

Physics of the Interstellar and Intergalactic Medium

Errata in the second and third printings.

Updated 2024.12.08

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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 $N_{\rm P}/N_{\rm H} = 3.23\times10^{-7\pm0.03}$, $M_{\rm P}/M_{\rm H} = 1.00\times10^{-5}$ to $N_{\rm P}/N_{\rm H} = 2.82\times10^{-7\pm0.03}$, $M_{\rm P}/M_{\rm H} = 8.73\times10^{-6}$
  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

$$\sigma_{{\rm rr},u\ell}(E) = \frac{1}{2}\frac{g(X_\ell)}{g(X_u^+)}\frac{(I_{X,\ell u}+E)^2}{Em_ec^2}\sigma_{{\rm pi},\ell u}(h\nu = I_{X,\ell u}+E) \quad , \qquad (3.31)$$

  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

$$I_{n\alpha} \propto A_{n\alpha}h\nu_{n\alpha}\int n[{\rm H}(n)]ds \propto n^{-6}b_n\int n_en({\rm H}^+)ds$$

$$\rightarrow I_{n\alpha} \propto A_{n\alpha}h\nu_{n\alpha}\int n[{\rm H}(n+1)]ds \propto n^{-6}b_{n+1}\int n_en({\rm H}^+)ds$$

  noted 2019.02.06

- §5.2.2, p. 50, 3rd paragraph, typos: change
  para-H_2O must have $K_{-1}+K_{+1}$ odd →
  para-H_2O must have $K_{-1}+K_{+1}$ even
  and
  ortho-H_2O must have $K_{-1}+K_{+1}$ even →
  ortho-H_2O 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_ℓ. Should read
$$\kappa_\nu = n_\ell \sigma_{\ell\to u}\left(1-\frac{n_u/g_u}{n_\ell/g_\ell}\right) < 0$$
noted 2020.10.12 by Yan Liang.

- §8.3, p. 74, Eq. (8.26), typos: $T_A^{\rm on}(v) \to T_A^{\rm off}(v)$ (two occurrences).
noted 2013.02.14 by Munan Gong.

- §9.8, p. 84, typo in line following Eq. (9.35): change
$(v_{\rm FWHM}/2\,{\rm km\,s^{-1}})^2/3 \;\;\to\;\; (v_{\rm FWHM}/2\,{\rm km\,s^{-1}})^{2/3}$.
noted 2020.09.09 by Roohi Dalal.

- §9.10, Table 9.4, p. 88, typos: for C II and N III, change $^2{\rm D}^o_J \to {}^2{\rm D}_J$ 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
$\to$
...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
$$j_{{\rm fb},\nu} = \frac{g_{\rm b}}{g_e g_i}\frac{2\,h^4\nu^3}{(2\pi m_e kT)^{3/2}c^2}\,{\rm e}^{(I_{\rm b}-h\nu)/kT}\,\sigma_{\rm b,pi}(\nu)n_e n_i$$
noted 2021.02.14 by Shigenobu Hirose.

- §11.4, p. 110, Eq. (11.35) should read
$$\nu \ll \frac{e^2(\Delta n_e)_{L,{\rm rms}}}{2\pi m_e c}\,(2LD)^{1/2} = 1{\times}10^3\,{\rm GHz}\frac{(\Delta n_e)_{L,{\rm rms}}}{10^{-3}\,{\rm cm^{-3}}}\left(\frac{L}{10^{14}\,{\rm cm}}\frac{D}{\rm kpc}\right)^{1/2}.$$
noted 2013.02.03 by W. Vlemmings.

- §11.4, p. 110, Eq. (11.34), typo (was off by factor 10^4): should read
$$= 6.53\times10^{-5}\,{\rm arcsec}\left(\frac{D/\,{\rm kpc}}{L/10^{14}\,{\rm cm}}\right)^{1/2}\frac{(\Delta n_e)_{L,{\rm rms}}}{10^{-3}\,{\rm cm^{-3}}}\nu_9^{-2}$$
noted 2021.10.25 by I. Wasserman.

- §12, p. 121, Table 12.1, typos:

CMB, $T=2.725\,{\rm K}$	:	$4.19{\times}10^{-13}$	$\to$	4.17×10^{-13}
$T_2=4000\,{\rm K}$, $W_2=1.65{\times}10^{-13}$	:	$3.19{\times}10^{-13}$	$\to$	$3.20{\times}10^{-13}$
$T_3=7500\,{\rm K}$, $W_3=1{\times}10^{-14}$	:	$2.29{\times}10^{-13}$	$\to$	$2.39{\times}10^{-13}$
Starlight total	:	$1.05{\times}10^{-12}$	$\to$	$1.06{\times}10^{-12}$
ISRF total	:	$2.19{\times}10^{-12}$	$\to$	$1.98{\times}10^{-12}$.

noted 2012.11.08

- §12.5, p. 123, below eq. (12.4): change
  ...W_1 by 40%, from $W_1 = 5\times10^{-13}$ to 7×10^{-13}. $\rightarrow$
  ...W_1 by 75%, from $W_1 = 4\times10^{-13}$ to 7×10^{-13}, and raised W_2 from 1.0×10^{-13} to 1.65×10^{-13}.
  noted 2014.11.11 by S. Bianchi.

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

- §13.1, p. 130, second paragraph, typo:
  ...to $3\times10^{-10}\,{\rm s}^{-1}$ for Si $\rightarrow$ ...to $3\times10^{-9}\,{\rm s}^{-1}$ for Si
  noted 2017.03.05

- §14.2.4, p. 145, Eq. (14.13), typo (was off by factor of 10): should read

$$\tau_0({\rm Ly}\alpha) = 8.02\times10^3 \left(\frac{15\,{\rm km\,s}^{-1}}{b}\right) \tau({\rm Ly\,cont})$$

  noted 2024.06.11 by D. Chernoff.

- §14.6, p. 154, Table 14.8 update: replace
  $H_3^+ + e^- \rightarrow H_2 + H$ $\quad 1.1\times10^{-7}T_2^{-0.56}$ McCall et al. (2004)
  with
  $H_3^+ + e^- \rightarrow H + H + H$ $\quad 8.9\times10^{-8}T_2^{-0.48}$ McCall et al. (2004)
  $H_3^+ + e^- \rightarrow H_2 + H$ $\quad 5.0\times10^{-8}T_2^{-0.48}$ McCall et al. (2004)
  noted 2013.04.03

- §14.7.1, p. 156, Eq. (14.21), typo:
  $${\rm H}(^1{\rm S}_{1/2}) \rightarrow {\rm H}(^2{\rm S}_{1/2})$$
  noted 2022.07.06 by S. R. Kulkarni.

- §14.9, p. 159, typo: factor of 2 error. Eq. (14.41) should read

$$\sigma_{\rm rr}(E) = \frac{g_\ell}{2g_u}\frac{(I+E)^2}{Em_ec^2}\sigma_{\rm pi}(h\nu = I+E) \quad . \qquad (14.41)$$

  noted 2015.06.01 by E. B. Jenkins.

- §14.9, p. 160, typo: factor of 2 error. Eq. (14.43) should read

$$\frac{\langle\sigma v\rangle_{\rm rr}}{\langle\sigma v\rangle_{\rm ci}} \approx 2\pi\alpha^3\frac{f_{\rm pi}}{C}\frac{I}{kT}e^{I/kT} \quad , \qquad (14.43)$$

  noted 2015.06.01 by E. B. Jenkins.

- §14.9, p. 160, typo: factor of 2 error. Eq. (14.44) and following should read

$$\frac{I}{kT}e^{I/kT} = \frac{C}{2\pi f_{\rm pi}}\frac{1}{\alpha^3} \quad . \qquad (14.44)$$

  If $C \approx 1$ and $f_{\rm pi} \approx 1$, 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: $38.0 \to 28.0$
  noted 2013.01.31

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

- §16.4, p. 186, Eq. (16.9, 16.10), update: change

$$\mathrm{H}_3^+ + e^- \to \mathrm{H}_2 + \mathrm{H} \quad , \quad k_{16.9} = 4.1\times10^{-8}T_2^{-0.52}\,\mathrm{cm}^3\,\mathrm{s}^{-1} \;,$$
$$\mathrm{H}_3^+ + e^- \to \mathrm{H} + \mathrm{H} + \mathrm{H} \quad , \quad k_{16.10} = 7.7\times10^{-8}T_2^{-0.52}\,\mathrm{cm}^3\,\mathrm{s}^{-1} \;,$$

  to

$$\mathrm{H}_3^+ + e^- \to \mathrm{H}_2 + \mathrm{H} \quad , \quad k_{16.9} = 5.0\times10^{-8}T_2^{-0.48}\,\mathrm{cm}^3\,\mathrm{s}^{-1} \;,$$
$$\mathrm{H}_3^+ + e^- \to \mathrm{H} + \mathrm{H} + \mathrm{H} \quad , \quad k_{16.10} = 8.9\times10^{-8}T_2^{-0.48}\,\mathrm{cm}^3\,\mathrm{s}^{-1} \;,$$

  and cite McCall 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
  $x_e \approx x_M \approx 1.9\times10^{-4} \quad \to \quad x_e \approx x_M \approx 1.1\times10^{-4}$ (see Eq. 16.3)
  noted 2013.04.04

- §16.5, p. 188, Eq. (16.16), typo: should read

$$\mathrm{H}_2 + \mathrm{CR} \to \mathrm{H}_2^+ + e^- + \mathrm{CR}$$

  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 $\zeta_\mathrm{CR} = 1\times10^{-17}\,\mathrm{s}^{-1}$:

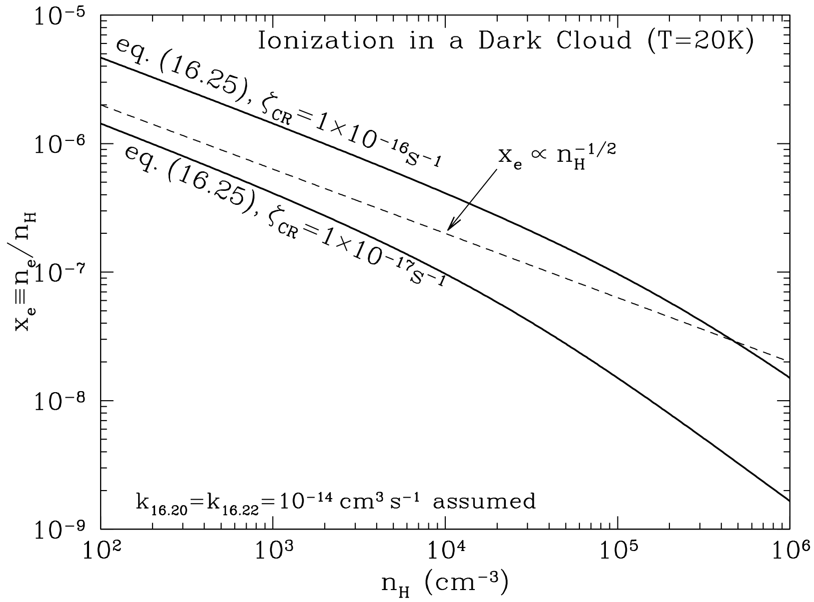


Figure 16.3 Fractional ionization in a dark cloud, estimated using Eq. (16.25), with the grain recombination rate coefficients set to $k_{16.20} = k_{16.22} = 10^{-14}\,\mathrm{cm}^3\,\mathrm{s}^{-1}$ (see Fig. 14.6). The dashed line is a simple power-law approximation $x_e \approx 2\times 10^{-5}(n_\mathrm{H}/\,\mathrm{cm}^{-3})^{-1/2}$.

noted 2013.03.05.

- §17.3, p. 195, footnote 3, typos:
  ...frequency $\sim 8\times10^{10}$ Hz... → ...frequency $\sim 1.1\times10^{10}$ Hz...
  ...$\sim 10^2$ precession periods. → ...~ 18 precession periods.
  noted 2020.10.02

- §18.5, p. 214, Eq. (18.11): Change
  ... Ω_{03} is approximately independent of T_e, we have

$$\frac{n(\mathrm{O\,III})}{n(\mathrm{H}^+)} = C\frac{I([\mathrm{O\,III}]5008)}{I(\mathrm{H}\beta)} T_4^{-0.37} \mathrm{e}^{2.917/T_4}\ , \qquad (18.11)$$

  to
  ... $\Omega_{03} \propto T_4^{0.12}$ (see Appendix F), we have

$$\frac{n(\mathrm{O\,III})}{n(\mathrm{H}^+)} = C\frac{I([\mathrm{O\,III}]5008)}{I(\mathrm{H}\beta)} T_4^{-0.49} \mathrm{e}^{2.917/T_4}\ , \qquad (18.11)$$

  noted 2015.02.27

- §19.3, p. 222: revise value for A_{10}: replace
  $A_{10} = 6.78\times10^{-8}\,\mathrm{s}^{-1} \to A_{10} = 7.16\times10^{-8}\,\mathrm{s}^{-1}$ (see Eq. 5.7).
  noted 2013.04.17

- §19.3, p. 223: revised numbers according to revised value for A_{10}:
  Eq. (19.15): $281 \rightarrow 297$, Eq. (19.17): $281 \rightarrow 297$, Eq. (19.19): $46 \rightarrow 50$
  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
  http://code.google.com/p/ddscat $\rightarrow$ http://www.ddscat.org
  noted 2019.03.25

- §23.1, p. 265, typo:
  lower oscillator strength $f(\mathrm{C\,II}]2325\,\text{Å}) = 1.0 \times 10^{-7}$
  $\rightarrow$
  larger oscillator strength $f(\mathrm{C\,II}]2325\,\text{Å}) = 1.0 \times 10^{-7}$
  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 $Z_{\rm gr} = Ua$ can... $\rightarrow$ ...charge $Z_{\rm gr} = Ua/e$ can...
  noted 2021.06.25 by Yu Fung Wong.

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

$$\frac{\omega}{2\pi} = 4.6\,\mathrm{GHz}\left(\frac{T_{\rm rot}}{100\,\mathrm{K}}\right)^{1/2}\left(\frac{0.001\,\mu\mathrm{m}}{a}\right)^{5/2} \tag{26.23}$$

  noted 2014.06.27 by B. Jiang.

- §27.3.1, p 320, typos in coefficient of $\ln(T_4/Z^2)$ term: Eq. (27.19) and (27.20) should read

$$\gamma_A = -1.2130 - 0.0115\ln(T_4/Z^2) \tag{27.19}$$
$$\gamma_B = -1.3163 - 0.0208\ln(T_4/Z^2) \tag{27.20}$$

  and (27.22) and (27.23) should read

$$\langle E_{\rm rr}\rangle_A = \left[0.787 - 0.0115\ln(T_4/Z^2)\right] kT \tag{27.21}$$
$$\langle E_{\rm rr}\rangle_B = \left[0.684 - 0.0208\ln(T_4/Z^2)\right] kT \tag{27.22}$$

  noted 2023.01.29 by S. R. Kulkarni.

- §28.3, p. 328, 4th paragraph, typo: change distance from Θ_1Ori C to the Orion Bar ionization front: $\sim 7.8\times10^{18}\,\mathrm{cm}$ $\rightarrow$ $\sim 7.8\times10^{17}\,\mathrm{cm}$
  noted 2020.10.26

- §29.1, p. 332, 1st paragraph, typo: $b=0 \rightarrow b=90°$, so that the 2nd sentence reads
  ...vary as $N(\mathrm{H\,I}, b) = N(\mathrm{H\,I}, b = 90°)/\sin|b| = N_0 \csc|b|$.
  noted 2012.11.04 by R. Simons.

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

$$\frac{\pi e^2}{m_e c^2 h}\sum_u f_{\ell u}\lambda_{\ell u}^3 u_\lambda f_{\mathrm{shield},\ell u} \rightarrow \frac{\pi e^2}{m_e c^2 h}\sum_u f_{\ell u}\lambda_{\ell u}^3 u_\lambda f_{\mathrm{shield},\ell u}\, p_{\mathrm{diss},u}$$

  noted 2013.04.12 by Ai-Lei Sun.

- §32.9, p. 368, just before eq. (32.11), typo: change
  $A_V/N_\mathrm{H} = 1.87\times10^{21}\,\mathrm{cm}^2 \;\rightarrow\; A_V/N_\mathrm{H} = 5.3\times10^{-22}\mathrm{mag\,cm}^2$.
  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

$$-4\pi r^2\kappa\frac{dT}{dr} \quad\rightarrow\quad 4\pi r^2\kappa\frac{dT}{dr}$$

  noted 2019.04.18 by G. Halevi.

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

$$t_\mathrm{evap} = \frac{3M}{2\dot{M}} = \frac{25\times2.3(n_\mathrm{H})_c R_c^2 m_e^{1/2} e^4 \ln\Lambda}{8\times0.87(kT_h)^{2.5}} \qquad (34.17)$$

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

$$= 5.1\times10^4\,\mathrm{yr}\left(\frac{(n_\mathrm{H})_c}{30\,\mathrm{cm}^{-3}}\right)\left(\frac{R_c}{\mathrm{pc}}\right)^2\left(\frac{T_h}{10^7\,\mathrm{K}}\right)^{-2.5}\left(\frac{\ln\Lambda}{30}\right) . \qquad (34.18)$$

  noted 2013.01.05 by B. Hensley.

- §36.2.3, p. 400, Eq. (36.10): v_x multiplying B_yB_x should be v_y, and v_x multiplying B_zB_x should be v_z.
  noted 2015.12.17 by J. Miralda-Escudé.
  The equation should read

$$\left\{\left[\frac{\rho v^2}{2}+\frac{\gamma p}{(\gamma-1)}\right]v_x + \frac{(B_y^2+B_z^2)}{4\pi}v_x - \frac{(B_xB_yv_y+B_xB_zv_z)}{4\pi} - \kappa\frac{dT}{dx}\right\}_1 =$$

$$\left\{\left[\frac{\rho v^2}{2}+\frac{\gamma p}{(\gamma-1)}\right]v_x + \frac{(B_y^2+B_z^2)}{4\pi}v_x - \frac{(B_xB_yv_y+B_xB_zv_z)}{4\pi} - \kappa\frac{dT}{dx}\right\}_2 . \qquad (36.10)$$

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

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

- §37.1, Eq. (37.8): The correction terms for $u_{\rm R}$, $x_{\rm R}$, $u_{\rm D}$, and $x_{\rm D}$ can be improved by analyzing the full cubic equation (37.3): change

$$u_{\rm R} \approx 2c_2 \quad \rightarrow \quad u_{\rm R} \approx 2c_2\left[1 - \frac{2c_1^2 - 3v_{A1}^2}{8c_2^2}\right]$$

$$x_{\rm R} \approx \frac{1}{2} + \frac{2c_1^2 + v_{A1}^2}{16c_2^2} \quad \rightarrow \quad x_{\rm R} \approx \frac{1}{2}$$

$$u_{\rm D} \approx \frac{2c_1^2 + v_{A1}^2}{4c_2} \quad \rightarrow \quad \frac{2c_1^2 + v_{A1}^2}{4c_2}\left[1 + \frac{2c_1^2 + v_{A1}^2}{8c_2^2}\right]$$

$$x_{\rm D} \approx \frac{4c_2^2}{2c_1^2 + v_{A1}^2} \quad \rightarrow \quad x_{\rm D} \approx \frac{4c_2^2}{2c_1^2 + v_{A1}^2}\left[1 - \frac{v_{A1}^2}{8c_2^2}\right]$$

  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...
    $\rightarrow$
    ...are called **weak R-type**. Weak R-type solutions...
  - §37.1.1, p. 414, second paragraph:
    ...referred to as **weak R-type**,... $\rightarrow$ ...referred to as **strong R-type**,...
  - §37.1.1, p. 414, second paragraph:
    Hence, only strong R-type I-fronts are physically relevant.
    $\rightarrow$
    Hence, only weak R-type I-fronts are physically relevant.
  - §37.1.2, p. 414, first paragraph:
    ...is termed **weak D-type**. $\rightarrow$ ...is termed **strong D-type**.
  - §37.1.2, p. 414, second paragraph:
    ...is termed **strong D-type**. $\rightarrow$ ...is termed **weak D-type**.
  - Fig. 37.1 and caption should be:

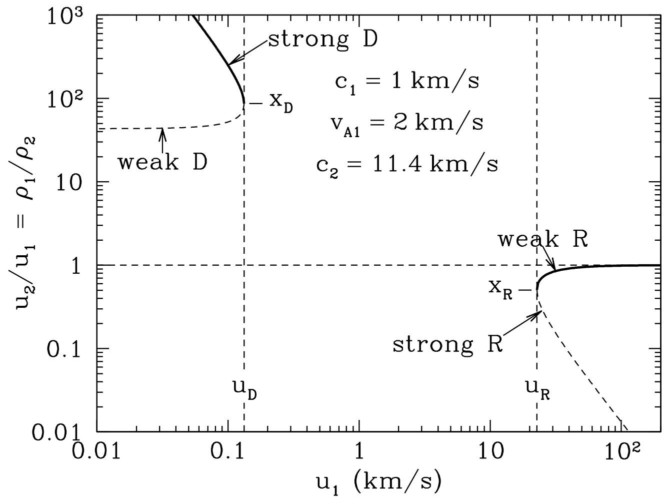


Figure 37.1 $u_2/u_1 = \rho_1/\rho_2$, as a function of the velocity u_1 of the I-front relative to the neutral gas just ahead of the I-front, for D-type and R-type ionization front solutions (see text) for an example with $c_1 = 1\,{\rm km\,s^{-1}}$, $v_{A1} = 2\,{\rm km\,s^{-1}}$, and $c_2 = 11.4\,{\rm km\,s^{-1}}$. 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 $u_{\rm D}$ and $u_{\rm R}$.

- §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:

$$v_s \approx V_i \quad . \tag{37.21}$$

→

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

$$V_s \approx V_i \quad . \tag{37.21}$$

noted 2016.12.08 by Ryohei Nakatani.

- §38.3, p. 428, last paragraph, typo:
  $\dot{M}_w \approx 2 \times 10^{-5}\,{\rm km\,s^{-1}} \rightarrow \dot{M}_w \approx 2 \times 10^{-5}\,M_\odot\,{\rm yr}^{-1}$
  noted 2015.12.17 by J. Miralda-Escudé.

- §39.1.2, p. 433, Eqs. (39.22, 39.23, 39.24), typos: the factor (E_{51}/n_0^2) should be $(E_{51}n_0^2)$, so that the equations should read

$$v_s(t_{\rm rad}) = 188\,{\rm km\,s^{-1}}(E_{51}n_0^2)^{0.07} \quad , \tag{39.22}$$
$$T_s(t_{\rm rad}) = 4.86\times10^5\,{\rm K}(E_{51}n_0^2)^{0.13} \quad , \tag{39.23}$$
$$kT_s(t_{\rm rad}) = 41\,{\rm eV}(E_{51}n_0^2)^{0.13} \quad . \tag{39.24}$$

noted 2012.10.02 by G.B. Field.

- §39.4, p. 438, Eqs. (39.35) and (39.36), typos: they should read

$$N_{\rm SN} = 0.24 S_{-13} E_{51}^{1.26} n_0^{-1.47} c_{s,6}^{-13/5} \tag{39.35}$$
$$= 0.48 S_{-13} E_{51}^{1.26} n_0^{-0.17} p_4^{-1.30} \quad , \quad p_4 \equiv \frac{p/k}{10^4\,{\rm cm^{-3}\,K}} \tag{39.36}$$

noted 2014.06.27 by B. Jiang.

- §39.4, p. 438, Eq. (39.37), typos: Eq. (39.37) should read

$$\frac{p}{k} = S_{-13}^{0.77} E_{51}^{0.97} n_0^{-0.13} \times 5700\,{\rm cm^{-3}\,K} \tag{39.37}$$

noted 2014.06.27 by B. Jiang.

- §40.5, p. 447, typo: protons with $E \lesssim 10^5$ GeV have $R_{\rm gyro} < 10^{-4}\,{\rm pc} \rightarrow$ protons with $E \lesssim 10^3$ GeV have $R_{\rm gyro} < 10^{-4}\,{\rm pc}$
noted 2011.04.26

- §41.1, p. 453, typos: Eq. (41.17) should read

$$M_{\rm J} \equiv \frac{4\pi}{3}\rho_0\left(\frac{\lambda_{\rm J}}{2}\right)^3 = \frac{\pi}{6}\left(\frac{\pi kT}{G\mu}\right)^{3/2}\frac{1}{\rho_0^{1/2}}$$
$$= 1.34\,M_\odot\left(\frac{T}{10\,{\rm K}}\right)^{3/2}\left(\frac{m_{\rm H}}{\mu}\right)^{3/2}\left(\frac{10^6\,{\rm cm^{-3}}}{n_{\rm H}}\right)^{1/2} \quad . \tag{41.17}$$

noted 2024.07.09 by Zhang Zhijun.

- §41.3, p. 456, typo: missing factor of G. Eq. (41.36) should read

$$E_{\rm grav} = -\frac{G}{2}\int dV_1 \int dV_2 \frac{\rho(\mathbf{r}_1)\rho(\mathbf{r}_2)}{|\mathbf{r}_1 - \mathbf{r}_2|} \tag{41.36}$$

noted 2015.04.30 by J. Greco.

- §41.3.2, p. 457, Eq. (41.46), typo: replace

$$E_{\rm mag} = \frac{B_{\rm rms}^2 - B_0^2}{8\pi}V \quad \rightarrow \quad E_{\rm mag} = \frac{B_{\rm rms}^2}{8\pi}V$$

noted 2011.04.28

- §41.4, p. 460, Eq. (41.55), typo: $m_m \rightarrow m_n$
  noted 2013.04.30 by K. Silsbee

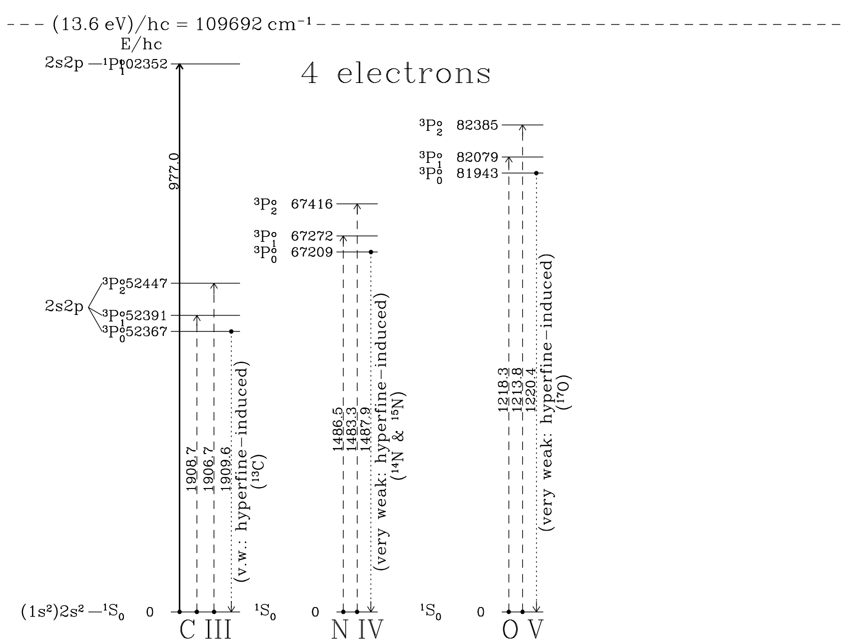
- Appendix A, p. 473, typo: entry for a_0 should read
  ...Bohr radius $\equiv \hbar^2/m_e e^2 =$...
  noted 2013.03.05 by Wenhua Ju.

- Appendix B, p. 476: typo: incorrect units for Stefan-Boltzmann constant σ:
  $5.67040\times10^{-5}\,\mathrm{erg\,s^{-1}\,cm^{-3}\,K^{-4}} \quad \rightarrow \quad 5.67040\times10^{-5}\,\mathrm{erg\,s^{-1}\,cm^{-2}\,K^{-4}}$
  noted 2019.05.14 by Aaron Tran.

- 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 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.

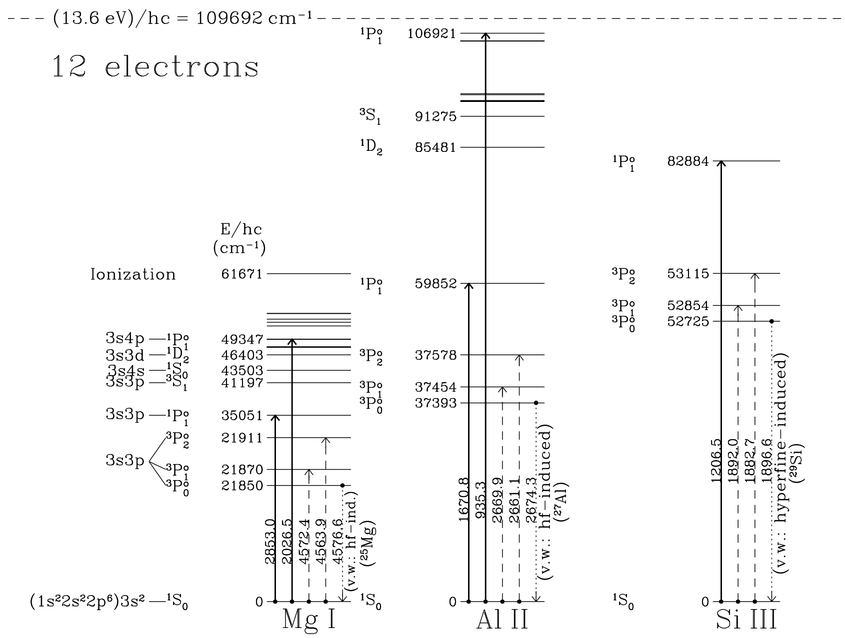
- Appendix E, p. 485: diagrams for N IV and O V: the levels shown as ${}^2\mathrm{P}^o_1$ and ${}^2\mathrm{P}^o_2$ should be ${}^3\mathrm{P}^o_1$ and ${}^3\mathrm{P}^o_2$, respectively.
  noted 2023.05.23

- Appendix E, p. 485, diagrams for C III, N IV, and O V: The weak (spin-forbidden magnetic dipole) ${}^1\mathrm{S}_0$-${}^3\mathrm{P}_2$ transitions were inadvertently omitted. Very weak ${}^1\mathrm{S}_0$-${}^3\mathrm{P}_0$ transitions occur only if hyperfine-induced by nucleus with nonzero spin (now noted in figure). Corrected figure:



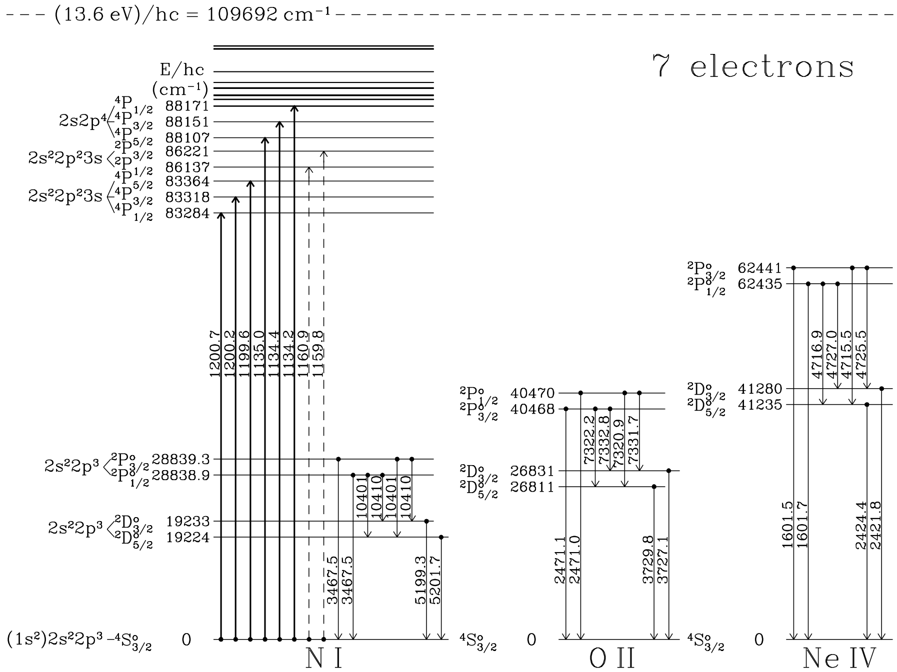
noted 2024.12.06 by S.R. Kulkarni

- Appendix E., p. 486: The weak (spin-forbidden magnetic dipole) $^1S_0$-$^3P_2$ transitions were inadvertently omitted. Very weak $^1S_0$-$^3P_0$ transitions can occur if hyperfine-induced by nuclei with nonzero spin (now noted in figure). Corrected figure:



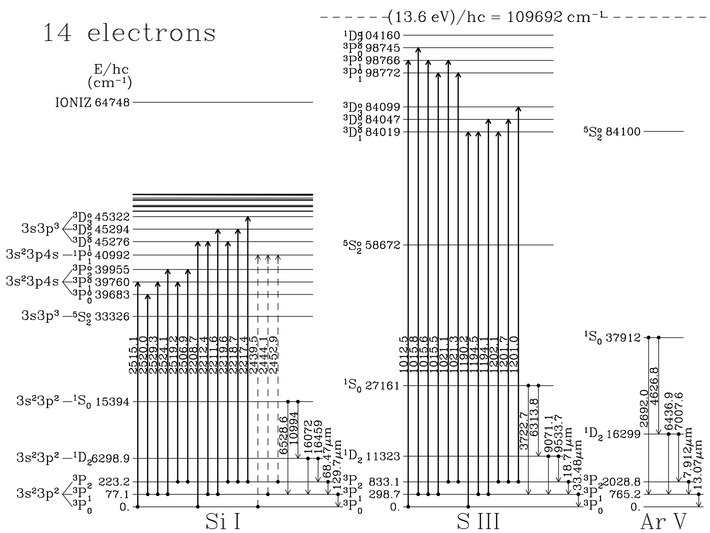
noted 2024.12.08

- Appendix E, p. 488: inadvertent omission of $^2P^o_{1/2} \rightarrow ^2D^o_{5/2}$ emission lines for N I, O II, and Ne IV. Corrected figure:



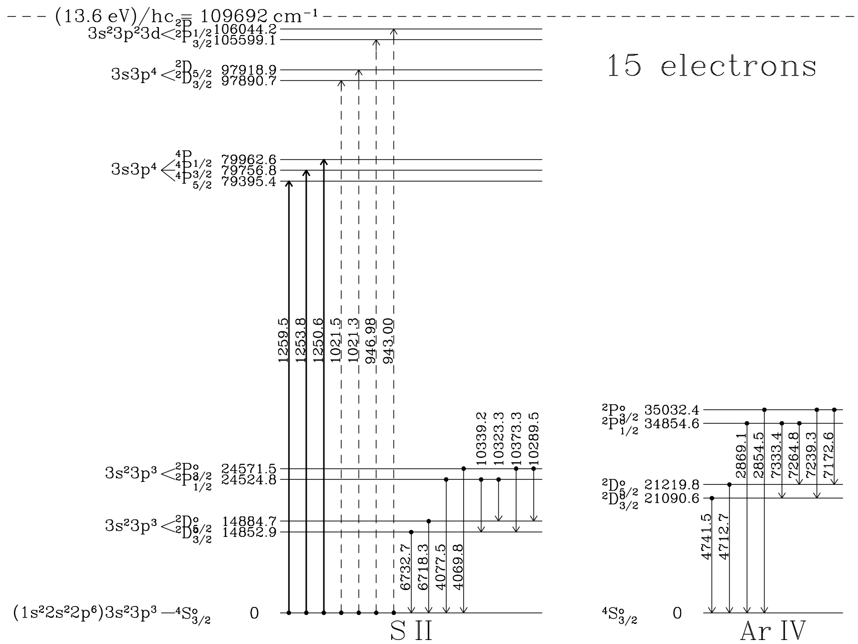
noted 2023.04.16 by S.R. Kulkarni.

- Appendix E, p. 494: inadvertent omission of ${}^1S_0 \rightarrow {}^1D_2$ emission lines for Si I and S III. Corrected figure:



noted 2023.04.16 by S.R. Kulkarni.

- Appendix E, p. 495: $^2\mathrm{D}^o_{3/2,5/2}$ 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 $^3\mathrm{P}_0$–$^1\mathrm{P}_0 \rightarrow {}^3\mathrm{P}_0$–$^3\mathrm{P}_1$
  noted 2016.10.03 by C.D. Kreisch.

- Appendix F, Table F.3, p. 498: updated electron collision strengths for O I:

Ion	$\ell - u$	$\Omega_{u\ell}$	Note
O I	$^3\mathrm{P}_2-{}^3\mathrm{P}_1$	$0.0105\, T_4^{0.4861+0.0054\ln T_4}$	*a*
”	$^3\mathrm{P}_2-{}^3\mathrm{P}_0$	$0.00459\, T_4^{0.4507-0.0066\ln T_4}$	*a*
”	$^3\mathrm{P}_1-{}^3\mathrm{P}_0$	$0.00015\, T_4^{0.4709-0.1396\ln T_4}$	*a*
”	$^3\mathrm{P}_J-{}^1\mathrm{D}_2$	$0.0312(2J+1)\, T_4^{0.945-0.001\ln T_4}$	*b*
”	$^3\mathrm{P}_J-{}^1\mathrm{S}_0$	$0.00353(2J+1)\, T_4^{1.000-0.135\ln T_4}$	*b*
”	$^1\mathrm{D}_2-{}^1\mathrm{S}_0$	$0.0893\, T_4^{0.662-0.089\ln T_4}$	*b*
		...	

  a fit to Bell et al. (1998)
  b fit to Zatsarriny & Tayal (2003)
  noted 2015.02.27

- Appendix F, Table F.5, p. 500: Level u in the fourth line in the table should be $^2\mathrm{P}^o_{3/2}$ rather than $^2\mathrm{P}^o_{5/2}$.

noted 2022.09.03 by S. R. Kulkarni

- 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	C I	$^3P_0 - {}^3P_1$	$1.26\times10^{-10}T_2^{0.115+0.057\ln T_2}$	*b*
H	C I	$^3P_0 - {}^3P_2$	$8.90\times10^{-11}T_2^{0.228+0.046\ln T_2}$	*b*
H	C I	$^3P_1 - {}^3P_2$	$2.64\times10^{-10}T_2^{0.231+0.046\ln T_2}$	*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(para)	O I	$^3P_2 - {}^3P_1$	$1.49\times10^{-10}T_2^{0.369-0.026\ln T_2}$	*h*
H_2(ortho)	O I	$^3P_2 - {}^3P_1$	$1.37\times10^{-10}T_2^{0.395-0.005\ln T_2}$	*h*
H_2(para)	O I	$^3P_2 - {}^3P_0$	$2.37\times10^{-10}T_2^{0.255+0.016\ln T_2}$	*h*
H_2(ortho)	O I	$^3P_2 - {}^3P_0$	$2.23\times10^{-10}T_2^{0.284+0.035\ln T_2}$	*h*
H_2(para)	O I	$^3P_1 - {}^3P_0$	$2.10\times10^{-12}T_2^{1.117+0.070\ln T_2}$	*h*
H_2(ortho)	O I	$^3P_1 - {}^3P_0$	$3.00\times10^{-12}T_2^{0.792+0.188\ln T_2}$	*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 $x = x_0 e^{-i\omega t}$. noted 2019.02.11

- Appendix I, p. 506, typo: ...a time $\sim E_{u\ell}/h \rightarrow$ ...a time $\sim h/E_{u\ell}$ noted 2013.02.07 by Munan Gong.

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

$$\frac{Ze^2}{a_0 kT} = \frac{31.56Z}{T_4}$$

noted 2019.01.14.

- Appendix J, p. 510, Eq. (J.8): missing sign:

$$Y_3 = E_{\rm grav} = \frac{1}{2}\int dV_1 \int dV_2\, G\, \frac{\rho(\mathbf{r}_1)\rho(\mathbf{r}_2)}{|\mathbf{r}_1 - \mathbf{r}_2|}$$

$\rightarrow$

$$Y_3 = E_{\rm grav} = -\frac{1}{2}\int dV_1 \int dV_2\, G\, \frac{\rho(\mathbf{r}_1)\rho(\mathbf{r}_2)}{|\mathbf{r}_1 - \mathbf{r}_2|}$$

noted 2020.11.13

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

$$\Pi_0 \equiv \oint d\mathbf{S}\cdot\mathbf{r}p \quad \rightarrow \quad \Pi_0 \equiv \frac{1}{3}\oint d\mathbf{S}\cdot\mathbf{r}p$$

noted 2017.03.08.