Physics of the Interstellar and Intergalactic Medium

Errata in the second and third printings.

Updated 2021.06.25

Bruce T. Draine
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
- Second printing: 3 5 7 9 10 8 6 4 2
- Third printing: 3 5 7 9 10 8 6 4
- Fourth printing: 5 7 9 10 8 6 4
- Fifth printing: 5 7 9 10 8
- Sixth printing: 7 9 10 8

Errata in the second and third printings.

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

- §1.2, p. 8, Table 1.4: change abundance of P from \( \frac{N_P}{N_H} = 3.23 \times 10^{-7 \pm 0.03} \) to \( \frac{N_P}{N_H} = 2.82 \times 10^{-7 \pm 0.03} \), \( \frac{M_P}{M_H} = 8.73 \times 10^{-6} \)
  noted 2013.10.21 by Bon-Chul Koo.

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

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

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

- §5.2.2, p. 50, 3rd paragraph, typos: change
  para-H\(_2\)O must have \( K_{-1} + K_{+1} \) odd → para-H\(_2\)O must have \( K_{-1} + K_{+1} \) even
  and
  ortho-H\(_2\)O must have \( K_{-1} + K_{+1} \) even → ortho-H\(_2\)O must have \( K_{-1} + K_{+1} \) odd
  noted 2015.01.15 by Neal Evans.
• §7.5, p. 69, Eq. (7.29), typo: missing a factor $n_\ell$. Should read

$$\kappa_\nu = n_\ell \sigma_{\ell \rightarrow n} \left( 1 - \frac{n_n / g_n}{n_\ell / g_\ell} \right) < 0$$

noted 2020.10.12 by Yan Liang.

• §8.3, p. 74, Eq. (8.26), typos: $T_A^a(v) \rightarrow T_A^a(v)$ (two occurrences).

noted 2013.02.14 by Munan Gong.

• §9.8, p. 84, typo in line following Eq. (9.35): change $(v_{FWHM}/2 \text{ km s}^{-1})^2/3 \rightarrow (v_{FWHM}/2 \text{ km s}^{-1})^3/3$.

noted 2020.09.09 by Roohi Dalal.

• §9.10, Table 9.4, p. 88, typos: for C II and N III, change $^2D_J \rightarrow ^2D_J$ for $J = 3/2$ and $J = 5/2$.

noted 2015.02.12 by Semyeong Oh.

• §10.2, sentence preceding Eq. (10.5): change...

...the Gaunt factor from quantum-mechanical calculations is approximately

...the Gaunt factor is approximately (Scheuer 1960)

noted 2018.11.18 by S. Weinberg.

• §10.5, p. 97, Eq. (10.25), typo (missing factor of 2): should read

$$j_{b,\nu} = \frac{g_h}{g_e g_i} \frac{2 h^4 \nu^3}{(2 \pi m_e k T)^{3/2} c^2} e^{(h_\nu-h) k T} \sigma_{b,pi}(\nu) n_e n_i$$

noted 2021.02.14 by Shigenobu Hirose.

• §11.4, p. 110, Eq. (11.35) should read

$$\nu \ll \frac{e^2 (\Delta n_e)_{L,RMS}}{2 \pi m_e c} (2LD)^{1/2} = 1 \times 10^3 \text{ GHz} \frac{(\Delta n_e)_{L,RMS}}{10^{-3} \text{ cm}^{-3}} \left( \frac{L}{10^{14} \text{ cm}} \frac{D}{\text{kpc}} \right)^{1/2}$$

noted 2013.02.03 by W. Vlemmings.

• §12, p. 121, Table 12.1, typos:

<table>
<thead>
<tr>
<th>CMB, $T$ = 2.725 K</th>
<th>$4.19 \times 10^{-13} \rightarrow 4.17 \times 10^{-13}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_2 = 4000$ K, $W_2 = 1.65 \times 10^{-13}$</td>
<td>$3.19 \times 10^{-13} \rightarrow 3.20 \times 10^{-13}$</td>
</tr>
<tr>
<td>$T_3 = 7500$ K, $W_3 = 1 \times 10^{-14}$</td>
<td>$2.29 \times 10^{-13} \rightarrow 2.39 \times 10^{-13}$</td>
</tr>
<tr>
<td>Starlight total</td>
<td>$1.05 \times 10^{-12} \rightarrow 1.06 \times 10^{-12}$</td>
</tr>
</tbody>
</table>
| ISRF total | $2.19 \times 10^{-12} \rightarrow 1.98 \times 10^{-12}$.

noted 2012.11.08

• §12.5, p. 123, below eq. (12.4): change

...$W_1$ by 40%, from $W_1 = 5 \times 10^{-13}$ to $7 \times 10^{-13}$.

...$W_2$ by 75%, from $W_1 = 4 \times 10^{-13}$ to $7 \times 10^{-13}$, and raised $W_2$ from $1.0 \times 10^{-13}$ to $1.65 \times 10^{-13}$.

noted 2014.11.11 by S. Bianchi.
4

- §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:
  \( ...to 3 \times 10^{-10} \text{s}^{-1} \text{ for Si} \rightarrow ...to 3 \times 10^{-9} \text{s}^{-1} \text{ for Si} \)
  noted 2017.03.05

- §14.6, p. 154, Table 14.8 update: replace
  \( H^3^+ + e^- \rightarrow H_2 + H \quad 1.1 \times 10^{-7} T_2^{-0.56} \quad \text{McCall et al. (2004)} \)
  with
  \( H^3^+ + e^- \rightarrow H + H + H \quad 8.9 \times 10^{-8} T_2^{-0.48} \quad \text{McCall et al. (2004)} \)
  \( H^3^+ + e^- \rightarrow H_2 + H \quad 5.0 \times 10^{-8} T_2^{-0.48} \quad \text{McCall et al. (2004)} \)
  noted 2013.04.03

- §14.9, p. 159, typo: factor of 2 error. Eq. (14.41) should read
  \[
  \sigma_{rr}(E) = \frac{g_e (I + E)^2}{2 g_n E m_e c^2} \sigma_{pi} \left( \frac{h \nu}{I + E} \right).
  \]
  noted 2015.06.01 by E. B. Jenkins.

- §14.9, p. 160, typo: factor of 2 error. Eq. (14.43) should read
  \[
  \frac{\langle \sigma v \rangle_{rr}}{\langle \sigma v \rangle_{ci}} \approx 2 \pi \alpha^3 f_{pi} \frac{I}{C k T} e^{I/kT},
  \]
  noted 2015.06.01 by E. B. Jenkins.

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

- Table 15.1, p. 164, typo: \( M/M_\odot \) for O6.5V star: 38.0 \( \rightarrow \) 28.0
  noted 2013.01.31

- §15.5, p. 174, sentence preceding Eq. (15.36), typo:
  \( N(\text{He}^+)/N(\text{H}^+) < n_{\text{He}}/n_{\text{He}} \rightarrow N(\text{He}^+)/N(\text{H}^+) < n_{\text{He}}/n_{\text{H}} \)
  noted 2020.09.29 by H. Jia

- §16.4, p. 186, Eq. (16.9, 16.10), update: change
  \[
  \begin{align*}
  H^3^+ + e^- & \rightarrow H_2 + H, \quad k_{16.9} = 4.1 \times 10^{-8} T_2^{-0.52} \text{ cm}^3 \text{s}^{-1}, \\
  H^3^+ + e^- & \rightarrow H + H + H, \quad k_{16.10} = 7.7 \times 10^{-8} T_2^{-0.52} \text{ cm}^3 \text{s}^{-1},
  \end{align*}
  \]
  to
  \[
  \begin{align*}
  H^3^+ + e^- & \rightarrow H_2 + H, \quad k_{16.9} = 5.0 \times 10^{-8} T_2^{-0.48} \text{ cm}^3 \text{s}^{-1}, \\
  H^3^+ + e^- & \rightarrow H + H + H, \quad k_{16.10} = 8.9 \times 10^{-8} T_2^{-0.48} \text{ cm}^3 \text{s}^{-1},
  \end{align*}
  \]
and cite McCull et al. (2004) for \(k_{16.9}\) and \(k_{16.10}\).

noted 2013.04.03

- §16.4, p. 187, typo: in paragraph below Eq. (16.15), change
  \[ x_e \approx x_M \approx 1.9 \times 10^{-4} \rightarrow x_e \approx x_M \approx 1.1 \times 10^{-4} \]  
  (see Eq. 16.3)
  noted 2013.04.04

- §16.5, p. 188, Eq. (16.16), typo: should read
  \[ \text{H}_2 + \text{CR} \rightarrow \text{H}_2^+ + e^- + \text{CR} \]
  noted 2020.09.29 by R. Córdova

- §16.5, p. 189, Fig. 16.3. The original figure was evaluated with a too-large rate for \(k_{16.19}\). The figure has been redone, now also showing the result if \(\zeta_{\text{CR}} = 1 \times 10^{-17} \text{s}^{-1}\):  

![Figure 16.3](image_url)  

**Figure 16.3** Fractional ionization in a dark cloud, estimated using Eq. (16.25), with the grain recombination rate coefficients set to \(k_{16.20} = k_{16.22} = 10^{-14} \text{cm}^3 \text{s}^{-1}\) (see Fig. 14.6). The dashed line is a simple power-law approximation \(x_e \approx 2 \times 10^{-5} (n_H / \text{cm}^{-3})^{-1/2}\).

noted 2013.03.05.

- §17.3, p. 195, footnote 3, typos:
  ...frequency \(\sim 8 \times 10^{10} \text{Hz}... \rightarrow \) ...frequency \(\sim 1.1 \times 10^{10} \text{Hz}...\)
  ...\(\sim 10^2\) precession periods. \(\rightarrow \) ...\(\sim 18\) precession periods.
  noted 2020.10.02
• §18.5, p. 214, Eq. (18.11): Change
... $\Omega_{\text{OIII}}$ is approximately independent of $T_e$, we have

$$\frac{n(\text{O III})}{n(\text{H}^+)} = C \frac{I(\text{O III}5008)}{I(\text{H}\beta)} T_4^{-0.37} e^{2.917/T_4},$$

(18.11)

to
... $\Omega_{\text{OIII}} \propto T_4^{0.12}$ (see Appendix F), we have

$$\frac{n(\text{O III})}{n(\text{H}^+)} = C \frac{I(\text{O III}5008)}{I(\text{H}\beta)} T_4^{-0.49} e^{2.917/T_4},$$

(18.11)

noted 2015.02.27

• §19.3, p. 222: revise value for $A_{10}$: replace

$A_{10} = 6.78 \times 10^{-8} \text{ s}^{-1} \rightarrow A_{10} = 7.16 \times 10^{-8} \text{ s}^{-1}$ (see Eq. 5.7).

noted 2013.04.17

• §19.3, p. 223: revised numbers according to revised value for $A_{10}$:


noted 2013.04.17

• §20.1, p. 229, typo just below Eq. (20.2): replace

...unit time that level $x$ will... $\rightarrow$ ...unit time the level $u$ will...

noted 2020.10.12 by Yan Liang

• §22.6, p. 256, footnote 6: the DDSCAT website has moved. Change


noted 2019.03.25

• §23.1, p. 265, typo:

lower oscillator strength $f(\text{C II}]2325 \text{ Å}) = 1.0 \times 10^{-7}$

$\rightarrow$

larger oscillator strength $f(\text{C II}]2325 \text{ Å}) = 1.0 \times 10^{-7}$

noted 2012.12.27

• §23.3.2, p. 268, typo: Si-O-Si bending mode $\rightarrow$ O-Si-O bending mode

noted 2020.10.12

• §25.3, p. 299, typo following Eq. (25.11): change

...charge $Z_{\text{gr}} = Ua$ can... $\rightarrow$ ...charge $Z_{\text{gr}} = Ua/e$ can...

noted 2021.06.25 by Yu Fung Wong.

• §26.2, p. 308, Eq. (26.23), numerical error: should read

$$\frac{\omega}{2\pi} = 4.6 \text{ GHz} \left( \frac{T_{\text{rot}}}{100 \text{ K}} \right)^{1/2} \left( \frac{0.001 \mu\text{m}}{a} \right)^{5/2}$$

(26.23)

noted 2014.06.27 by B. Jiang.
• §28.3, p. 328, 4th paragraph, typo: change distance from Θ1Ori C to the Orion Bar ionization front: \( \sim 7.8 \times 10^{18} \text{ cm} \) → \( \sim 7.8 \times 10^{17} \text{ cm} \)

noted 2020.10.26

• §29.1, p. 332, 1st paragraph, typo: \( b = 0 \rightarrow b = 90^\circ \), so that the 2nd sentence reads

\[ ... \text{vary as } N(\text{HI}, b) = N(\text{HI}, b = 90^\circ)/\sin |b| = N_0 \csc |b|, \]

noted 2012.11.04 by R. Simons.

• §31.4, p. 349, Eq. (31.24), typo: on RHS, change

\[ \frac{\pi \epsilon^2}{m_e c^2 \hbar} \sum_u f_{\ell u} \lambda_{\ell u}^3 u_\lambda f_{\text{shield}, \ell u} \rightarrow \frac{\pi \epsilon^2}{m_e c^2 \hbar} \sum_u f_{\ell u} \lambda_{\ell u}^3 u_\lambda f_{\text{shield}, \ell u} \rho_{\text{diss}, u} \]

noted 2013.04.12 by Ai-Lei Sun.

• §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

\[ -4\pi r^2 \frac{dT}{dr} \rightarrow 4\pi r^2 \frac{dT}{dr} \]

noted 2019.04.18 by G. Halevi.

• §34.4, p. 387, typo: Eq. (34.17) is off by a factor 3, and should read

\[ t_{\text{evap}} = \frac{3M}{2M} = \frac{25 \times 2.3(n_H)_{\odot} R_2^2 n_e^{1/2} e^4 \ln \Lambda}{8 \times 0.87(k T_h)^{2.5}} \]

\[ (34.17) \]

Eq. (34.18) is numerically correct, but should have shown the dependence on \( \ln \Lambda \):

\[ = 5.1 \times 10^4 \text{ yr} \left( \frac{(n_H)_{\odot}}{30 \text{ cm}^{-3}} \right) \left( \frac{R_c}{\text{pc}} \right)^2 \left( \frac{T_h}{10^7 \text{ K}} \right)^{2.5} \left( \frac{\ln \Lambda}{30} \right). \]

\[ (34.18) \]

noted 2013.01.05 by B. Hensley.

• §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

\[ \left\{ \frac{\rho v^2}{2} + \frac{\gamma p}{\gamma - 1} \right\} v_x + \frac{(B_y^2 + B_z^2)}{4\pi} v_x - \frac{(B_y v_y + B_z v_z)}{4\pi} - \kappa \frac{dT}{dx} \right\} = \]
\[
\left\{ \frac{\rho v^2}{2} + \frac{\gamma p}{\gamma - 1} \right\} v_x + \frac{(B_y^2 + B_z^2)}{4\pi} v_x - \frac{(B_y B_y + B_z B_z)}{4\pi} + \kappa \frac{dT}{dx} \right\}_2. \tag{36.10}
\]

- §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):
  \( Jh\nu/c = \rho_1 u_1 h\nu/\mu_i c \ll \rho_1 (u_1^2 + e_1^2 + B_1^2/8\pi). \)
  →
  \( Jh\nu/c = \rho_1 u_1 h\nu/\mu_i c \ll \rho_1 (u_1^2 + e_1^2) + B_1^2/8\pi. \)
  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

  \[
  u_R \approx 2c_2 \quad \rightarrow \quad u_R \approx 2c_2 \left[ 1 - \frac{2c_2^2 - 3v_{A_1}^2}{8c_2^4} \right]
  \]

  \[
  x_R \approx \frac{1}{2} + \frac{2c_1^2 + v_{A_1}^2}{16c_2^2} \quad \rightarrow \quad x_R \approx \frac{1}{2}
  \]

  \[
  u_D \approx \frac{2c_1^2 + v_{A_1}^2}{4c_2} \quad \rightarrow \quad u_D \approx \frac{2c_1^2 + v_{A_1}^2}{4c_2} \left[ 1 + \frac{2c_1^2 + v_{A_1}^2}{8c_2^4} \right]
  \]

  \[
  x_D \approx \frac{4c_1^2}{2c_1^2 + v_{A_1}^2} \quad \rightarrow \quad x_D \approx \frac{4c_1^2}{2c_1^2 + v_{A_1}^2} \left[ 1 - \frac{v_{A_1}^2}{8c_2^4} \right]
  \]
  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,...
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:

  $$v_s \approx V_i .$$  \hfill (37.21)

  →

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

  $$V_s \approx V_i .$$  \hfill (37.21)

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

• §39.1.2, p. 433, Eqs. (39.22, 39.23, 39.24), typos: the factor \( \left( \frac{E_{51}}{n_0^0} \right) \) should be \( \left( \frac{E_{51}}{n_0^0} \right) \), so that the equations should read
  \[
  v_s(t_{\text{rad}}) = 188 \text{ km s}^{-1} \left( \frac{E_{51}}{n_0^0} \right)^{0.07},
  \]
  \[
  T_s(t_{\text{rad}}) = 4.86 \times 10^{5} \text{ K} \left( \frac{E_{51}}{n_0^0} \right)^{0.13},
  \]
  \[
  kT_s(t_{\text{rad}}) = 41 \text{ eV} \left( \frac{E_{51}}{n_0^0} \right)^{0.13}.
  \]
  noted 2012.10.02 by G.B. Field.

• §39.4, p. 438, Eqs. (39.35) and (39.36), typos: they should read
  \[
  N_{\text{SN}} = 0.24 S_{-13} E_{51}^{1.26} n_0^{-1.47} \rho_4^{-1.30}, \quad p_4 = \frac{p/k}{10^4 \text{ cm}^{-3} \text{ K}}
  \]
  noted 2014.06.27 by B. Jiang.

• §39.4, p. 438, Eq. (39.37), typos: Eq. (39.37) should read
  \[
  \frac{p}{k} = S_{-13} E_{51}^{0.97} n_0^{-0.13} \times 5700 \text{ cm}^{-3} \text{ K}
  \]
  noted 2014.06.27 by B. Jiang.

• §40.5, p. 447, typo: protons with \( E \lesssim 10^5 \text{ GeV} \) have \( R_{\text{gyro}} < 10^{-4} \text{ pc} \) → protons with \( E \lesssim 10^3 \text{ GeV} \) have \( R_{\text{gyro}} < 10^{-4} \text{ pc} \)
  noted 2011.04.26

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

• §41.3.2, p. 457, Eq. (41.46), typo: replace
  \[
  E_{\text{mag}} = \frac{B_{\text{rms}}^2 - B_0^2}{8\pi} V \to E_{\text{mag}} = \frac{B_{\text{rms}}^2}{8\pi} V
  \]
  noted 2011.04.28

• §41.4, p. 460, Eq. (41.55), typo: \( m_m \to m_n \)
  noted 2013.04.30 by K. Silsbee
• Appendix A, p. 473, typo: entry for $a_0$ should read
...Bohr radius $\equiv \hbar^2/m_e e^2 =...$
noted 2013.03.05 by Wenhua Ju.

• Appendix B, p. 476: typo: incorrect units for Stefan-Boltzmann constant $\sigma$:
$5.67040 \times 10^{-5} \text{erg s}^{-1} \text{cm}^{-3} \text{K}^{-4} \rightarrow 5.67040 \times 10^{-5} \text{erg s}^{-1} \text{cm}^{-2} \text{K}^{-4}$
noted 2019.05.14 by Aaron Tran.

• Appendix D, p. 481: corrected typos:
  FVI $\rightarrow$ 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 V $\rightarrow$ 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 E, p. 495: $^2\text{D}^o_{3/2,5/2}$ energy levels were misplotted for S II and Ar IV.
noted 2013.10.21 by Bon-Chul Koo.
Corrected figure [Opportunity taken to update energy Ar IV energy levels using latest values from NIST Atomic Spectra Database (ver. 5.1 [Online])]:

• Appendix F, Table F.2, p. 497, typo: the first transition listed for S III: change
$^3\text{P}_0 \rightarrow ^3\text{P}_1 \rightarrow ^3\text{P}_0 \rightarrow ^3\text{P}_1$
noted 2016.10.03 by C.D. Kreisch.
• Appendix F, Table F.3, p. 498: updated electron collision strengths for O I:

<table>
<thead>
<tr>
<th>Ion</th>
<th>( \ell - u )</th>
<th>( \Omega_{\ell u} )</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>O I</td>
<td>(^3P_2 - ^3P_1)</td>
<td>0.0105 ( T_4^{0.4861+0.0054 \ln T_4} )</td>
<td>a</td>
</tr>
<tr>
<td>&quot;</td>
<td>(^3P_2 - ^3P_0)</td>
<td>0.00459 ( T_4^{0.4507-0.0066 \ln T_4} )</td>
<td>a</td>
</tr>
<tr>
<td>&quot;</td>
<td>(^3P_1 - ^3P_0)</td>
<td>0.00015 ( T_4^{0.4709-0.1396 \ln T_4} )</td>
<td>a</td>
</tr>
<tr>
<td>&quot;</td>
<td>(^3P_J - ^1D_2)</td>
<td>0.0312 ( (2J+1) T_4^{0.945-0.001 \ln T_4} )</td>
<td>b</td>
</tr>
<tr>
<td>&quot;</td>
<td>(^3P_J - ^1S_0)</td>
<td>0.00353 ( (2J+1) T_4^{1.000-0.135 \ln T_4} )</td>
<td>b</td>
</tr>
<tr>
<td>&quot;</td>
<td>(^3D_2 - ^1S_0)</td>
<td>0.0893 ( T_4^{0.662-0.089 \ln T_4} )</td>
<td>b</td>
</tr>
</tbody>
</table>

... 

a fit to Bell et al. (1998) 

b fit to Zatsarriny & Tayal (2003) 

noted 2015.02.27

• 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

| H   | CI   | \(^3P_0 - ^3P_1\) | 1.26 \times 10^{-10} T_2^{0.115+0.057 \ln T_2} | b |
| H   | CI   | \(^3P_0 - ^3P_2\) | 8.90 \times 10^{-11} T_2^{0.228+0.046 \ln T_2} | b |
| H   | CI   | \(^3P_1 - ^3P_2\) | 2.64 \times 10^{-10} T_2^{0.231+0.046 \ln T_2} | b |

noted 2015.07.03 by Munan Gong.

• Appendix F, Table F.6, p. 501: the rates for entries 23-28 should be changed to

| H_2(\text{para}) O I | \(^3P_2 - ^3P_1\) | 1.49 \times 10^{-10} T_2^{0.369-0.026 \ln T_2} | h |
| H_2(\text{ortho}) O I | \(^3P_2 - ^3P_1\) | 1.37 \times 10^{-10} T_2^{0.395-0.005 \ln T_2} | h |
| H_2(\text{para}) O I | \(^3P_2 - ^3P_0\) | 2.37 \times 10^{-10} T_2^{0.255+0.016 \ln T_2} | h |
| H_2(\text{ortho}) O I | \(^3P_2 - ^3P_0\) | 2.23 \times 10^{-10} T_2^{0.284+0.035 \ln T_2} | h |
| H_2(\text{para}) O I | \(^3P_1 - ^3P_0\) | 2.10 \times 10^{-12} T_2^{1.117+0.070 \ln T_2} | h |
| H_2(\text{ortho}) O I | \(^3P_1 - ^3P_0\) | 3.00 \times 10^{-12} T_2^{0.792+0.188 \ln T_2} | h |

noted 2015.08.24 by E.B. Jenkins.

• Appendix G, p. 503, typo just before Eq. (G.7): change 

...solution \( x_0 = e^{-i\omega t} \) \rightarrow ...solution \( x_0 e^{-i\omega t} \). 

noted 2019.02.11

• Appendix I, p. 506, typo: ...a time \( ~E_{\ell} / h \rightarrow ...a\ time \sim h / E_{\ell} \)

noted 2013.02.07 by Munan Gong.

• Appendix I, p. 507, typo (15.78-31.56): Eq. (I.7) should read

\[
\frac{Z e^2}{a_0 kT} = \frac{31.56Z}{T_4}
\]

noted 2019.01.14.
• Appendix J, p. 510, Eq. (J.8): missing sign:

\[ Y_3 = E_{\text{grav}} = \frac{1}{2} \int dV_1 \int dV_2 G \frac{\rho(r_1) \rho(r_2)}{|r_1 - r_2|} \]

\[ \rightarrow \]

\[ Y_3 = E_{\text{grav}} = -\frac{1}{2} \int dV_1 \int dV_2 G \frac{\rho(r_1) \rho(r_2)}{|r_1 - r_2|} \]

noted 2020.11.13

• Appendix J, p. 510, Eq. (J.13), typo:

\[ \Pi_0 \equiv \oint dS \cdot r_p \quad \rightarrow \quad \Pi_0 \equiv \frac{1}{3} \oint dS \cdot r_p \]

noted 2017.03.08.