Testing CLES 18

Task 1.5

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Comparison models, Aarhus 24-28 October 2005

Task1.5

PARAMETERS:

mass	2.0 $M_\odot$
Z	0.02
X	0.72
α	1.60
ov	0.15 Hp
Xc	0.01

Isotopic ratios

	CLES	CESAM
$^2H/H$	$3.4001\ 10^{-5}$	$3.010\ 10^{-5}$
$^3He/^4He$	$1.420\ 10^{-4}$	$1.100\ 10^{-4}$
		$4.185\ 10^{-4}$

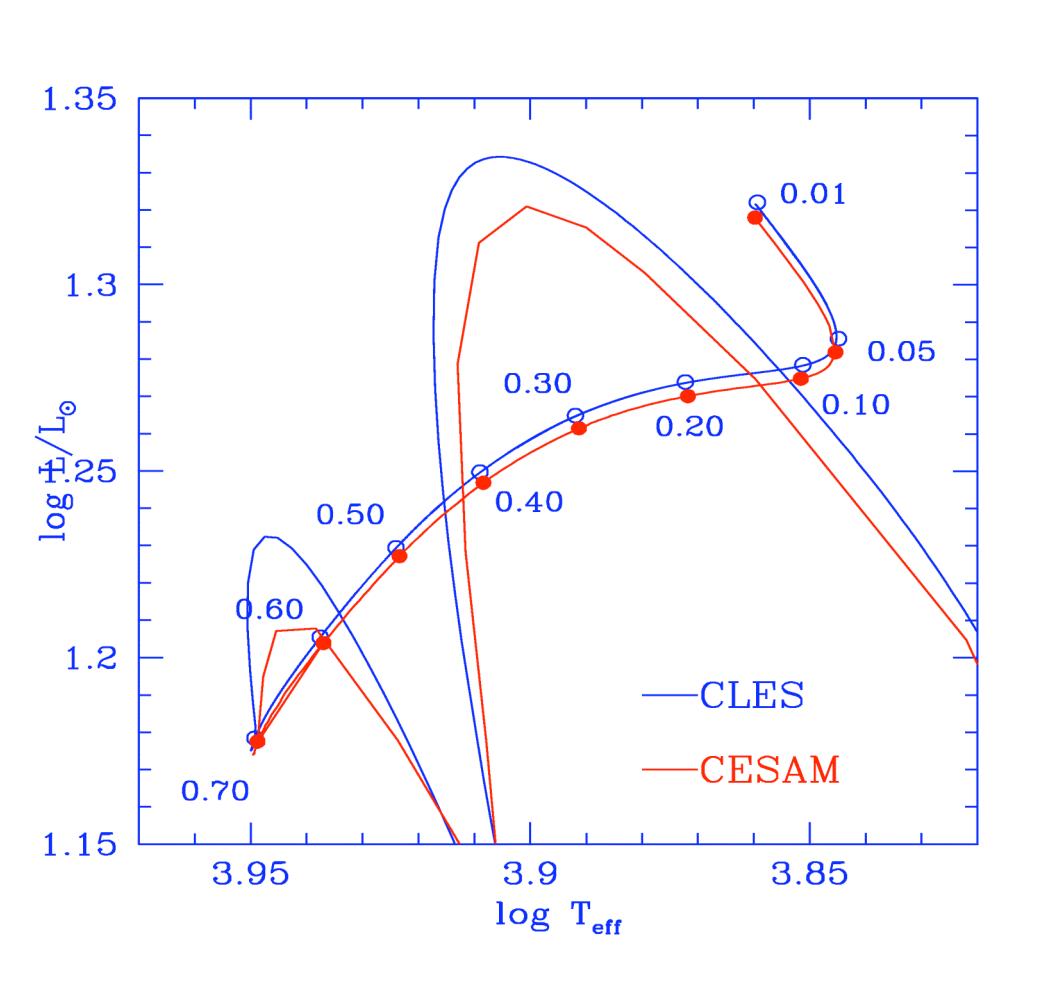
PHYSICS:

Conv.	MLT (Bohm-Vitense 68 + Heyney et al. 65)
Atm.	Gray Eddington
Opacities	OPAL (96) + Alexander & Ferguson(94)
EOS	OPAL (2001, Tables)
Reaction rates	NACRE (Angulo et al. 9
Mixture	Solar (Grevesse & Noels
Overshoot	$\nabla = \nabla_{ad}$ (Zahn 91)

GN93 mixture

	CLES	CESAM
He	10.93	10.99
Li	3.31	1.16
Be	1.42	1.15
B	2.60	2.60

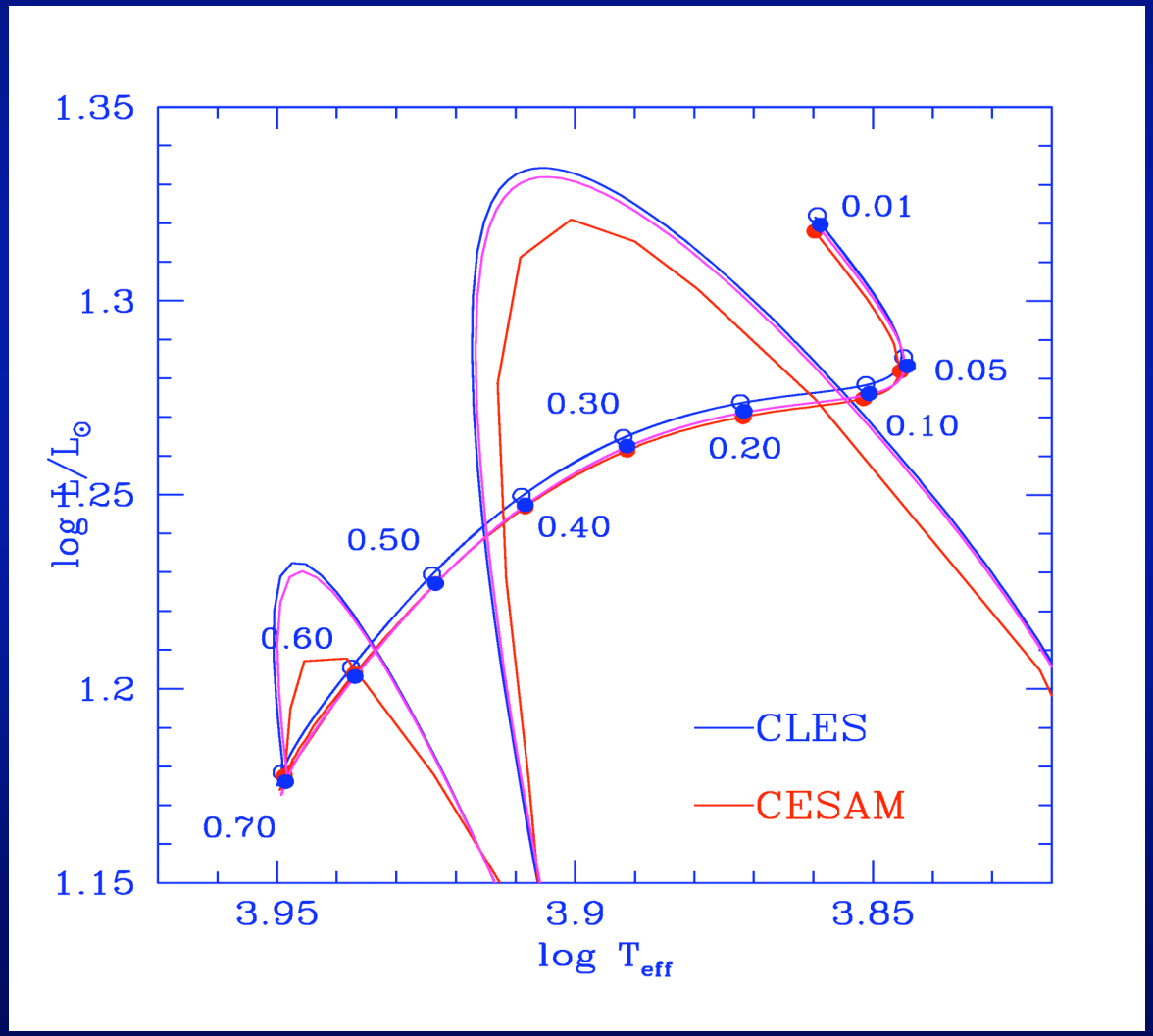
HR diagram



$\Delta T_{eff} < 0.2\%$

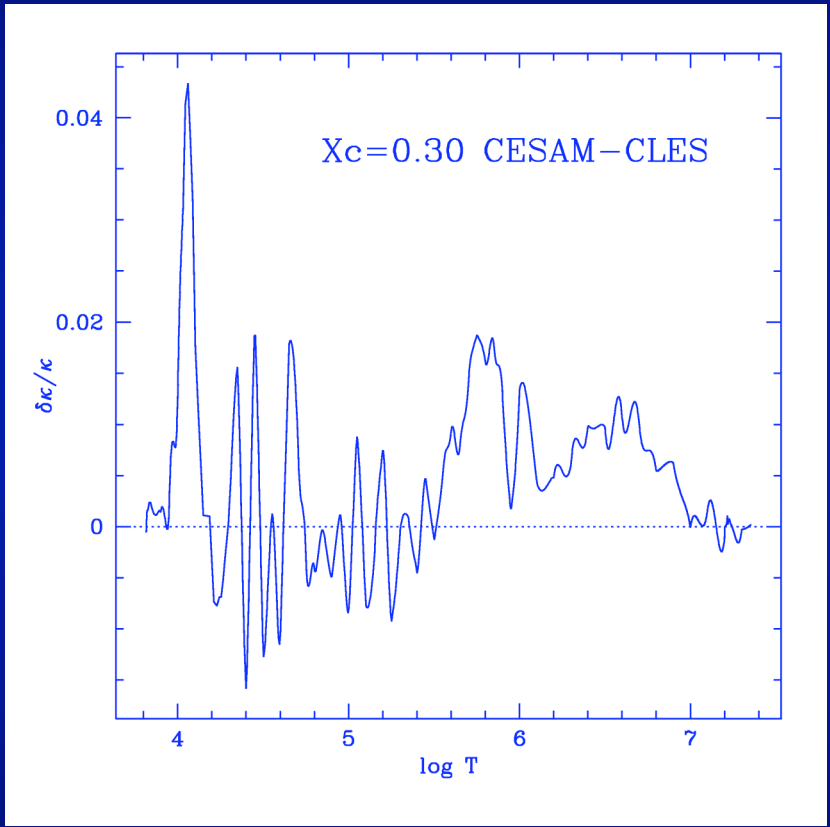
$\Delta L/L_{\odot} < 1\%$

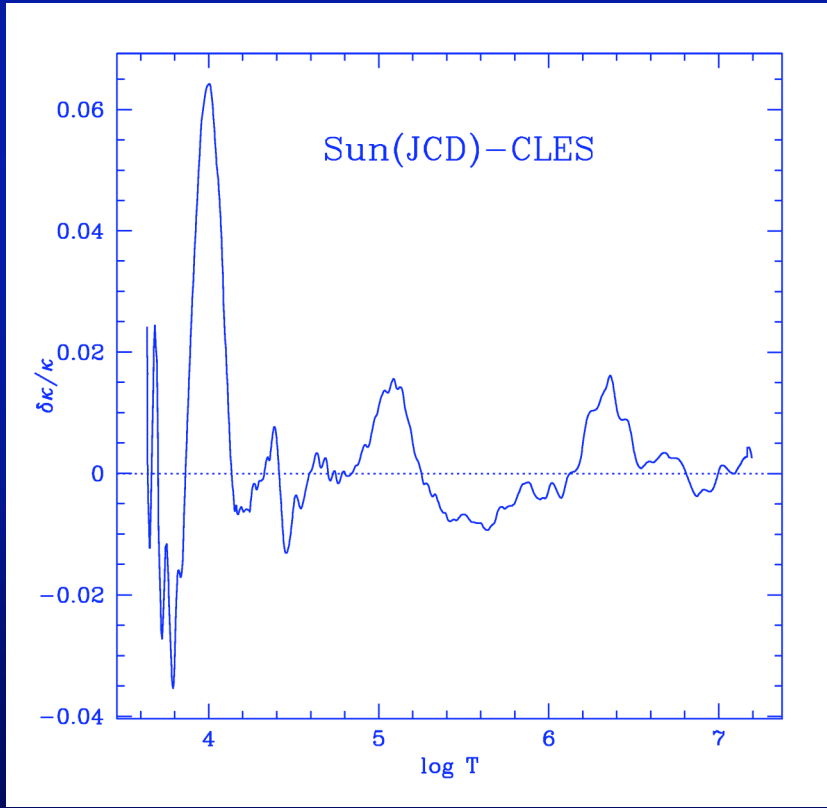
HR diagram:



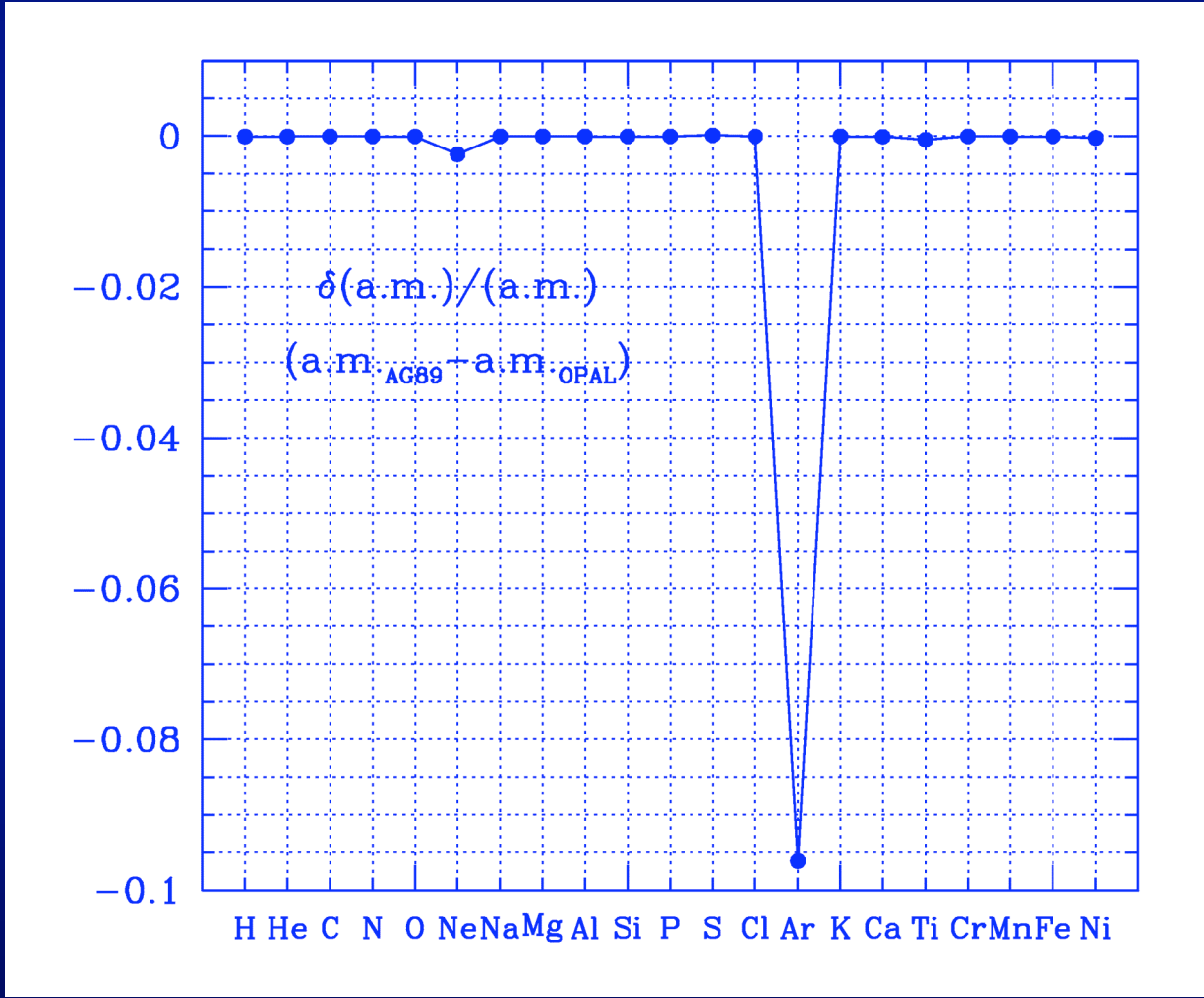
κ_{CLES} increased by 0.5%

Opacity

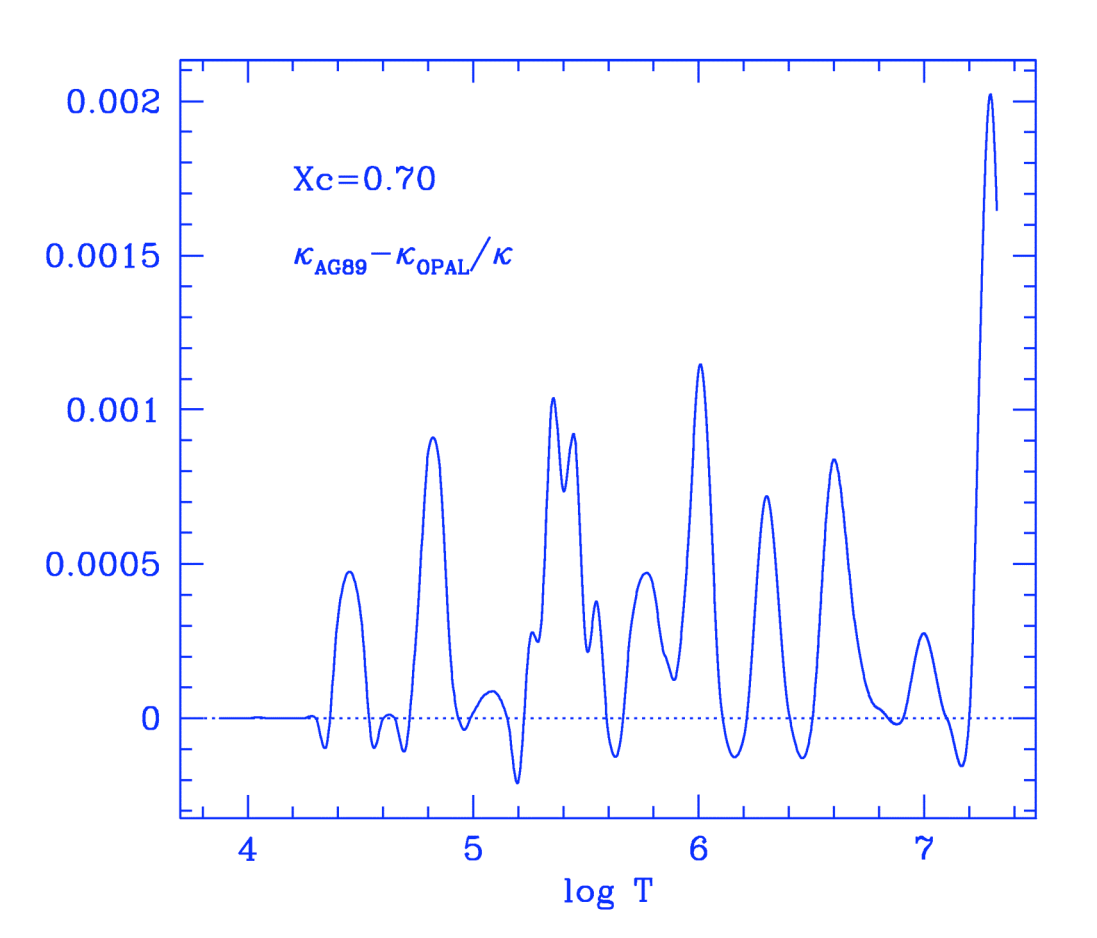

Xc=0.30 CESAM−CLES
0.04
0.02
0
δκ/κ
4
5
6
7
log T


Sun(JCD)−CLES
0.06
0.04
0.02
0
−0.02
−0.04
δκ/κ
4
5
6
7
log T

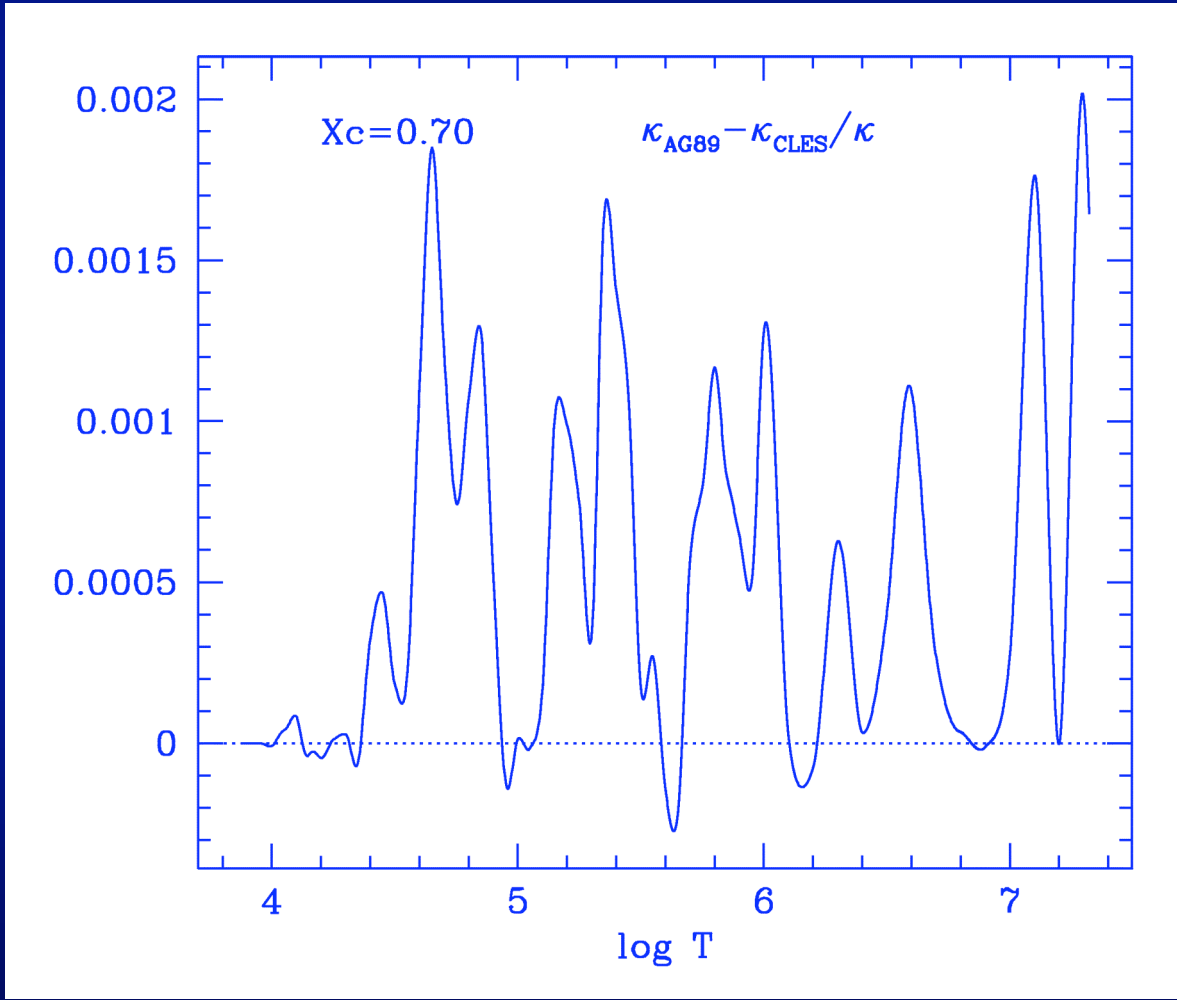
Opacity :effect of atomic mass



Opacity :effect of atomic mass



Opacity : GN93 ??



X(F) =2.5 10^{-5} { O, Ne }

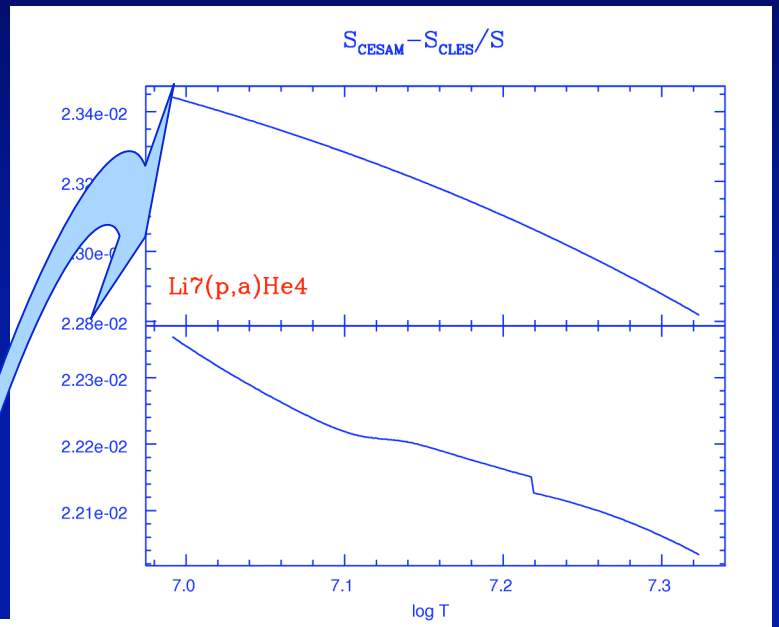
X(Sc)=1. 10^{-6} { Ca, Ti }

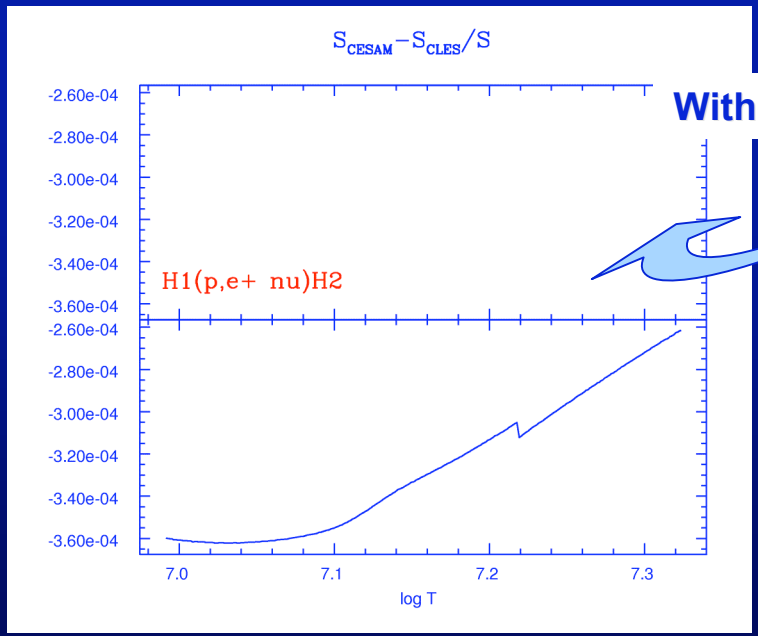
X(V)=7. 10^{-6} { Ti, Cr }

X(Co)=5.8 10^{-5} { Fe, Ni }

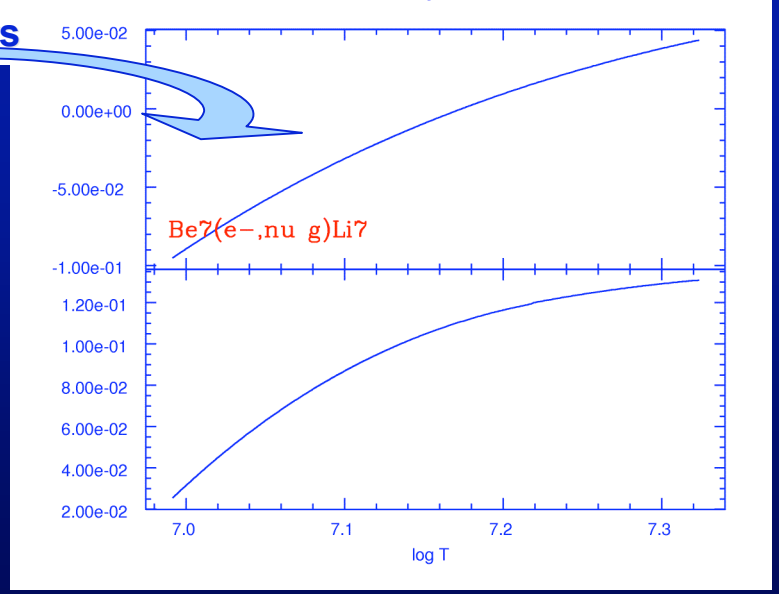
Nuclear reaction rates: PP

1.	$H(p,e^+,n)^2H$	-3. e-4	< e-8
2.	$^2H(p,g)^3He$	-3. e-4	1.e-7
3.	$^3He(^3He,2p)^4He$	-1.5e-3	< e-8
4.	$^3He(a,g)^7Be$	-1.5e-3	< e-8
5.	$^7Li(p,a)^4He$	2. e-2	1.3e-2
6.	$^7Be(e^-,n\ g)^7Li$	1.5e-2	-0.1, 5.e-2
7.	$^7Be(p,g)^8B(,e^+n)^8Be(a)^4He$	-1.5e-3	< e-8





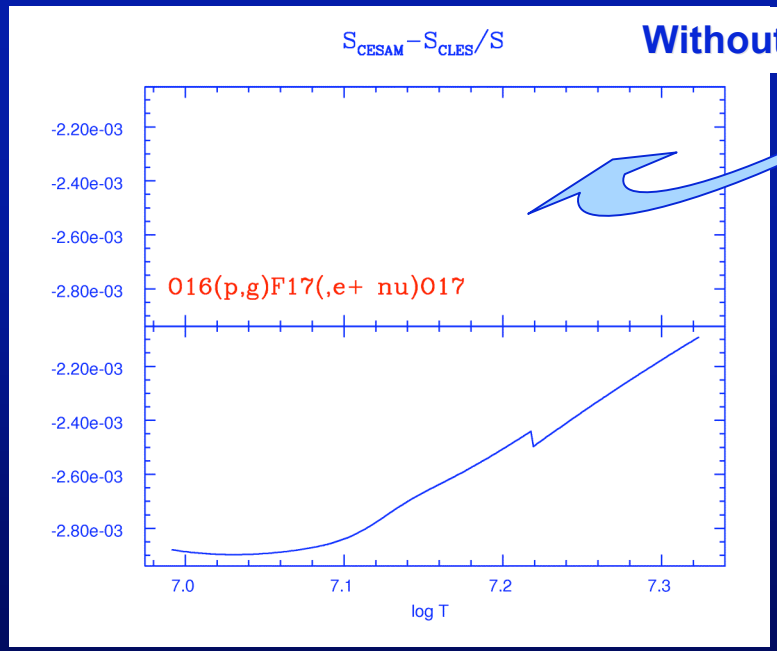
Without Screening Factors

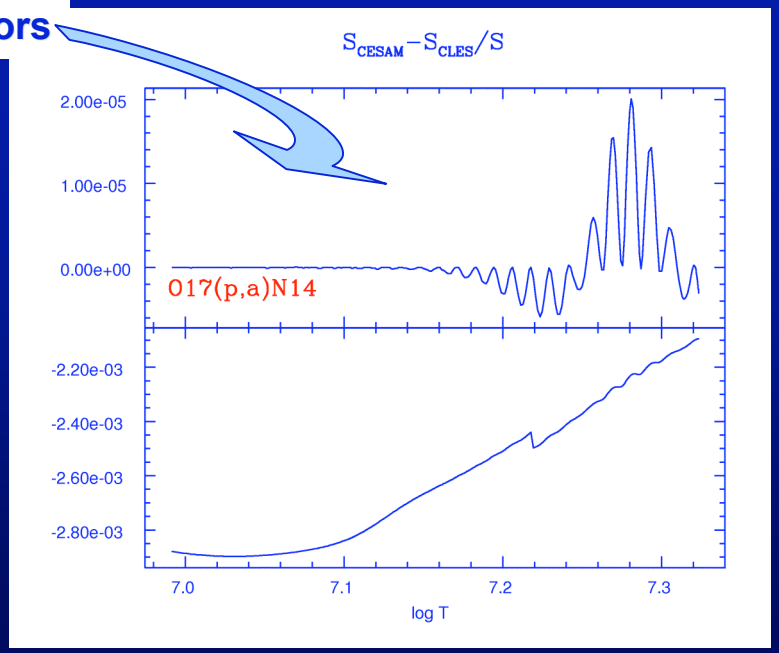


Nuclear reaction rates: CNO

1.	$^{12}C(p,g)^{13}N(,e^{+})^{13}C$	-2. e-3	< e-8
2.	$^{13}C(p,g)^{14}N$	-2. e-3	< e-8
3.	$^{14}N(p,g)^{15}O(e+,n)^{15}N$	-2.2e-3	< e-8
4.	$^{15}N(p,g)^{16}O$	-2.2e-3	< e-8
5.	$^{15}N(p,a)^{12}C$	-2.2e-3	1.e-6
6.	$^{16}O(p,g)^{17}F(,e^{+},n)^{17}O$	-2.5e-3	< e-8
7.	$^{17}O(p,a)^{14}N$	-2.5e-3	2.e-5(max)

Without Screening Factors





Screen-Factor: (Salpeter 1954)

CESAM:

$$f = \exp\left(1.88 d^8 z_1 z_2 \left(\frac{\rho\zeta}{T^3}\right)^{\frac{1}{2}}\right)$$

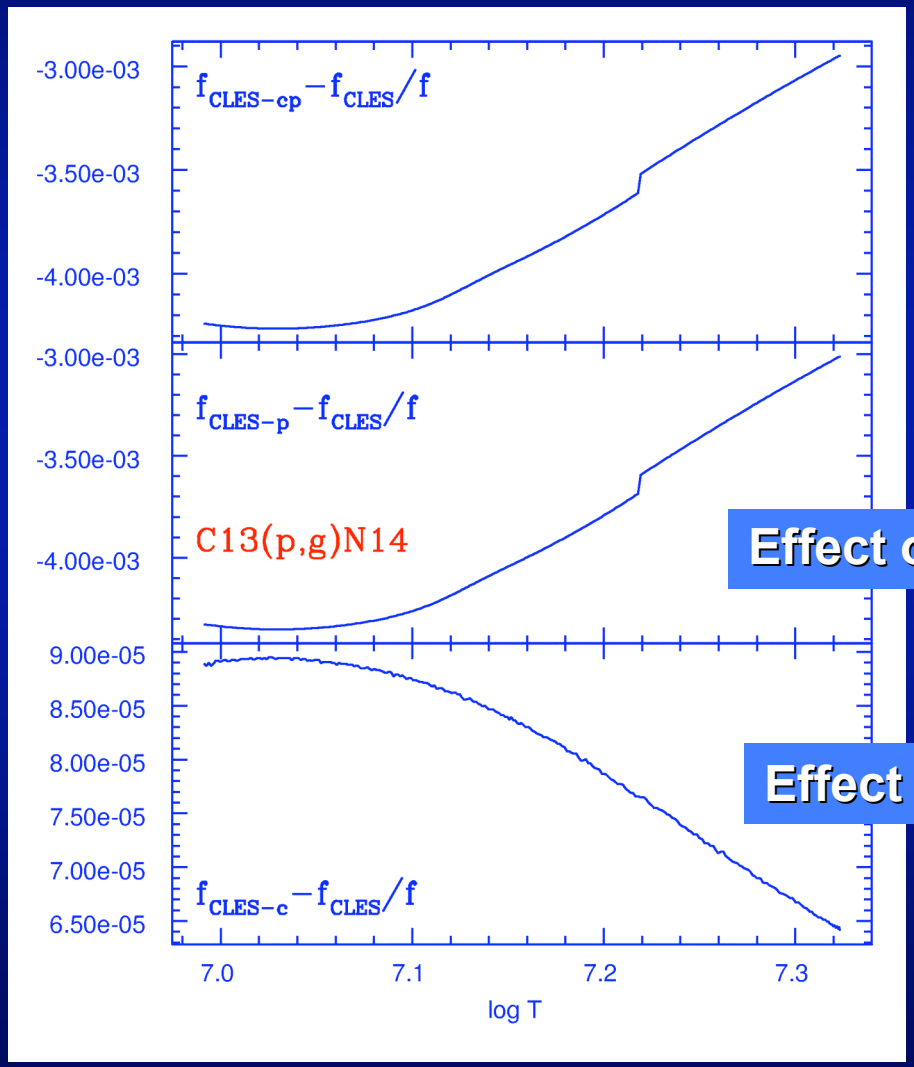
$$\zeta = \sum_i z_i(1 + z_i)x_i$$

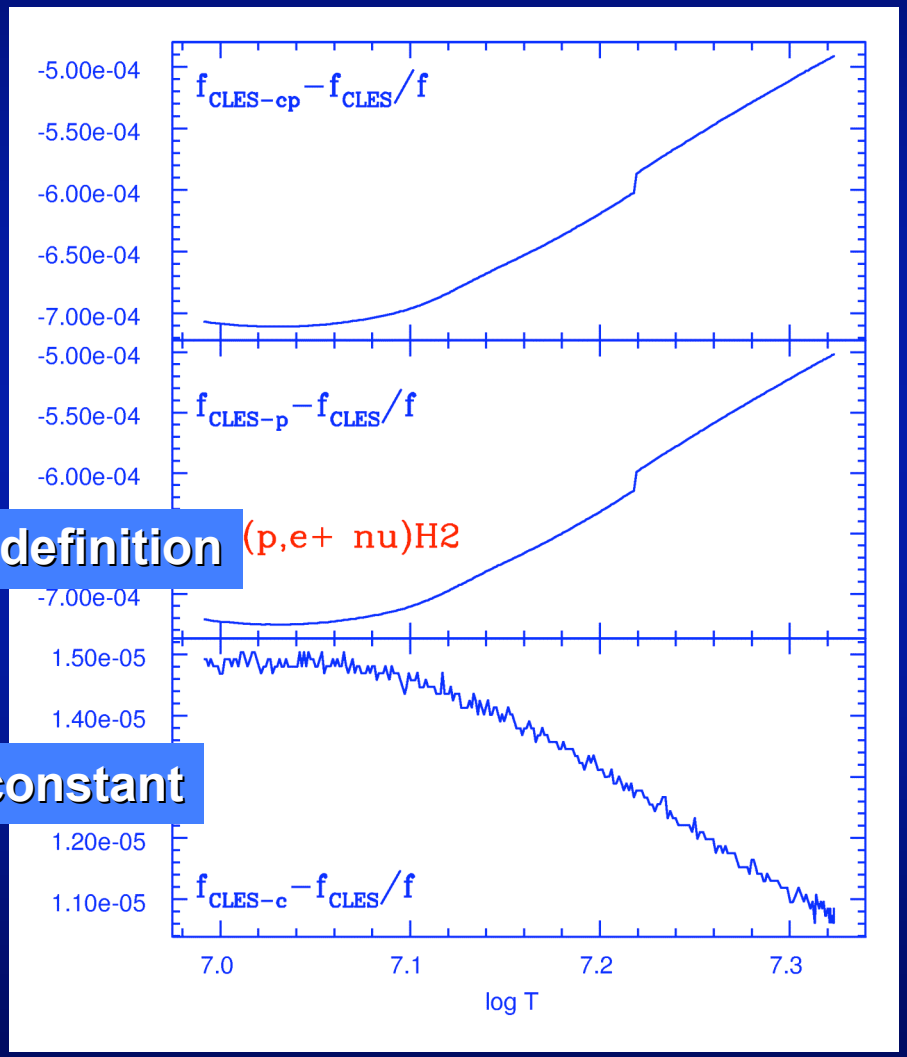
CLES:

$$f = \exp\left(5.942168 d^{-6} z_1 z_2 \left(\frac{\rho\psi}{T_9^3}\right)^{\frac{1}{2}}\right)$$

$$\zeta = \sum_{1-4} z_i(1 + z_i)x_i + Z(1 + Z)x(Z)$$

Screen-Factor:

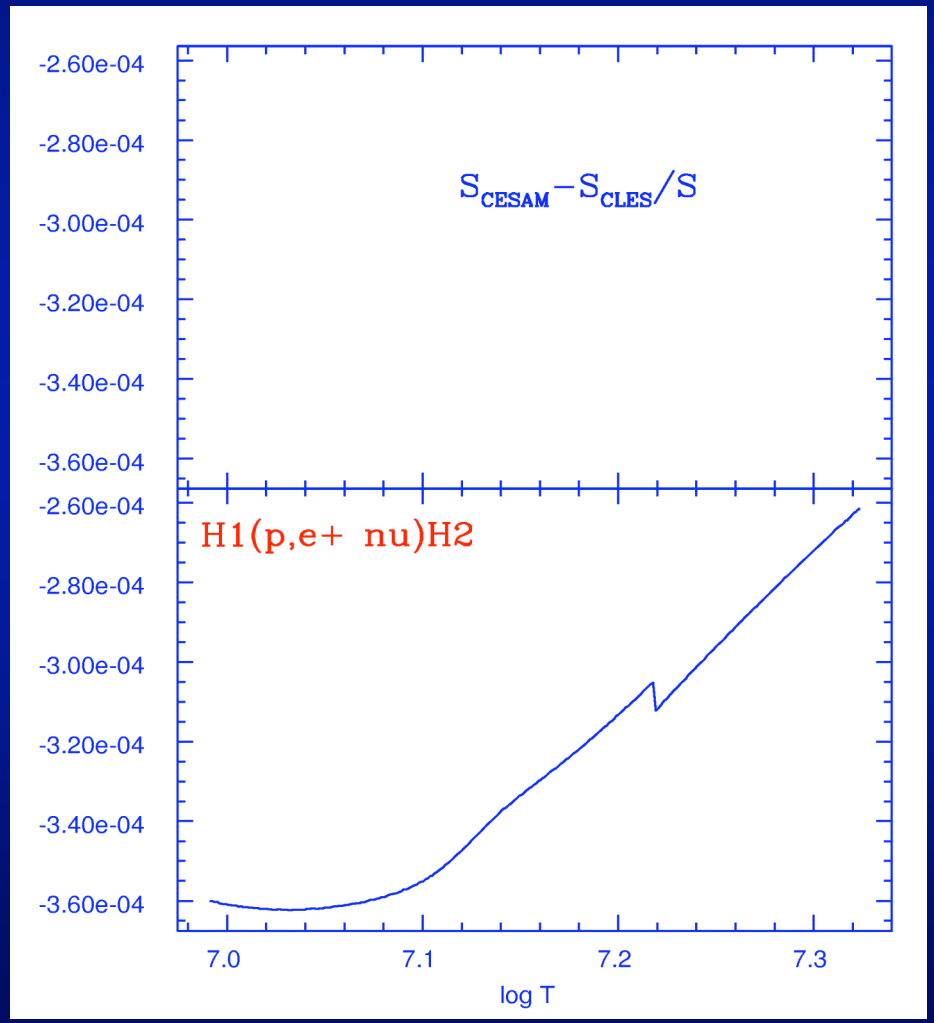


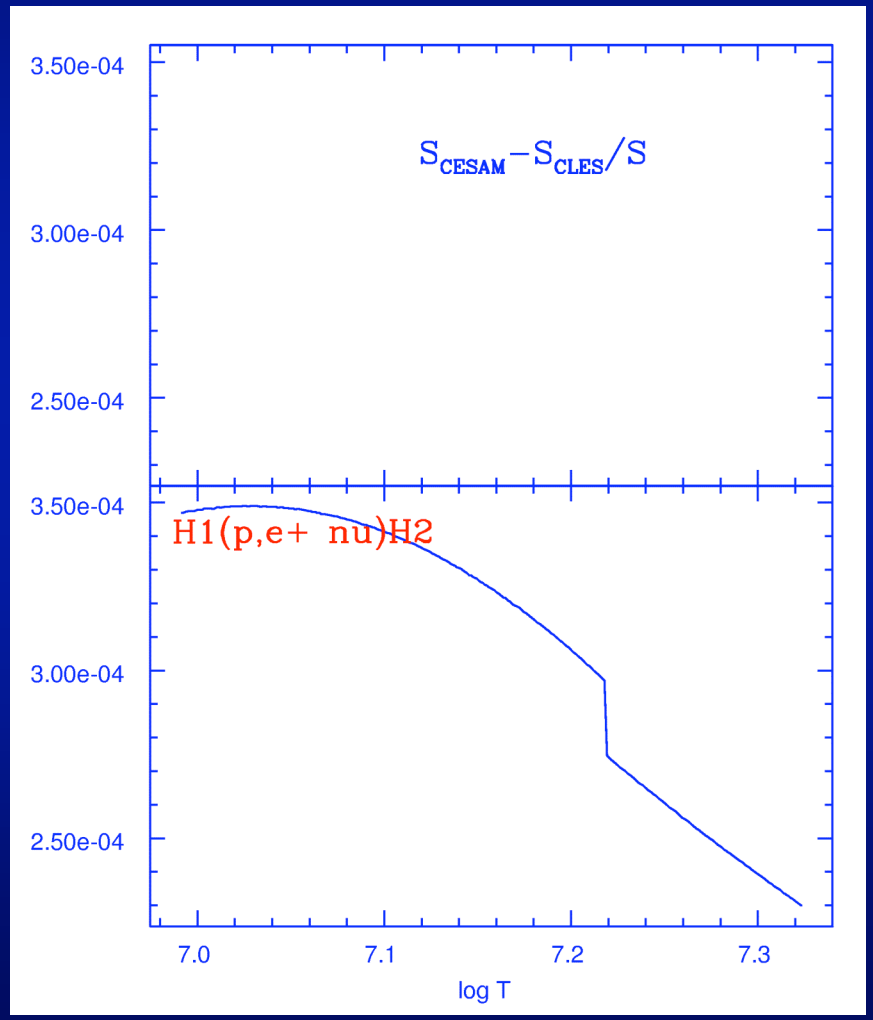


Effect of ζ definition

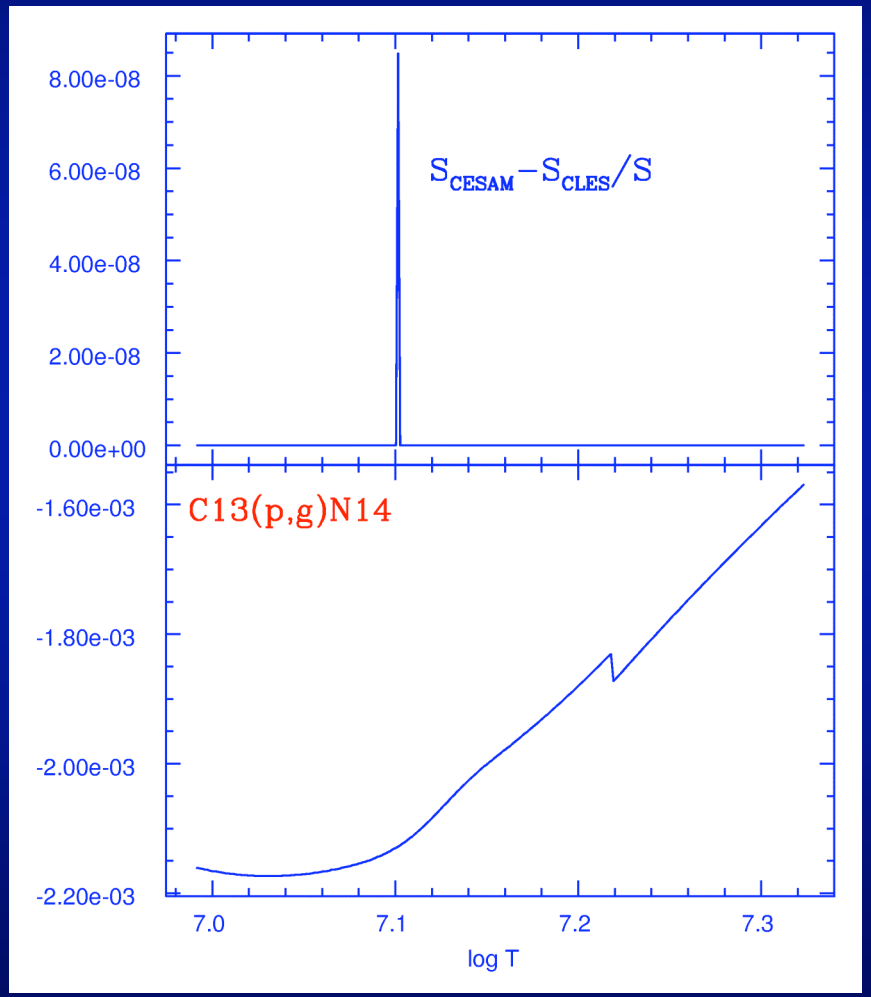
Effect of constant

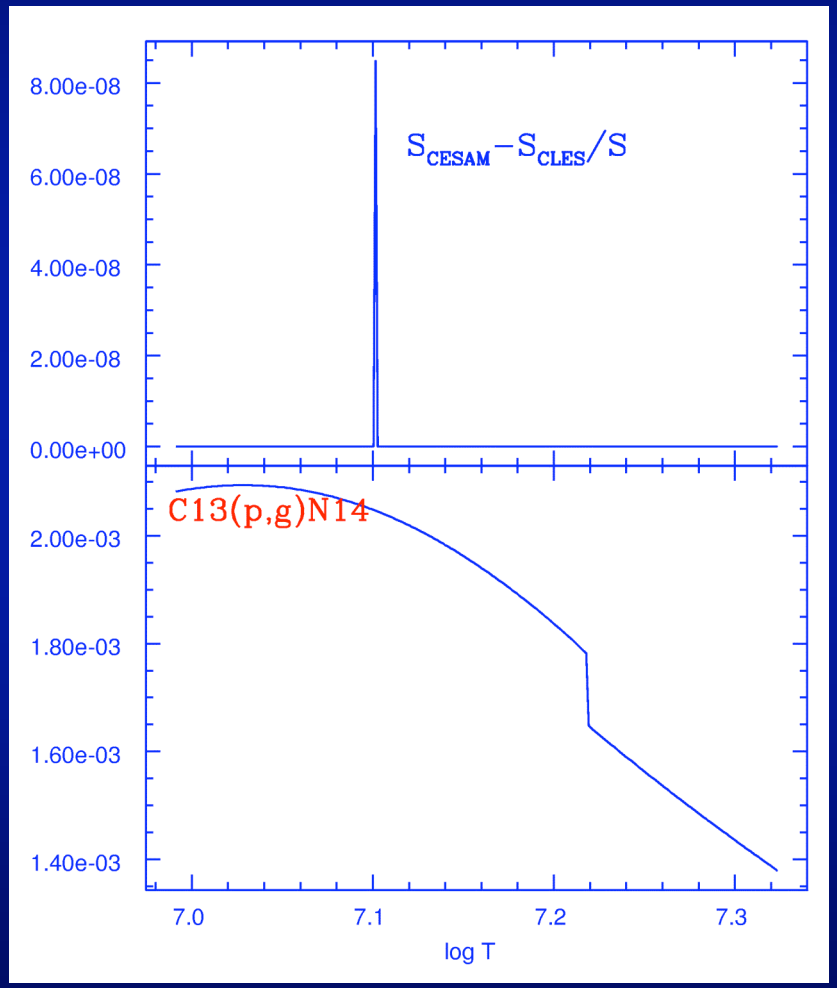
Nuclear reaction rates: PP





Nuclear reaction rates: CNO





Summary

1. Opacity: CESAM > CLES , average: 1%, more than 4% in surface

2. EoS :
   1. Interpolation:

Γ_1 :	0.2 %	$T < 10^5$
C_p :	0.6 %	$T < 10^5$
	0.2 %	$T > 10^7$
δ :	$5\ 10^{-4}$	$T < 10^5$
P :	$6\ 10^{-4}$	$T < 10^5$
	$2\ 10^{-4}$	$T > 10^7$
∇_{ad} :	0.5%	$T < 10^5$

   2. Inconsistency

Γ_1 :	1.5 %	$T < 10^5$
C_p :	5 %	$T < 10^5$
δ :	$2\ 10^{-6}$	numeric
P :	$\pm 10^{-7}$	numeric
∇_{ad} :	2 – 4 %	$T < 10^5$

Summary

1. **Nuclear reaction rates: Main difference is in Screen Factors**

2. **Convective core:**
    1. **Difference in convective core mass Δ mcc/M = 6.10-4**
    2. **Difference in N_{BV} profile … a suivre…**