Physics of the Interstellar and Intergalactic Medium

Errata in the fourth and fifth printings.

Updated 2019.04.18

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Which printing of the book you have can be determined from the last line on the copyright page:
First printing: 1 3 5 7 9 10 8 6 4 2
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Fourth printing: 5 7 9 10 8 6 4
Fifth printing: 5 7 9 10 8 6
Sixth printing: 7 9 10 8 6

Errata in the fourth and fifth printings.

- Plate 5 caption, typo:
  ...seen in Plate 6. → ...seen in Plate 4.
noted 2018.04.07 by L. Bouma.

- §3.6, p. 28, Eq. 3.31, typo: factor of 2 error. Eq. (3.31) should read
  \[
  \sigma_{rr,\mu}(E) = \frac{1}{2} \frac{g(X_e)}{g(X_n^+)} \frac{(I_{X,nu} + E)^2}{E m_e c^2} - \sigma_{pi,\mu}(h\nu = I_{X,nu} + E), \quad (3.31)
  \]
noted 2015.06.01 by E. B. Jenkins

- §3.7, p. 28, Eq. (3.33), typo: sign error. Change \( e^{-l_n/kT} \) → \( e^{l_n/kT} \).
noted 2017.02.09

- §3.8, p. 31, Eq. (3.48), typo: change
  \[
  I_{\alpha} \propto A_{n\alpha} h\nu_{\alpha} \int n(H(n)) ds \propto n^{-6} b_n \int n_e n(H^+) ds
  \]
  \[
  \rightarrow I_{\alpha} \propto A_{n\alpha} h\nu_{n\alpha} \int n(H(n+1)) ds \propto n^{-6} b_{n+1} \int n_e n(H^+) ds
  \]
noted 2019.02.06

- §10.2, sentence preceding Eq. (10.5): change
  ...the Gaunt factor from quantum-mechanical calculations is approximately
  \rightarrow
  ...the Gaunt factor is approximately (Scheuer 1960)
noted 2018.11.18 by S. Weinberg.

- §13.1, pp. 128, eq. (13.1), (13.3), (13.4): for notational consistency with the rest of the chapter, change \( \sigma_{pe} \rightarrow \sigma_{pi} \)
noted 2018.01.07 by L. Bouma.

- §13.1, p. 130, second paragraph, typo:
  ...to \( 3 \times 10^{-10} \) s\(^{-1}\) for Si → ...to \( 3 \times 10^{-9} \) s\(^{-1}\) for Si
noted 2017.03.05
• §14.9, p. 159, typo: factor of 2 error. Eq. (14.41) should read
\[ \sigma_{rr}(E) = \frac{g_{\ell}}{2g_{u}} \frac{(I + E)^2}{E m_{c} c^2} \sigma_{pi}(h\nu = I + E) . \] (14.41)

noted 2015.06.01 by E. B. Jenkins.

• §14.9, p. 160, typo: factor of 2 error. Eq. (14.43) should read
\[ \frac{\langle \sigma v \rangle_{rr}}{\langle \sigma v \rangle_{ci}} \approx 2 \pi \alpha^3 \frac{I}{kT} e^{I/kT} , \] (14.43)

noted 2015.06.01 by E. B. Jenkins.

• §14.9, p. 160, typo: factor of 2 error. Eq. (14.44) and following should read
\[ \frac{I}{kT} e^{I/kT} = \frac{C}{2\pi f_{pi} \alpha^3} . \] (14.44)

If \( C \approx 1 \) and \( f_{pi} \approx 1 \), this has solution \( I/kT \approx 10.6 \). ...
noted 2015.06.01 by E. B. Jenkins.

noted 2019.03.25

• §28.3, p. 328, 4th paragraph, typo: change distance from \( \Theta_1 \text{Ori C} \) to the Orion Bar ionization front: \( \sim 7.8 \times 10^{18} \text{cm} \rightarrow \sim 7.8 \times 10^{17} \text{cm} \)
noted 2015.04.07

• §32.9, p. 368, just before eq. (32.11), typo: change
\[ A_V/N_H = 1.87 \times 10^{21} \text{cm}^2 \rightarrow A_V/N_H = 5.3 \times 10^{-22} \text{mag cm}^2 . \]
noted 2016.03.04 by Ilsang Yoon.

• §32.11, p. 372, prepenultimate paragraph: terminological correction. Change “core” to “clump” (three occurrences).
noted 2015.04.16

• §34.4, p. 386, Eq. (34.10): sign mistake on RHS; change
\[ -4\pi r^2 \kappa \frac{dT}{dr} \rightarrow 4\pi r^2 \kappa \frac{dT}{dr} \]
noted 2019.04.18 by G. Halevi.

• §36.2.3, p. 400, Eq. (36.10): \( v_x \) multiplying \( B_y B_x \) should be \( v_y \), and \( v_x \) multiplying \( B_z B_x \) should be \( v_z \).
noted 2015.12.17 by J. Miralda-Escudé.

The equation should read
\[ \left\{ \frac{\rho v^2}{2} + \frac{\gamma p}{\gamma - 1} \right\} v_x + \frac{(B_y^2 + B_z^2)}{4\pi} v_x - \frac{(B_x v_y + B_y v_x)}{4\pi} - \kappa \frac{dT}{dx} \right\} = \]
\[
\left\{ \frac{\rho v^2}{2} + \frac{\gamma p}{\gamma - 1} \right\} v_x + \frac{(B_y^2 + B_z^2)}{4\pi} v_x - \frac{(B_x B_y v_y + B_x B_z v_z)}{4\pi} - \kappa \frac{dT}{dx} \right\}^2. \quad (36.10)
\]

- §37.1, p. 413, 2nd paragraph: Change
  Cases of astrophysical interest will normally have...
  →
  Many cases of astrophysical interest will have...
  noted 2018.04.09.

- §37.1, p. 413, typo just above Eq. (37.3):
  \[ Jh\nu/c = \rho_1 u_1 h\nu/\mu_i c \ll \rho_1 (u_1^2 + c_1^2 + B_1^2/8\pi). \]
  →
  \[ Jh\nu/c = \rho_1 u_1 h\nu/\mu_i c \ll \rho_1 (u_1^2 + c_1^2) + B_1^2/8\pi. \]
  noted 2016.12.08 by Ryohei Nakatani.

- §37.1, Eq. (37.8): The correction terms for \( u_R, x_R, u_D, \) and \( x_D \) can be improved by analyzing the full cubic equation (37.3): change
  \[
u_R \approx 2c^2 \quad \rightarrow \quad u_R \approx 2c^2 \left[ 1 - \frac{2c^2 - 3v_{A1}^2}{8c^2} \right] \]
  \[ x_R \approx \frac{1}{2} + \frac{2c_1^2 + v_{A1}^2}{16c^2} \quad \rightarrow \quad x_R \approx \frac{1}{2} \]
  \[
u_D \approx \frac{2c_1^2 + v_{A1}^2}{4c_2} \quad \rightarrow \quad \frac{2c_1^2 + v_{A1}^2}{8c_2} \left[ 1 + \frac{2c_1^2 + v_{A1}^2}{8c_2} \right] \]
  \[ x_D \approx \frac{4c_1^2}{2c_1^2 + v_{A1}^2} \quad \rightarrow \quad x_D \approx \frac{4c_1^2}{2c_1^2 + v_{A1}^2} \left[ 1 - \frac{v_{A1}^2}{8c_2} \right] \]
  noted 2018.02.19 by Woong-Tae Kim.

- §37.1 and §37.2, pp. 414-416: the mathematics is correct, but the “weak-type”, and “strong-type” terminology was unfortunately inverted: all occurrences of “weak-type” should be changed to “strong-type”, and vice-versa:
  - §37.1.1, p. 414, first paragraph:
    ...
    are called **strong R-type**. Strong R-type solutions...
    →
    ...
    are called **weak R-type**. Weak R-type solutions...
  - §37.1.1, p. 414, second paragraph:
    ...
    referred to as **weak R-type**, ... → ...
    referred to as **strong R-type**, ...
  - §37.1.1, p. 414, second paragraph:
    Hence, only strong R-type I-fronts are physically relevant.
    →
Hence, only weak R-type I-fronts are physically relevant.

- §37.1.2, p. 414, first paragraph:
  ...is termed weak D-type. → ...is termed strong D-type.

- §37.1.2, p. 414, second paragraph:
  ...is termed strong D-type. → ...is termed weak D-type.

- Fig. 37.1 and caption should be:

![Figure 37.1](image)

**Figure 37.1** $u_2/u_1 = \rho_1/\rho_2$, as a function of the velocity $u_1$ of the I-front relative to the neutral gas just ahead of the I-front, for D-type and R-type ionization front solutions (see text) for an example with $c_1 = 1 \text{ km s}^{-1}$, $v_{A1} = 2 \text{ km s}^{-1}$, and $c_2 = 11.4 \text{ km s}^{-1}$. The astrophysically relevant solutions are the strong D-type and weak R-type cases, shown as heavy curves. There are no solutions with $u_1$ between $u_D$ and $u_R$.

- §37.1, p. 416, first paragraph:
  ...will be strong R-type, ... → ...will be weak R-type, ...

- §37.1, p. 417, fourth line:
  ...will now be weak D-type, ... → ...will now be strong D-type, ...
  noted 2016.12.06 by Ryohei Nakatani.

- §37.2, p. 418, typos:
  ...moving at a speed $v_s$ that will be close to (just slightly larger than) the speed of the I-front:

  $$v_s \approx V_i$$  \hspace{1cm} (37.21)

  →

  ...moving at a speed $V_s$ that will be close to (just slightly larger than) the speed of the I-front:

  $$V_s \approx V_i$$  \hspace{1cm} (37.21)

  noted 2016.12.08 by Ryohei Nakatani.
• §38.3, p. 428, last paragraph, typo: 
\[ M_w \approx 2 \times 10^{-5} \text{ km s}^{-1} \rightarrow M_w \approx 2 \times 10^{-5} \text{ M}_\odot \text{ yr}^{-1} \]
noted 2015.12.17 by J. Miralda-Escudé.

• §41.3, p. 456, typo: missing factor of \( G \). Eq. (41.36) should read
\[ E_{\text{grav}} = \frac{-G}{2} \int dV_1 \int dV_2 \rho(r_1) \rho(r_2) \frac{\rho(r_1)}{|r_1 - r_2|} \]  
(41.36)
noted 2015.04.30 by J. Greco.

• Appendix D, p. 481: corrected typos:
  
  F VI \rightarrow VII: \( I = 147.163 \rightarrow 157.163 \)
  Ne VI \rightarrow VII: \( I = 154.214 \rightarrow 157.934 \)
  Ti III \rightarrow IV: \( I = 24.492 \rightarrow 27.492 \)
  Ti IV \rightarrow VI: \( I = 123.7 \rightarrow 99.299 \)
  Zn VI \rightarrow VII: \( I = 133.903 \rightarrow 108.0 \)
noted 2015.07.10 by Guangtun Ben Zhu.

• Appendix F, Table F.2, p. 497, typo: the first transition listed for S III: change 
\[ 3\text{P}_0 \rightarrow 3\text{P}_0 \rightarrow 3\text{P}_1 \] 
noted 2016.10.03 by C.D. Kreisch.

• Appendix F, Table F.6, p. 501: The table title should be “Rate Coefficients for ... Deexcitation...” rather than “... Excitation...”. 
noted 2015.07.03

• Appendix F, Table F.6, p. 501: the rates for entries 5 and 6 should be interchanged, so that entries 4-6 read
\[
\begin{array}{cccc}
\text{H} & \text{CI} & 3\text{P}_0 - 3\text{P}_1 & 1.26 \times 10^{-10} T_0^{0.115+0.057} \ln T_2 b \\
\text{H} & \text{CI} & 3\text{P}_0 - 3\text{P}_2 & 8.90 \times 10^{-11} T_0^{0.228+0.046} \ln T_2 b \\
\text{H} & \text{CI} & 3\text{P}_1 - 3\text{P}_2 & 2.64 \times 10^{-10} T_0^{0.231+0.046} \ln T_2 b \\
\end{array}
\]
noted 2015.07.03 by Munan Gong.

• Appendix F, Table F.6, p. 501: the rates for entries 23-28 should be changed to
\[
\begin{array}{cccc}
\text{H}_2(\text{para}) & \text{O I} & 3\text{P}_2 - 3\text{P}_1 & 1.49 \times 10^{-10} T_0^{-0.369-0.026} \ln T_2 h \\
\text{H}_2(\text{ortho}) & \text{O I} & 3\text{P}_2 - 3\text{P}_1 & 1.37 \times 10^{-10} T_0^{-0.395-0.005} \ln T_2 h \\
\text{H}_2(\text{para}) & \text{O I} & 3\text{P}_2 - 3\text{P}_0 & 2.37 \times 10^{-10} T_0^{-0.255+0.016} \ln T_2 h \\
\text{H}_2(\text{ortho}) & \text{O I} & 3\text{P}_2 - 3\text{P}_0 & 2.23 \times 10^{-10} T_0^{-0.284+0.035} \ln T_2 h \\
\text{H}_2(\text{para}) & \text{O I} & 3\text{P}_1 - 3\text{P}_0 & 2.10 \times 10^{-12} T_0^{-0.792+0.188} \ln T_2 h \\
\text{H}_2(\text{ortho}) & \text{O I} & 3\text{P}_1 - 3\text{P}_0 & 3.00 \times 10^{-12} T_0^{-0.792+0.188} \ln T_2 h \\
\end{array}
\]
noted 2015.08.24 by E.B. Jenkins.

• Appendix G, p. 503, typo just before Eq. (G.7): change
\[ ... \text{solution } x_0 = e^{-i\omega t} \rightarrow ... \text{solution } x = x_0 e^{-i\omega t} \]
noted 2019.02.11
• Appendix I, p. 507, typo (15.78→31.56): Eq. (I.7) should read
  \[ \frac{Ze^2}{a_0kT} = \frac{31.56Z}{T_4} \]
  noted 2019.01.14.

• Appendix J, p. 510, Eq. (J.13), typo:
  \[ \Pi_0 \equiv \oint dS \cdot rp \rightarrow \Pi_0 \equiv \frac{1}{3} \oint dS \cdot rp \]
  noted 2017.03.08.