Evolution & Nucleosynthesis in Super AGB Stars

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Overview

- What is a Super AGB star?
- Their evolution
- Overview of the Codes used (MSSSP & MOSN)
- Comparison with other models
- Thermal Pulses
- What next?

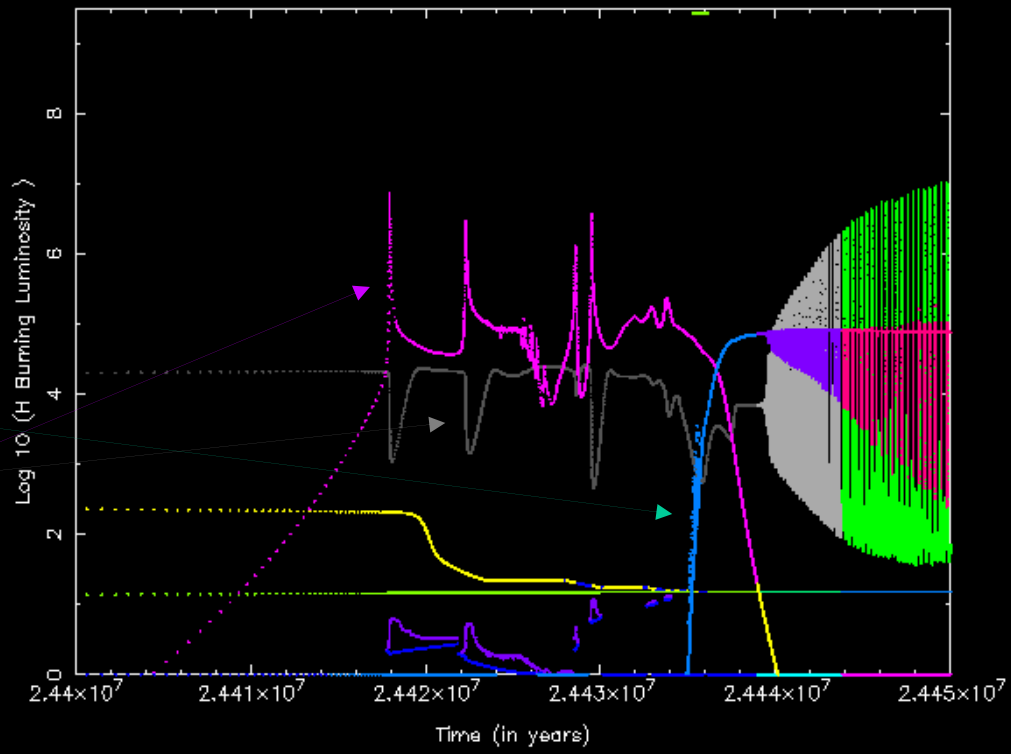
What is a SAGB Star?

- M9.5 Z=0.02
- ≈8-11 solar masse undergoes H,He C and then TPs!

L_H

LHe

LC

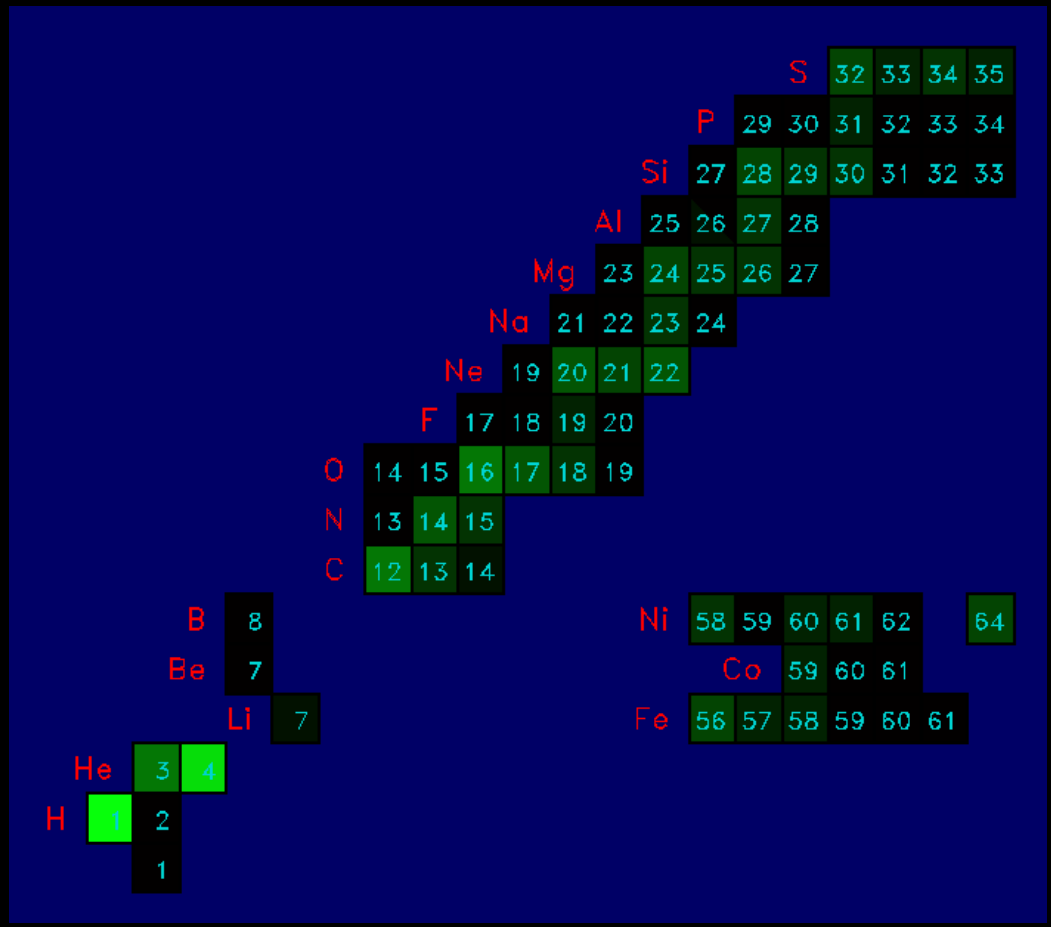


MSSSP – Stellar Evolution Code

- Monash Version of Mount Stromlo Stellar Evolution Program (MSSSP)
- 1D code, 7 species - H, ^{3}He, ^{4}He, ^{12}C, ^{14}N, ^{16}O + other
- Uses the Henyey relaxation method
- Opal Opacities
- Use our "standard" model – instantaneous mixing
- Neutrino Loss rates Itoh
- Vassiliadis/Wood mass loss rate on (S)AGB phase
- Importantly: no convective overshoot BUT – uses a neutral border approach at convective envelope boundary

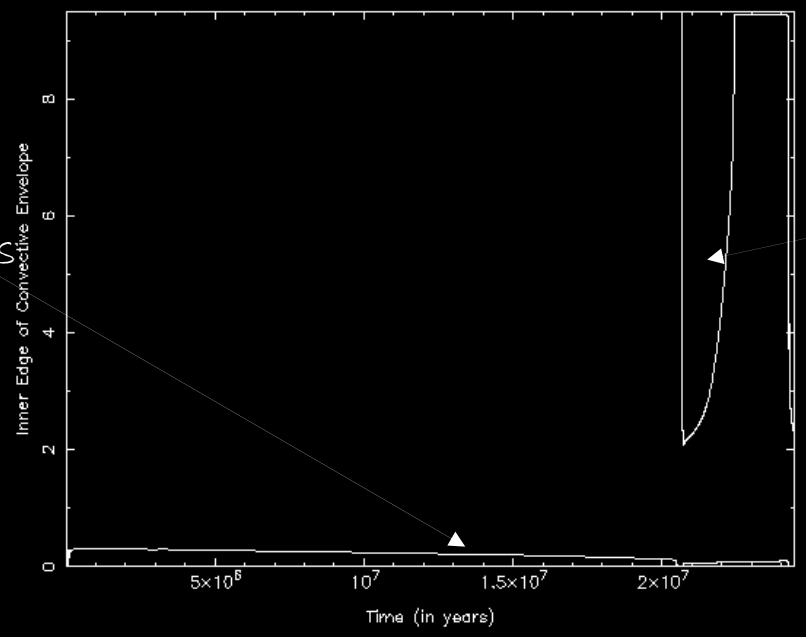
MOSN- Monash Nucleosynthesis code

- Post Processing nucleosynthesis code
- 74 Species, Isotope from H to Silicon + Iron peak species
- 506 nuclear reactions, α, p, n reaction and beta decays
- Charge particle reactions from Iliadis updates,
- n Bao 2000
- Majority of rates from Non smoker tabulation.



Comparison up to C burn

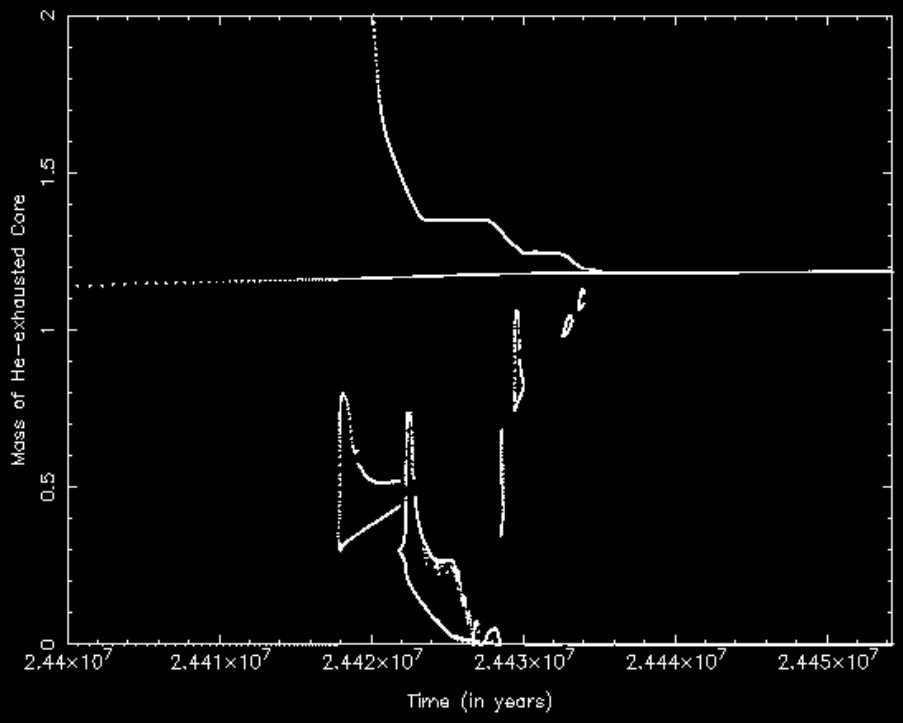
Convective Cores / mass



1DU

M_{HB}	M_{HeB}	M_{1DU}	M_{CoI}	$X\{^{12}C\}$	$X\{^{16}O\}$	
2.902	0.947	2.091	1.150	0.623	0.350	MSSSP
2.906	0.850	2.018	1.095	0.630	0.344	Siess

Carbon Burning



$C^{12} + C^{12} \rightarrow Na^{23} + p$

$\rightarrow Ne^{20} + \alpha$

About 50% go into each channel

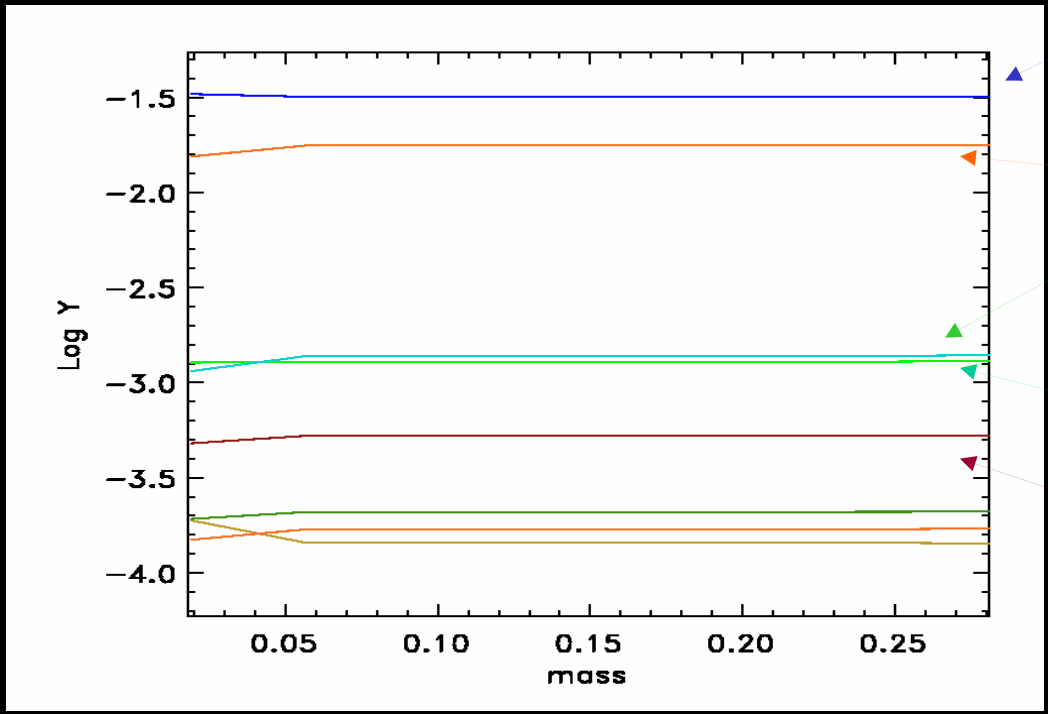
$O^{16} + \alpha \rightarrow Ne^{20} + \gamma$

$C^{12} + C^{12} + O^{16} \rightarrow 2Ne^{20} + \gamma$

As included in MSSSP

Composition After C-Burning

- Comparing with Siess (2006) we find the same ONeNa core i.e. Na23 > Mg24 abundances, we find



O16 ~ 50%

Ne22 ~ 34%

Na23 ~ 3%

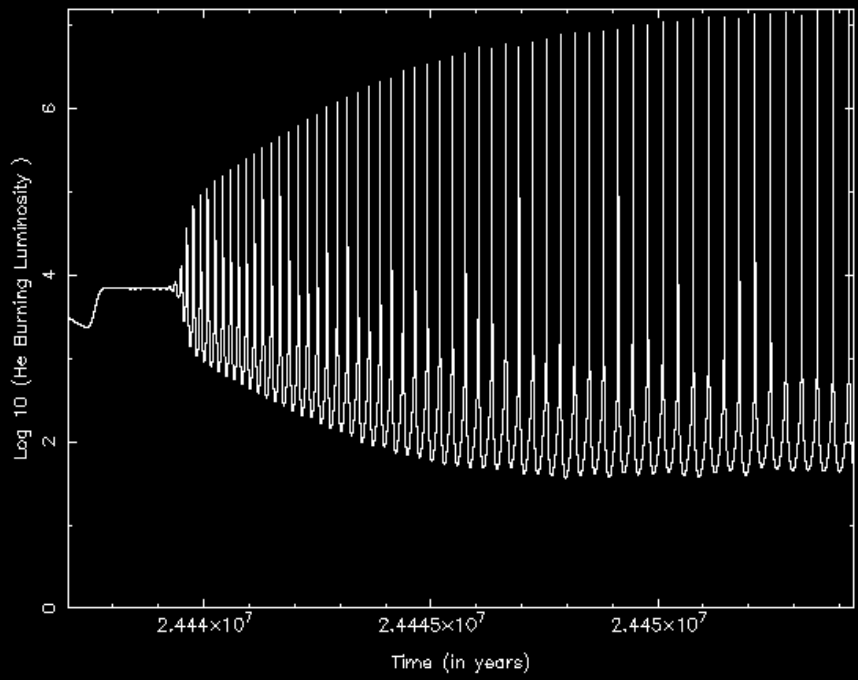
Mg24 ~3%

Al27 ~ 2%

+ other, C12, Mg26 etc

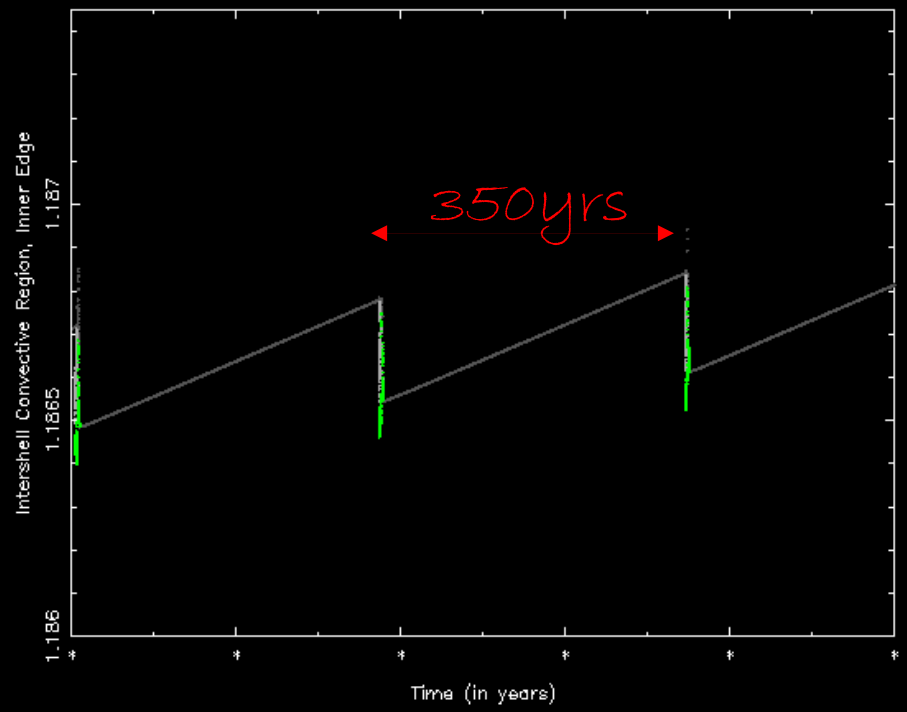
Thermally Pulsing (Super-AGB) Phase

- With the large envelope mass and using mass loss rates by reimer & vassiliadis/wood In some cases we will have in excess of 500 thermal pulses BUT- what happens to the main nucleosythesis during Tps ? (HBB + 3DU)



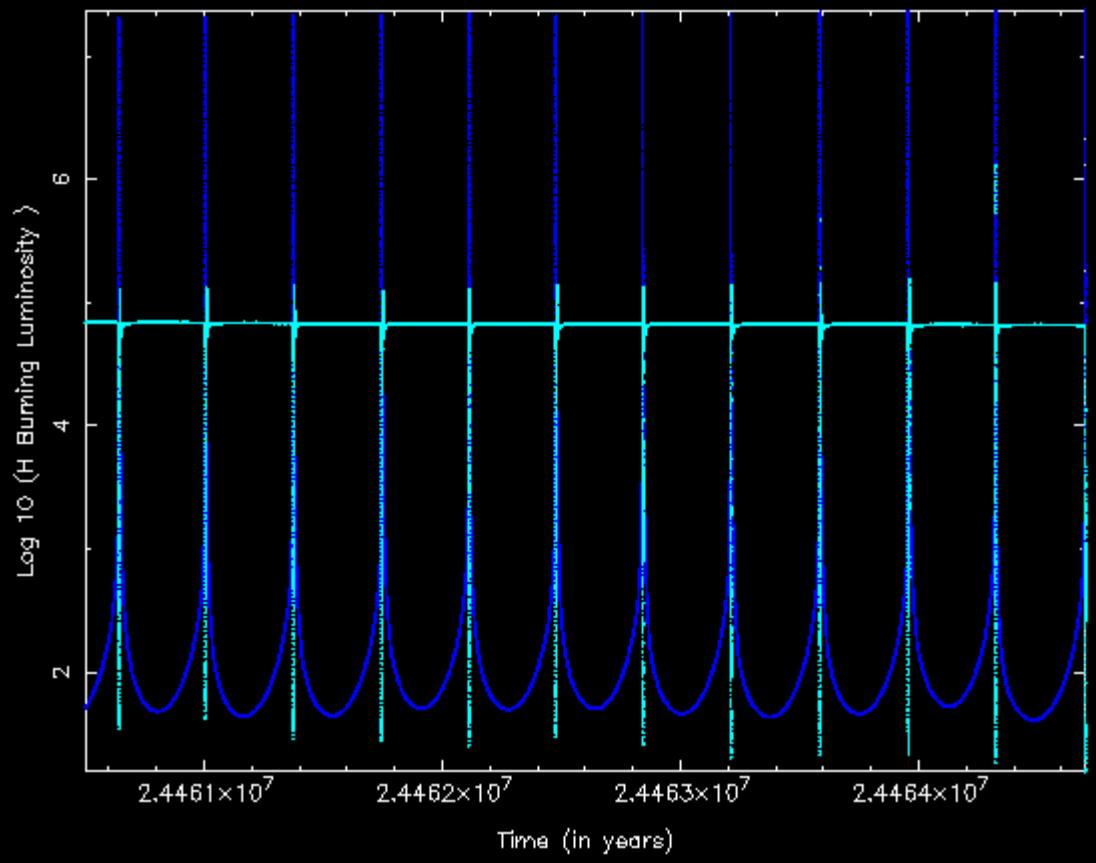
Thermal Pulse Convective Pocket

- We find a the convective pocket in our star last only 3years and is about 10^-4 solar masses in size…with the interpulse period ≈ 350 years.
- The time resolution is for convective pocket is why there is currently no nucleosynthesis.



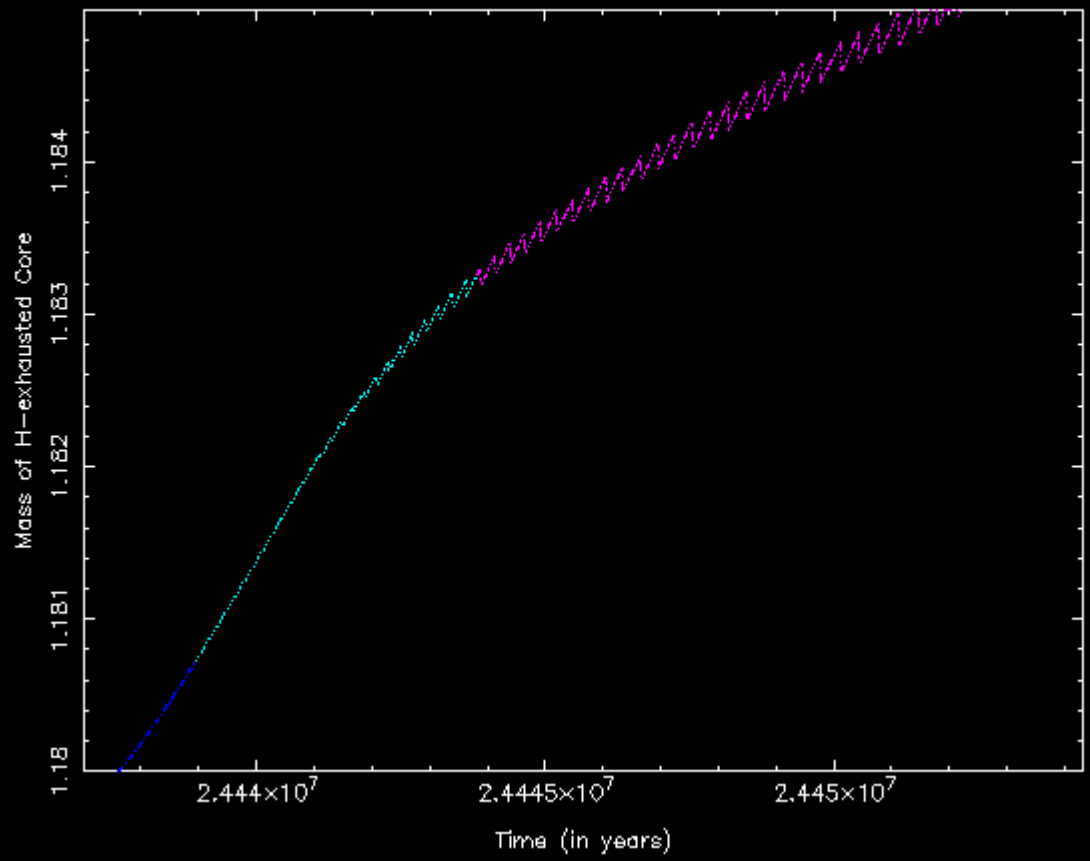
H & He Luminosities

The He Luminosity is greater than 10^7 and this "extinguishes" the H burning shell enough for 3DU



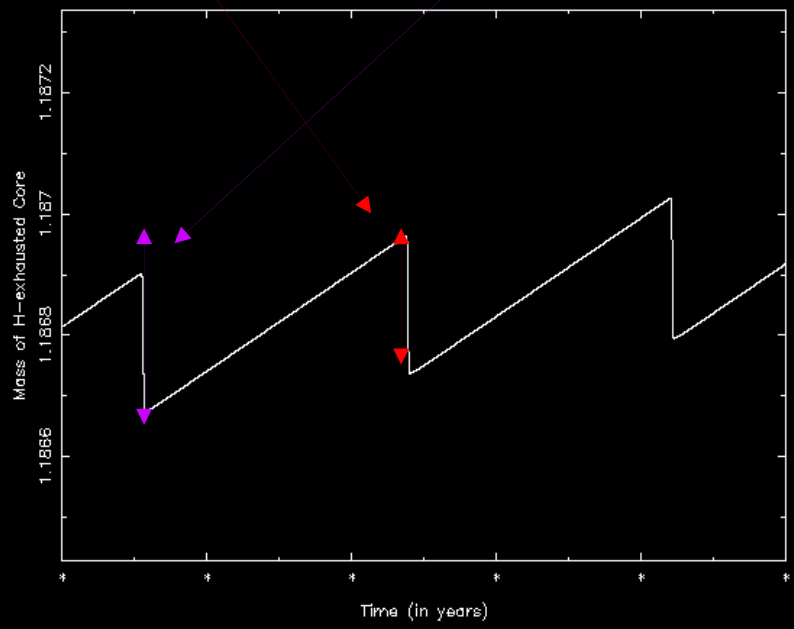
Third Dredge Up (TDU)?

- using our standard case model we FIND Efficient 3DU .

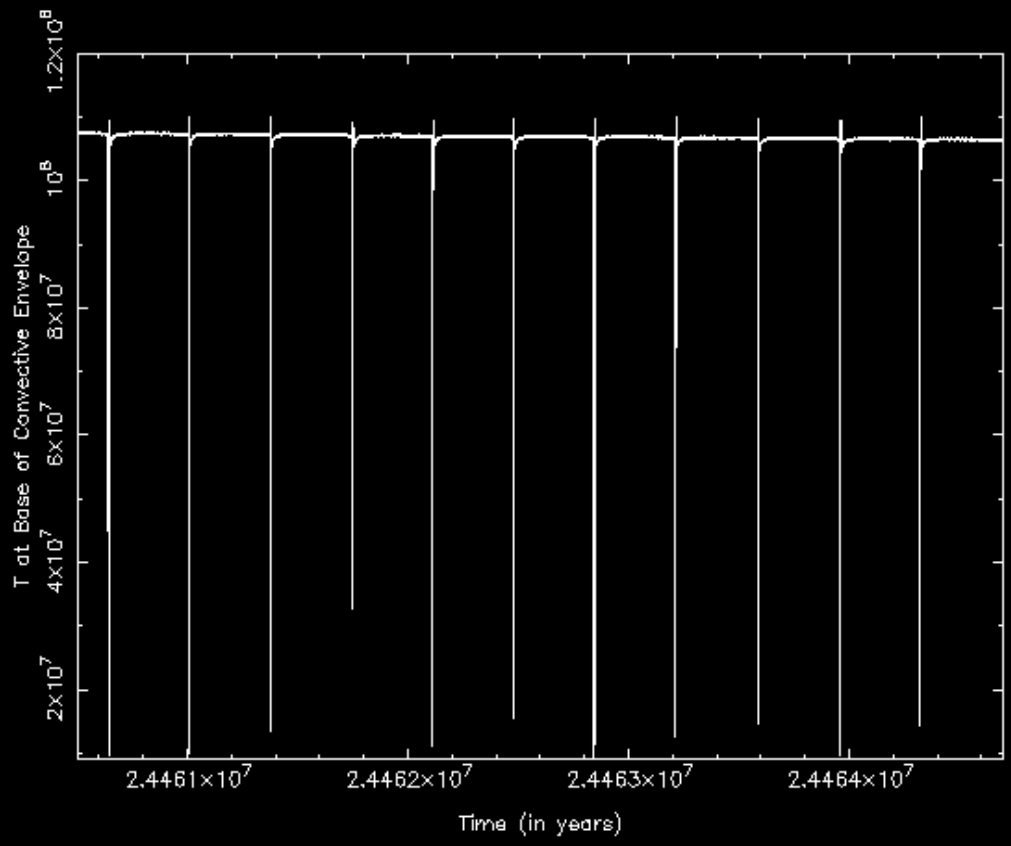


Third Dredge Up (TDU)?

- $\lambda = \Delta M_{dredge} / \Delta M_{H} \approx 0.7$



Temperature at the Base of the Convective Envelope



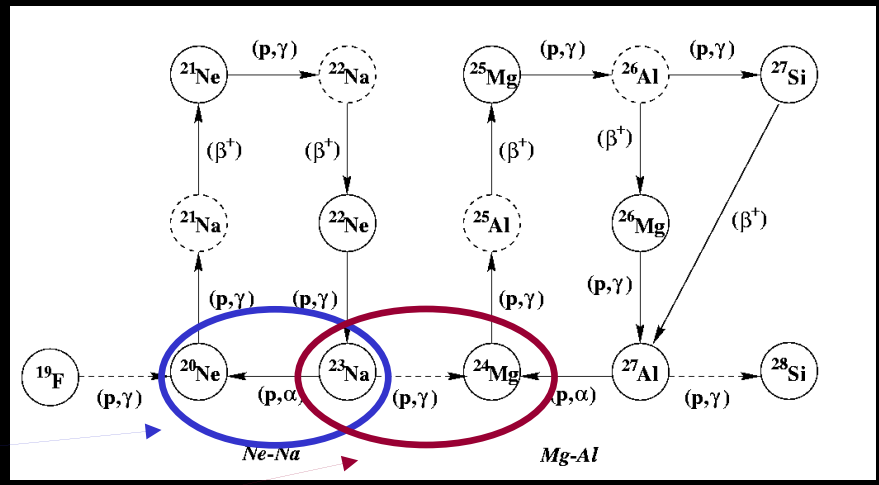
The temperatures involved are very large, compare to "normal" agb stars. Ie How does this effect HBB

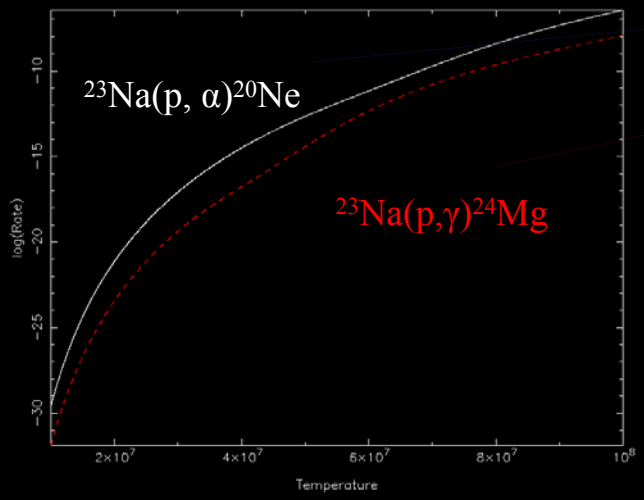
& in particular the Ne-Na to Al-Mg cycles?

Hot Bottom Burning (HBB)

Convective Timescale in envelope is a few years

For temperature involved the 23Na(p, α)20Ne dominates





What shall be the end results of HBB in SAGBs?

Further Work - Nucleosynthesis

Complete nucleosynthesis to the end of the TPs and then produce a set of yield results, for varying masses, metallicitys.

Run further comparisons with work of others and explore the 3DU.

Thank you for your time