EFFECTS OF ROTATION ON THE MAIN SEQUENCE EVOLUTION OF A $5M_\odot$ STAR

J. FLIEGNER and N. LANGER
MPI für Astrophysik, D-85740 Garching, Germany

The way rotation influences the main sequence evolution of early type stars depends strongly on their internal angular momentum distribution. Their convective core mass is not always decreased as a consequence of a reduced "effective mass" due to rotation, since rotation laws close to uniform specific angular momentum may increase ∇_{rad} and thereby the convective core mass (Clement). In addition, rotationally induced mixing processes may redistribute angular momentum and chemical elements inside the stars (e.g. Endal & Sofia 1978).

To investigate the effects of rotation for a 5 $M_\odot$ star, we calculated the main sequence (MS) evolution for 3 different values of the total angular momentum, i.e. 0, 1.2×10^{51} and $6.1 \times 10^{51} gcm^2s^{-1}$ (corresponding to the sequences R0, R1 and R1M, and R2M, where rotational mixing is suppressed for sequence R1; cf. Fig. 1). All sequences are started with a fully convective, rigidly rotating model at the Hayashi-line. The effects of rotation are treated as in Pinsonneault et al. (1989).

On the ZAMS, sequence R1 develops a convective core of $0.90M_\odot$ compared to $0.95M_\odot$ in the non-rotating model. Since its luminosity is slightly smaller, the evolutionary time-scale is nearly unchanged (cf. McGregor & Gilliland 1986). The models calculated with rotational mixing of angular momentum and chemical elements (R1M & R2M) develop larger convective core masses (cf. Fig. 2): During the pre-MS evolution rotationally induced mixing establishes a homogeneous distribution of specific angular momentum on a short time-scale. An even larger effect on the main sequence life time is caused by rotational mixing of hydrogen into the convective core (cf. Fig. 2 & Fig. 3). In total, the duration of central hydrogen burning is extended from $8.3 \times 10^7 yr$ for the non-rotating model (R0) to $1.4 \times 10^8 yr$ for model R1M and $2.5 \times 10^8 yr$ for model R2M.

In summary, rotationally induced mixing may support or even supersede convective overshooting as cause of an observationally required main sequence widening (cf. Fig. 1). Note that in our rotating models no alteration of the surface abundances occurs on the MS, in agreement with recent observations of Gies & Lambert (1992). However, from Fig. 3 large effects for both, surface abundances and internal evolution in the post MS phases can be anticipated.

L. A. Balona et al. (eds.), Pulsation, Rotation and Mass Loss in Early-Type Stars, 147–148.

https://doi.org/10.1017/S0074180900214733 Published online by Cambridge University Press

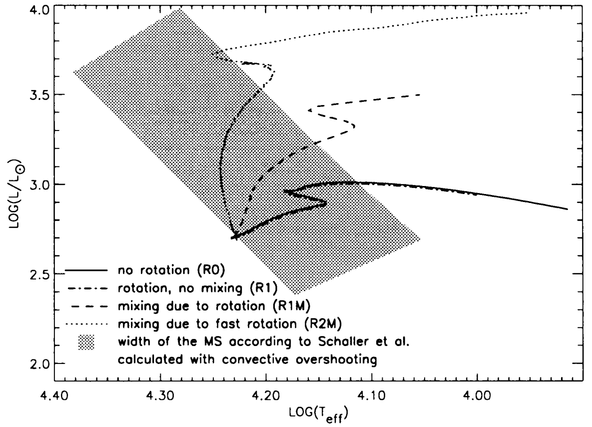
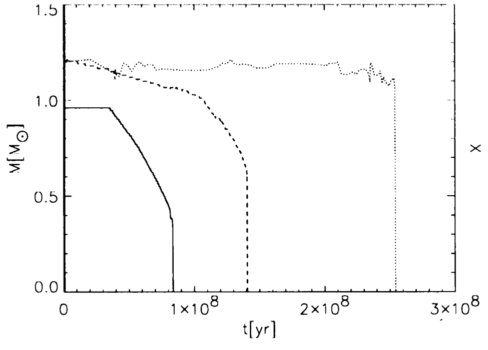


Fig. 1. The evolution of our models in the HR-diagram. The pre-MS phase is omitted.



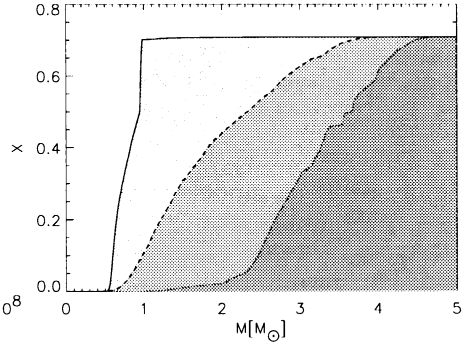


Fig. 2. The evolution of the convective core mass during central hydrogen burning. Lines are coded as in Fig. 1.

Fig. 3. The hydrogen profile at hydrogen exhaustion. Lines are coded as in Fig. 1.

References

Clement, Maurice J.: 'Differential Rotation and the Convective Core Mass of Upper Main Sequence Stars', *Preprint*

Endal, A.S. and Sofia, S.: 1978, *ApJ* **220**, 279

Gies, Douglas R. and Lambert, David J.: 1992, *ApJ* **387**, 673

MacGregor, K.B. and Gilliland, R.L.: 1986, *ApJ* **310**, 273

Pinnsonneault, M.H., Kawaler, S.D., Sofia, S. and Demarque, D.: 1989, *ApJ* **338**, 424

Schaller, G., Schaerer, D., Meynet, G., Maeder, A.: 1992, *A&A* **96**, 269

https://doi.org/10.1017/S0074180900214733 Published online by Cambridge University Press