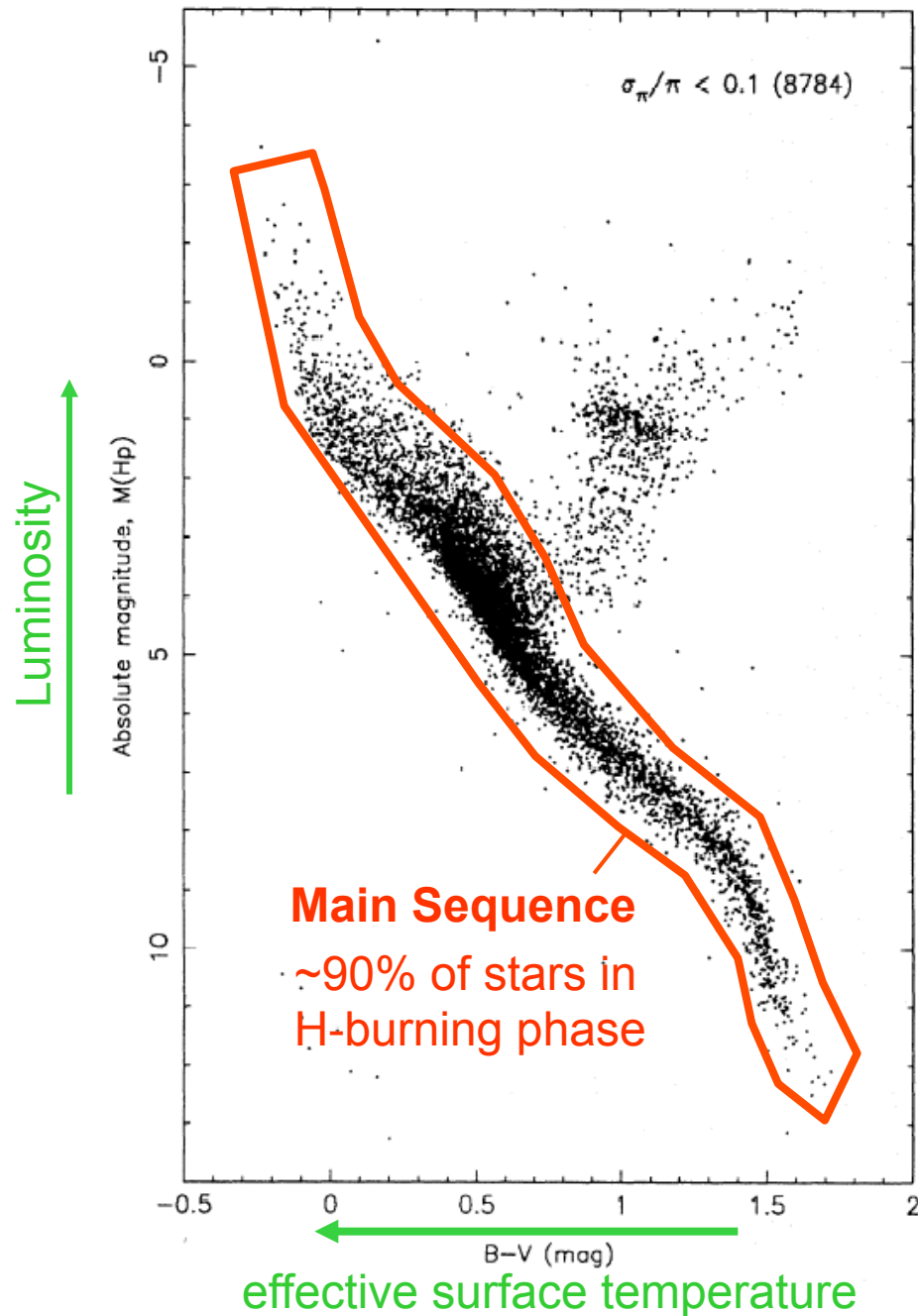


Hertzsprung-Russell diagram



Perryman et al. A&A 304 (1995) 69
 HIPPARCOS distance measurements

Magnitude:

Measure of stars brightness

Def: difference in magnitudes m from ratio of brightnesses b :

$$m_2 - m_1 = 2.5 \log \frac{b_1}{b_2}$$

(star that is x100 **brighter** has by 5 **lower** magnitude)

absolute scale for apparent magnitude
 historically defined
 (Sirius: -1.5, Sun: -26.72
 naked eye easy: <0, limit: <4 or 6?)

absolute magnitude is measure of luminosity = magnitude that star would have at **10 pc distance**

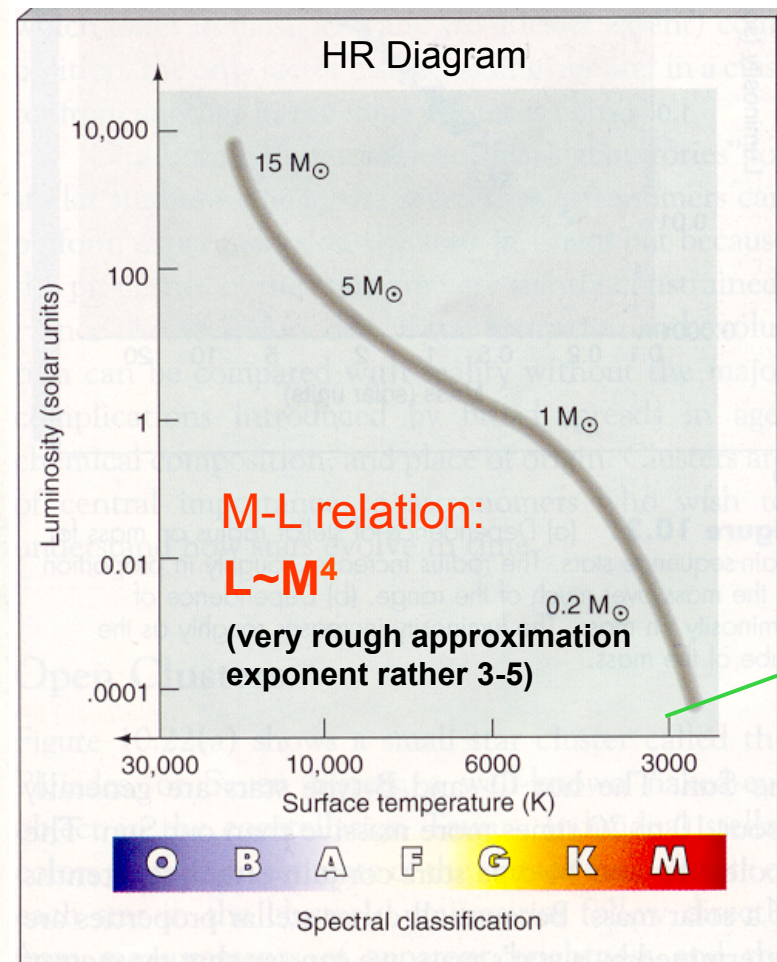
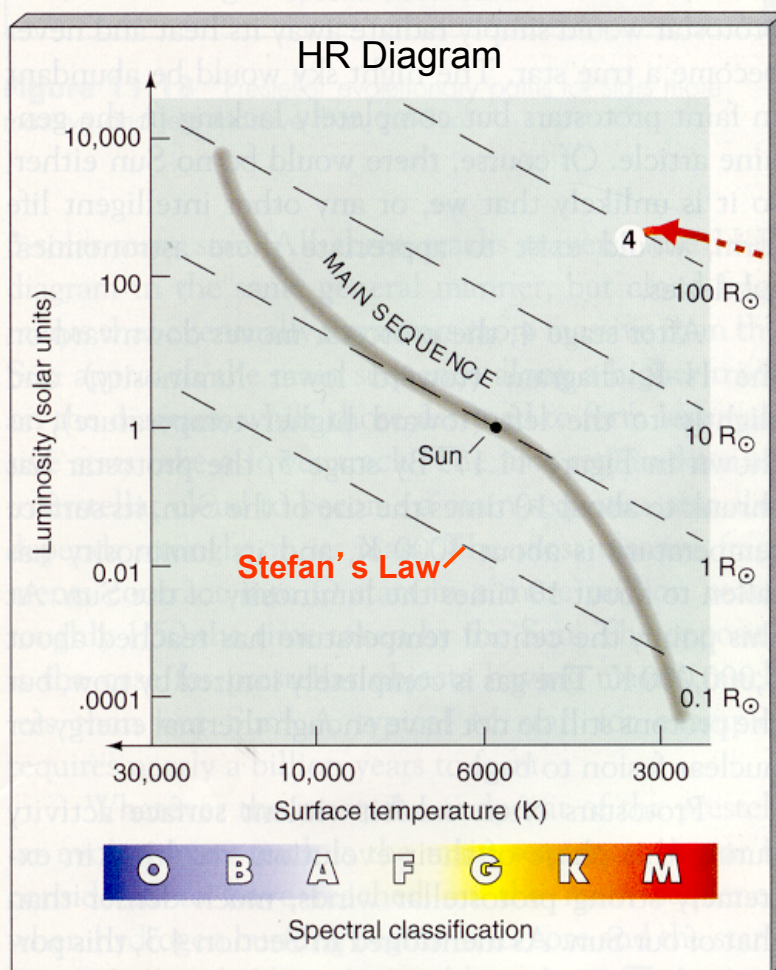
Sun: + 4.83 (visual magnitude)
 + 4.75 (bolometric magnitude)

Temperature, Luminosity, Mass relation during core H-burning:

It turns out that as a function of mass there is a rather unique relationship between

- surface temperature (can be measured from continuous spectrum)
- luminosity (can be measured if distance is known)

(recall Stefan's Law $L \sim R^2 T^4$)



(from Chaisson McMillan)

Mass – Radius relation:

In solar units: $R \sim M^{0.8}$

(10 M_{sol} : 6.3 x R_{sol} , 100 M_{sol} : 40 x R_{sol})
(really exponent is ~ 0.8 for $M < M_{\text{sol}}$, 0.57 for $M > M_{\text{sol}}$)

Main Sequence evolution:

Main sequence lifetime:

$$\begin{array}{l} \text{H Fuel reservoir } F \sim M \\ \text{Luminosity } L \sim M^4 \end{array} \longrightarrow \text{lifetime } \tau_{\text{MS}} = \frac{F}{L} \propto M^{-3}$$

Recall from Homework: H-burning lifetime of sun $\sim 10^{10}$ years

$$\tau_{\text{MS}} \approx \left(\frac{M}{M_{\oplus}} \right)^{-3} 10^{10} \text{ years}$$

note: very approximate
exponent is really
between 2 and 3

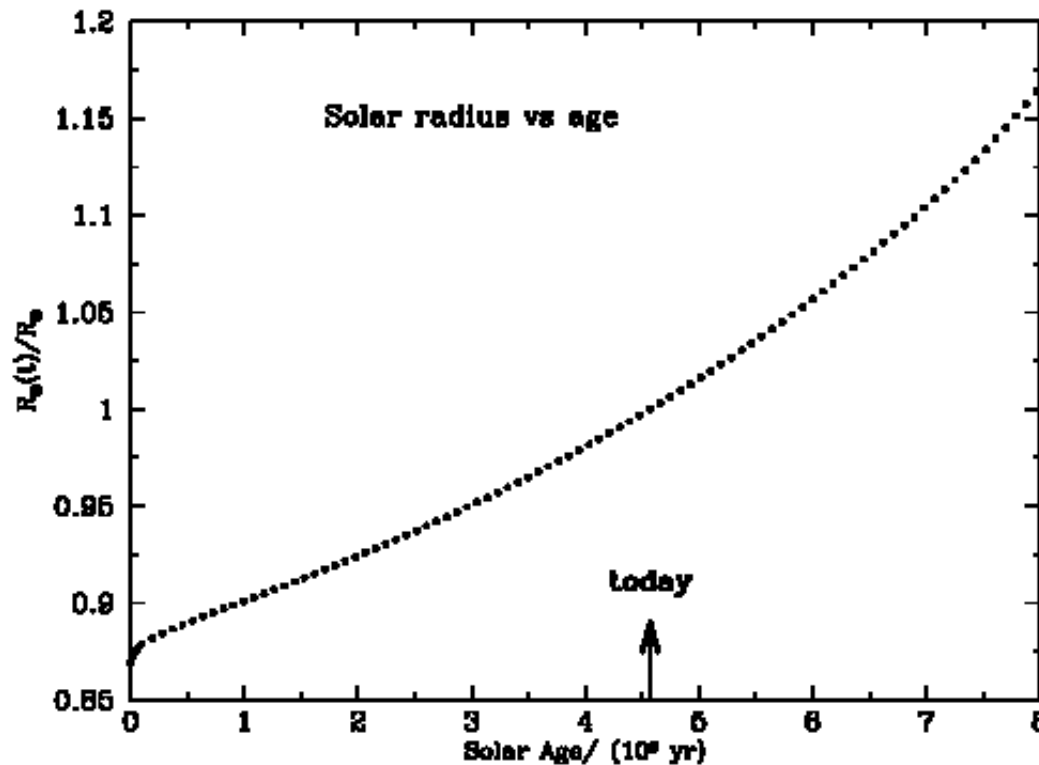
so a 10 solar mass star lives only for 10-100 Mio years
a 100 solar mass star only for 10-100 thousand years !

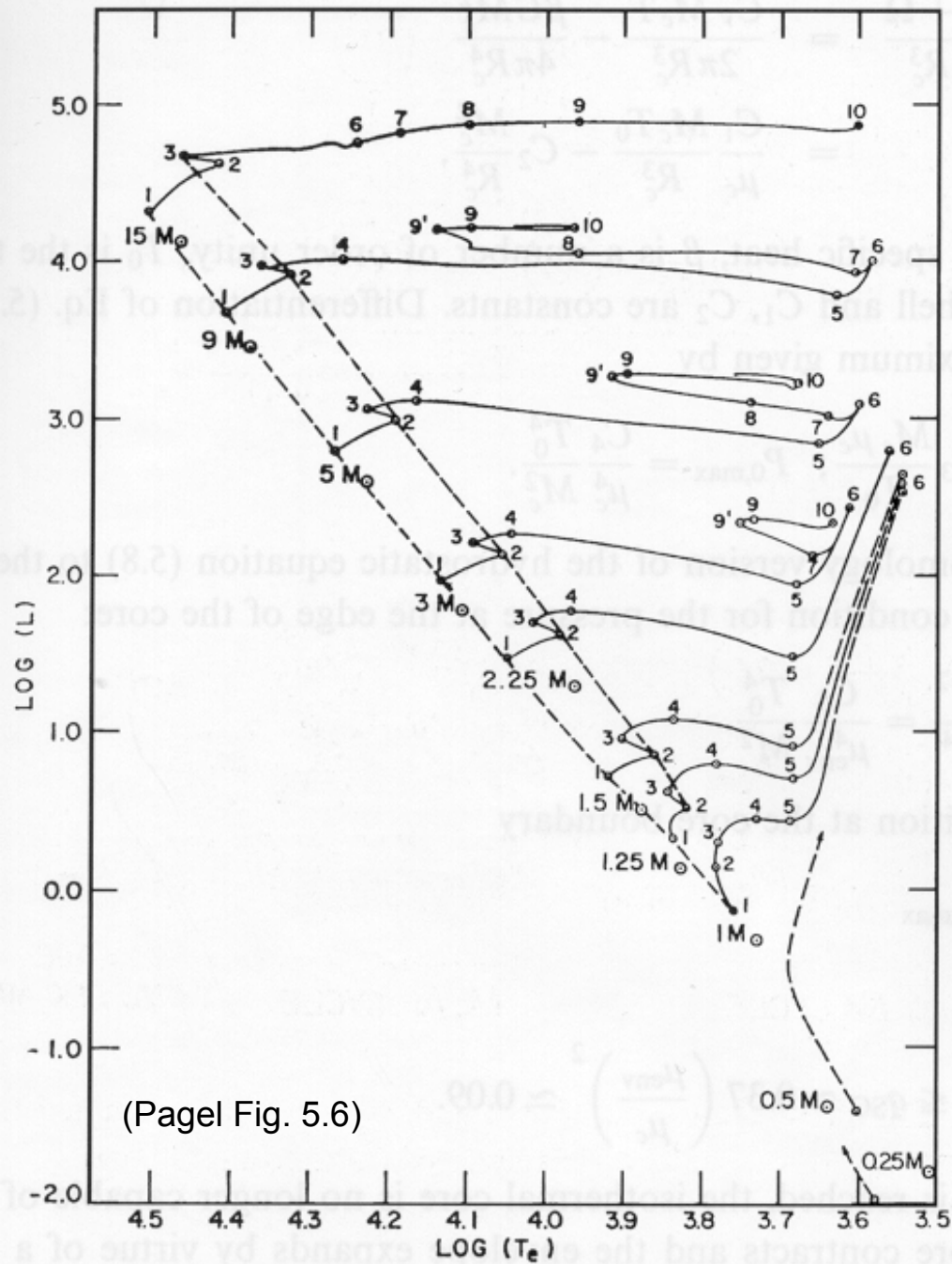
Changes during Main Sequence evolution:

With the growing He abundance in the center of the star slight changes occur (star gets somewhat cooler and bigger) and the stars moves in the HR diagram slightly

→ main sequence is a band with a certain width

For example, predicted radius change of the sun according to Bahcall et al. ApJ555(2001)990





Zero Age Main Sequence (ZAMS): "1"

End of Main Sequence: "2"

Stellar masses are usually given in ZAMS mass !