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Fast Be grids:

Changes to the first lines of the tables

Motivation

In order to include the fast rotating models computed by Lionel Haemmerlé in the Be grids, we need to adjust the first lines of the non-preMS models, correcting them for the abrupt decline of $\Omega/\Omega_{\rm crit}$ after the release of the solid-body rotation condition.

This allows to determine an effective $\Omega_{\rm ini}/\Omega_{\rm crit}$ for all models that is comparable with each other. However, changing $\Omega/\Omega_{\rm crit}$ only would make the models inconsistent: we have to rebuild some variables, such as $T_{\rm eff}$, R, or $V_{\rm eq}$. The method we used is explained below.

1 Correction

We define a reference line $i_{\rm ref}$, usually the one at which $\Omega/\Omega_{\rm crit}$ reaches the minimum. However, in order to keep the correction on the fewest lines possible, we do not let $i_{\rm ref}$ to be further away than 10% of the H-burning lifetime.

For all lines $i < i_{\rm ref}$, we

- keep the original values for the following variables:
  - luminosity
  $$L_{i,\rm new} = L_{i,\rm old}$$
  - Eddington factor
  $$\Gamma_{{\rm Edd},i,\rm new} = \Gamma_{{\rm Edd},i,\rm old}$$
- take the value of line $i_{\rm ref}$ for the following variables:
  - rotation ratio
  $$\left(\frac{\Omega}{\Omega_{\rm crit}}\right)_{i,\rm new} = \left(\frac{\Omega}{\Omega_{\rm crit}}\right)_{\rm ref}$$
  - oblateness
  $$\left(\frac{R_{\rm pol}}{R_{\rm eq}}\right)_{i,\rm new} = \left(\frac{R_{\rm pol}}{R_{\rm eq}}\right)_{\rm ref}$$
  - mass-loss enhancement factor
  $$F(\Omega)_{i,\rm new} = F(\Omega)_{\rm ref}$$
- rebuild the following variables:
  - effective temperature
  $$T_{{\rm eff},i,\rm new} = T_{{\rm eff},i,\rm old} \cdot \frac{\Sigma_{i,\rm old}}{\Sigma_{i,\rm new}}$$
  with Σ the normalised surface interpolated in the file AllOmegaData.dat
  - polar radius
  $$R_{{\rm pol},i,\rm new} = \sqrt{\frac{L_{i,\rm new}/\sigma T^4_{{\rm eff},i,\rm new}}{\Sigma_{i,\rm new}}}$$
  - critical angular velocity
  $$\Omega_{{\rm crit},i,\rm new} = \sqrt{\frac{GM}{\left(\frac{3}{2}R_{{\rm pol},i,\rm new}\right)^3}}$$
  - surface angular velocity
  $$\Omega_{{\rm surf},i,\rm new} = \left(\frac{\Omega}{\Omega_{\rm crit}}\right)_{\rm ref} \cdot \Omega_{{\rm crit},i,\rm new}$$

– equatorial velocity

$$V_{\mathrm{eq},i,\mathrm{new}} = R_{\mathrm{pol},i,\mathrm{new}} \cdot \left(\frac{\Omega}{\Omega_{\mathrm{crit}}}\right)_{\mathrm{ref}} \cdot \left(\frac{R_{\mathrm{eq}}}{R_{\mathrm{pol}}}\right)_{\mathrm{ref}}$$

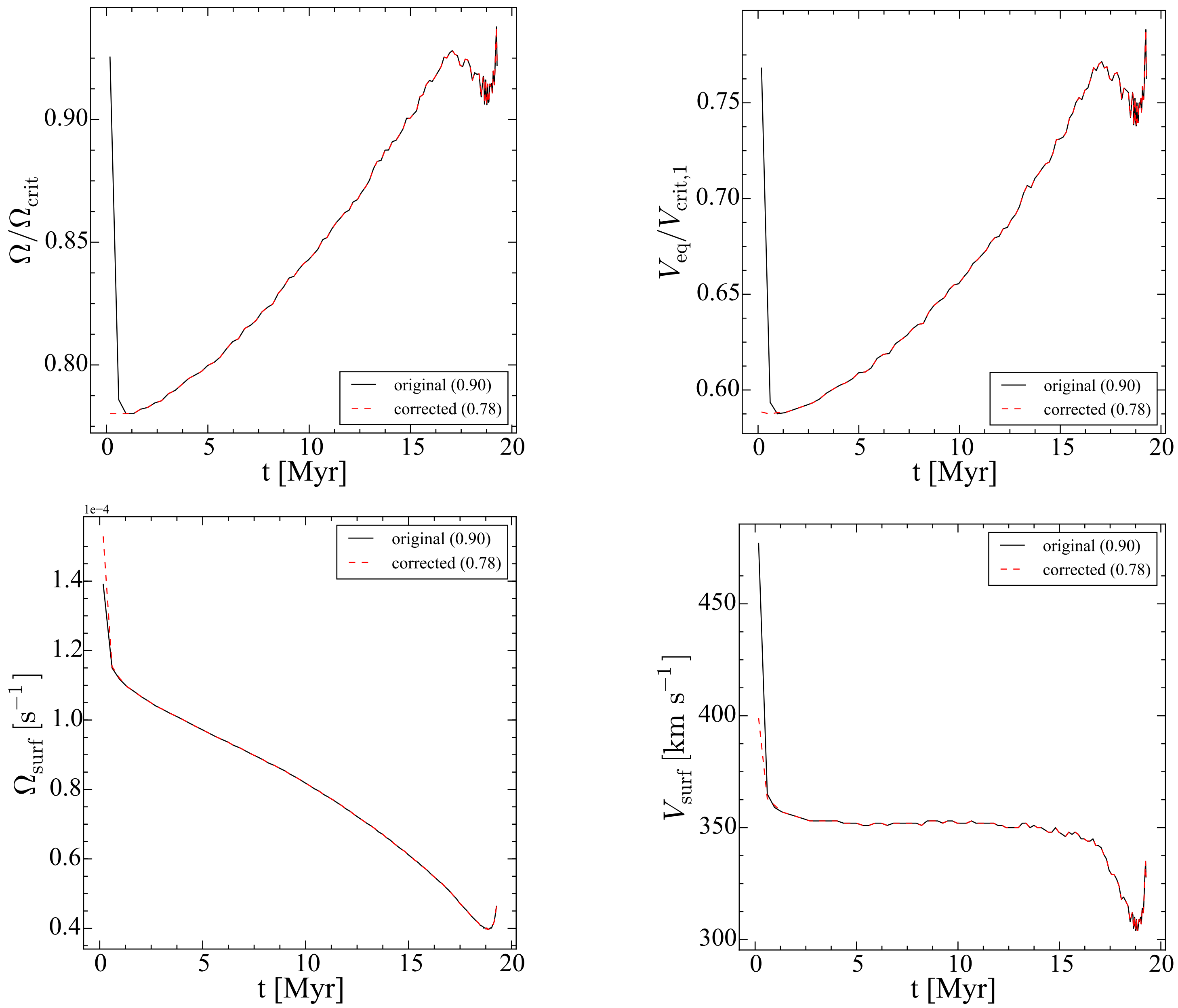
– velocity ratio $(V/V_{\mathrm{crit}})_{i,\mathrm{new}}$ is interpolated in AllOmegaData.dat

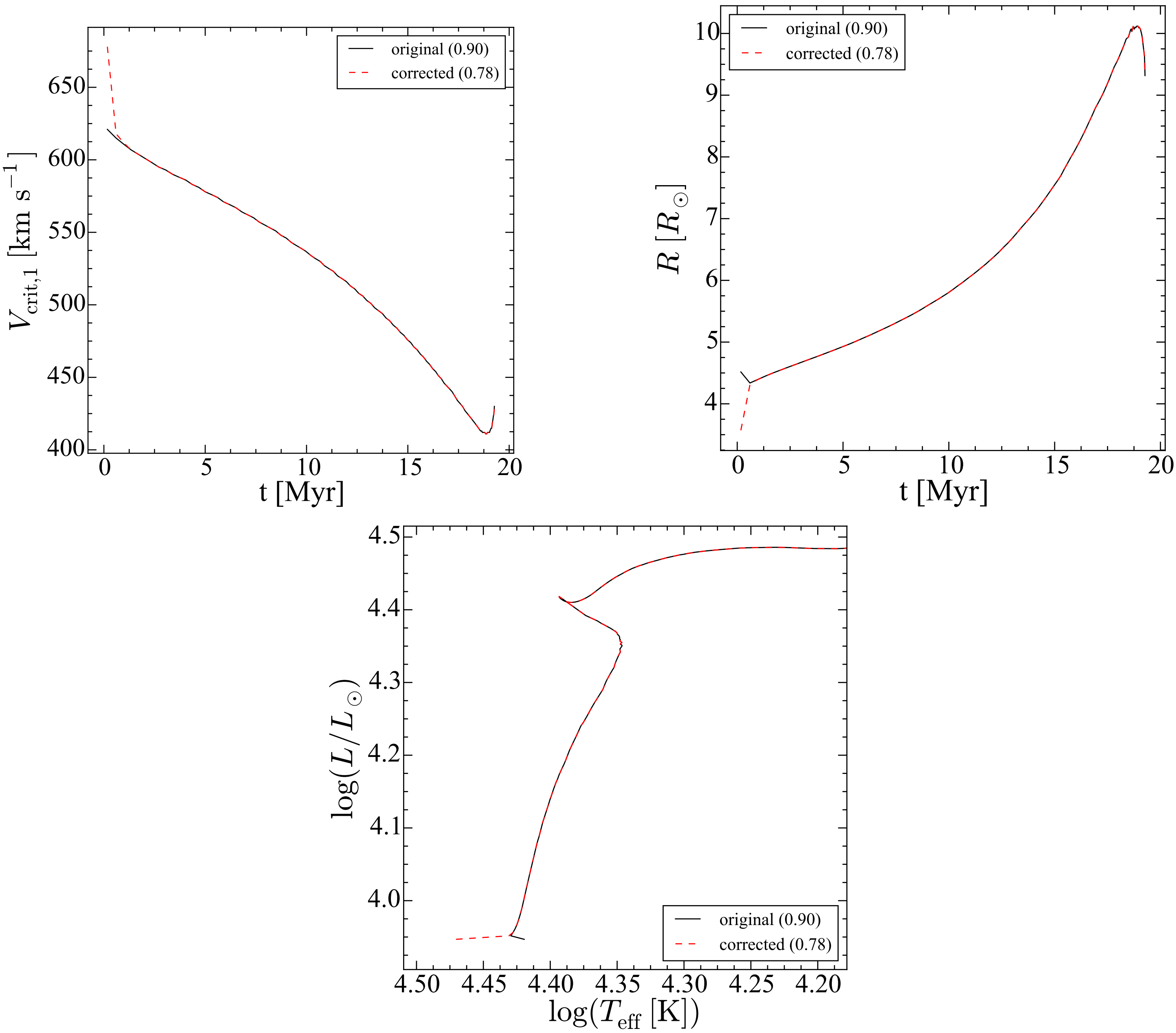
– critical velocity

$$V_{\mathrm{crit},1,i,\mathrm{new}} = \frac{V_{\mathrm{eq},i,\mathrm{new}}}{(V/V_{\mathrm{crit}})_{i,\mathrm{new}}}$$

Results

The results for a $7\,M_{\odot}$ model originally at $\Omega/\Omega_{\mathrm{crit}} = 0.90$ (corrected $\Omega/\Omega_{\mathrm{crit}} = 0.78$) are shown below.




original (0.90)
corrected (0.78)
$V_{\mathrm{crit},1}$ [km s^{-1}]
t [Myr]
original (0.90)
corrected (0.78)
R [$R_\odot$]
t [Myr]
original (0.90)
corrected (0.78)
$\log(L/L_\odot)$
$\log(T_{\mathrm{eff}}$ [K]$)$