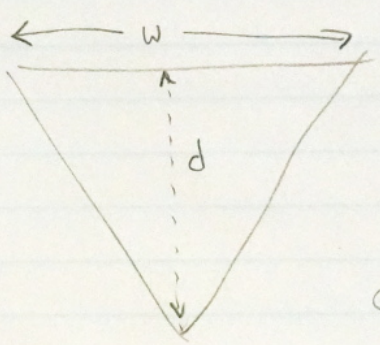
HW 4, #1

a) intensity of the continuum is ≈ 0.96 units

b) 

Very approximately

$\text{width} \cong 3.0\ \text{Å}$

$\text{depth} \approx 0.90\ \text{Å}$

$\text{area} = \frac{1}{2}(\text{width})(\text{depth})$

$= \frac{1}{2}(3.0\text{Å})(0.90)$

$\boxed{\text{area} = 1.35\ \text{Å}}$

c) numerical integration yields slightly different results, depending on one's choice of the continuum level:

cont =	area =
0.95	0.676
0.96	0.716
0.98	0.796
1.00	0.876

But the bottom line is that the equivalent width is much smaller than in the "triangle" approximation.

HW 4, #2

a) see attached graph "density_a.png"

b) note the data file has a column for

$$Q_M \equiv 1 - \frac{M_r}{M_{tot}}$$

So when the enclosed mass equals half the total mass,

$$M_r = 0.5 \rightarrow Q_M = 1 - \frac{0.5}{1.0} = 0.5$$

The table shows this happens between 1.77×10^{10} cm 1.84×10^{10} cm, so

$$r_m \approx 1.83 \times 10^{10} \text{ cm}$$

c) The total luminosity is $L = 3.29 \times 10^{33}$ erg/s; half of that is 1.65×10^{33} erg/s, which is reached at

$$r_L \approx 8.05 \times 10^{9} \text{ m}$$

d) The half-luminosity radius r_L is smaller than the half-mass radius r_M. In fact, $r_L < \frac{1}{2} r_M$. Energy is only generated at temperatures high enough to support fusion, $T \gtrsim 7 \times 10^6$ K. The temperature drops very quickly outside the central core, and so very little energy is generated outside that innermost core region. Even though density drops quickly, the volume of shells grows as r^3, so even relatively low-density shells can contain considerable mass.

Hw 4, #3

Running STATSTAR on 4 given stars, with masses
$1, 2, 4, 8\ M_\odot$
and other specified properties, yields output files which contain many properties of these models.
In particular,

total luminosity	L
radius	R
effective temp	T
central temp	T_c

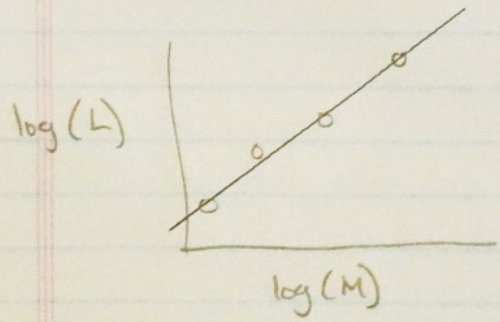
In order to find the exponents of power-law relationships such as

$$L \propto M^a$$

one can take log

$$\log L \propto a \log M$$

and then graph

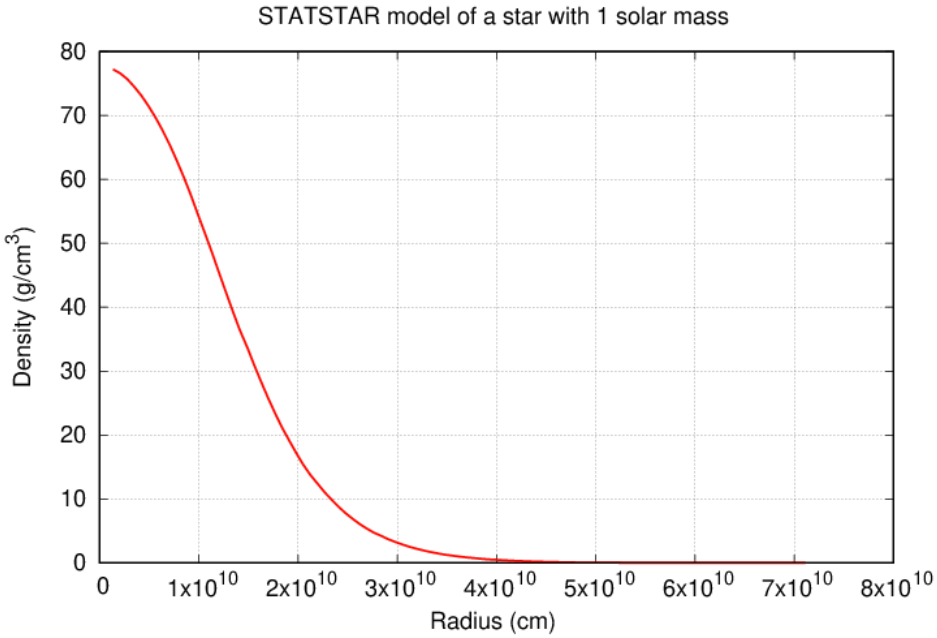


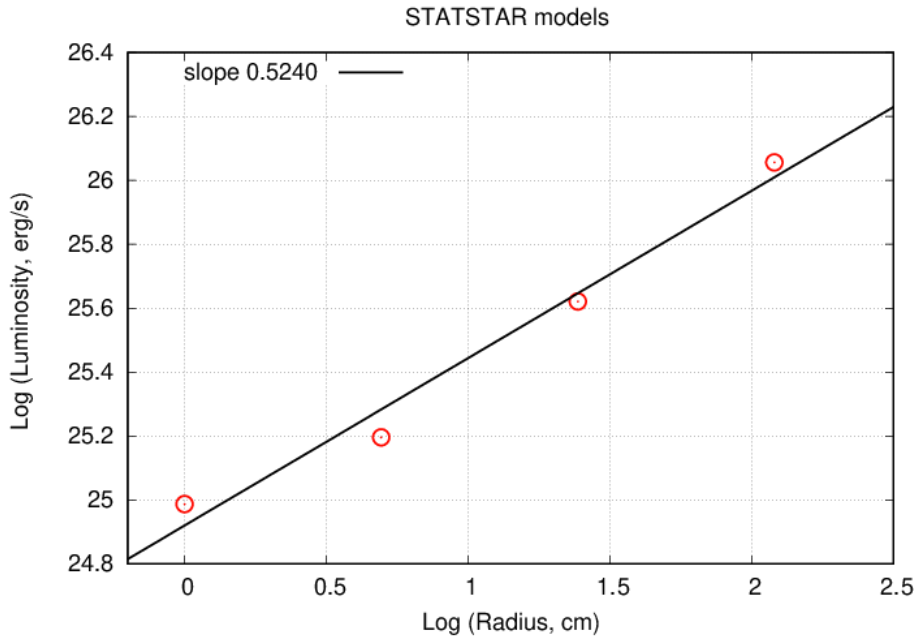
The slope of the data on these graph yields the exponent of the power law.

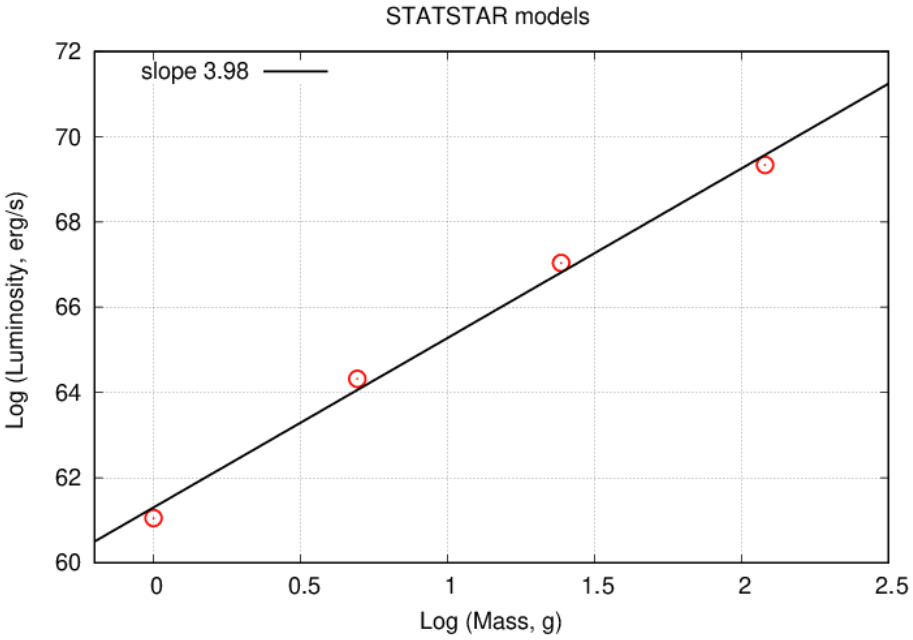
I find

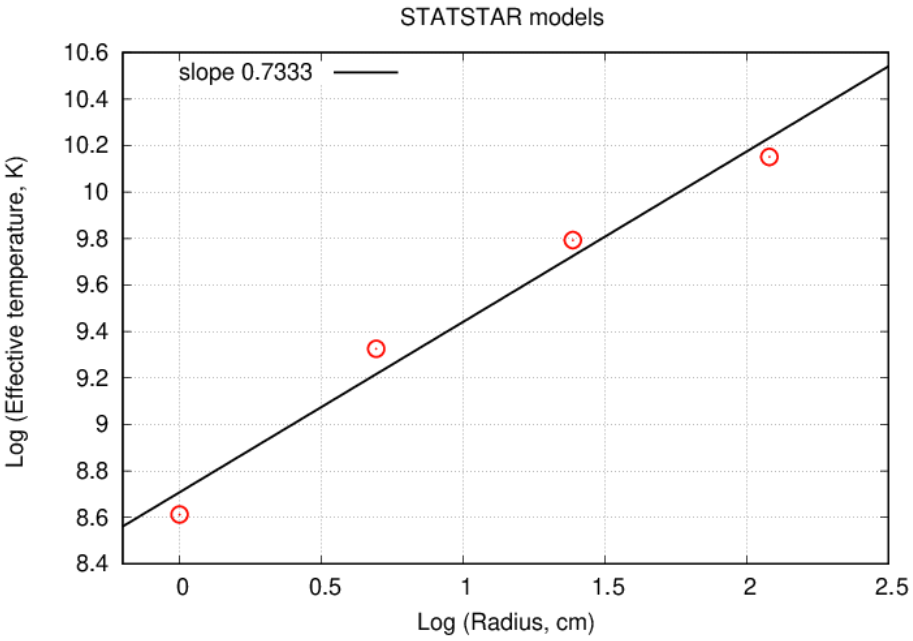
$$L \propto M^{3.98}$$
$$R \propto M^{0.52}$$
$$T \propto M^{0.73}$$
$$T_c \propto M^{0.38}$$

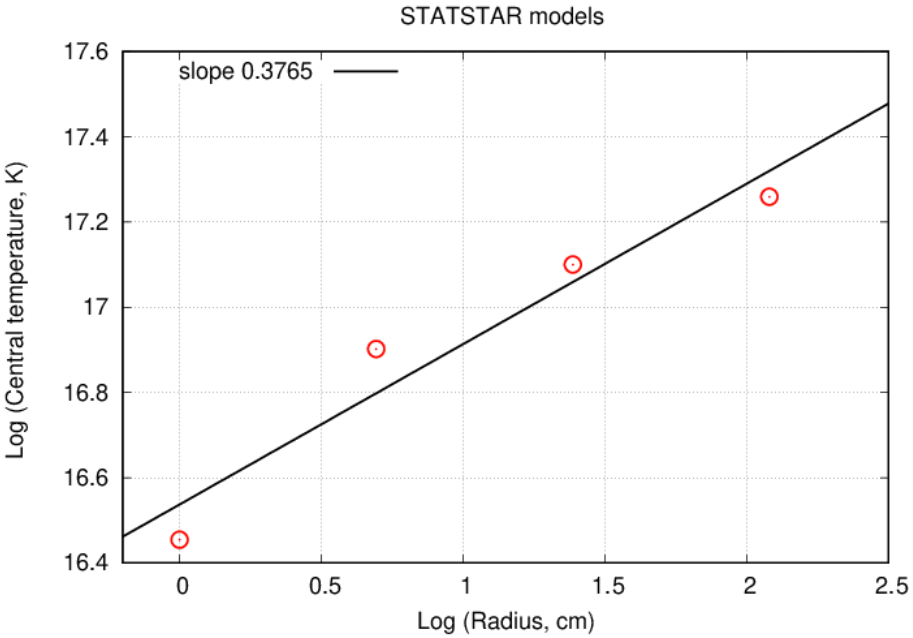
See attached graphs "lum_log_a.png", etc.


STATSTAR model of a star with 1 solar mass
Density (g/cm^3)
Radius (cm)
0
10
20
30
40
50
60
70
80
0
1x10^{10}
2x10^{10}
3x10^{10}
4x10^{10}
5x10^{10}
6x10^{10}
7x10^{10}
8x10^{10}


STATSTAR models
slope 0.5240
Log (Luminosity, erg/s)
Log (Radius, cm)
24.8
25
25.2
25.4
25.6
25.8
26
26.2
26.4
0
0.5
1
1.5
2
2.5


STATSTAR models
slope 3.98
Log (Luminosity, erg/s)
Log (Mass, g)
72
70
68
66
64
62
60
0
0.5
1
1.5
2
2.5


STATSTAR models
slope 0.7333
Log (Effective temperature, K)
Log (Radius, cm)
10.6
10.4
10.2
10
9.8
9.6
9.4
9.2
9
8.8
8.6
8.4
0
0.5
1
1.5
2
2.5


STATSTAR models
slope 0.3765
Log (Central temperature, K)
Log (Radius, cm)
17.6
17.4
17.2
17
16.8
16.6
16.4
0
0.5
1
1.5
2
2.5

HW 4, Bonus!

Can you use STATSTAR to generate a good model which has

mass = 1 solar mass
lum = 0.88 solar luminosity
X = 0.70 hydrogen mass fraction
Z = 0.008 metal " "

With trial and error, you should find that as you increase the luminosity (by small amounts), the effective temperature also rises.

A good strategy is

1) run STATSTAR
2) look at output file
3) identify the given reason for failure
4) if T_c is too low, must increase the input effective temperature
   go to 1
5) if core density "seems a bit off",
   must decrease input eff temp
   go to 1

One solution has input effective temperature

$$T_{eff} = 5556.6 \text{ K}$$