Corrections to Kippenhahn, Weigert & Weiss: Stellar structure and evolution

Like any important book, this edition requires some corrections. These range from simple misprints to issues that are perhaps more debatable. Many of them were discovered by Günter Houdek, in his use of the book for the lecture course "Advanced stellar evolution" at Aarhus University.

- **p. 25, Eq. (4.1)**: replace $d\nu$ by dv
- **p. 43, Eq. (5.29)**: replace π^6 by π^2 in the second equation.
- **p. 55, line above Eq. (6.22)**: replace 'V' by 'S'
- **p. 81, Eq. (8.28)**: This equation is not correct as it stands, even on dimensional grounds. A correct form would be to add to the diffusion equation the term
$$\frac{\partial}{\partial r}\left[D_c\frac{\partial X_i}{\partial r}\right] = \frac{\partial}{\partial r}\left[\left(\frac{1}{3}v_{\rm m}\ell_{\rm m}\right)\frac{\partial X_i}{\partial r}\right]$$
- **p. 103, Eq. (11.34)**: In the second equation 'g' should be replaced by 'G'.
- **p. 108, line below Eq. (12.4)**: Here the text talks about 'linearization' of the differential equations. Presumably 'discretization' is intended; this constitutes the approximation to the original equations. Linearization follows later, in the iterative solution of the nonlinear difference equations; this can in principle be done to any specified numerical accuracy (although in practice limited by round-off errors etc.).
- **p. 109, Fig. 12.1**: For consistency with the text, 'i' should have been used as subscript on 'A_i^1' etc. The double use of 'j' in the figure is potentially confusing.
- **p. 113, l. 4**: The size of the Henyey matrix is $(4K-2)\times(4K-2)$ (for $K=4$ as in Fig. 12.3 the matrix is 14×14), rather than $K\times K$.
- **p. 113, l. -4**: Here the equation should be $X_i^{n+1} = X_i^n + \Delta t\dot{X}_i^{n+1} = X_i^n + \Delta X_i^{n+1}$ and in the line below ΔX_i^n should correspondingly be replaced by ΔX_i^{n+1}.
- **p. 116, Eq. (12.20)**: It is perhaps a little confusing that 'M' is used here for the number of grid points, rather than 'K'.

- **p. 134, Eq. (14.36)**: Here the notation is a little confusing. The partition functions, now called u_r where r labels the ionization state, obviously also depend on the element that we consider. Thus u_r, u_{r+1} should be replaced by u_i^r, u_i^{r+1}, using a notation consistent with, e.g., χ_i^r.

- **p. 137, line below Eq. (14.43)**: Here there is a slightly confusing misplaced comma. The correct piece of text is: '... is the Bohr radius, ν the quantum number, and $n_{\rm H}$ the ... '.

- **p. 252, l. 7 from bottom of proper text**: add 'which are' after 'Those objects in Fig. 22.2'.

- **p. 260, Eq. (22.4)**: The equation should obviously be

$$\frac{dP_{\rm rad}}{dr} = \frac{4a}{3} T^3 \frac{dT}{dr}$$

  The rest of the analysis appears not to be affected by this error, however.

- **p. 295, Eq. (25.34)**: Here the first line should be

$$\frac{m_{\rm s}}{l_{\rm s}} = (m_{\rm s} d\varepsilon - dl_{\rm s}) l_{\rm s}^{-1} = \ldots$$

- **p. 301, equation just below Eq. (26.12)**: replace '$\rho 0$' by 'ρ_0'.

- **p. 330, Table 29.1**: Here the line 'Depth of conv. env.' actually gives the fractional radius at the base of the convective envelope. Thus the depth is $0.287 \pm 0.001\, R_\odot$.

- **p. 335, Fig. 29.3**: The rightmost label on the abscissa should obviously be '1.0'.

- **p. 345, Fig. 30.4**: There are problems with the labelling of the ordinate axis: the top three labels (1.0×10^3, 1.5×10^3 and 2.0×10^3) should be changed to 1.0×10^4, 1.5×10^4 and 2.0×10^4. Also, in l. -4 of the caption 'about 10^4 times larger' should be changed to 'about 10^3 times larger'.

- **p. 370, first paragraph**: Here there is a mistake in the Kelvin-Helmholz time quoted for the passage from C to D in Fig. 31.2; as is clear from the figure the appropriate time is more like 3×10^6 yr.

- **p. 380, l. 3 from bottom**: replace 'its maximum $h = 1$' by 'its minimum $h = 1$'.

- **p. 388, Fig.32.2**: It may be a little confusing that the figure shows results for two different evolutionary stages. The lines marked 'X' show the hydrogen profile in models at the end of central hydrogen burning, with the characteristic steep slope left behind by a retreating convective core. The lines marked 'Y' show the helium profile in a model roughly half-way through central helium burning. Here the growing convective core causes the discontinuous increase around $m/M = 0.1$, while the very thin hydrogen-burning shell corresponds to the decrease near $m/M = 0.2$.

- **The discussion of the red-giant bump, p. 397 – 399; Fig. 33.3**: This discussion is perhaps not completely clear, in particular with regards to the onset of the decrease in luminosity. Perhaps not surprisingly I prefer the analysis provided by Christensen-Dalsgaard (2015; *MNRAS*, **453**, 666).

- **p. 401, bottom, p. 402, top**: Here the timescale of the helium flash is underestimated. A more reasonable version of this sentence would be: 'The local luminosity l at maximum exceeds $10^{10}\, L_\odot$, comparable with that of a whole galaxy, but only for about a day'. (However, compared with the overall evolution time scales, the expression "helium flash" remains quite appropriate.)

- **p. 404, caption to Fig. 33.8**: In fact, the letters A – C bear no relation to the labelling in Figs 33.3 and 33.4. (It is only fair to point out that Thomas (1967) did not make this mistake.)

- **p. 420, 2 lines below Eq. (34.4)**: Replace 'dt' by 'dT' in $T = T_0 + dT$.

- **p. 428, last paragraph**: Here the description is a little short on the ^{13}C neutron production. The reaction

  $$^{12}\mathrm{C}(p,\gamma)^{13}\mathrm{N}(\beta^+\nu)^{13}\mathrm{C}$$

  takes place in the intershell region. Subsequently, the reaction

  $$^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$$

  takes place during the helium burning, when ^{13}C is mixed into the helium-burning region. This is described more clearly in the caption to Fig. 34.6.

- **p. 507, 6 lines from bottom**: Replace 'baryon condensates' by 'meson condensates' (since π^- and K^- are mesons).

- **pp. 562 – 564, Section 43.3**: Here there is a severe problem with the notation. The quantity 'ω' is introduced above Eq. (43.19) as $\Phi/\Phi_{\rm c}$. This should presumably have been $\Psi/\Psi_{\rm c}$. More seriously, this conflicts with the usage of 'ω' for the angular velocity. (In the original version of the book 'w' was used instead.) In the rest of the section some care is needed to ascertain which ω is intended. I shall not here attempt a detailed description of the changes required.

- **p. 566, Eq. (44.6)**: Here clearly the first '$-$' should be deleted. This follows directly from Eq. (44.5) and the definition of $\mathbf{g}_{\rm eff}$. Defining $k(\Psi)$ such that $k(\Psi) > 0$ the second equation then shows, correctly, that the flux and the gravity are in opposity directions. (Note that $\mathrm{d}T/\mathrm{d}\Psi < 0$.) However, the signs in the subsequent derivations, Eq. (44.7) and (44.28)*ff*, still need some checking.

- **p. 568, Eqs (44.10) and (44.11)**: Here '$\boldsymbol{v}$' should be replaced by '$\boldsymbol{v}\cdot$' to make clear that an inner product is involved.

- **p. 568, Eq. (44.12)**: Here the 'v' is still a vector and should be bold-face.

- **p. 569, Eq. (44.15)**: Here the last term should be 'ρc' (and the 'c' should be bold, to indicate a vector).

- **p. 569, Eq. (44.20)**: Since L_2 depends only on ϑ, in the last equation $\mathrm{d}L_2/\mathrm{d}\vartheta$ should be used.

- **p. 570, Eq. (44.25)**: This should be

  $$P_2 = -\rho_0 \Phi_2 - \frac{1}{3}\rho_0 \omega^2 r^2$$

  (I am a little unsure about the sign.) Note that the ϑ component of ∇ is $r^{-1}\partial/\partial\vartheta$, leading to the r^2 (which in any case is obviously required on dimensional grounds).

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