‘ c ’ [delete the ‘²’ on c , but leave it in the second denominator]
- p.281, 2nd line below Eq. (A.18): Replace ‘being’ by ‘, which is’ to read: “density, which is comparable to the critical ...”
- p. 281, line 1 above the paragraph heading **Partial cancellation of ...** : Insert a comma after the word ‘density’ to read: “dark energy density, which is ...”

- p.281, l. -6: Insert ‘the’ to read: “... assumed that the field is a boson field”
- p.281, l. -5: Change ‘spins’ to ‘spin’ [delete ‘s’] to read: “..., having integer spin and ...”
- p.281, l. -2: Change ‘electron’ to ‘electrons’ [add an ‘s’] and hyphenate ‘half integer’ to read: “... (such as electrons, quarks, etc.) have half-integer spins, and”
- p.282, line above Eq. (A.19): Insert ‘a’ before ‘quantized’ to read: “oscillators have a quantized energy ...”
- p.282, 9th line above Eq. (A.20): Hyphenate ‘spin $\frac{1}{2}$ ’ and insert ‘the’ after ‘called’ to read: “massless spin- $\frac{1}{2}$ particle called the “photino,” etc. A plausible ...”
- p.282, 4th line above Eq. (A.20): Insert ‘the’ before ‘121st’ to read: “... stops at the 121st”
- p.282, 2nd line above Eq. (A.20): Hyphenate ‘first order’ to read: “... comparing the first-order fermion and boson ...”
- p.282, Eq. (A.20): In the denominator, change ‘ c^2 ’ to just ‘ c ’ [delete the ‘ 2 ’ on ‘ c ’]
- p.282, 2nd line above Eq. (A.21): Insert ‘is’ before ‘associated’ and replace ‘ $\rho_X \approx \rho_c$ ’ by ‘, being comparable to the critical density $\rho_c c^2$ [cf. Eq. (7.19)],’ to read: “is associated with the dark energy. The observed dark energy, being comparable to the critical density $\rho_c c^2$ [cf. Eq. (7.19)], then corresponds to...”
- p.282, Eq. (A.21): Change ‘ c^2 ’ to ‘ c^5 ’ and ‘ $10^{-11}eV$ ’ to ‘ $10^{-3}eV$ ’ to read:

$$E_X \cong [16\pi^2 \hbar^3 c^5 \rho_c]^{1/4} = O(10^{-3}eV). \quad (\text{A.21})$$

- p. 282, line 1 below Eq (A.21): Replace the word ‘the’ by ‘this’ to read: " Phrased in this way the cosmological constant"
- p.283, Chapter 1, Answer 1, l. 2: Change ‘the’ to ‘to’ to read: “Inertial frames; GR, to general ...”
- p. 283, line 5 of Answer 2 (Chapter 1): Replace ‘under rotation — thus rotation symmetry.’ by ‘under rotation — thus rotationally symmetric.’ to read: " covariant under rotation — thus rotationally symmetric. Similar statements..."
- p.283, Answer 3, l.2: Change ‘Tensor’ to ‘A tensor’ to read: “... transformation. A tensor equation, ...”
- p.285, l. -1: Change ‘proportional’ to ‘proportionality’ to read: “... with the proportionality”

- p.286, Answer 8 (Chapter 6), l. 2: Insert a comma after ‘over’ to read: “over, forcing all worldliness ...”
- p. 286, Answer 1 (Chapter 7): Insert a parenthetical remark ‘(cf. discussion relating to Fig. 7.3)’ at the end to read: "... Hubble’s law (cf. discussion relating to Fig. 7.3)."
- p.286, l. -6: Insert a comma after ‘flat’ to read: "... to stay flat, $v \sim r_0$, way beyond ...”
- p.287, l. -2: Change ‘and’ to ‘or’ to read: “positive (bound system) or negative (unbound ...”
- p. 288, Answer 4 (Chapter 8): Insert ‘exp’ in front of ‘ $[-\Delta mc^2/k_b T_{bbn}]$ ’ to read: " $n_n/n_p \simeq \exp[-\Delta mc^2/k_b T_{bbn}]$ with $\Delta m = m_n - m_p$."
- p.288, Answer 10, l. 1: Delete the superscript ‘⁰’ on ‘ H ’ to read simply: "... $H + \gamma$ stopped ...“
- p.288, Answer 10, l. 2: Change ‘neutron’ to ‘neutral’ to read: "... into neutral atoms.”
- p.289, Answer 6, l. 2: Change ‘gains’ to ‘gain’ [delete the ‘s’] to read: "... increases the more gain in energy, ...”
- p.289, Answer 6, l. 4: Insert ‘the’ to read: "curvature, solving the flatness ...”
- p.289, Add new Answer 11:

“11. Cf. sidebar 5, p.184.”

[Should renumber subsequent Answers in this chapter accordingly.]
- p.289, Answer 13, l. 4: Delete ‘the’ to read: “and a^{-3} as $a \rightarrow 0$. Thus”
- p.290, Answer 3, l. 1 and l. 2: Insert comma after ‘contravariant’ and replace ‘the covariant components are’ by ‘covariant with components’ to read: “The position 4-vector x^μ is naturally contravariant, as opposed to covariant $x_\mu = \dots$ ”
- p.291, Answer 9, l. 3: Insert ‘a’ before ‘tensor’ to read: “Since this is a tensor equation ...”
- p.291, Answer 2, l.5: Change ‘is’ to ‘constitute’ to read: “(i.e., the metric), constitute the ...”
- p.291, Answer 6, l. 1: Change ‘spherical’ to ‘spherically’ to read: "... for a spherically symmetric”
- p.291, Answer 7, l. 2: Insert ‘an’ before ‘energy’ and hyphenate ‘energy momentum’ to read: "... metric and an energy-momentum tensor given ...”

- p.291, l. -4: Insert a comma after ‘theory’ and after ‘relativistic’ and insert ‘an’ before ‘equal’ to read: “... theory, being relativistic, treats space and time on an equal footing, ...”
- p.292, Answer 3, l. 3: Insert ‘a’ before ‘gravitational’ to read: “Propagation of a gravitational wave ...”
- p.292, Answer 8, l. 3: Change ‘proportional’ to ‘proportionality’ and change ‘dimension’ to ‘dimensional’ to read: “also. The dimensionful proportionality constant can be fixed by dimensional”
- p.292, Answer 9, l. 1: Insert ‘the’ before ‘second’ to read: “... amplitude must be the second”
- p.293, line above Eq. (C.1): Insert a comma after ‘components’ to read: “... nontrivial components, are”
- p.294, line below Eq. (C.3): Insert ‘the’ before ‘Lorentz’ to read: “... used the Lorentz ...”
- p.294, 2nd line below Eq. (C.3): Delete ‘the’ to read: “... x-component of Faraday’s equation”
- p.295, l. 4: Delete ‘at’ to read: “lie equidistant from the origin ...”
- p.295, Problem (2.11), l. 6: Change ‘length’ to ‘path’ to read: “... left to right. The path”
- p.295, Problem (2.11), l. 9: End with a colon, to read: “to the right:”
- p.295, line above Eq. (C.4): Replace the period with a comma, to read: “frame,”
- p.295, l. -6: Delete ‘a’ to read: “of $0.99c$ corresponds to $\gamma = 7.1$. (a) In the laboratory ...”
- p.297, line above (3.1): Change ‘gotten’ to ‘obtained’ to read: “... result (C.10) obtained from Lorentz ...”
- p.298, Problem (3.3), l. 5: Insert ‘the’ before ‘spaceship’ to read: “... along with the spaceship, ...”
- p.298, Problem (3.3), l. 6: Insert ‘the’ before ‘EP’ to read: “... According to the EP, this”
- p.298, Problem (3.3), l. 9: Hyphenate ‘free fall’ to read: “free-fall observer comparing ...”
- p.298, Problem (3.3), l. 10: Change ‘point’ to ‘points’ to read: “... potential points as ...”
- p.298, Problem (3.3), l. 13: Make ‘rocketship’ into two words, to read: “... the relative speed of the rocket ship before and”

- p.298, Problem (3.3), l. 14: Close up ‘turn around’ into one word, to read: “after the turnaround has been computed”
- p.298, Problem (3.4), l. 2: Insert a colon after ‘gravity’ to read: “gravity:”
- p.298, l. -11: End the line with a colon after ‘velocity’ to read: “. . . radius and tangential velocity:”
- p. 298, l. -8: End the line with a colon after ‘equations’ to read: “from these two equations:”
- p.298, l. -1: Insert ‘a’ before ‘hundred’ to read: “. . . value is a hundred times”
- p.300, l. -7: Insert a comma after ‘negative’ to read: “. . . determinant is negative,”
- p.300, l. -1: Insert ‘the’ before ‘solid’ to read: “The relation for the solid angle factor”
- p.301, top line: Insert a colon after ‘systems’ to read: “systems:”
- p.301, 7th line after Eq. (C.14): Insert a comma after ‘Also’ to read: “. . . = $\text{diag}(1,1,1,1)$. Also, we have”
- p.301, 2nd line below Eq. (C.15): Change ‘coordinate’ to ‘coordinates’ to read: “. . . , and for spherical coordinates”
- p.301, 5th line below Eq. (C.15): Insert ‘a’ before ‘3-sphere’ and a colon after ‘calculated’ to read: “thus the volume of a 3-sphere with radius R can be calculated:”
- p.302, l. 6: Insert ‘a’ before ‘Taylor’ to read: “a Taylor series expansion”
- p.302, Problem (5.2), l. 1: Insert parentheses to read: “The spacetime separation vanishes ($ds^2 = 0$) for a light pulse”
- p.302, Problem (5.2), l. 4: Change ‘take’ to ‘it takes’ to read: “it takes the pulse going”
- p.302, l. -4: End the line with a comma, to read: “hence the spatial distance dl ,”
- p.303, l. 17: Insert ‘the’ to read: “From Problem (5.2), we have the spatial distance”
- p.303, l. -2: Hyphenate ‘weak field’ to read: “. . . the weak-field approximation, that is,”
- p.303, l. -1: Change ‘be’ to ‘being’ to read: “to being the flat space Minkowski”

- p.304, l. 3: Change ‘use’ to ‘using’ and replace the period at the end of the line by a comma, to read: “. . . , and using ”
- p.304, line below Eq. (C.17): Change ‘Huygen’s’ to ‘Huygens’ ’ to read: “. . . result obtained by Huygens’ principle in . . . ”
- p.304, 2nd line below Eq. (C.17): Insert ‘the’ to read: “For the argument that the GR value ”
- p.304, Problem (5.7), line below the displayed equation: Insert ‘vanishes’ after ‘density’ and insert parentheses, to read: “Since the mass density vanishes ($\rho = 0$) at any field . . . ”
- p. 304, Problem (6.1) line 2: Replace ‘ γ^* ’ by ‘ r^* ’ to read: "The $r^* = 0$ limit (6.40) is"
- p.304, Problem (6.1), 2nd line below the first displayed equation: Insert ‘by’ to read: “Multiplying by a factor of . . . ”
- p.305, l. 3: End the sentence with a comma after ‘variables’ to read: “. . . usual change of variables,”
- p.305, l. 14: Delete an ‘s’ to change the split ‘corre-sponds’ to ‘corre-pond’ to read: “In the absence of gravity . . . correspond to . . . ”
- p.305, Problem (6.5), l.1: Insert ‘a’ before ‘circular’ to read: “. . . For a circular orbit ”
- p.306, Problem (7.3), l. 2: Change ‘if’ to ‘is’ to read: “. . . redshift is given by (3.26), . . . ”
- p.306, Problem (7.4), l. 3: End with a comma, to read: “. . . as given by (7.21),”
- p.306, Problem (7.4), 2nd line below first displayed equation: Insert ‘be’ [or ‘have been’] to read: “been assumed to be emitting light . . . ”
- p.306, Problem (7.4), 3rd line below first displayed equation: Change ‘a’ to ‘an’ to read: “. . . , leading to an energy density”
- p.306, Problem (7.4), line below second displayed equation: Insert a comma twice, to read: “or, using (7.19), a density ratio”
- p.306, Problem (7.5), l. 2: Change ‘star lights’ to ‘starlight’ to read: “. . . due to all the starlight is, according to (7.2),”
- p.307, Problem (7.6), line below first displayed equation: Change ‘take’ to ‘taking’ and change ‘sides. We’ to ‘sides, we’ to read: “and taking the time average on both sides, we have the LHS”
- p.308, Para. (c), l. 1: Insert ‘the’ and write out ‘Steady-State Universe (SSU)’ to read: “. . . for the 3D space in the Steady-State Universe (SSU)”

- p.308, Para. (c), l. 4: Insert ‘an’ after ‘Namely,’ to read: “ $k = 0$. Namely, an SSU requires ”
- p.308, line below Eq. (C.22): Insert ‘the’ to read: “The first term on the RHS is just ...”
- p.310, Problem (8.7), l. 1: Insert a comma after ‘(8.27)’ to read: “... Plug (8.27), $a(t) = \dots$ ”
- p.311, top 4 lines: Change the sentence to read: “NB: These simple relations between redshift and time hold only for a universe with a single-component energy content; moreover, it does not apply to the situation when the equation-of-state parameter is negative ($w = -1$), even though the energy content is the single-component case.”
- p.311, 2nd line above Eq. (C.30): Change ‘Hubble’s’ to ‘Hubble’ to read: “... scaling behaviour of the Hubble parameter”
- p.311, line above Eq. (C.30): Delete ‘being’ and end the line with a colon, to read: “... (8.1) for a flat universe:”
- p.312, Problem (8.13), line above the second displayed equation: Insert ‘the’ before ‘cubic’ and end the line with a comma, to read: “density being the cubic power of temperature (8.35),”
- p.312, Problem (8.13), line below the second displayed equation: Change ‘being’ to ‘becomes’ to read: “The energy density ratio becomes”
- p.313, Problem (9.1), 1st and 2nd line above the final displayed equation: Change ‘divide’ to ‘dividing through by’ and ‘use’ to ‘using’ to read: “which can also be obtained easily from (8.1). Dividing through by the second term and using the definition of critical density we have”
- p.313, Problem (9.2), line above the final displayed equation: Change ‘Equation’ to ‘Eq.’ to read: “Eq. (C.34) becomes”
- p.314, line below the first displayed equation: Insert ‘the’ before ‘big’ to read: “The cosmic time for the big crunch ...”
- p.314, Problem (9.5), line below the first displayed equation: Change ‘use’ to ‘using’ and ‘density’ to ‘densities’ to read: “Using the scaling properties of these densities we have”
- p.315, Problem (10.5), line above the final displayed equation: Change ‘use’ to ‘using’ to read: “both sides and using the relation ...”
- p.316, 2nd line below Eq. (C.37): Insert ‘the’ before ‘Lorentz’ to read: “term in the Lorentz force vanishes.”
- p.316, 4th line below Eq. (C.37): Insert ‘a’ before ‘dual’ to read: “...: from the definition of a dual”

- p.316, 7th line below Eq. (C.37): Insert ‘a’ before ‘nontrivial’ to read: “... are unequal do we get a nontrivial relation: ...”
- p.317, 2nd line above the second displayed equation: Change ‘Use’ to ‘Using’ to read: “density. Using the formula for the Lorentz force (density) of (10.60),”
- p.317, 2nd line below the second displayed equation: Insert a comma after ‘charges’ to read: “current for free charges, $j_\lambda = \dots$ ”
- p.317, line above the fourth displayed equation: Change the period to a colon to end the line, to read: “... has a nonvanishing RHS:”
- p.317, Problem (10.17), l. 1: Insert ‘an’ to read: “... system of an electro-“
- p.317, Problem (10.17), l. 2: Insert ‘a’ before ‘field’ to read: “... system of a field with”
- p.317, Problem (10.17), line after the first displayed equation: Insert ‘an’ before ‘ideal’ to read: “or as a system of an ideal fluid ...”
- p.317, l. -2: Insert ‘be’ before ‘equal’ to read: “should be equal:...”
- p.319, Para. (e), l. 1: Transpose to read: “... coordinates has only one non-trivial element,”
- p.320, top line: End the line with a colon, to read: “... derivatives of the metric:”
- p.320, Para. (b), l. 1: Change ‘Metric’s’ to ‘The metric’s’ to read: “The metric’s first ...”
- p.320, l. -5: Insert ‘of’ to read: “... remind ourselves of the symmetry”
- p.325, Problem (12.5), l. 2: Insert ‘the’ before ‘Newtonian’ and insert ‘a’ before ‘weak’ to read: “particles, the Newtonian limit means a weak gravitational ...”
- p.325, l. -1: Hyphenate ‘weak field’ to read: “Also, in this weak-field limit, we can drop ...”
- p.326, line above Eq. (C.47): End the line with a comma, to read: “... gauge transformation of $\bar{h}_{\alpha\beta}$,”
- p.326, line below Eq. (C.47): End the line with a comma, to read: “... derivative on both sides of (C.47),”
- p.326, 4th line below Eq. (C.47): Delete the comma to read: “condition $\partial^\alpha \bar{h}'_{\alpha\beta} = 0$ if”
- p.326, Para. (c), l. 1: Change ‘Plug’ to ‘Plugging’ to read: “(c) Plugging ...”
- p.327, Para. (d), l. 1: Insert a comma after ‘symmetric’ and insert ‘, it’ before ‘has 10’ to read: “... tensor being symmetric, $\varepsilon_{\mu\nu} = \varepsilon_{\nu\mu}$, it has 10”

- p.327, Problem (13.2), l. 4: Change ‘down’ to ‘as’ to read: “written as”
- p.330, l. 1: Insert colon to read: ‘... “The MACHO project: Large Magellanic ...’
- p.330, bottom line: Insert a space in ‘p44’ to read: “New York, p 44”
- p.331, l. 12: Capitalize the first letters of ‘milky way’ to read: “Milky Way”
- p.331, l. 14: Change ‘, Oxford.’ To ‘/Elsevier, Amsterdam.’
- p.331, l. 15: Change ‘Lugunov’ to ‘Logunov’; insert ‘*the*’ before ‘*Articles*’; change ‘*e*’ to accented ‘*é*’ in ‘*Poincaré*’; change ‘*The*’ to ‘*the*’, to read: “Logunov, A.A. (2001). *On the Articles by Henri Poincaré “On the Dynamics of the Electron,”* translated into English by G. Pontecorvo, 3rd edn, JINR, Dubna.”
- p.331, l. -3: Capitalize the first letters in ‘hubble space telescope’ to read: “Hubble Space Telescope:”
- p.332, l. 7: Insert a comma after ‘*Relativity*’ to read: “... *Relativity, Thermodynamics and* ”
- p.332, l. 9: Change ‘*The*’ to ‘*the*’ to read: “... *Introduction to the General Theory* ...”
- p.332, l. 14/15: Capitalize initial letters of title to justify the acronym ‘TACMB’ to read: “... : TACMB-1 the Theory of Anisotropies in the Cosmic Microwave Background, ”
- p.334, Section 3, ii: Insert ‘the’ to read: “... *General Relativity to the Test*”
- p.334, bottom line: Change ‘Birkhouser’ to ‘Birkhäuser’ to read: “... (Birkhäuser Boston ..”
- p.335, middle column, first entry under ‘C’: Change ‘Casimier’ to ‘Casimir’ to read: "Casimir effect, 281”
- p.335, middle column, 6th entry under ‘Christoffel symbols: Change ‘176’ to just ‘76’ to read: “as metric derivatives, 76, 221”
- p.335, middle column, l. -17: After ‘CMB’ insert ‘(Cosmic Microwave Background)’ to read: “CMB (Cosmic Microwave Background) anisotropy, 152, 159, 178”
- p.335, middle column, l. -5: Change ‘octopole’ to ‘octupole’ with a ‘u’
- p.335, middle column, l. -3: After ‘COBE’ insert ‘(Cosmic Background Explorer)’ to read: “COBE (Cosmic Background Explorer), 155, 159, 182, 190”
- p.335, right column, l. 18: Change ‘Galileon’ to ‘Galilean’ to read: “Galilean, see inertial ”

- p.336, left column, l. -17 & -18: Insert ‘137’ and change ‘185’ to ‘184’ and move ‘184, 189, 191’ to l. -18 to read: “dark energy, 4, 137, 184, 189, 191, see cosmological constant”
- p.336, middle column, l. -3: After ‘equivalence principle’ insert ‘(EP)’ to read: “equivalence principle (EP), 9, 38, 233”
- p.336, middle column, l. -4: Insert new entry above the entry ‘equivalence principle’: “equation-of-state parameter w , 138, 142-143, 167, 184, 189, 191”
- p.336, right column, l. 12: Insert ‘a’ to read: “in the presence of a cosmological constant,”
- p.337, left column, l. 9: Insert ‘(GR)’ to read: “general relativity (GR), 6”
- p.337, left column, l. -24: Insert ‘(GPS)’ to read: “Global Position System (GPS), 48, 54”
- p.337, right column, l. 28: After ‘LIGO’ insert ‘(Laser Interferometer Gravitational Observatory)’ to read: “LIGO (Laser Interferometer Gravitational Observatory), 258”
- p.337, right column, l. -23: After ‘LISA’ insert ‘(Laser Interferometer Space Antenna)’ and change the page number from ‘258’ to ‘259’ to read: “LISA (Laser Interferometer Space Antenna), 259”
- p.338, left column, l. 11: Insert ‘(MASSive Compact Halo Objects)’ after ‘MACHOs’ to read: “MACHOs (Massive Compact Halo Objects), 97”
- p.338, l. 16: Insert new entry: “MAT/TOCO (Mobile Anisotropy Telescope, Cerro Toco), 182”
- p.338, left column, l. 20: After line 20, insert an entry reading: “Maxwell’s Equations, 6, 18”
- p.338, right column, last entry under letter ‘P’: Insert ‘(PSR)’ to read: “pulsar (PSR), 250”
- p.339, left column, l. 5: Insert ‘(GR)’ to read: “general, see general relativity (GR)”
- p.339, left column, l. 9: Insert ‘(SR)’ to read: “special, see special relativity (SR)”
- p.339, left column, l. 25: Insert ‘(RW)’ to read: “Robertson-Walker (RW) metric, 127, 244”
- p.339, left column, l. -12: Change ‘Schmdt’ to ‘Schmidt’ [insert an ‘i’] to read: “Schmidt, B., 185”
- p.339, left column, l. -5: After ‘SDSS’ insert ‘(Sloan Digital Sky Survey)’ to read: “SDSS (Sloan Digital Sky Survey), 119, 121, 189”

- p.339, left column, penultimate entry: insert an entry after ‘Slipher’ to read: “Sloan Digital Sky Survey, *see* SDSS”
- p.339, middle column, l. 11: After ‘special relativity’ insert ‘(SR)’ to read: “special relativity (SR), 6, 14, 197, 234”
- p.339, middle column, l. 29: Change ‘superluminary’ to ‘superluminal’ to read: “superluminal expanding universe, 173, 176”
- p.339, middle column, l. 36, 1st sub-entry under ‘symmetry’: Change ‘48’ to ‘4, 8’ to read: “as guide to new theories, 4, 8, 233”
- p.339, right column, l. 18: Change ‘TT’ to ‘transverse traceless (TT)’ to read: “transverse traceless (TT) gauge”
- p.339, right column: Change ‘2dF’ entry to “Two-degree Field (2dF), 119, 121, 189”
- p.339, right column, l. -15: Insert new entry: “ w , see equation-of-state parameter w ”
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