

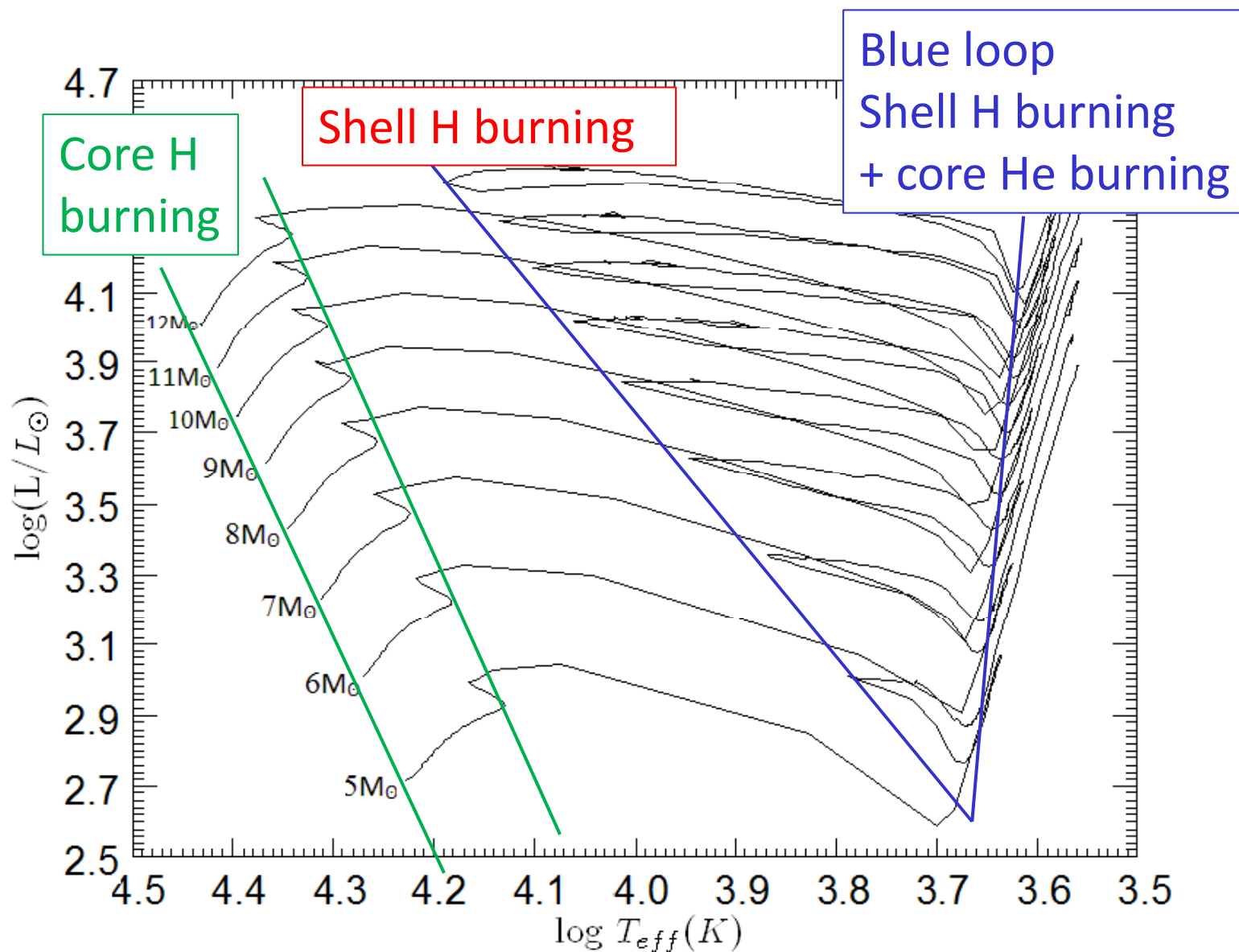
The Effect of the $^{14}\text{N}(p, \gamma)^{15}\text{O}$ Reaction on the Blue Loops in Intermediate-Mass Stars

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THE ORIGIN OF COSMIC ELEMENTS

June 12 – 15, 2013, Barcelona

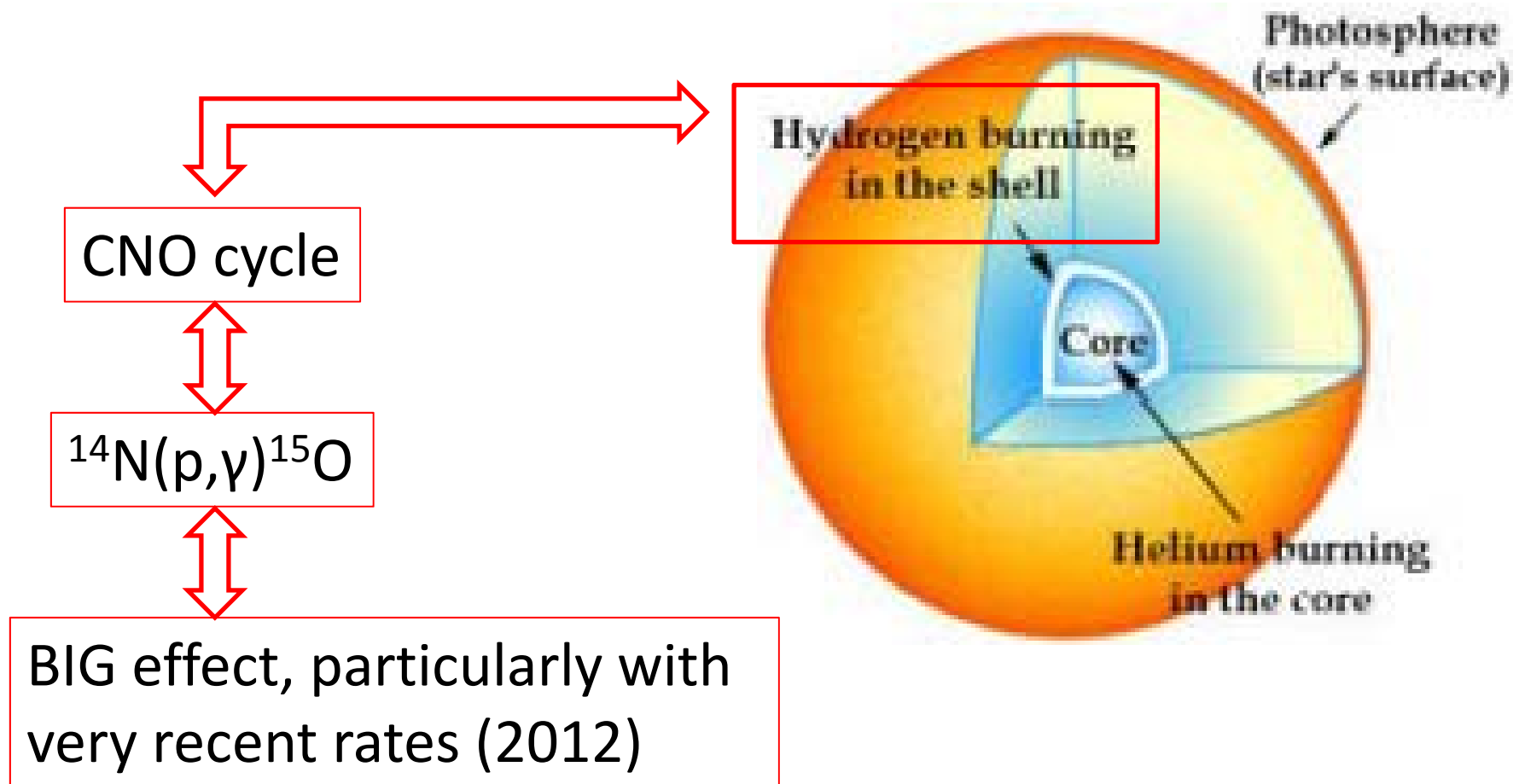
What's a blue loop?



HR diagrams of stellar models with solar-like metallicity

Why does the blue loop occur?

Crossing of stars to the blue side of the HR diagram (high effective temperatures) of stellar masses 5 to $15M_{\odot}$



$^{14}\text{N}(\text{p},\gamma)^{15}\text{O}$ reaction rate

Compare between two $^{14}\text{N}(\text{p},\gamma)^{15}\text{O}$ rates (N14 rates):

NACRE rate:

Angulo et al. 1999.

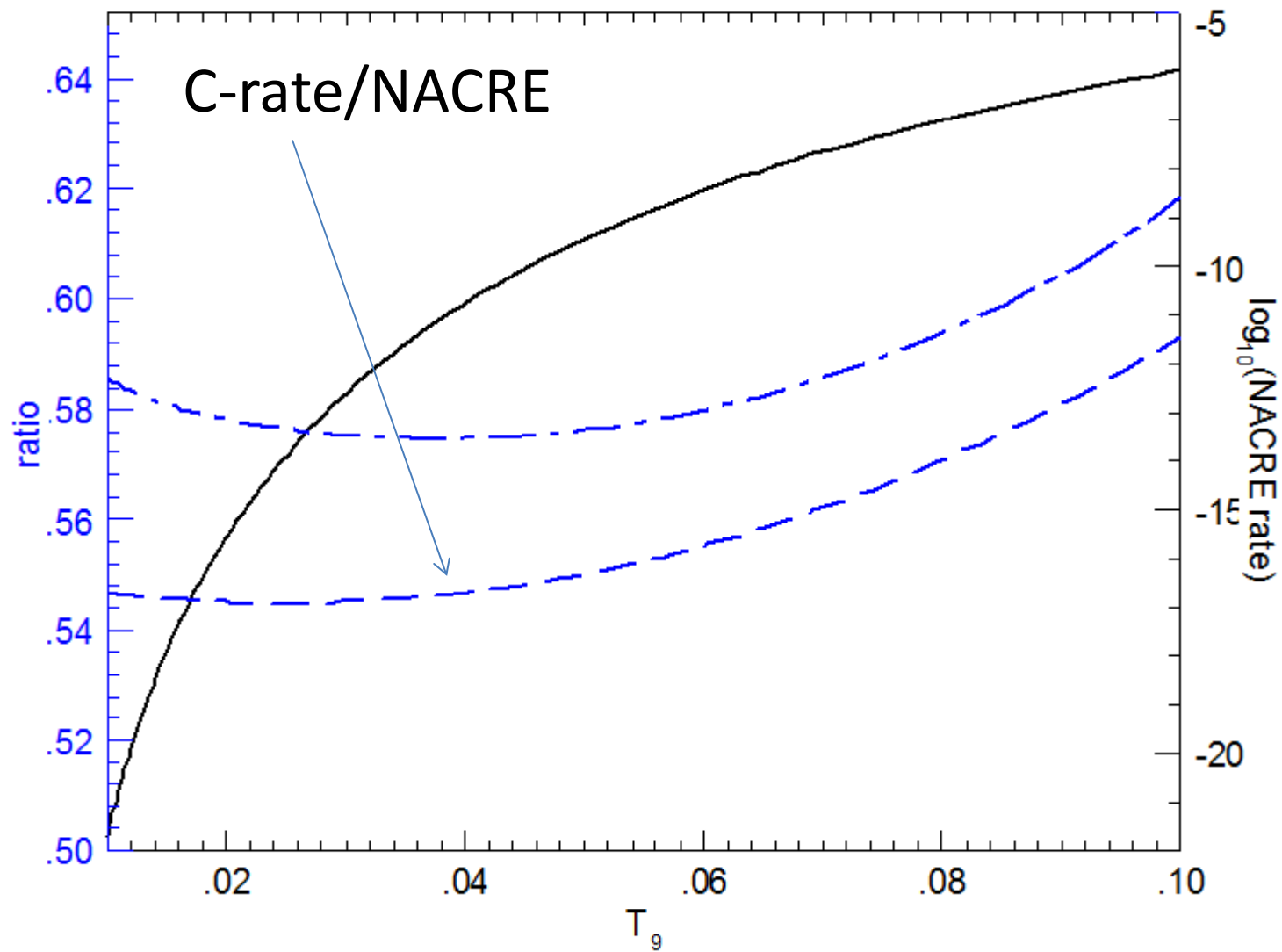
Over-estimated,
only used here as a
reference for an
efficient rate.

C- rate:

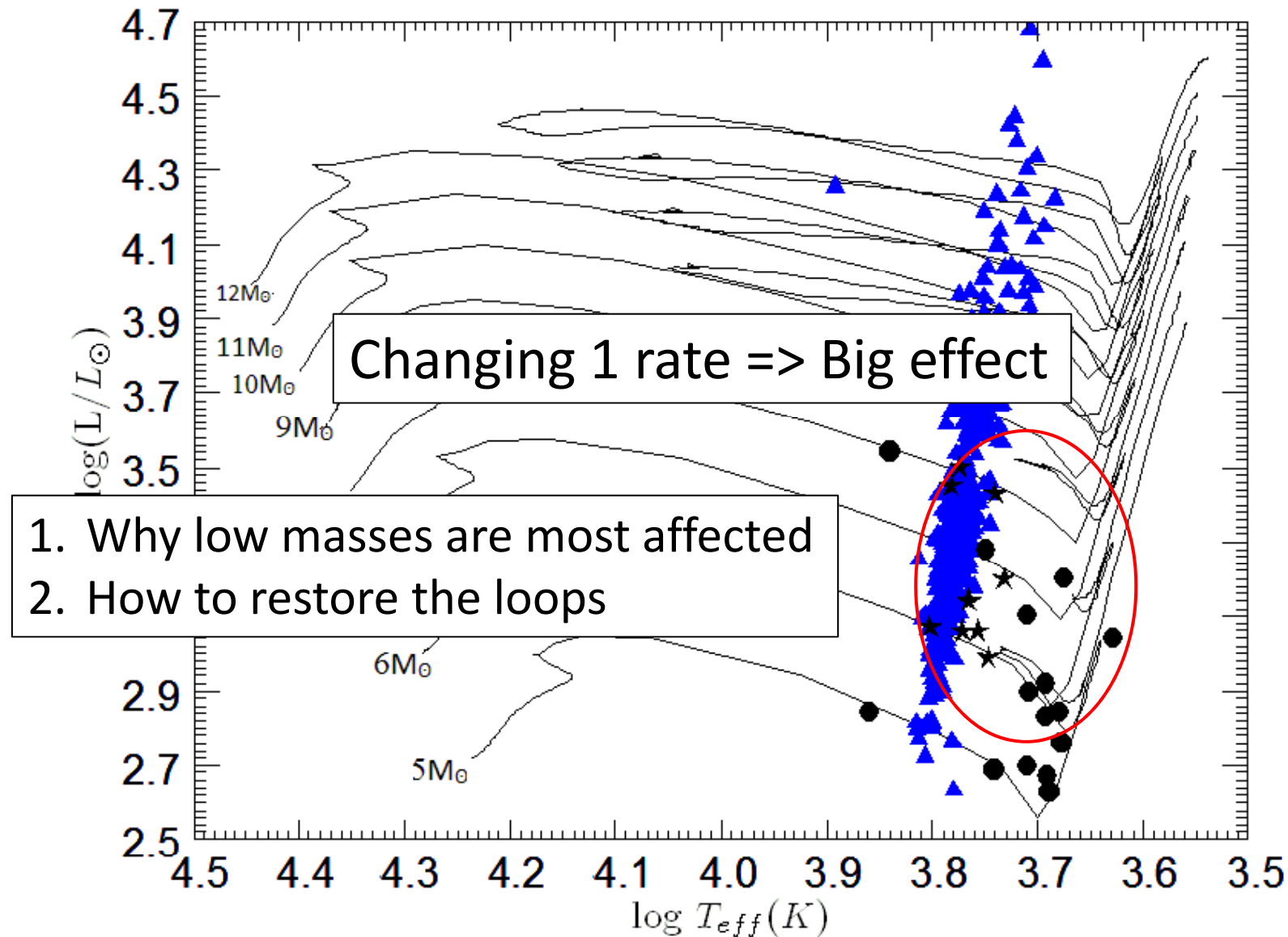
G. Halabi, M. El Eid &
A. Champagne 2012,
ApJ 761, 10

→ motivated by the
evaluation of
Adelberger et al. 2011

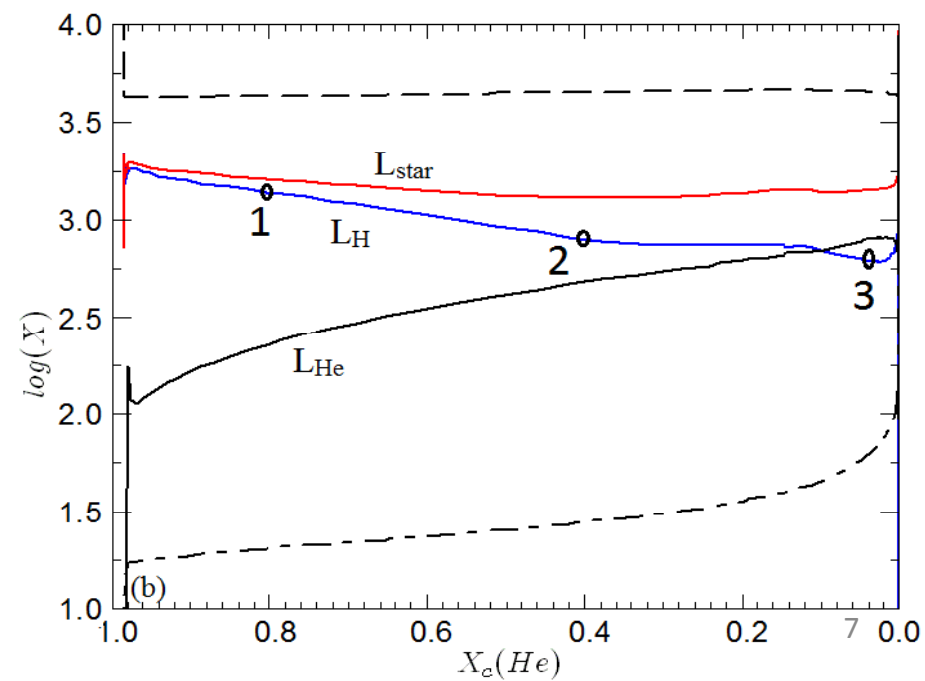
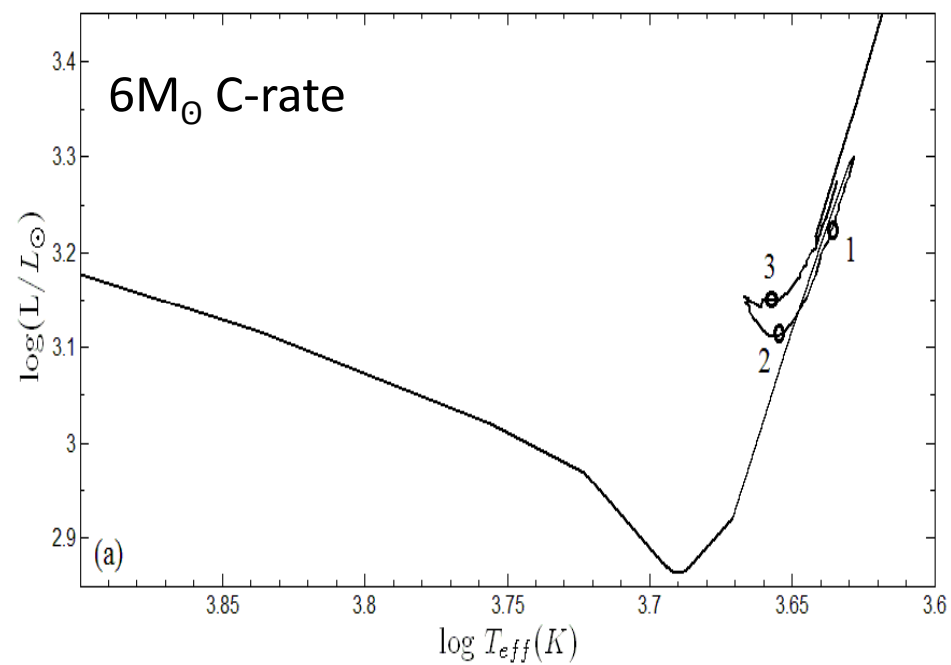
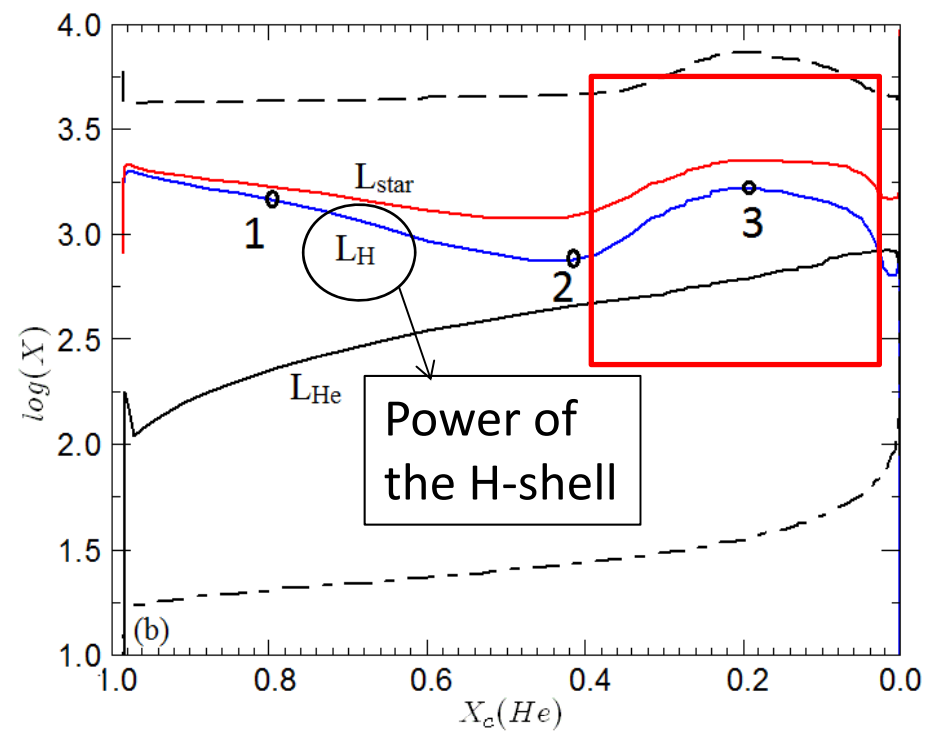
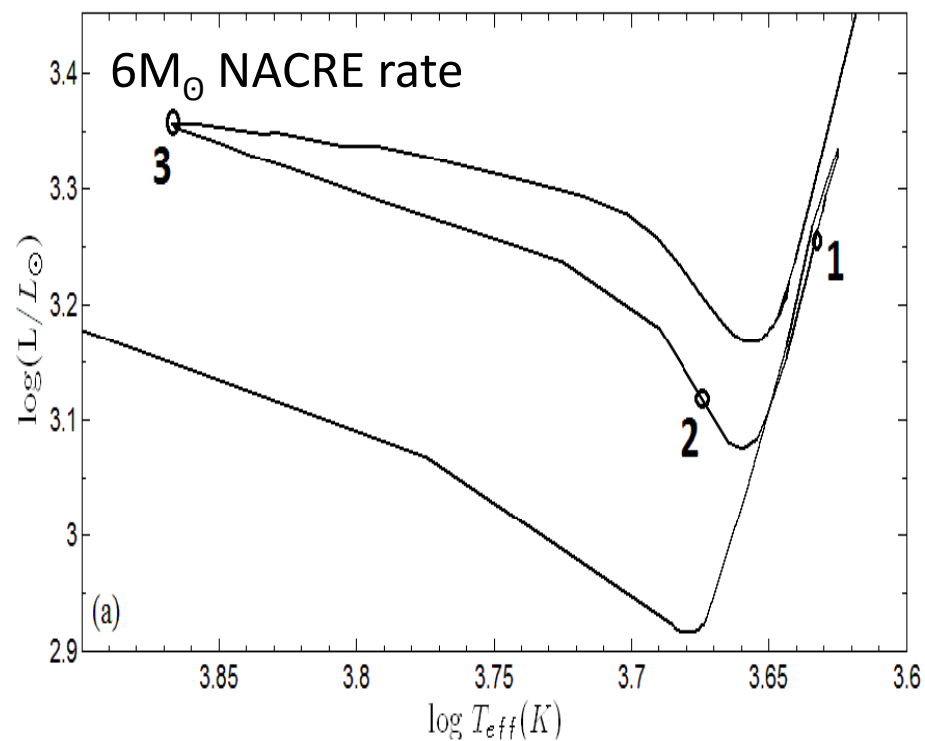
How do the rates compare?



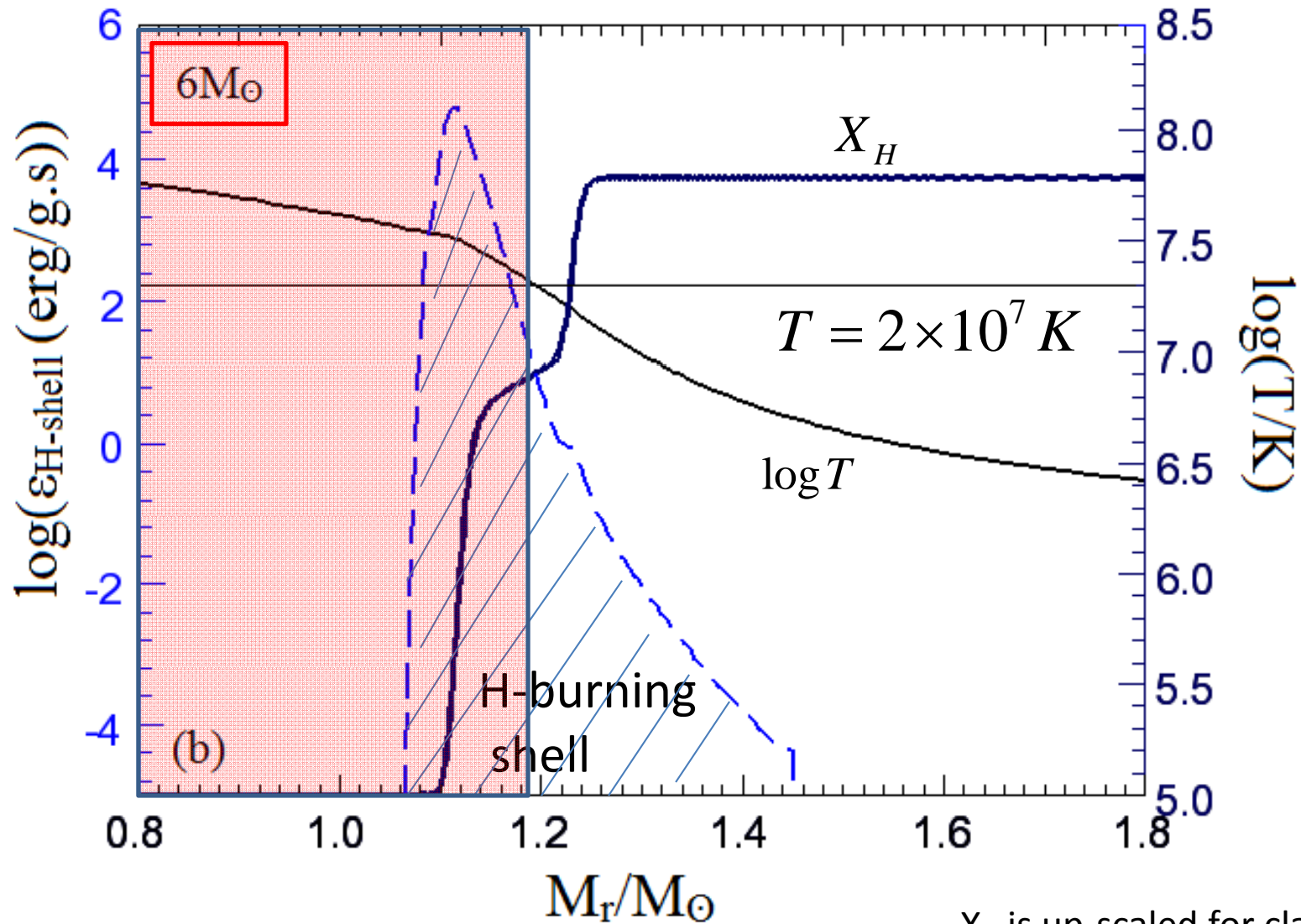
HR diagrams of stellar models with the C-rate



Observations from Schmidt (1984) & Fernie et al. (1995) (David Dunlap Observatory database)

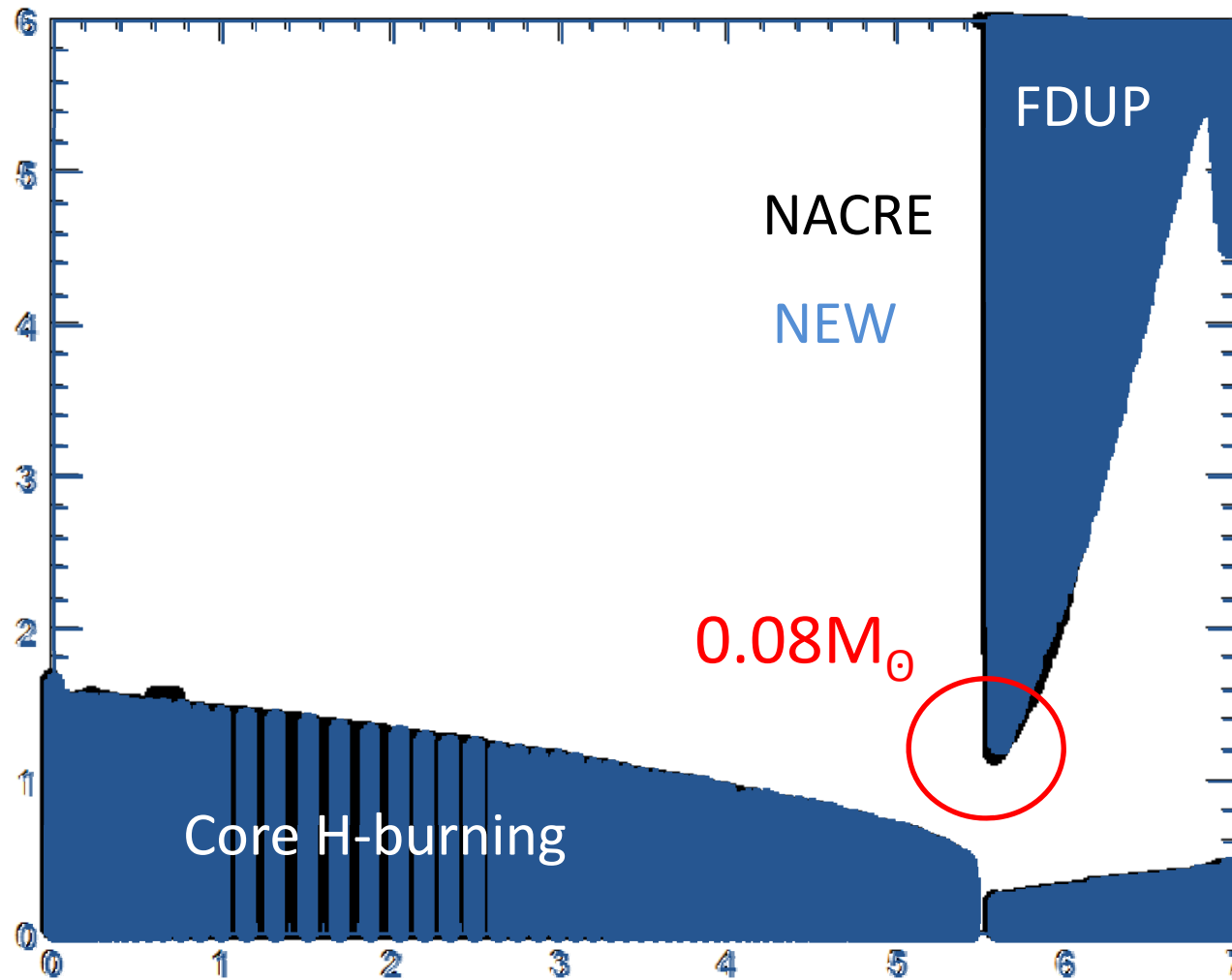


Shallow H-discontinuity



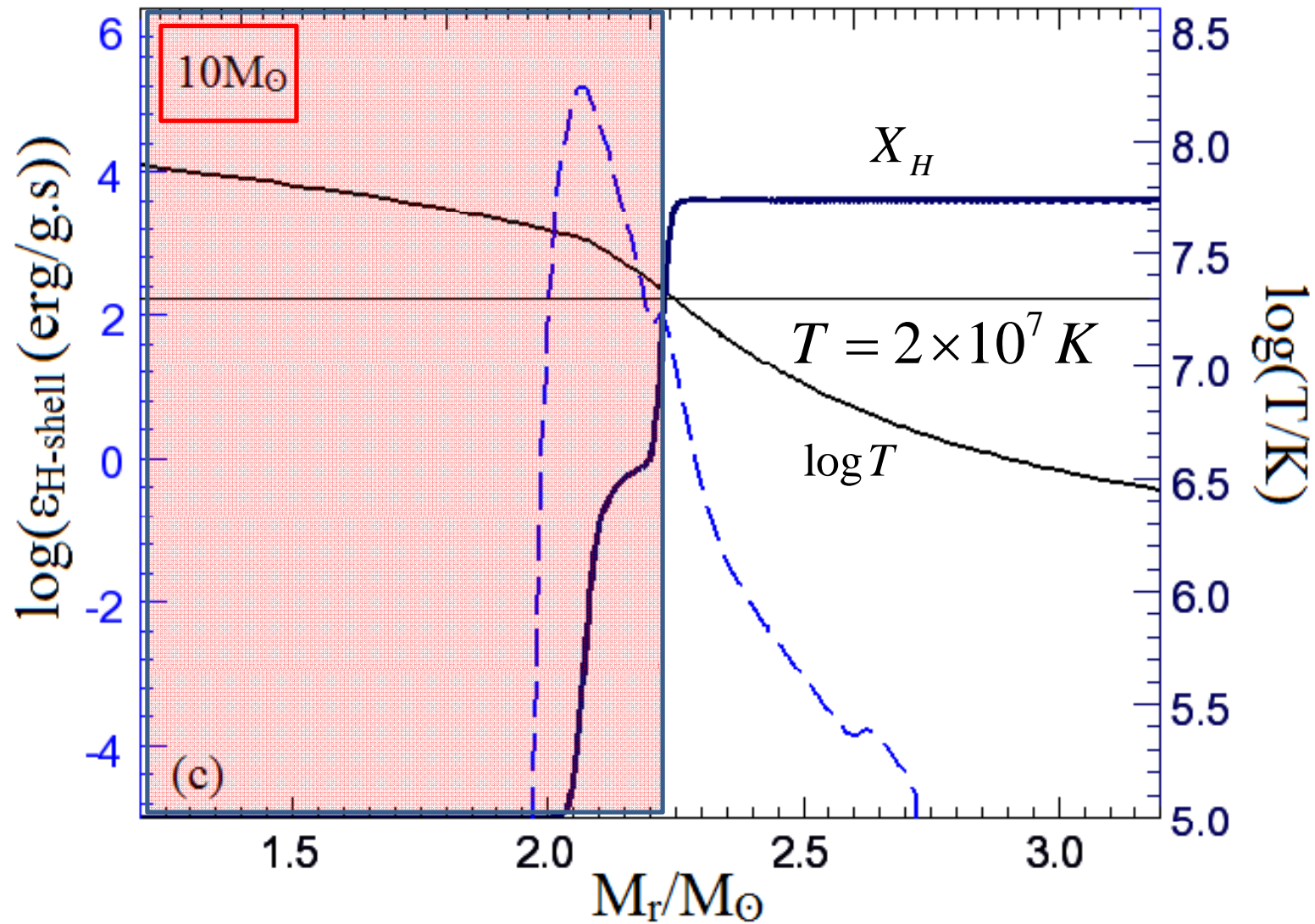
X_{H} is up-scaled for clarity⁸

Convective Structure: Dark regions convective, white region is radiative



What about the more
massive stars??

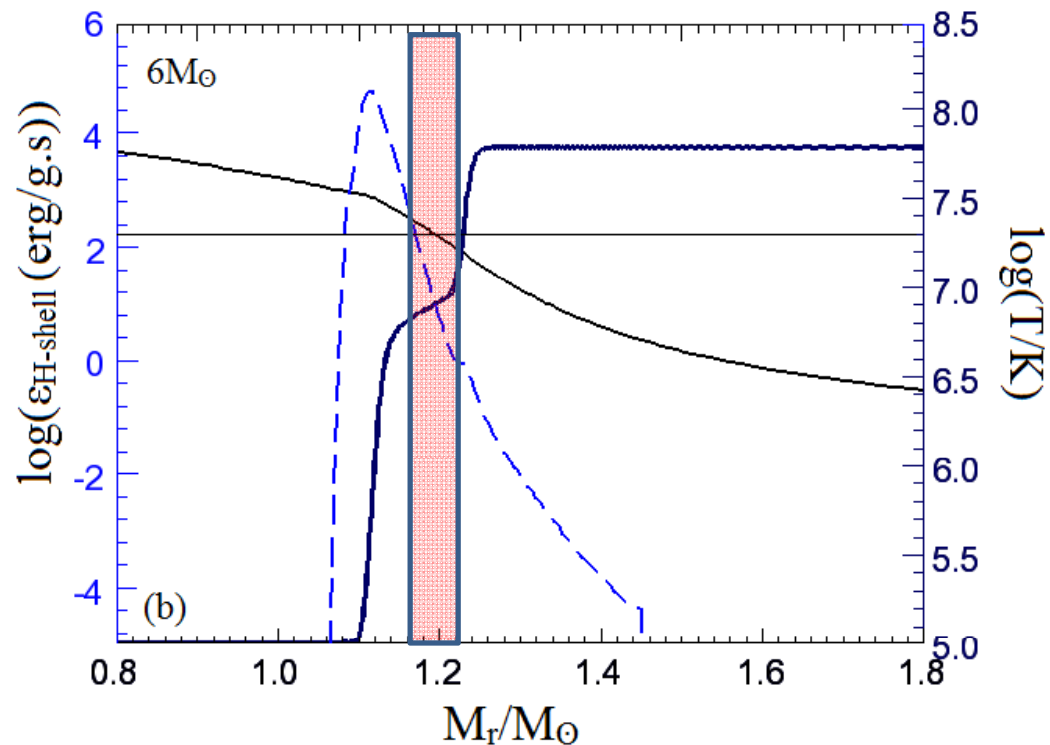
High temperature



How to restore the loops in the $5M_{\odot}$, $6M_{\odot}$ and $7M_{\odot}$?

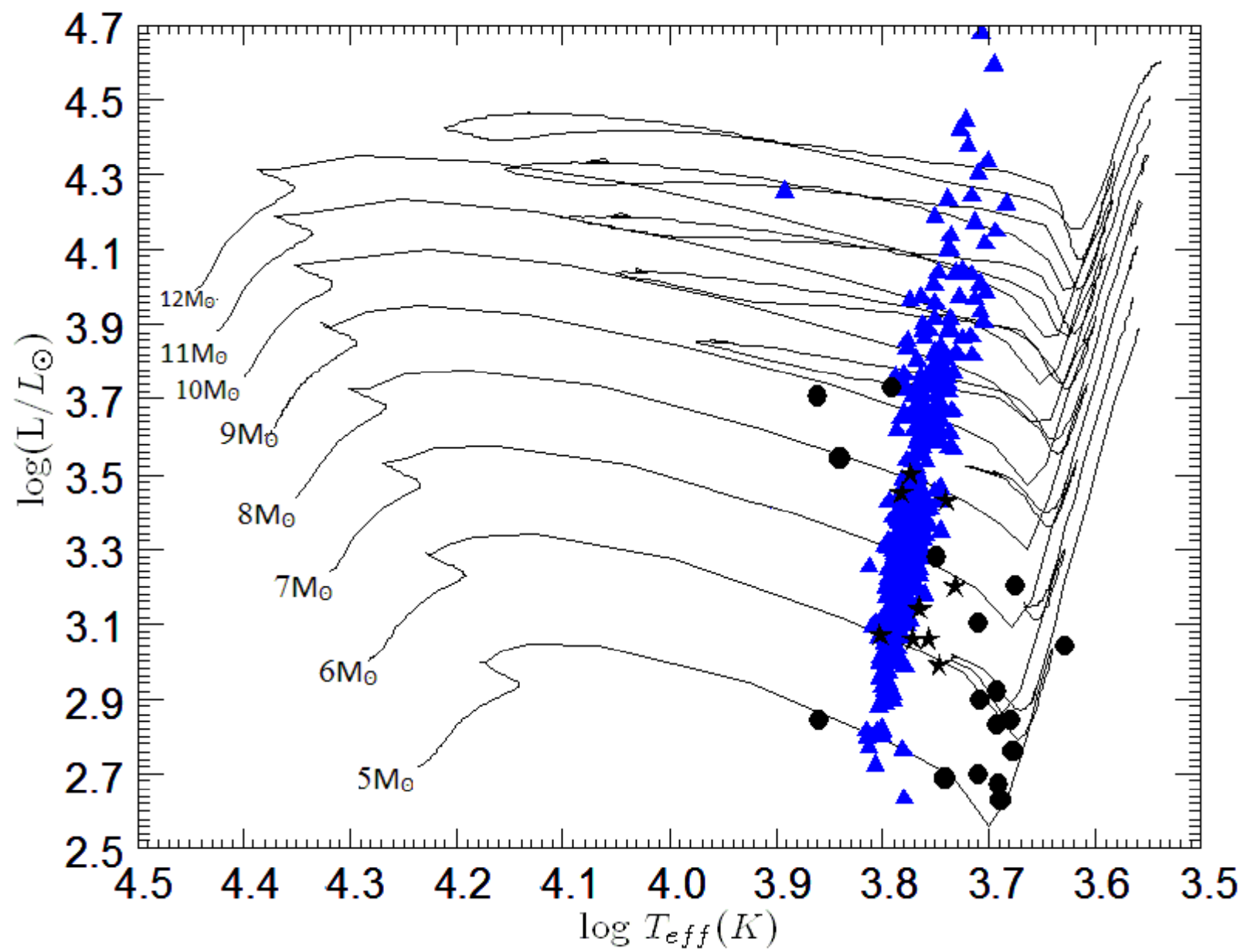
Overshooting: extra mixing below the boundary of the convective envelope

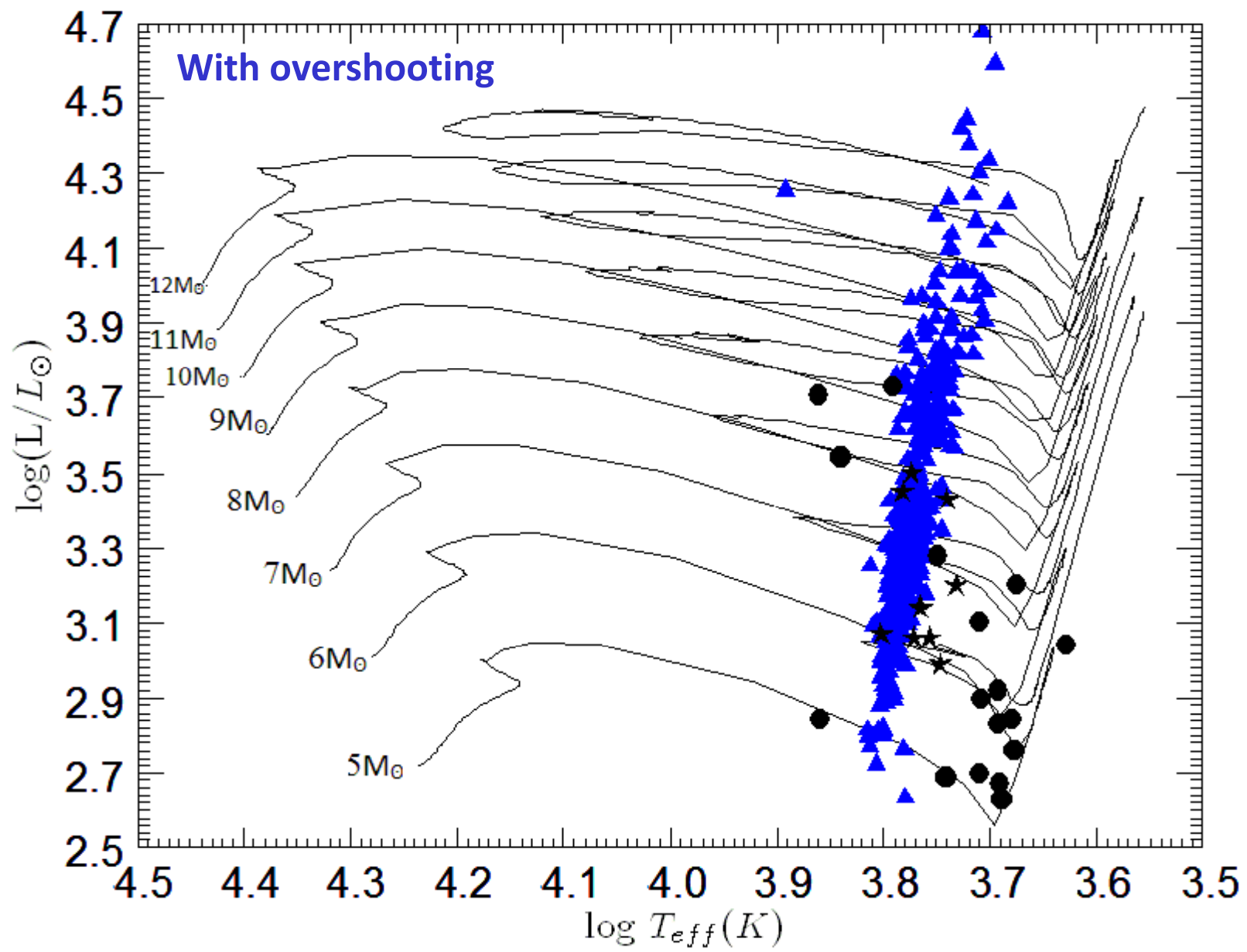
CLOSER to
the shell source



Comparing with observations

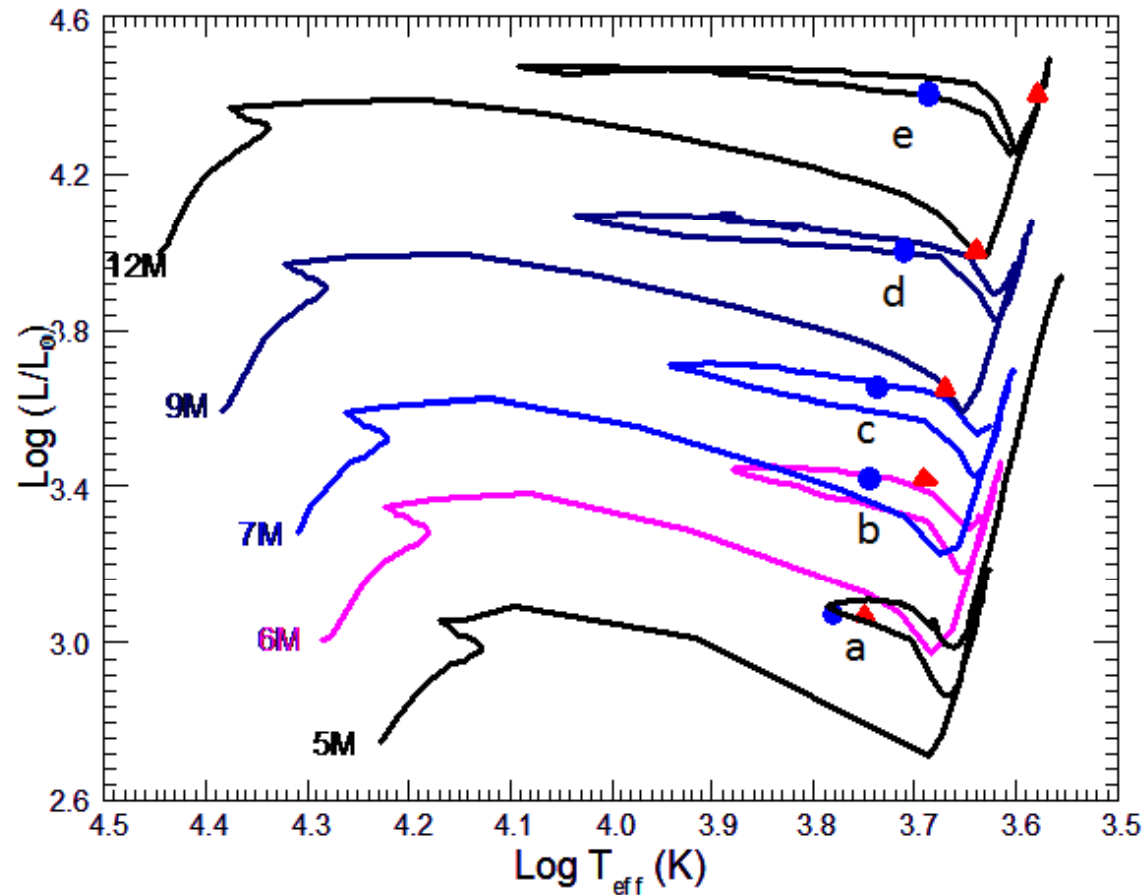






Work in progress:

Effect of core overshooting and modifications of the MLT



Predicted model properties adopted from Criscienzo et al. (2012). Blue circles denote the blue edge of the instability strip and red triangles denote its red edge.

Conclusions

- The blue loop is a delicate phenomena that cannot be attributed to single cause-effect scenario, as many parameters are at play contributing to its appearance and extension.
- The N14 rate has very interesting evolutionary implications that need to be carefully addressed.
- The effect of the N14 rate on loops has been studied for the whole mass range, which is a first.
- The new compilation of the N14 rate causes a severe reduction in the blue loops of the stellar masses $5M_{\odot}$, $6M_{\odot}$ and $7M_{\odot}$ which is very undesirable observationally.
- Moderate overshooting is called for in order to restore the loops in the models that would otherwise lack them.