ERRATA

Gravitation and Spacetime (Second Printing)

p. xv, last line: . . . Chapter 9).
p. 40, Eq. [46]: . . . $\simeq 2zGM/r_0^3$
p. 44, next to last line: . . . 24 hr 50 min

p. 49, Exercise 15: Find τ_y and τ_z ; Eq. [66]: $\tau^n = c^2 \sum_{k,l,s} \epsilon^{nkl} R^k{}_{0s0} \left(- I^{ls} + \frac{1}{2}\delta^s_l I^{rr}\right)$

p. 73, Eq. [7]: Change $\mu = 0\ \mu = 0$ to $\mu = 0\ \nu = 0$.
p. 74, Exercise 2: . . . value as [8].

p. 76, Eq. [22]: $d\tau = \sqrt{dx^\mu dx_\mu} = \ldots$

p. 86, fourth line: . . . system is conserved*
p. 90, Eq. [98] and left side of Eq. [99]: Change d^3x to d^3x'
p. 93, Eq. [114]: $= (cqn, \ldots)$
p. 96, first equation in Exercise 21: . . . $+ 2a^0{}_0 a^0{}_1 B^{01}$
p. 123, Prob. 6, next to last line: What is the difference between . . .
p. 144, last column of table: $\partial_\nu T_{(m)\mu}{}^\nu = \frac{1}{2}\kappa h_{\alpha\beta,\mu} T_{(m)}{}^{\alpha\beta}$

p. 152, lines 1 and 2 of paragraph 3: . . . $x^\mu(\tau)$ . . . $\delta x^\mu(\tau)$ . . .

p. 153, equation after Eq. [81]: $I = \int_{\tau_1}^{\tau_2} \ldots$

p. 156, Eq. [92]: $\ldots + h_{\mu\alpha,\beta} u^\alpha u^\beta$
p. 160, Eq. [108]: $\nabla^2 h^{00} = \ldots$

p. 161, Eq. [113]: $f_{\alpha\beta} = \frac{\kappa}{2}(h_{0\beta,\alpha} - h_{0\alpha,\beta})$

p. 162, line before Eq. [117]: [2.104] and [2.105]

p. 165, Eq. [128]: $L = \sqrt{g_{\mu\nu} \frac{dx^\mu}{d\tau}\frac{dx^\nu}{d\tau}}$

p. 172, line 5 after Exercise 19: . . . Exercise 20),
p. 186, line before Eq. [26]: . . . Using Eqs. [23] and [24], . . .
p. 189, line 3: . . . given by a . . .
p. 193, line 3 in second paragraph: . . . 1919, at Sobral (Brazil) and on the island of Principe . . .
p. 197, last line: . . . last term on the right side . . .
p. 214, Eq. [61]: Change $(\xi - x')$ in numerator to $(x' - \xi)$; Eq. [62]: Change $(\xi - x')$ in numerator to $2(x' - \xi)$

p. 216, Eq. [67]: $\frac{\delta x'}{D_2} = \frac{\delta x}{D_{12}} - \delta x' \frac{\partial \alpha_x}{\partial x'} \frac{D_1}{D_{12}} - \delta y' \frac{\partial \alpha_x}{\partial y'} \frac{D_1}{D_{12}}$; Eq. [68]: $\frac{\delta y'}{D_2} = \frac{\delta y}{D_{12}} - \delta y' \frac{\partial \alpha_y}{\partial y'} \frac{D_1}{D_{12}} - \delta x' \frac{\partial \alpha_y}{\partial x'} \frac{D_1}{D_{12}}$
and corresponding corrections for the second parts of these equations
p. 216, Eq. [70]: Change D_1/D_{12} to D_1D_2/D_{12}
p. 221, Eq. [74]: Change $T^{\mu\nu}(x)$ to $T^{\mu\nu}(x')$
p. 222, Eq. [81]: Change $T^{l\mu}(x)$ to $T^{l\mu}(x')$ . . . ; Eq. [88]: Change x^k to x'^k
p. 224, Eq. [94], first column of right side: $2GS_z x/\kappa r^3$; line 7 in third paragraph: precession of the plane of . . .
p. 239, Problem 30: first equation: . . . D_1D_2/D_{12} ; last equation . . . $= -2\pi\delta(x' - \xi)\delta(y' - \varsigma)$
p. 243, Eq. [8]: $\phi^{\mu\nu} = \ldots$

p. 255, Eq. [60]: $\ldots = \frac{n^s}{4}(2\phi^{kl,0}\phi^{kl,s} \ldots)$

p. 256, line 1: $\phi^{kk} \propto \ddot{Q}^{kk} = 0$
p. 285, line after Eq. [144]: . . . $\bar{\sigma}_{abs}(\omega)$
p. 297, Problem 7, line 2: . . . erg/cm²·s

p. 324, Eqs. [47] and [48]: $\ldots = \frac{1}{g_{00}}[-g_{0k}dx^k \ldots$

p. 325, Delete the entire footnote

p. 326, line 1: $g_{\mu\nu} = \frac{\partial}{\partial(dx^\mu)} \frac{\partial}{\partial(dx^\nu)} ds^2$; next to last line: $A^\mu B^\nu g_{\mu\nu}$

p. 337, Exercise 23: $R_{00} = \ldots - \frac{N'}{r}]$

p. 341, line 2 after Exercise 25: $DA^\mu/D\tau \ldots [A^\mu(\tau + d\tau) \ldots$

p. 346, Eq. [134]: $dx^\mu \left(\frac{\partial}{\partial x^\nu}\right) = \ldots$

p. 343, Eq. [122]: $\frac{d^2 s'^k}{dt'^2} = \ldots$

p. 358, last three lines of first paragraph: . . . maximally symmetric spacetime is the de Sitter spacetime, an isotropic and homogeneous model of the universe we will discuss in Chapter 9.
p. 366, line 2: . . . $(d\theta^2 + \sin^2\theta\, d\phi^2)]$
p. 373, line 7: . . . From a physical point of view, . . .
p. 376, Eq. [14]: $\ldots = \eta^{\mu\nu} - \ldots$
p. 381, line 3 of paragraph 2: . . . $g'_{\mu\nu} = \eta_{\mu\nu}$ and . . . ; Eq. [24]: $\ldots - \partial'^\lambda \partial'_\mu g'_{\nu\lambda} + \partial'_\mu \partial'_\nu g'_\sigma{}^\sigma)$
p. 392, line 10 of paragraph 3: . . . $d\theta^2 + \sin^2\theta\, d\phi^2$ . . .
line 12 of paragraph 3: $dl^2 = B(r)(r^2 d\theta^2 + r^2\sin^2\theta\, d\phi^2) + C(r)dr^2$

p. 396, Eq. [79]: $ds^2 = \left(\frac{1 - C/4r'}{1 + C/4r'}\right)^2 dt^2 - \ldots$

p. 110, line 3 after Eq. [175]:
$\epsilon_{0123} = \epsilon_{2301} = \epsilon_{0231} = \epsilon_{3102} = \ldots = 1,$
$\epsilon_{1023} = \epsilon_{3201} = \epsilon_{2031} = \epsilon_{1302} = \ldots = -1$
p. 114, line 2: . . . $m_1 u_1{}^\mu$ and $m_2 u_2{}^\mu$
p. 118, footnote: . . . Eq. [1.19] . . .
p. 131, line 10 in 3rd paragraph: $j'^0 = \ldots$
p. 133, Eq.[4]: . . . $\partial^\nu \partial_\mu A^\mu, \ldots$
p. 134, line 3 from bottom: . . . Eq. [2.119] . . .
p. 154, Exercise 16: . . . Problem 2.14 . . .
p. 165, Eq. [129]: . . . $\frac{d}{d\tau}\left(\frac{1}{L} g_{\mu\nu} \frac{dx^\nu}{d\tau}\right) \ldots$
p. 186, Table 4.1: . . .redshift of K lines 1.01 ± 0.06
p. 225, Eqs. [98]-[100]: With the replacement of L by s, this calculation is correct for the precession of the spin s of a small rotating body (a gyroscope) in a circular orbit, but it is not correct for precession of the orbital angular momentum. The correct formula for precession of orbital angular momentum is $\mathbf{\Omega} = 2GS/r^3$ (eastward).

p. 255, Eq. [60]: $\ldots = \frac{n^s}{4}(2\phi^{kl,0}\phi^{kl,s} - \ldots$
$= \frac{n^s}{4}(2\phi^{kl,0}\phi^{kl,s} - 4\phi^{k0,0}\phi^{k0,s} + \phi^{00,0}\phi^{00,s})$
p. 291, Eq. [158]: $e^{i(x + 4\pi n/\lambda)}$
p. 318, 2nd equation in Exercise 9: $\ldots + 2\cot\theta \ldots$
p. 338, line after Eq. [110]: . . . in the last four terms. . .
p. 349, Eq. [153]: $g_{\alpha\mu} g^{\alpha\nu} = \delta_\mu{}^\nu$
p. 367, Problem 25, line 2 of equation: $+g^{\mu\nu}\sqrt{-g}(\ldots$
p. 400, equation after [98]: $dt' = e^{h(t)/2}dt$
p. 434, Problem 18: Replace " local geodesic coordinates" by "local measured distances"
p. 527, last line: . . . Exercise 1.4)
p. 531, line 2 before Eq. [29]: . . . $l/v = H_0^{-1}$
p. 581, Problem 4: change b to r
p. 339, Eq. [113]: change − to +

p. 400, line 5 from bottom: . . . Exercise 1.4

p. 414, Eq. [144]: . . . $\left(-I^{ls} + \frac{1}{2}\delta_l{}^s I^{rr}\right)$

p. 417, Eq. [150]: $\left(\ldots + S_z g_{33} \frac{dz}{d\tau}\right) \simeq S_y v$

p. 433, Prob. 14: . . . $(dr'^2 + r'^2 d\theta^2 + r'^2 \sin^2\theta\, d\phi^2)$

p. 442, Eq. [12]: . . . $\frac{1}{1 - r_S/r_0} = \ldots$

p. 445, Eq. [17]: . . . $= \pm\left(1 - \frac{r_S}{r}\right)$

p. 456, Fig. 8.6(a): Change lower label u = 0.8 to u = - 0.8

p. 462, Eq. [43]: $f(r) = a \int_{\infty}^{r} \frac{dr}{r^2 - 2GMr + a^2} + \tan^{-1}\frac{a}{r}$

p. 469, Fig. 8.13: horizontal axis is z/r_S

p. 471, Eq. [66]: . . . $+ \frac{S^2}{(2GM_{ir})^2}$

p. 476, second paragraph: Change Eq. [30] to [32], and change Eqs. [43] and [47] to [51] and [55].
p. 476, Fig. 8.19: On left side, change label ~~III~~(1, 2) to III(2, 1)
p. 498, first three lines: . . . gives $E(r_2) = \sqrt{8/9}\,m$. Hence the amount of energy that is converted to heat is $-E(r_2) + E(r_1) = (1 - \sqrt{8/9})m = 0.057m$, or . . .
p. 502, Exercise 18: . . . Kepler's law $(T/2\pi)^2 = \ldots$
p. 527, line after Eq. [15]: . . . position **r** has . . .
p. 544, Eq. [50] : $ds^2 = (dx^0)^2 + g_{kn}\,dx^k dx^n$

p. 559, Eq. [117]: . . . $= \frac{4GM}{\pi a^3}$

p. 560, third column of matrix: $-a^2\chi^2$; Eq. [121]: . . . $= \frac{4GM}{\pi a^3} + \Lambda$

p. 565, Exercise 11: . . . solution of [104] . . . ; Exercise 12: . . . equation of motion [104] . . .
p. 567, Eq. [139]: Change $\lambda(0)$ to $\lambda(i)$

p. 570, Eq. [150]: . . . $\frac{dl}{dt} = \frac{da}{dt}\chi = Hl$

p. 572, Exercise 14: Multiply Eq. [104] . . .
p. 582, Problem 8: first equation: . . . $\Omega_0/(\Omega_0 - 1)^{3/2}$ . . . ; second equation: . . . $\Omega_0/(1 - \Omega_0)^{3/2}$ . . .
p. 584, line 1: . . . $+ \chi^2 \sin^2\theta\, d\phi^2)$; Problem 17, line 1: . . . Problem 15.
last line: . . . at an age of 0.55×10^{11} years. . .
p. 585, line 4: . . . $\simeq 0.8 \times 10^{11}$ years, . .
p. 588, Eq. [5]: . . . $= 4.2 \times 10^4\, \Omega_0 h^2$; Eq. [6]: . . . $= 4.2 \times 10^4\, \Omega_0 h^2$ $T_0 = 1.1 \times 10^5$ K $\times\, \Omega_0 h^2$
p. 591, line 2 after Eq. [15]: "Planck mass" should be in italics
p. 602, Eq. [50], denominator: Change -1 to +1:

p. 612, Eq. [73]: $= Ae^{-i\mathbf{k}\cdot\mathbf{x} - i\omega t}$
p. 612, lines 1,2,3 after Eq. [74]: . . . if k is large, . . . But if k is small, ω will . . . value of k below . . .
p. 630, Problem 8: . . . where $\sigma_T = (8\pi/3)(e^2/m_e c^2)^2 = \ldots$
p. 638, Eq. [20]: $(\ldots - \mathscr{L})\, d^3x$

p. 639, Eq. [22]: . . . $= \psi_{,\mu} \frac{\partial \mathscr{L}}{\partial \psi_{,\nu}} - \delta_\mu{}^\nu \mathscr{L}$

p. 640, line 11 in last paragraph: . . . and $\partial_\nu \overline{t_\mu}{}^\nu = 0$. Thus, . . .

p. 647, Eq. [55]: $(\ldots + \Gamma^\sigma_{\beta\iota}\, \Gamma^\iota_{\sigma\alpha} - \ldots)$

p. 650, Answer 1.6: 6.3×10^{-4} s/yr ; Answer 1.16: 7.7×10^{-8} N ; Answer 2.14: Change a_0 to a
Answer 2.22(b): $E' = \ldots$
p. 653, Answer 7.8, second line: 1.4×10^{28} cm^3; 1.4×10^{-6} ; Answer 7.20: $t = 6\pi GM\sqrt{3}$ . . .

p. 633, Eq. [3]: $\ldots - \frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i}\Big)\ldots$

p. 643, Eqs. [37], [39], [42], and equation after [37]: change sign in front of each A

p. 643, line before Eq. [38]: $h^{\mu\nu}{}_{,\mu} = \ldots$

p. 644, Eq. [43]: change last two minus signs to plus

p. 645, Eq. [45], line 2: $+g^{\mu\nu}\sqrt{-g}(\ldots$

p. 647, Eq. [56], last term: $\ldots(\sqrt{-g}g^{\alpha\beta}\ldots$

p. 648, line 5, paragraph 2: $\ldots + \Gamma^\sigma_{\beta\iota}\Gamma^\iota_{\sigma\alpha} - \ldots$

p. 648, Eqs. [58], [59]: change $\partial/\partial x_\lambda$ to $\partial/\partial x^\lambda$

p. 648, Eq. [60]: change plus sign to minus

p. 652, Answer 5.20: . . . 5×10^{-39} ; Answer 5.22: $a' = 8a/\pi^2; a' = 8a/9\pi^2$

H. C. O., November 2004