Post-AGB stars as probe for dust production and mass-loss mechanisms

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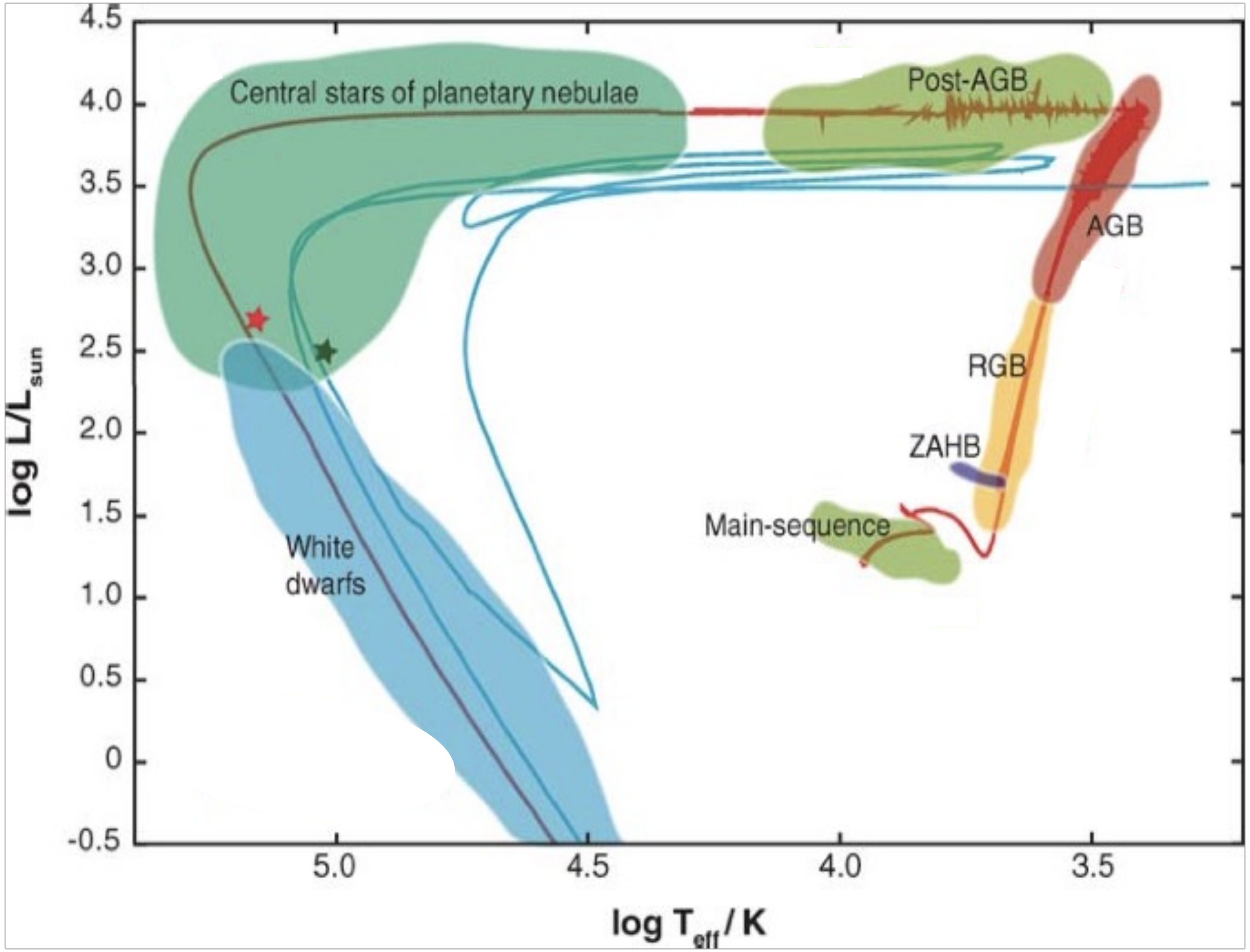
Summary

- Why study post-AGB stars?
- Characteristics of the sample
- Methodology
- Discussion focus on:
  - Intermediate mass carbon stars
  - low mass carbon stars
  - oxygen rich stars

Why study post-AGB stars?



1) Their chemical composition represents the final outcome of the **AGB evolution** and associated internal enrichment processes

2) Post-AGB stars provide the **unique** opportunity to obtain chemical abundances of a **wide range of elements**: CNO, Fe-peak, *s*-process elements and also obtain isotopic ratios of C, N and O

Characterization of the post-AGB sample

14 single stars in LMC & SMC
(from Kamath et al. 2014, 2015)

↓

Distances

↓

Luminosities → Initial masses

Starting point:

(Kamath et al. 2014, 2015)

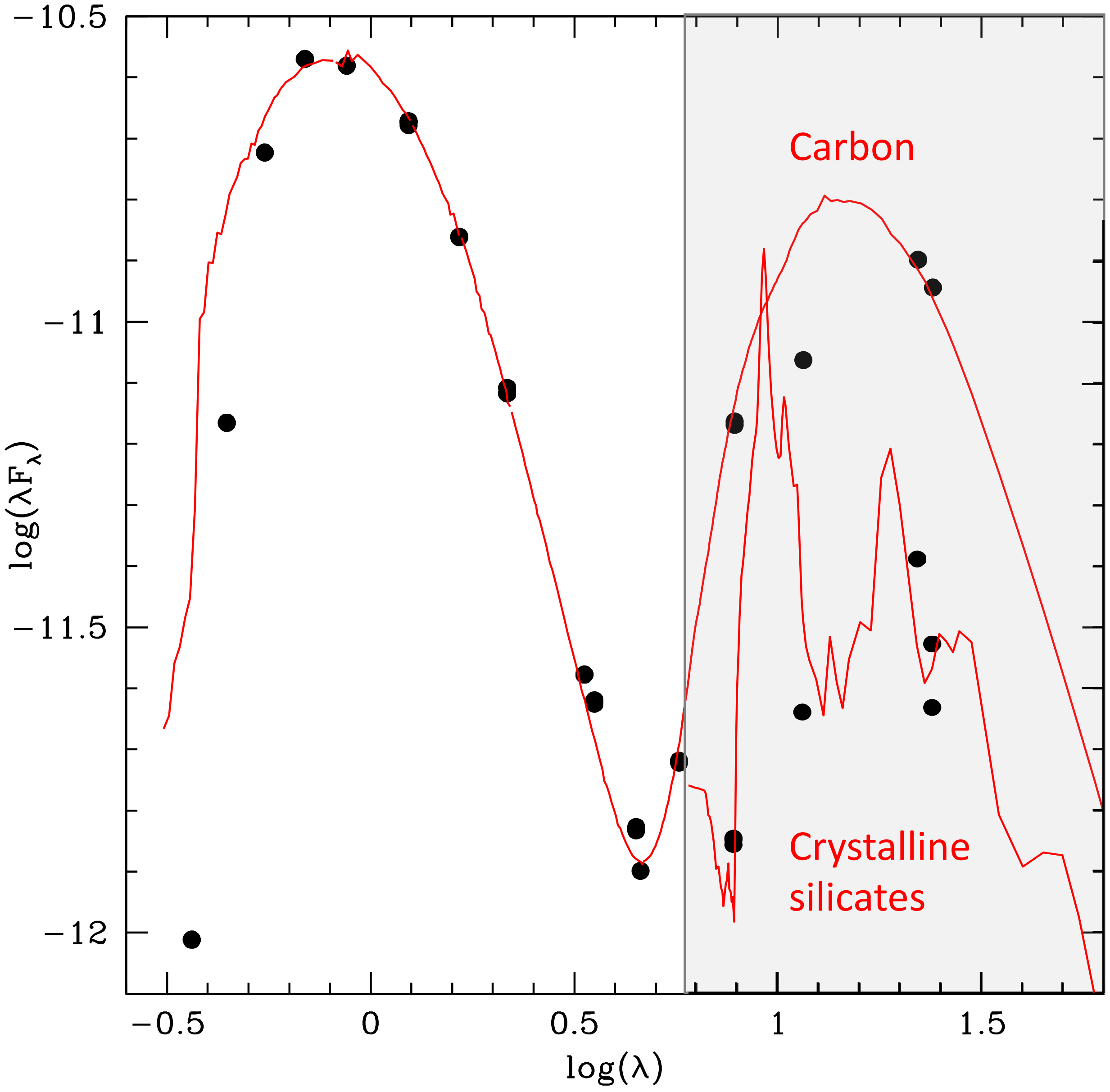
- Effective temperature
- Metallicity

DUSTY code

Nenkova et al. (1999)

From SED fitting **we can derive**:

- Dust properties:
  1. Mineralogy
  2. Optical depth (τ_{10})
  3. Dust temperature
  4. ($T_d \rightarrow R_{in}$)
- Luminosity → Progenitors' mass



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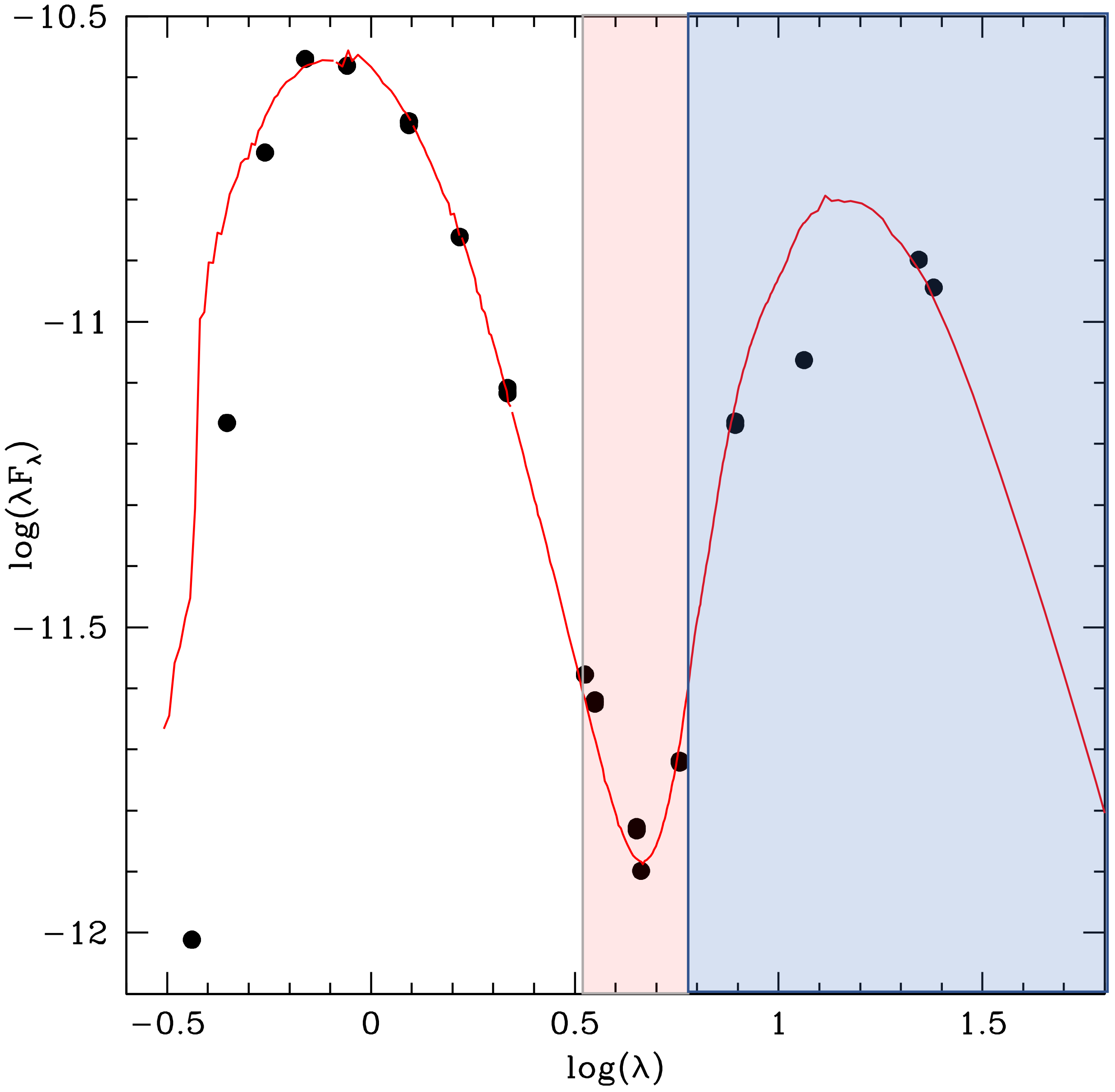

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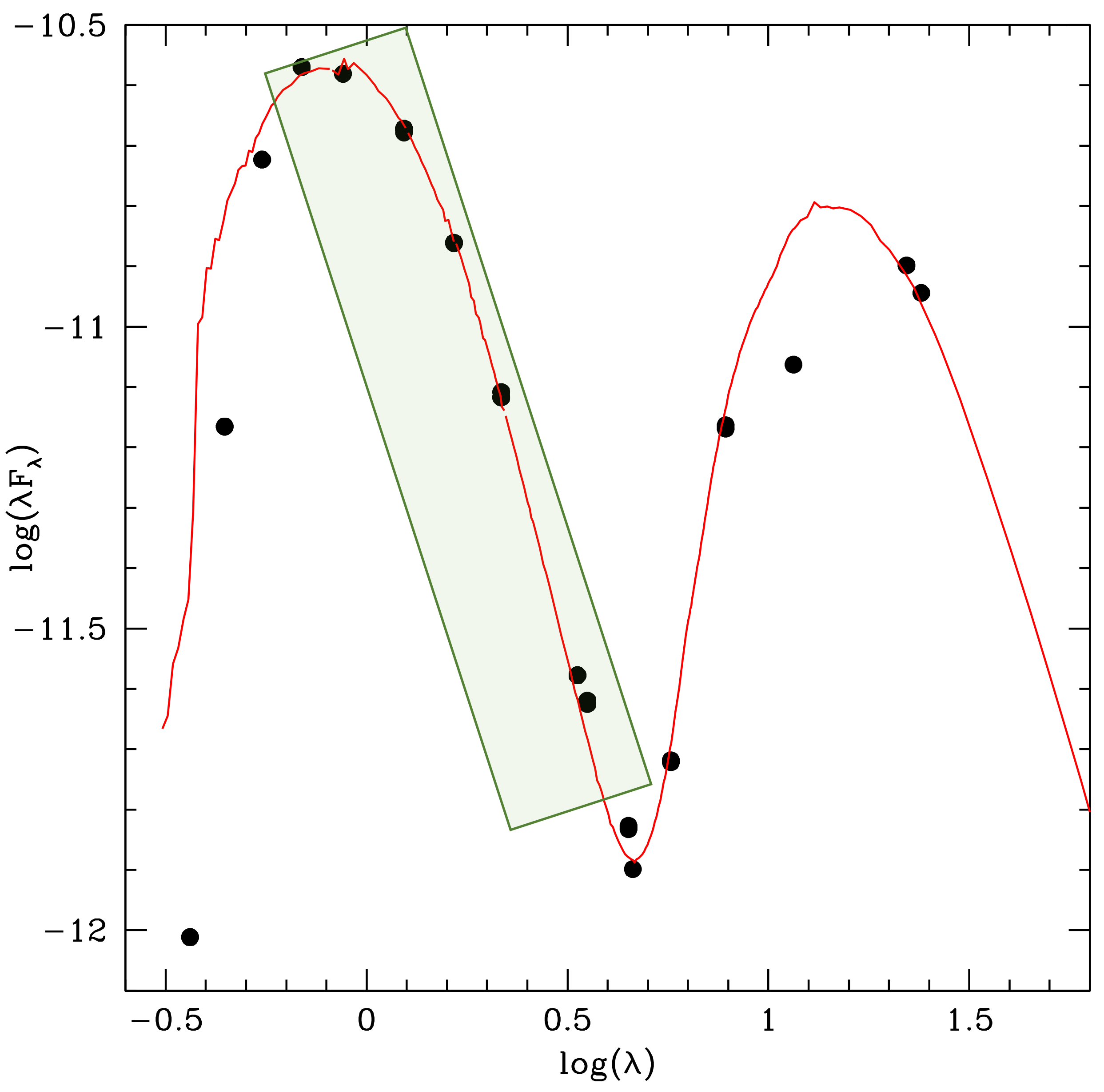
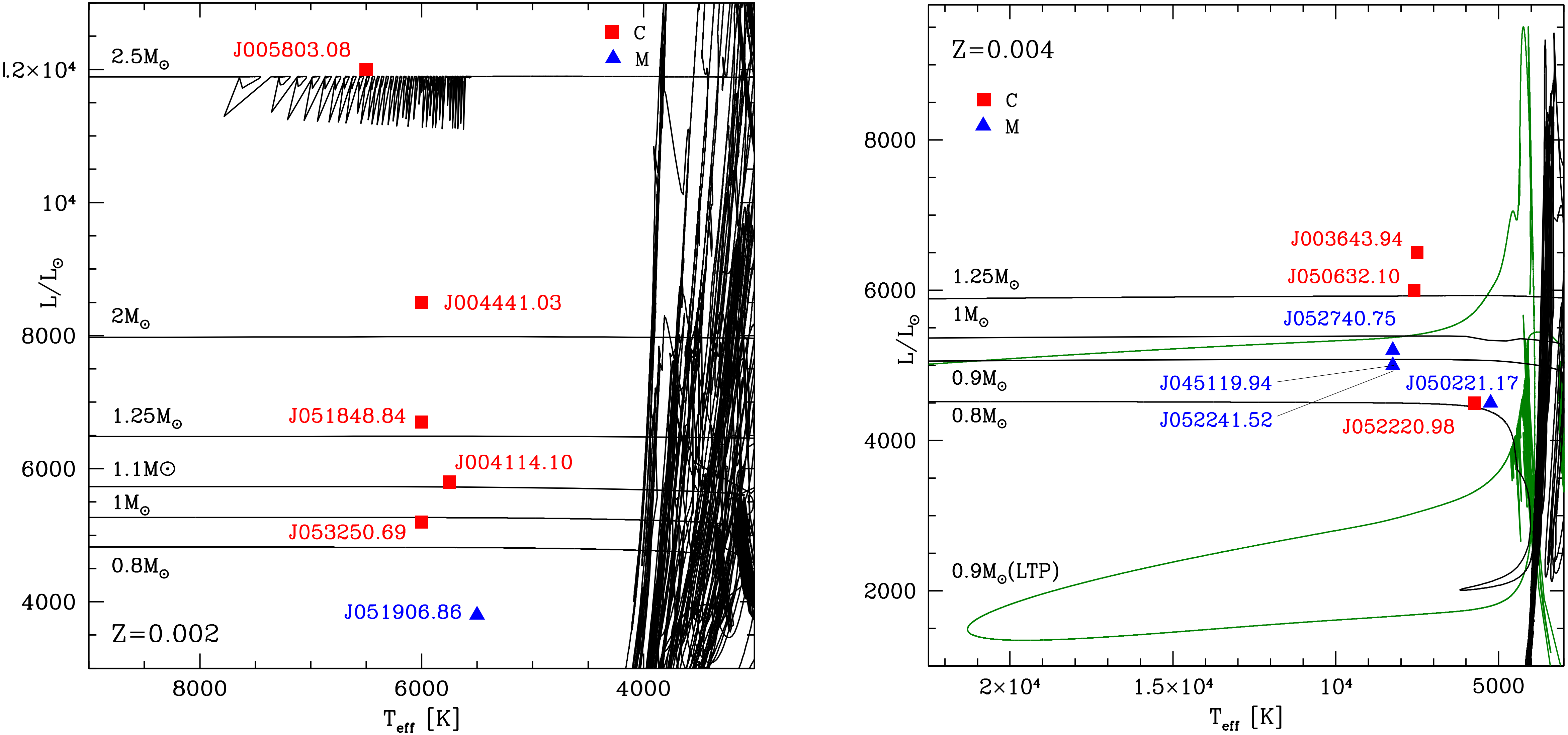


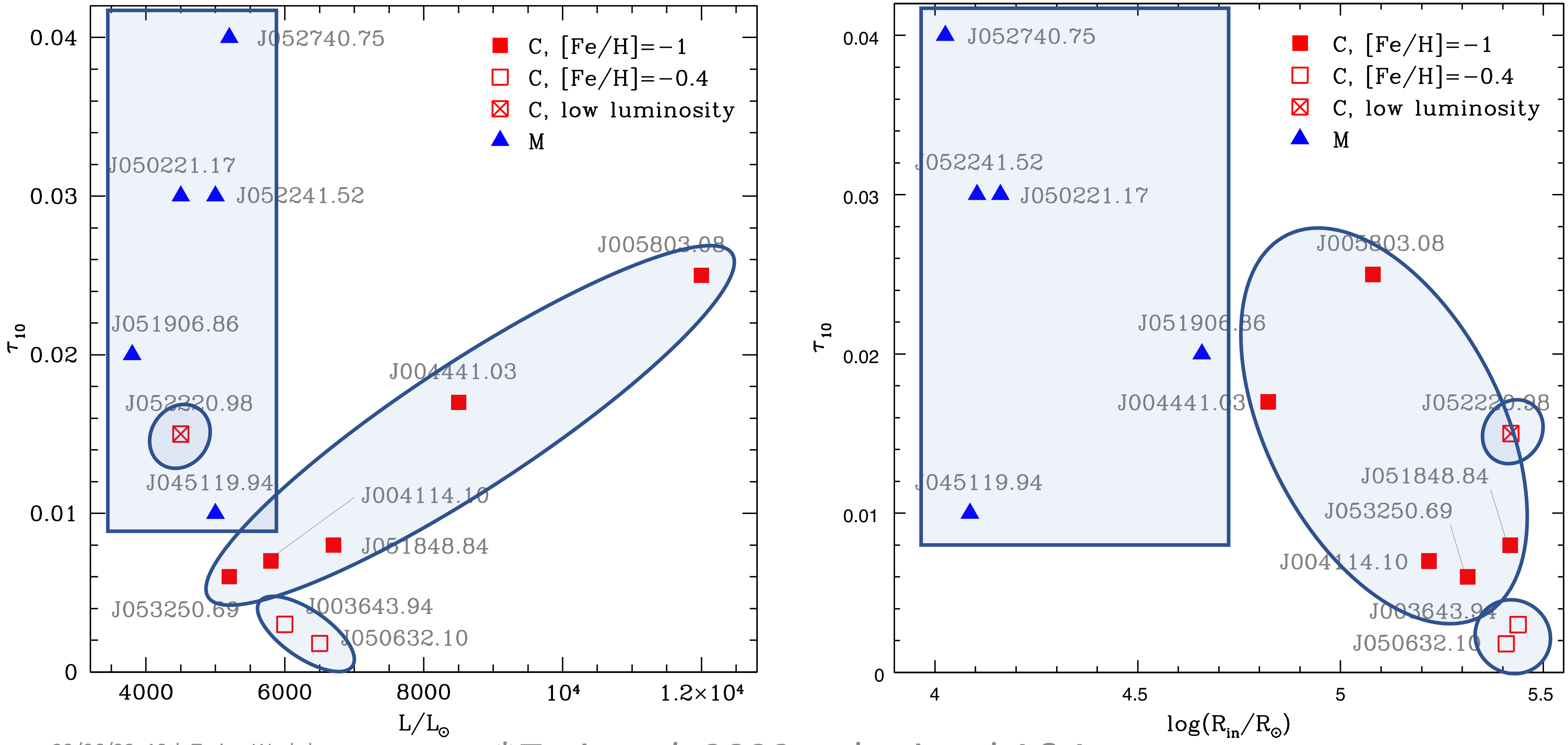
Progenitors' mass determination



22/06/22, 13th Torino Workshop

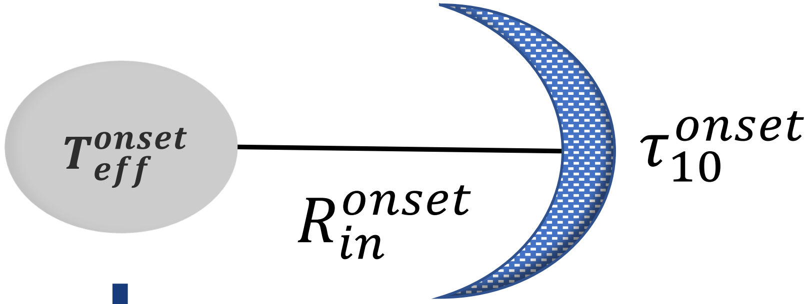
* Evolutionary tracks from **ATON** *Ventura et al. (1998)*

Dust properties



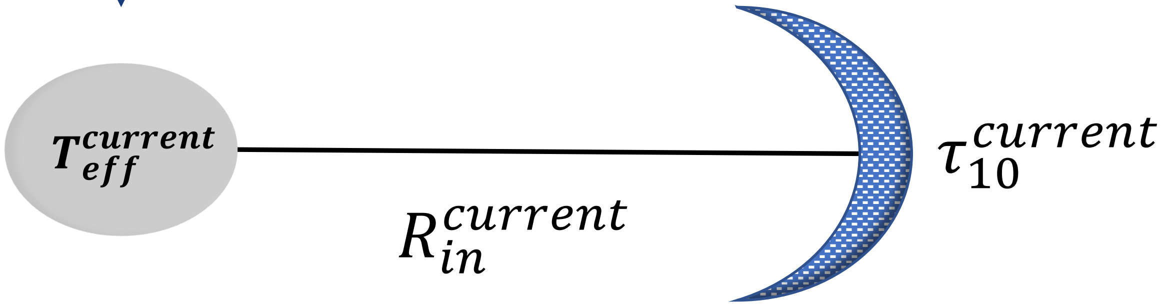
**Tosi et al. 2022*, submitted A&A

The methodology



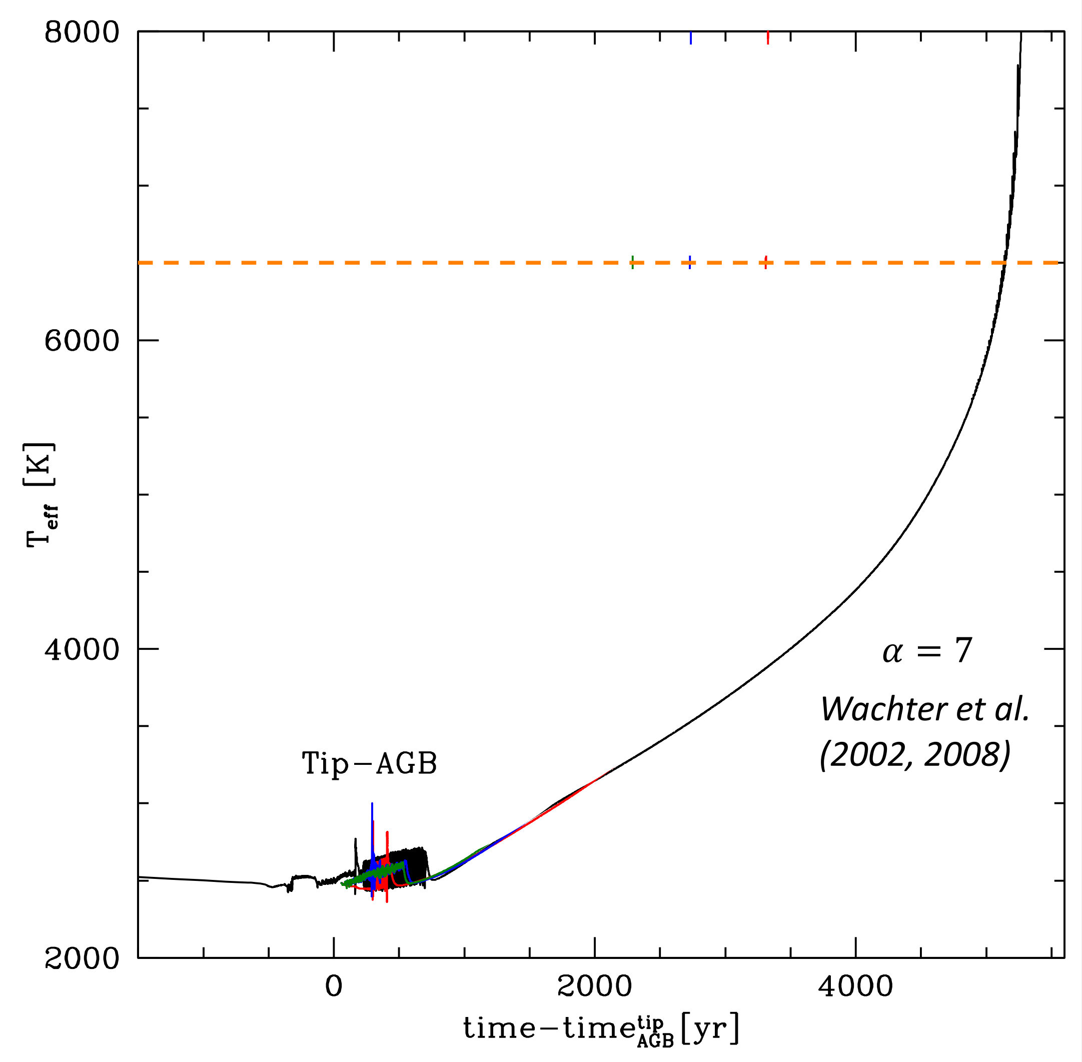
Δt

1. Mass loss rate at the Tip-AGB
2. Slope of the mass loss rate after the Tip-AGB
3. T_{eff}^{onset}

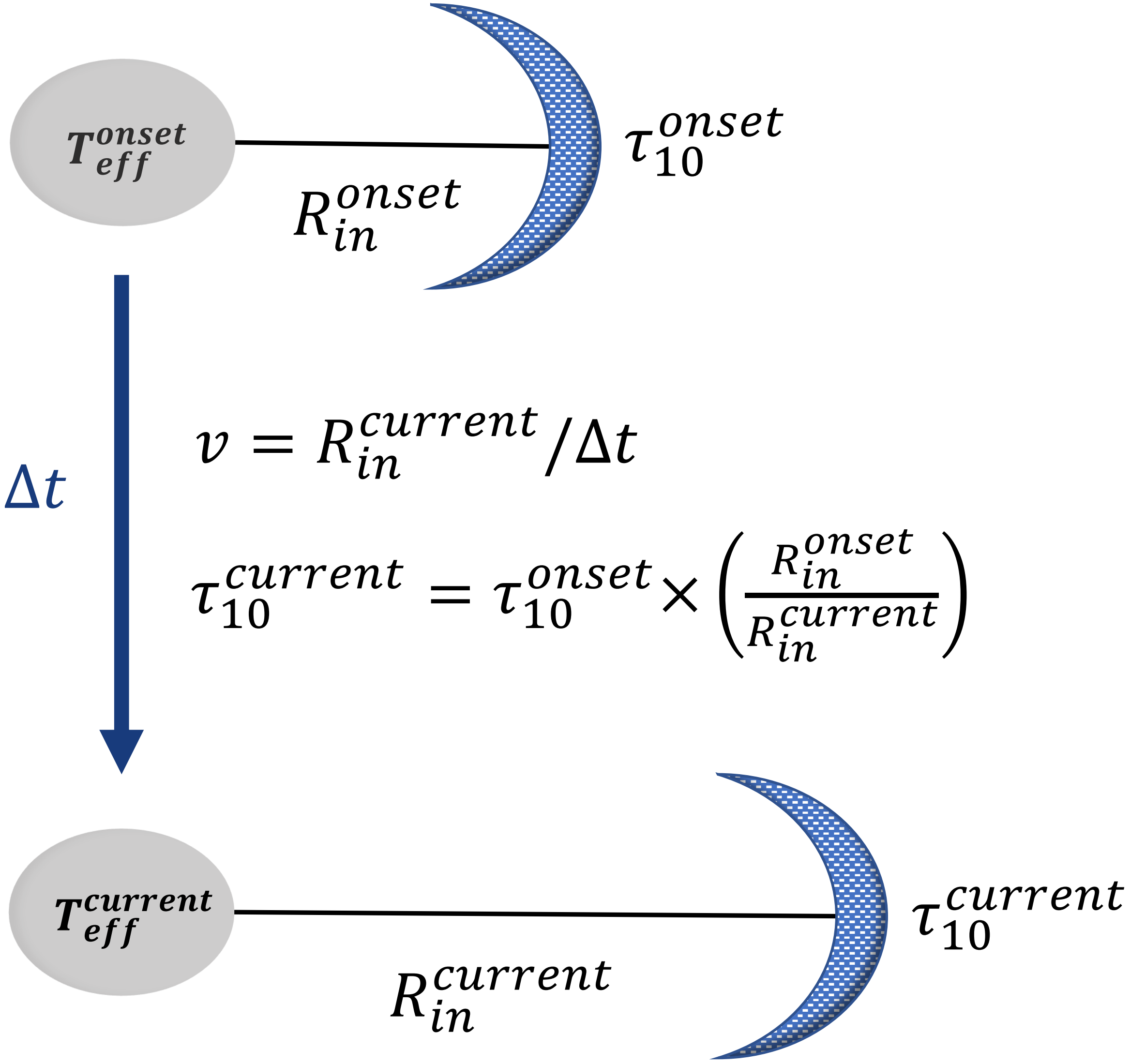


*Not in scale

Carbon star: $\dot{M} = \dot{M}^{Tip} \times \left(T_{eff}/T_{eff}^{Tip-AGB}\right)^{-\alpha}$



The methodology



$$v = R_{in}^{current} / \Delta t$$

$$\tau_{10}^{current} = \tau_{10}^{onset} \times \left(\frac{R_{in}^{onset}}{R_{in}^{current}} \right)$$

*Not in scale

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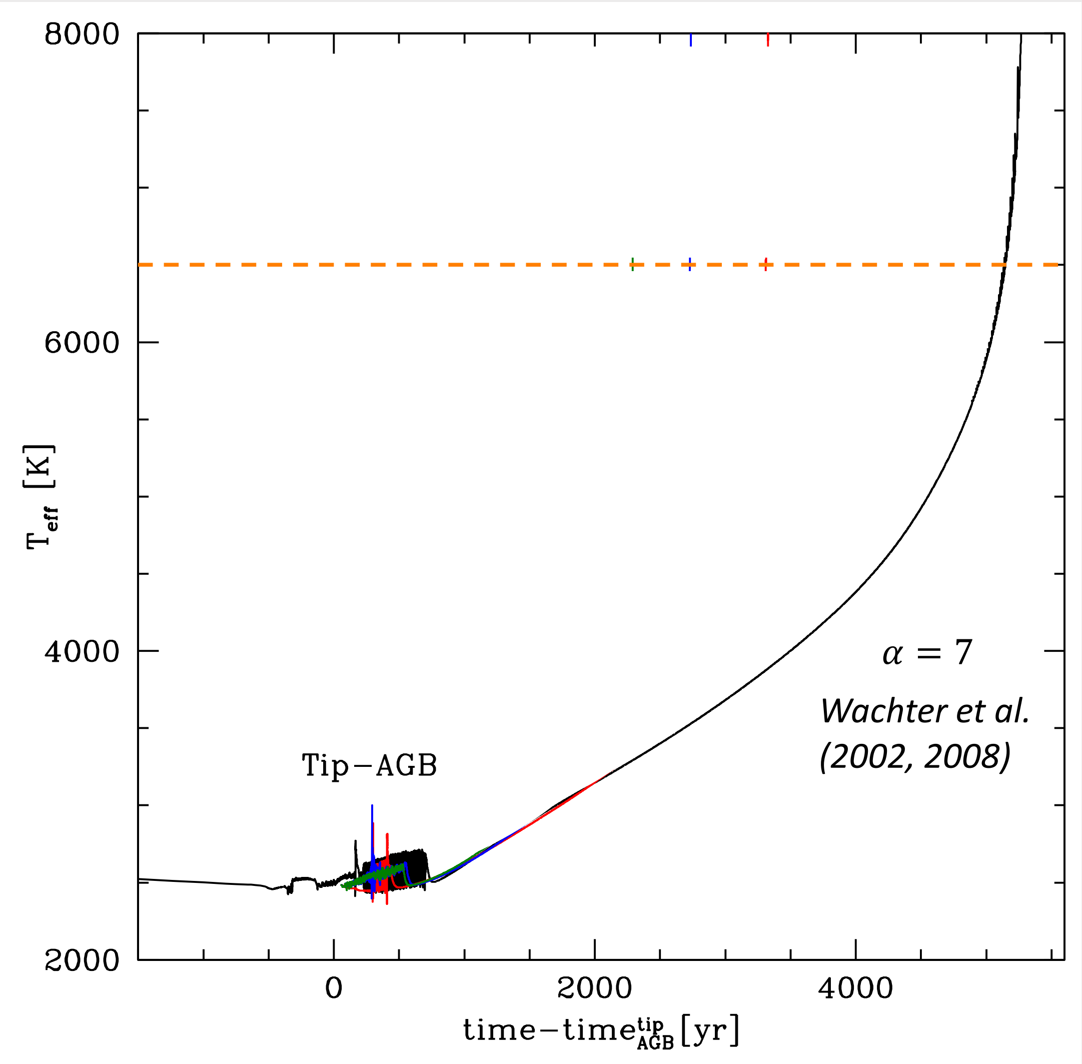

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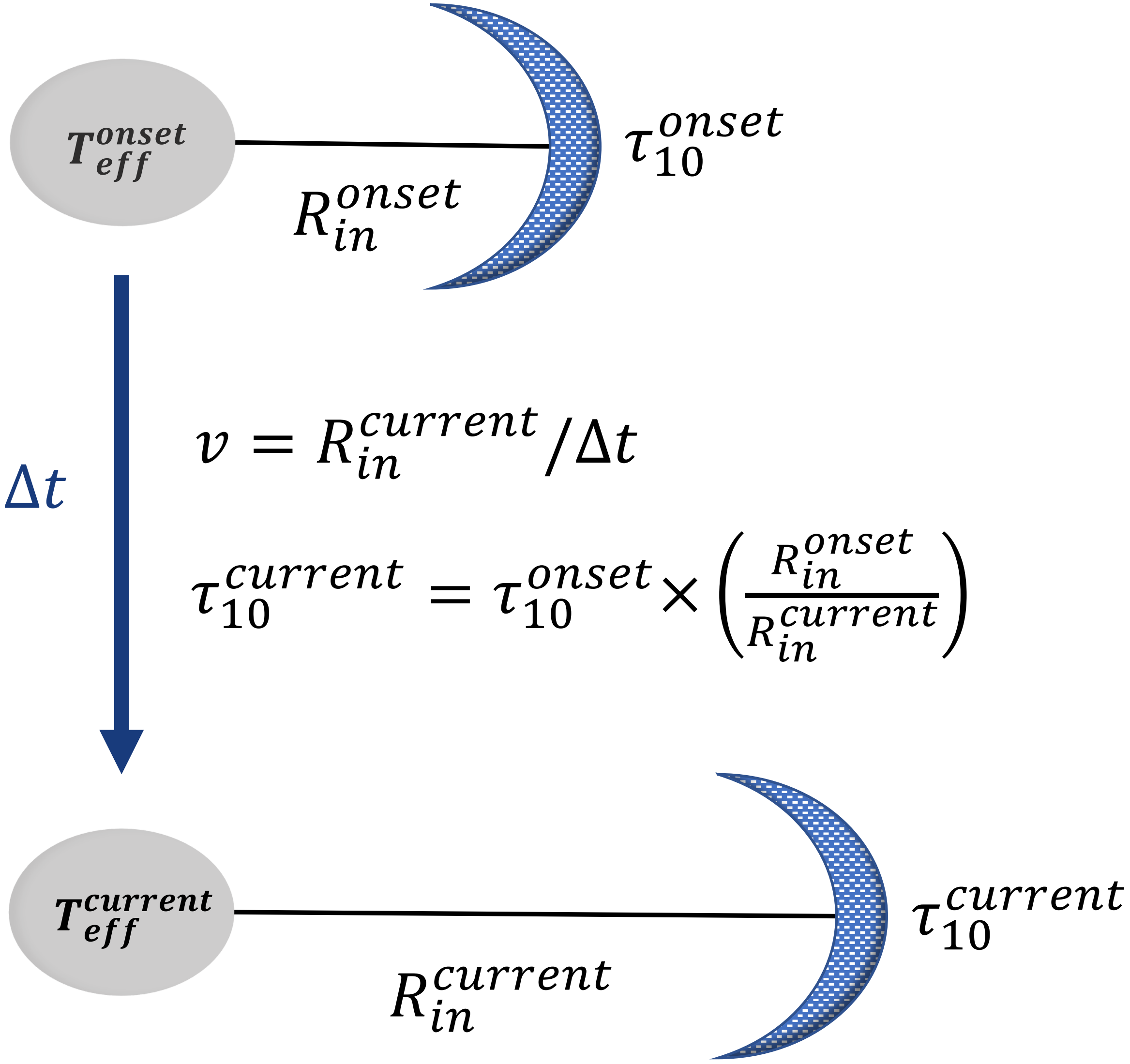

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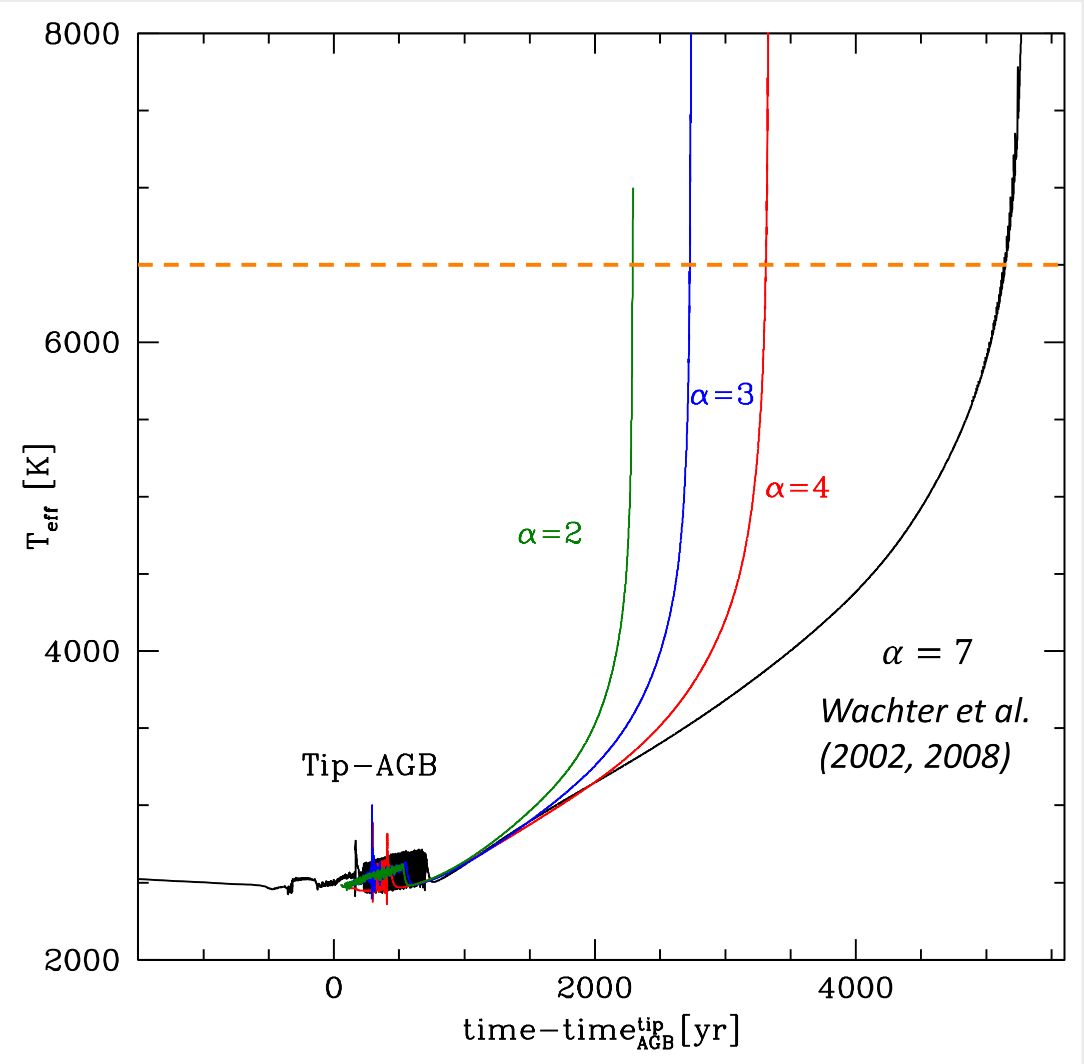
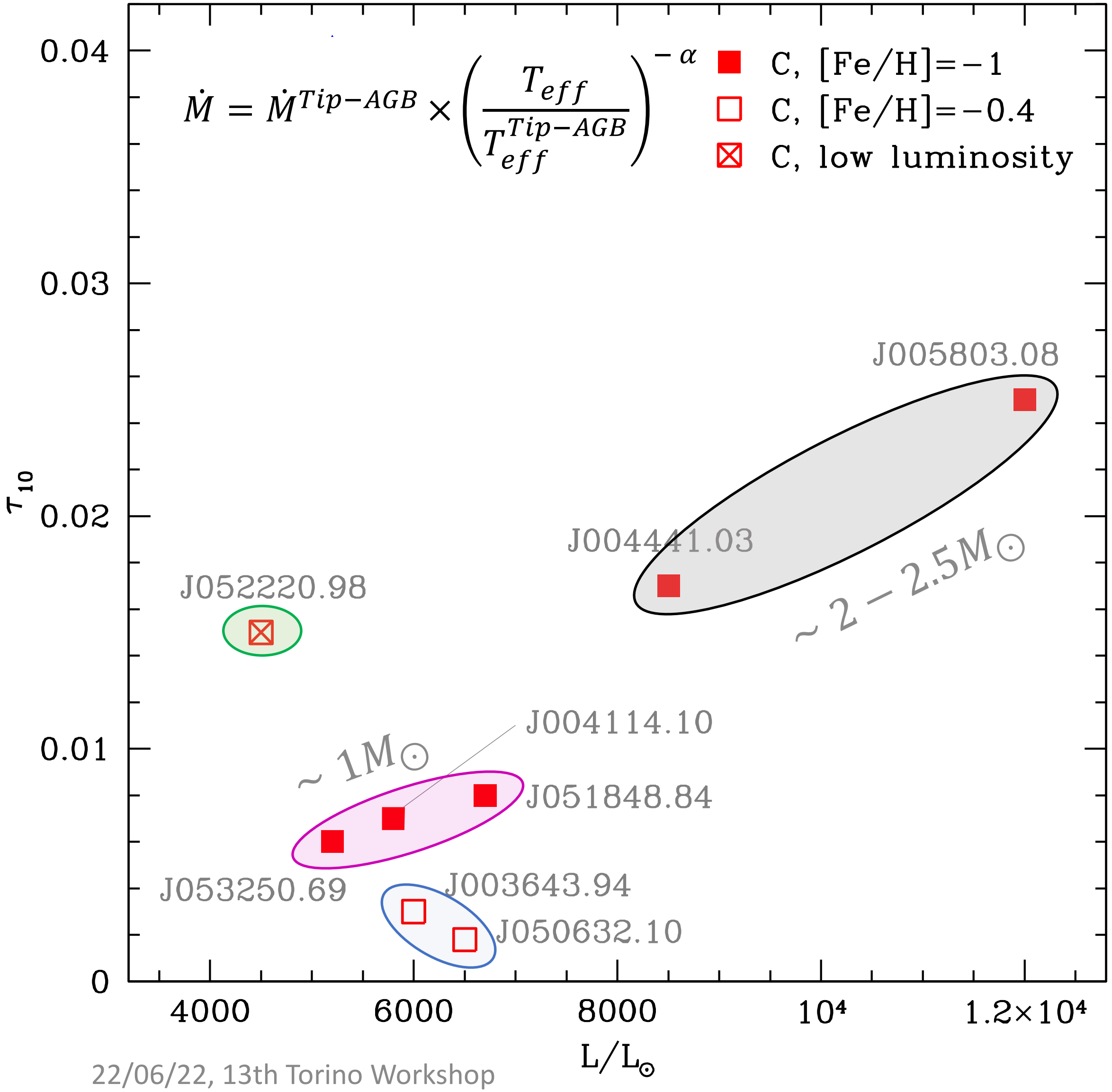


Carbon stars



1. $\dot{M} \propto T_{eff}^{-\alpha}$ with $\alpha = 2 - 3$
2. The dust that we see now was released when $T_{eff} = 3500 - 4000K$.
3. $\dot{M}^{Tip-AGB} \sim 10^{-4} M_{\odot}/yr$

τ_{10} → Large surface carbon abundances
R_{in} → Short contraction times

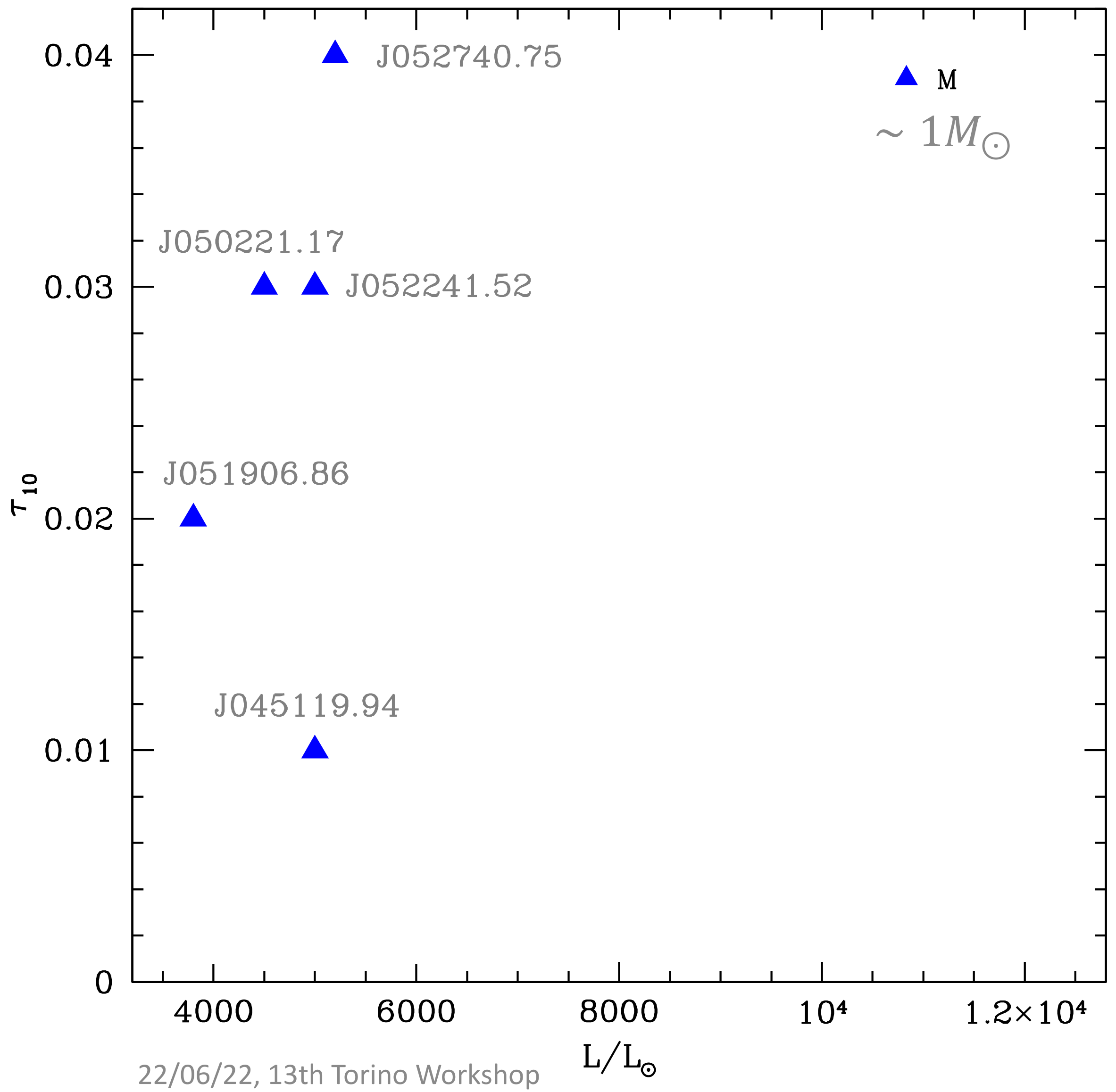
$\dot{M} \propto T_{eff}^{-\alpha}$ with $\alpha = 2 - 3$

The dust that we see now was not released when $T_{eff} = 3500 - 4000K$

$\dot{M}^{Tip-AGB} \sim 10^{-5}\ M_{\odot}/yr$

$\dot{M}^{Tip-AGB} \sim 3 - 4{\times}10^{-5}\ M_{\odot}/yr$

Oxygen stars



The standard mass loss relation used for the oxygen rich AGB stars (Blöcker 1995)

The dust that we see now was not released when $T_{eff} = 3500 - 4000K$

$$\dot{M}^{Tip-AGB} \sim 10^{-6} M_\odot/yr$$

$R_{in} \rightarrow$ Extinction coefficients of silicates are lower than those of carbon dust

Conclusions.

- The dust currently surrounding post-AGB stars was not released at the Tip-AGB but in a **later stage,** when $T_{eff} = 3500 - 4000K$;
- For **oxygen** rich stars we confirm the standard relation used during the AGB phase and also the mass loss rate at the Tip;
- For **carbon** stars the mass loss declines after the Tip with a slope softer dependent on the effective temperature than expected from the standard stellar evolution modelling;
- For **low-mass carbon** stars a correction of the mass loss rate at the tip of the AGB phase of a factor ~ $3 - 4$ is required.

Future prospectives

- Galaxy sample (from Kamath et al. 2022)
- Binary systems