Photometric trends from secular evolution

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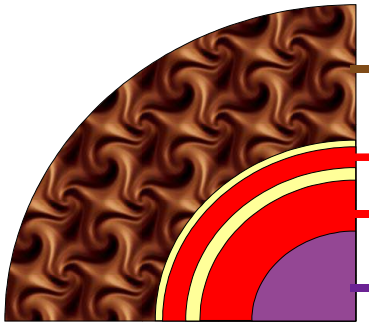
Can we observe 'in real time' the secular evolution of some type of stars with GAIA ?

* Late phases of low-mass stars
  - Asymptotic Giant Branch stars
  - Planetary nebulae
* Perspectives

The AGB phase - 1

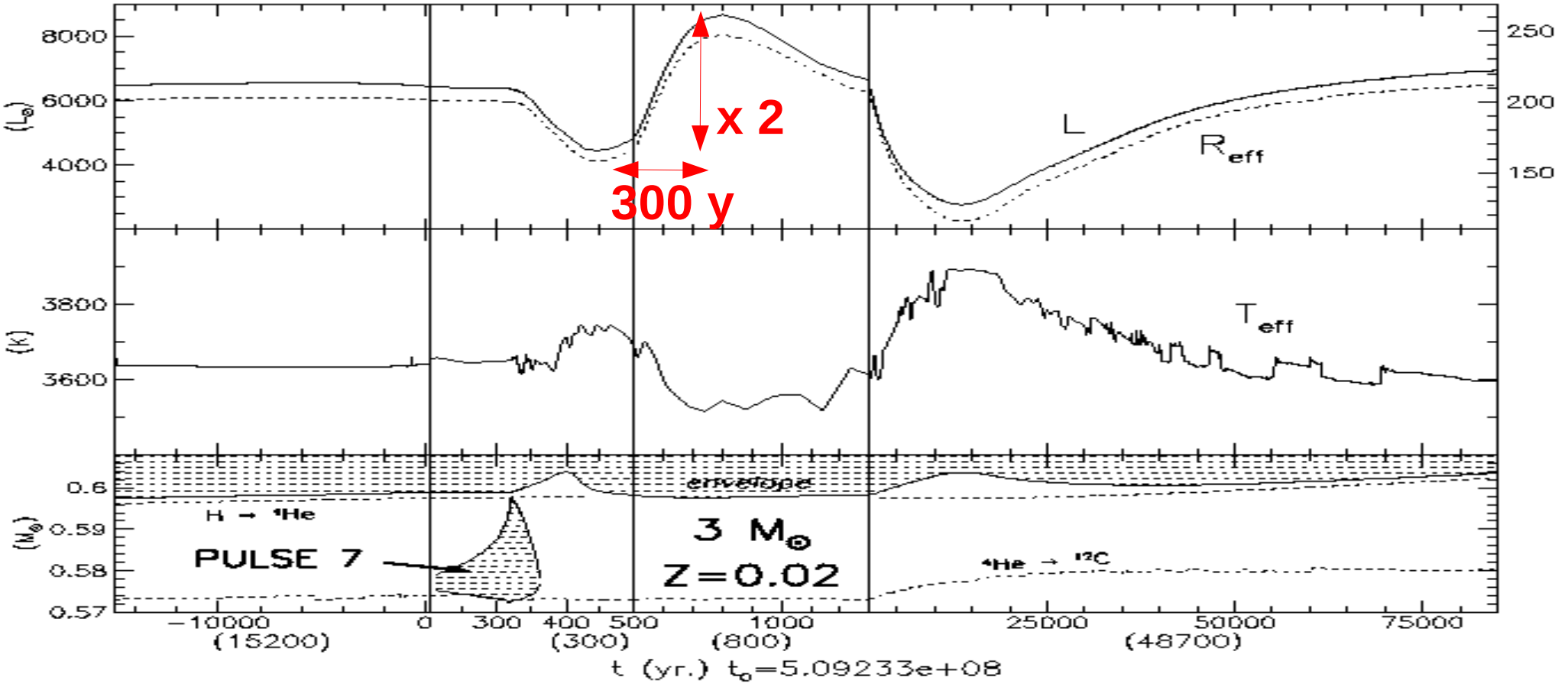


Convective enveloppe (< 6 $M_\odot$)

H-burning shell (~ 0.002 $M_\odot$)

He-burning shell (~ 0.02 $M_\odot$)

e^- degenerate core (0.5 - 0.9 $M_\odot$)

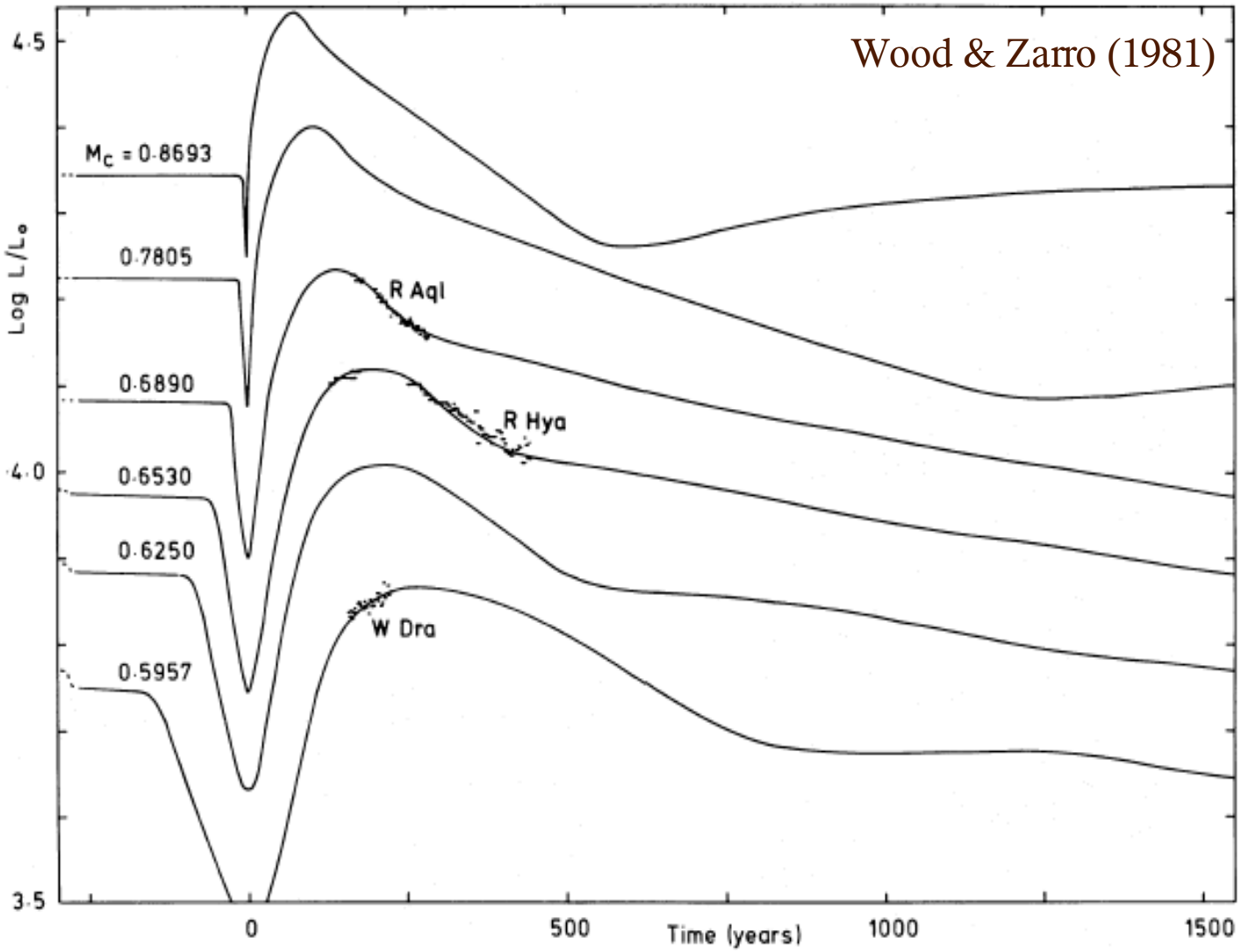


* L x 2 over ~300 yr during afterpulse phase.

* Δt (afterpulse) $\simeq$ 0.5% Δt (interpulse)
  → could be observed in ~1 out of 200 AGB stars

The AGB phase - 2

Expected variations possibly confirmed in few stars



BUT: large amplitude variability of Miras (up to 2 mag) on time scales of several hundred days

→ would require several years of averaged flux measurements

Transition from AGB to PN - 1

Thermal time scale

T_{eff} increases **from** ~5,000 K **to** > 80,000 K **within few** 10,000 yr

= time for the H-burning shell ($dM_c/dt \simeq 10^{-7}$ $M_\odot$/yr) to burn an envelope of $M_{env} \simeq 10^{-3}$ $M_\odot$

Dynamical time scale

Superwind leading to the removal of the AGB envelope.
The hot central star then illuminates the ejected material around it (->visible PN)

$v_{exp} \simeq 10 - 20$ km/s
size $\simeq 0.1$ pc
} $t_{dyn} \simeq 10^4$ yr

Could there be hidden post-AGB stars?

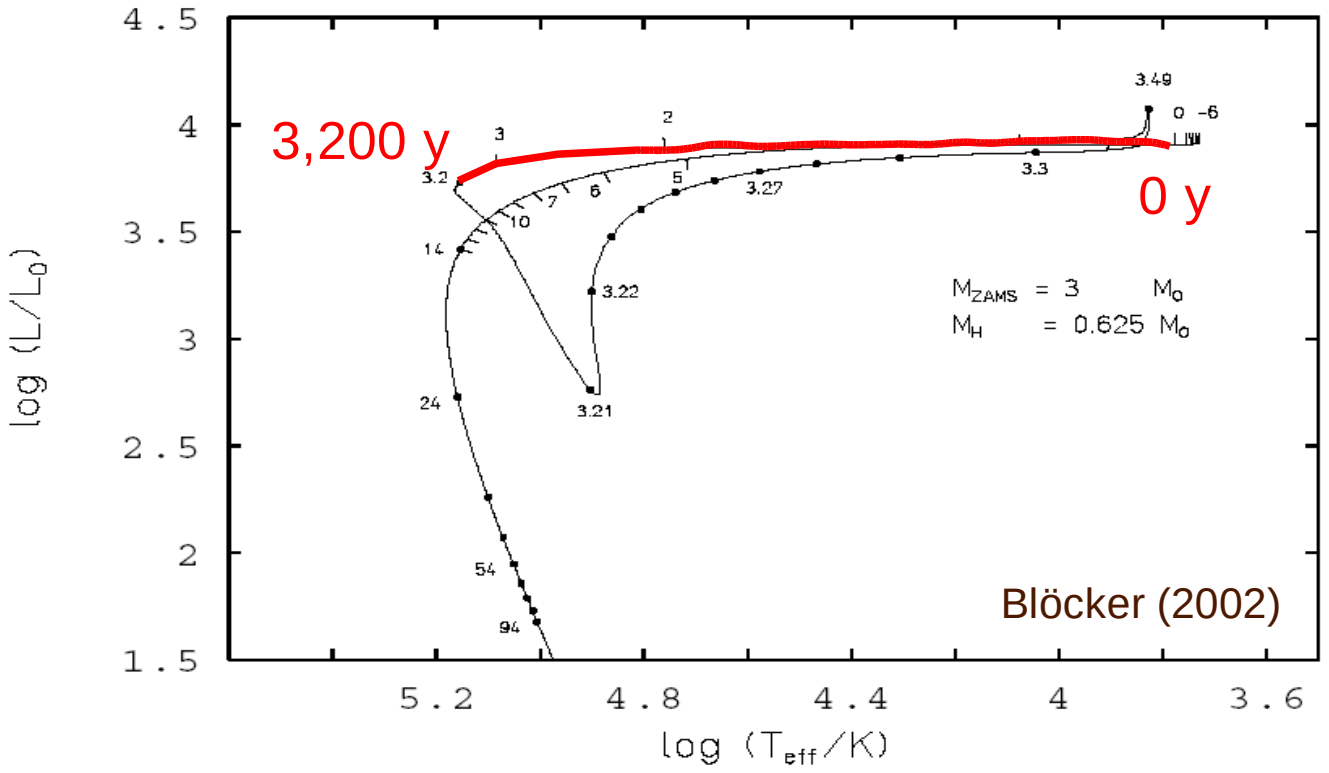
i.e. post-AGB stars that would have a faster dynamical evolution,
thus not leading to a visible PN?

Henize 1357 : 1971: 20,000 K
1988: 35,000 – 40,000 K
1994: 55,000 K (Parthasarathy et al. 1995)

Detectable by GAIA?

Transition from AGB to PN - 2

Crossing time scale from logT_{eff} ~3.9 to ~5.2 (Blöcker 2002):



0.55 $M_\odot$:	100,000 y
0.60 $M_\odot$:	4,000 y
0.70 $M_\odot$:	800 y
0.84 $M_\odot$:	350 y
0.94 $M_\odot$:	50 y

☛ $M_V = M_{bol} - BC$: with BC ≃ -2.58 for log T_{eff} = 4.40 (Mendez et al. 1992)
-6.36 for log T_{eff} = 4.95

For M_c = 0.6 $M_\odot$: **0.001 M_V / yr** (~3.8 M_V / 4000 yrs)

☛ **Reborn AGB stars:** still faster blue to red evolution

Perspectives

* **Intrinsic variability?**
* **Color evolution**
* **Estimate more accurately GAIA detectability of those AGB→PN transition**
* **Estimate statistics: expected number of post-AGB / reborn AGB stars ?**
* **Explore late stages of more massive stars**