In [30]:
```
#Potential MESA analysis code
#LOGS1 is initial mass loss
#LOGS2 is 2 solar mass star
#LOGS3 is 3.25 solar mass star
#LOGS4 is 5 solar mass star
#LOGS5 is a 4 solar mass star
```

In [2]:
```
%matplotlib inline
from astropy.io import fits
import numpy as np
import copy
import matplotlib.pyplot as plt
import constants as pc
import sys
sys.path.append('/home/adsc7680/py_mesa_reader')
import py_mesa_reader.mesa_reader as m
```

In [3]:
```
path = '/home/adsc7680/star_plus_point_mass_explicit_mdot/'
hist1 = m.MesaData(file_name=path+'LOGS1/history.data')
hist2=m.MesaData(file_name=path+'LOGS2/history.data')
hist3=m.MesaData(file_name=path+'LOGS3/history.data')
hist5=m.MesaData(file_name=path+'LOGS4/history.data')
hist4=m.MesaData(file_name=path+'LOGS5/history.data')
```

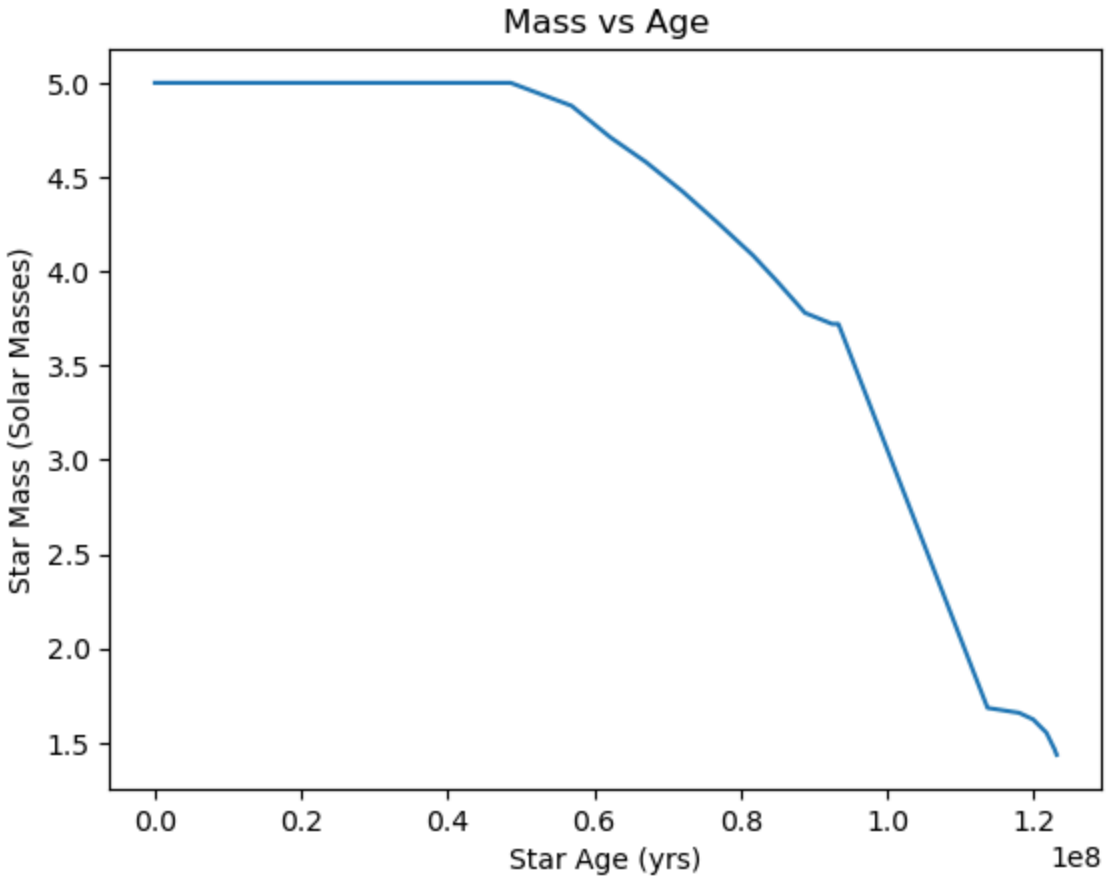
In [4]:
```
hist1.bulk_names
```

Out[4]:
```
('model_number',
 'star_age',
 'star_mass',
 'log_abs_mdot',
 'log_dt',
 'num_zones',
 'mass_conv_core',
 'conv_mx1_top',
 'conv_mx1_bot',
 'conv_mx2_top',
 'conv_mx2_bot',
 'mx1_top',
 'mx1_bot',
 'mx2_top',
 'mx2_bot',
 'epsnuc_M_1',
 'epsnuc_M_2',
 'epsnuc_M_3',
 'epsnuc_M_4',
 'epsnuc_M_5',
 'epsnuc_M_6',
 'epsnuc_M_7',
 'epsnuc_M_8',
 'he_core_mass',
 'co_core_mass',
 'fe_core_mass',
 'log_LH',
 'log_LHe',
 'log_LZ',
 'log_Lnuc',
 'log_Teff',
 'luminosity',
 'log_L',
 'log_R',
 'log_g',
 'gravity',
 'surf_avg_omega',
 'surf_avg_omega_div_omega_crit',
 'log_center_T',
 'log_center_Rho',
 'log_center_P',
 'center_mu',
 'center_ye',
 'center_h1',
 'center_he4',
 'center_c12',
 'center_o16',
 'surface_c12',
 'surface_o16',
 'total_mass_h1',
 'total_mass_he4',
 'pp',
 'cno',
 'tri_alpha',
 'v_div_csound_surf',
 'ries',
```

```
 'model_number_1',
 'age',
 'period_days',
 'binary_separation',
 'v_orb_1',
 'v_orb_2',
 'rl_1',
 'rl_2',
 'rl_relative_overflow_1',
 'rl_relative_overflow_2',
 'star_1_mass',
 'star_2_mass',
 'lg_mtransfer_rate',
 'lg_mstar_dot_1',
 'lg_mstar_dot_2',
 'lg_system_mdot_1',
 'lg_system_mdot_2',
 'lg_wind_mdot_1',
 'lg_wind_mdot_2',
 'fixed_xfer_fraction',
 'eff_xfer_fraction',
 'J_orb',
 'Jdot',
 'jdot_mb',
 'jdot_gr',
 'jdot_ml',
 'jdot_ls',
 'jdot_missing_wind',
 'extra_jdot',
 'donor_index',
 'point_mass_index')
```

In [8]:

```
plt.plot(hist1.data("star_age"), hist1.data("star_mass"))
plt.xlabel("Star Age (yrs)")
plt.ylabel("Star Mass (Solar Masses)")
plt.title("Mass vs Age");
```



In [32]:
```
#Prof21 is a separately evolved 5 solar mass star
#Everything else is the same naming convention as before
prof = m.MesaData(file_name=path+'LOGS1/profile4.data')
prof1 = m.MesaData(file_name=path+'LOGS1/profile13.data')
prof2 = m.MesaData(file_name=path+"LOGS2/profile19.data")
prof3 = m.MesaData(file_name=path+'LOGS3/profile10.data')
prof5 = m.MesaData(file_name=path+'LOGS4/profile11.data')
prof4 = m.MesaData(file_name=path+'LOGS5/profile10.data')
prof21 = m.MesaData(file_name = 'profile21.data')
```

In [18]:
```
prof.bulk_names
```

Out[18]:
```
('zone',
 'logT',
 'logRho',
 'logP',
 'logR',
 'luminosity',
 'logL',
 'velocity',
 'entropy',
 'mix_type',
 'csound',
 'v_div_csound',
 'v_div_r',
 'eta',
 'mu',
 'logdq',
 'dq_ratio',
 'q',
 'radius',
 'temperature',
 'tau',
 'logtau',
 'pressure',
 'pgas_div_ptotal',
 'logPgas',
 'grada',
 'free_e',
 'abar',
 'ye',
 'log_opacity',
 'eps_nuc',
 'non_nuc_neu',
 'eps_grav',
 'mlt_mixing_length',
 'log_D_mix',
 'log_conv_vel',
 'conv_vel_div_csound',
 'log_mlt_D_mix',
 'pressure_scale_height',
 'gradT',
 'gradr',
 'mass',
 'mmid',
 'logxq',
 'h1',
 'he3',
 'he4',
 'c12',
 'n14',
 'o16',
 'ne20',
 'mg24',
 'pp',
 'cno',
 'tri_alpha',
 ',
```

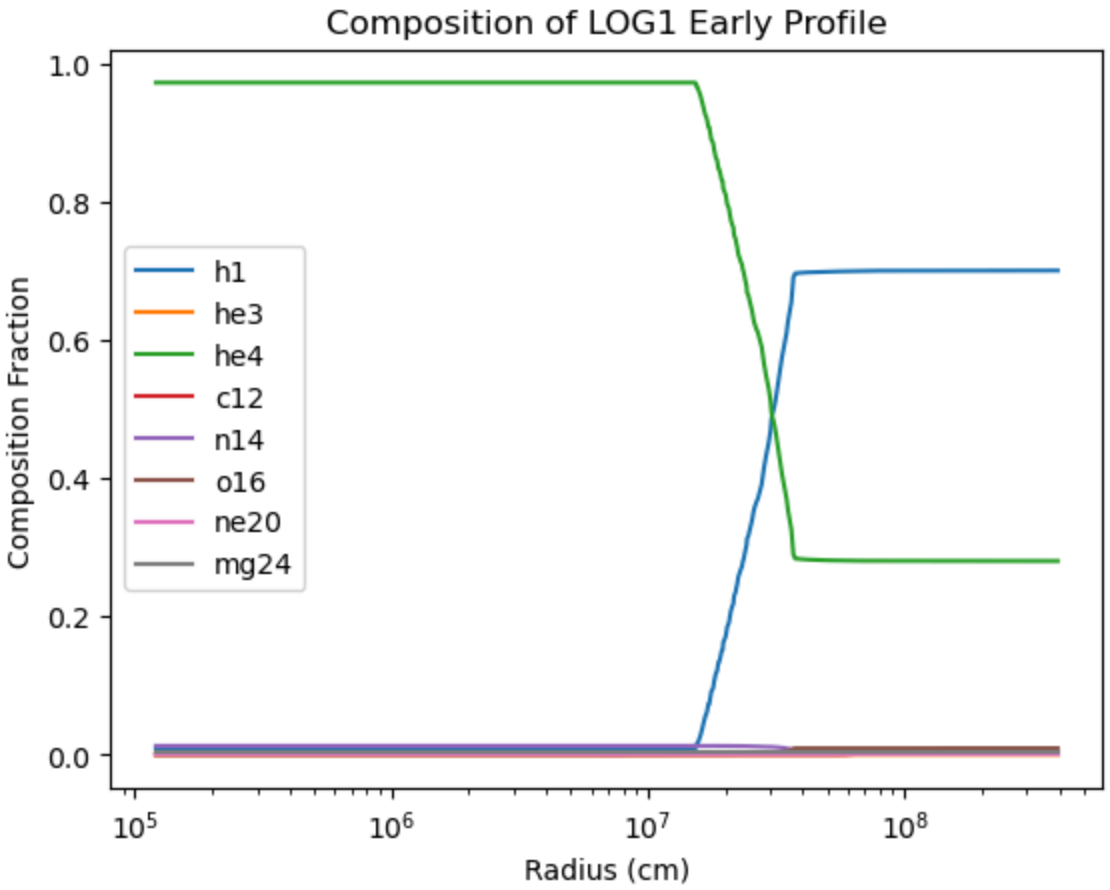
```
 'n_alpha',
 'o_alpha',
 'ne_alpha',
 'na_alpha',
 'mg_alpha',
 'si_alpha',
 's_alpha',
 'ar_alpha',
 'ca_alpha',
 'ti_alpha',
 'cr_alpha',
 'fe_co_ni',
 'c12_c12',
 'c12_o16',
 'o16_o16',
 'pnhe4',
 'photo',
 'ni56_co56',
 'co56_fe56',
 'other',
 'gradr_sub_grada',
 'logQ')
```

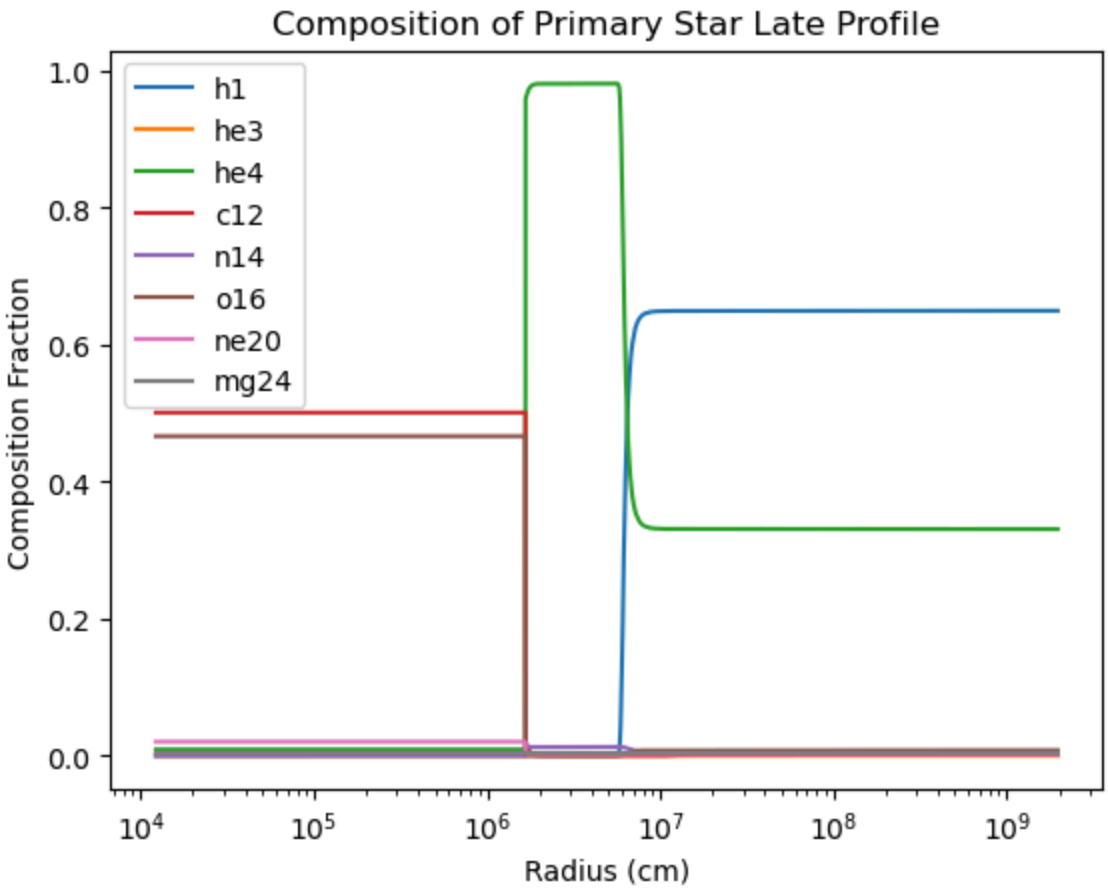
In [33]:

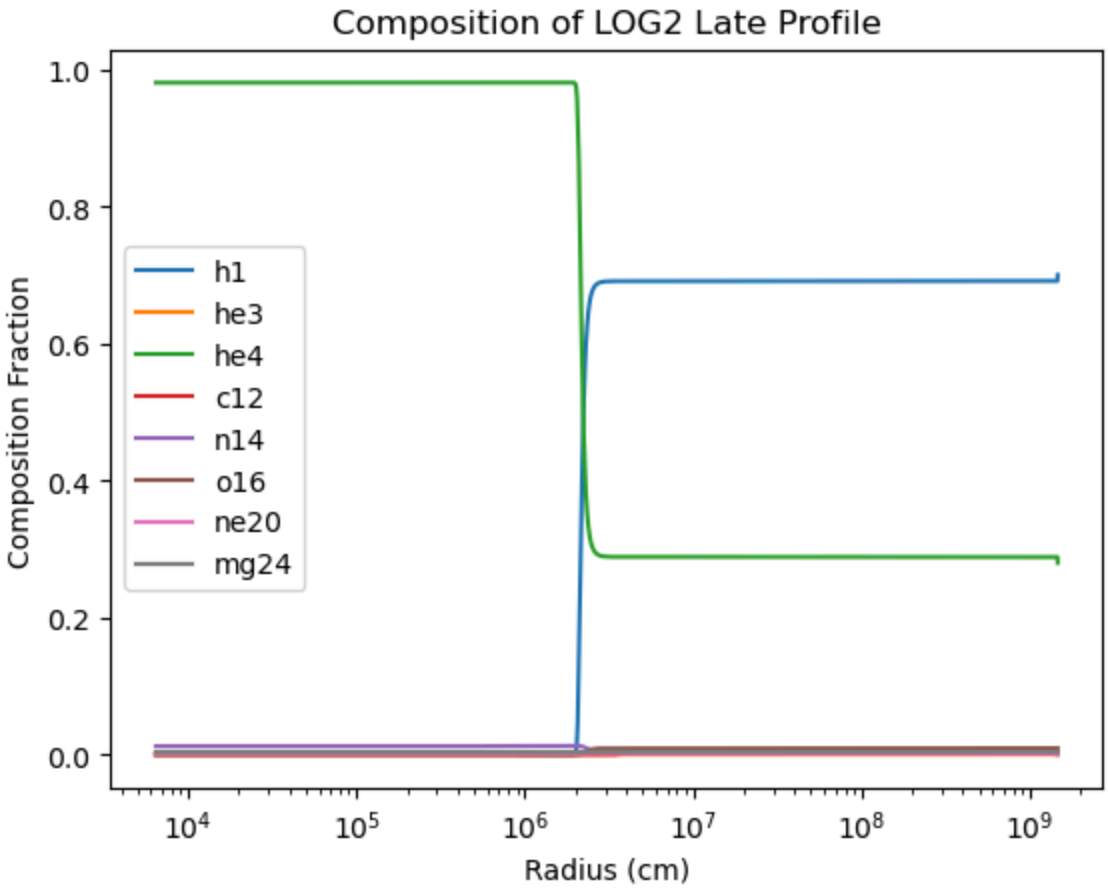
```
plt.semilogx(prof.data("radius")*6.957e7, prof.data("h1"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("he3"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("he4"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("c12"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("n14"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("o16"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("ne20"))
plt.semilogx(prof.data("radius")*6.957e7, prof.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of LOG1 Early Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();


plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("h1"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("he3"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("he4"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("c12"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("n14"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("o16"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("ne20"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of Primary Star Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();


plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("h1"))
```

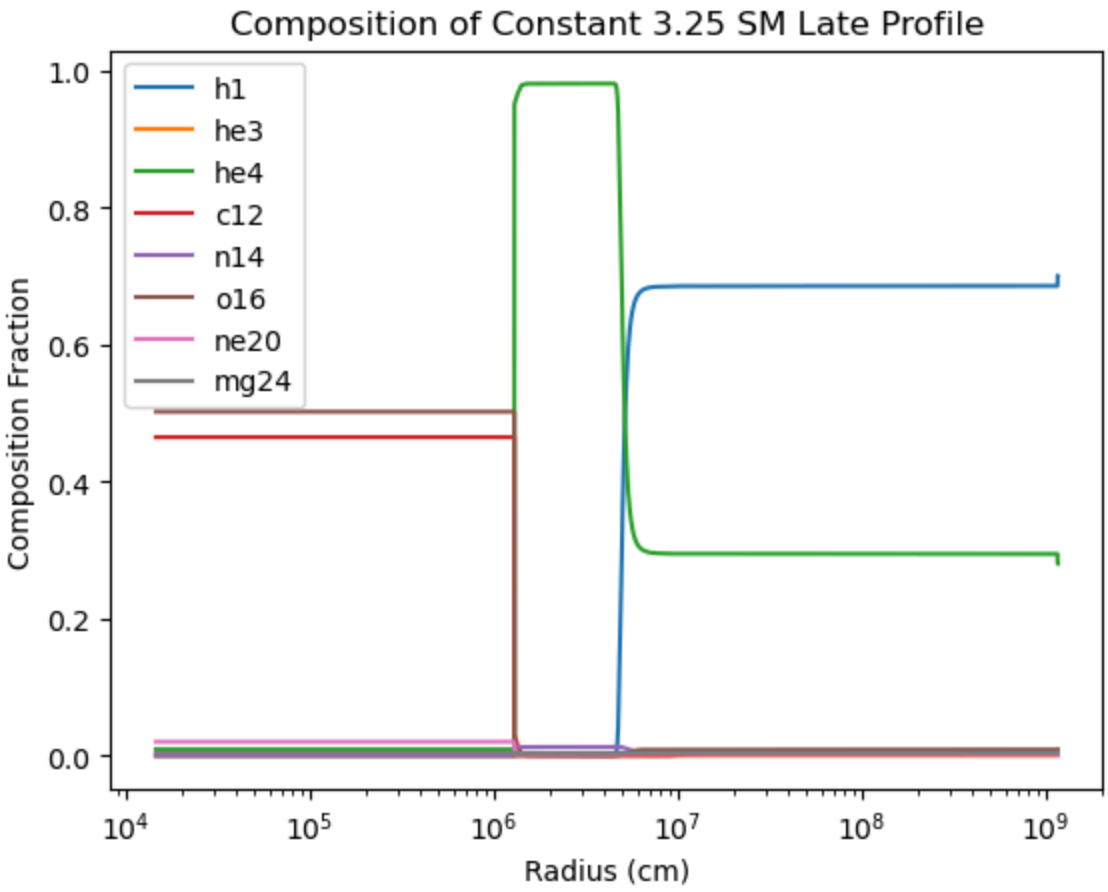
```
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("he3"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("he4"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("c12"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("n14"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("o16"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("ne20"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of LOG2 Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();


plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("h1"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("he3"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("he4"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("c12"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("n14"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("o16"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("ne20"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of Constant 3.25 SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();


plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("h1"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("he3"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("he4"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("c12"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("n14"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("o16"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("ne20"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of Constant 4SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();

plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("h1"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("he3"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("he4"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("c12"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("n14"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("o16"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("ne20"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
```

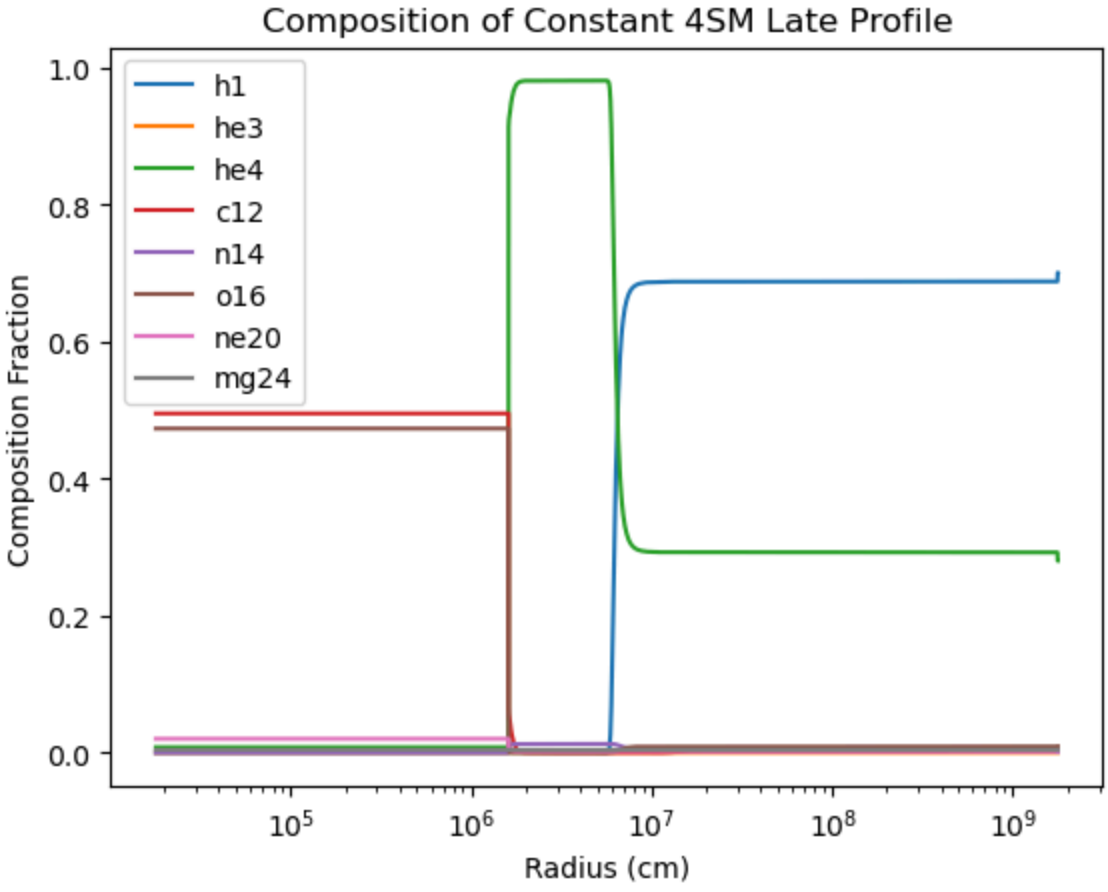
```
plt.title("Composition of Constant 5SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();


plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("h1"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("he3"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("he4"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("c12"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("n14"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("o16"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("ne20"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("mg24"))

plt.legend(["h1", "he3", "he4", "c12", "n14", "o16", "ne20", 'mg24'])
plt.title("Composition of Constant 5SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Composition Fraction")
plt.show();
```

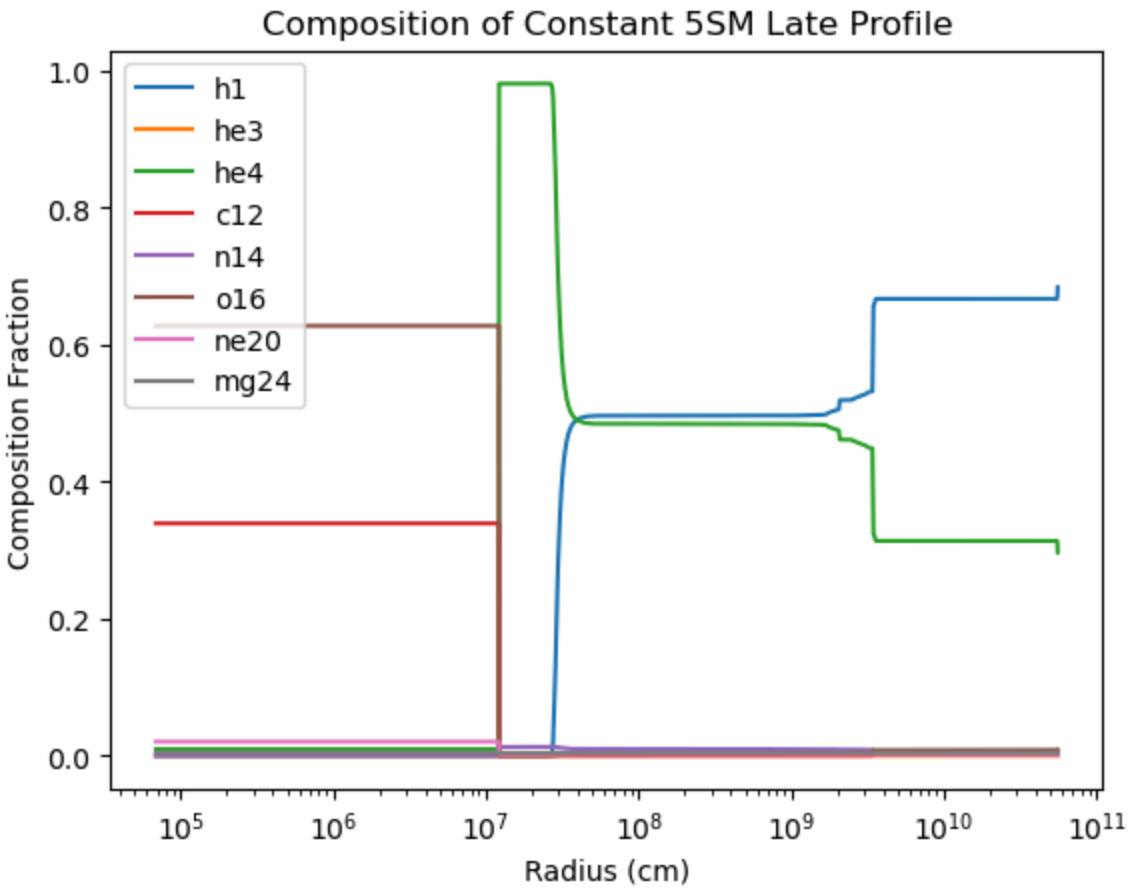


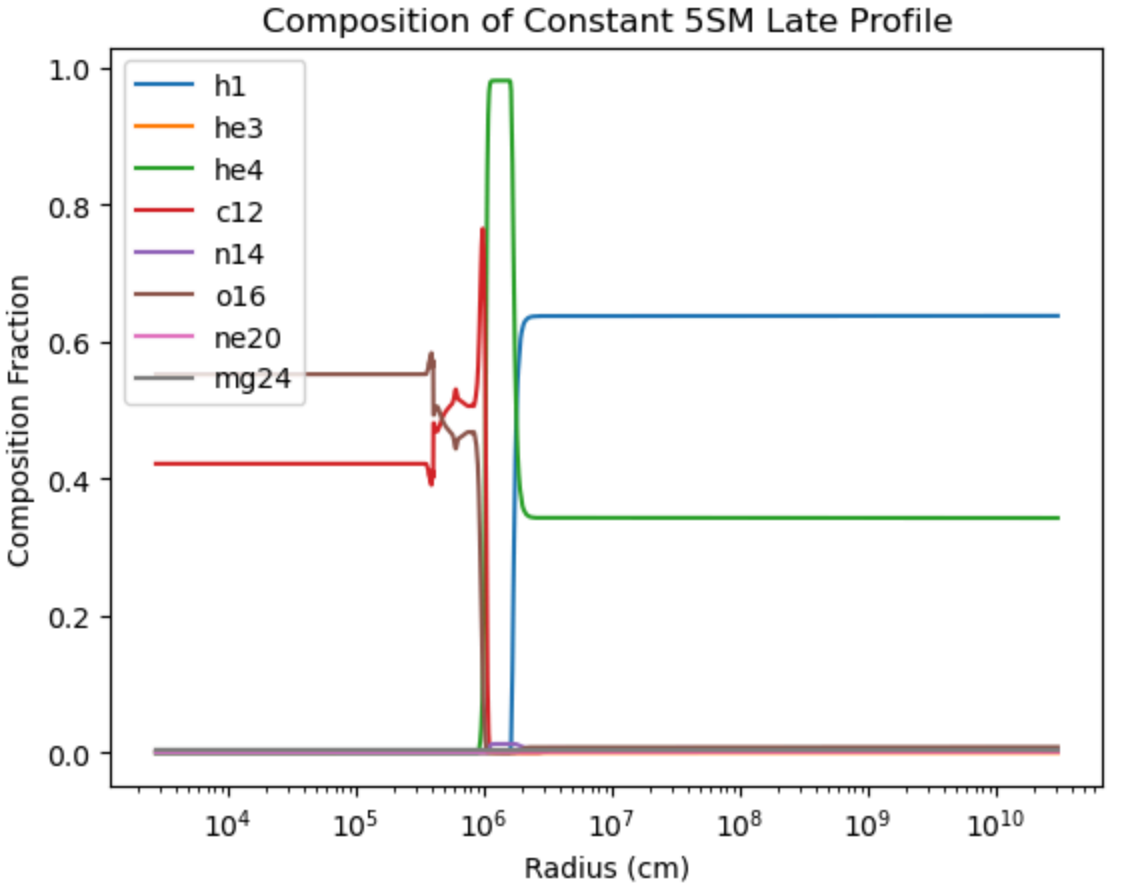








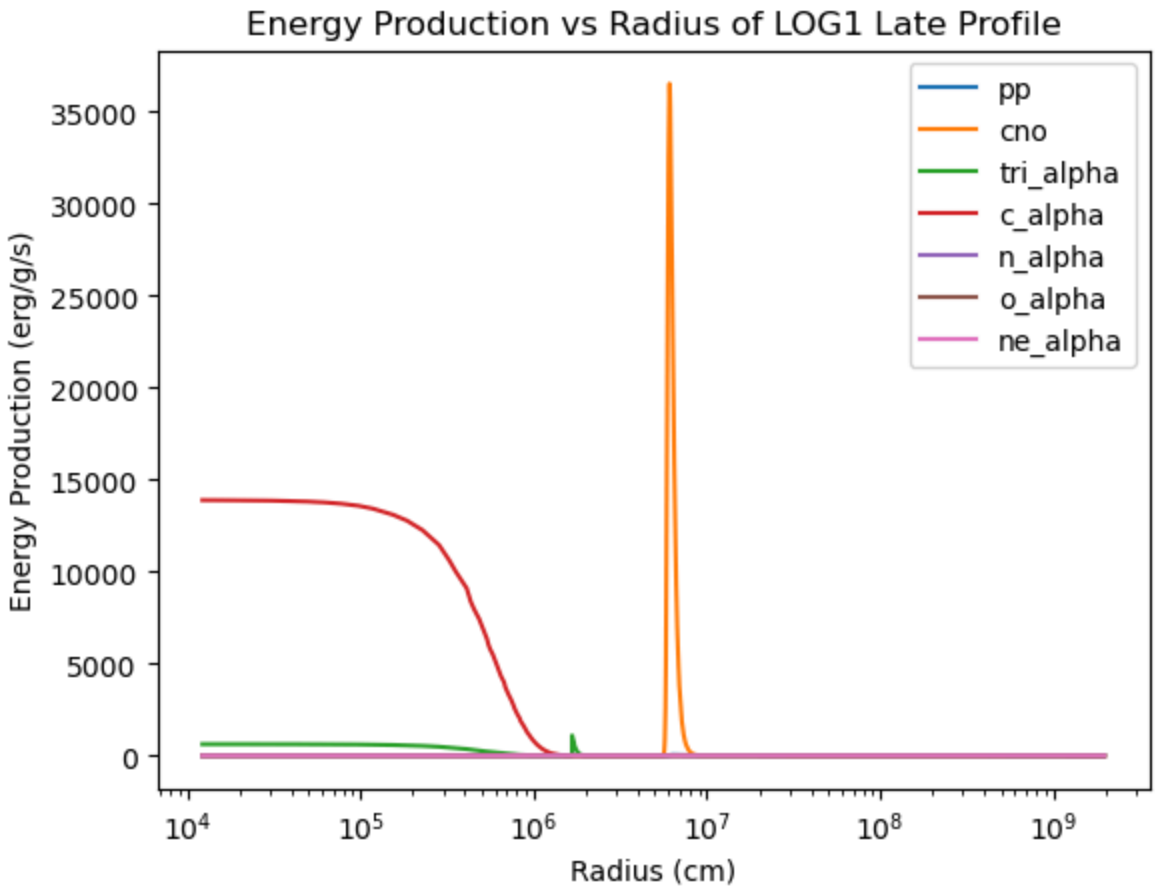


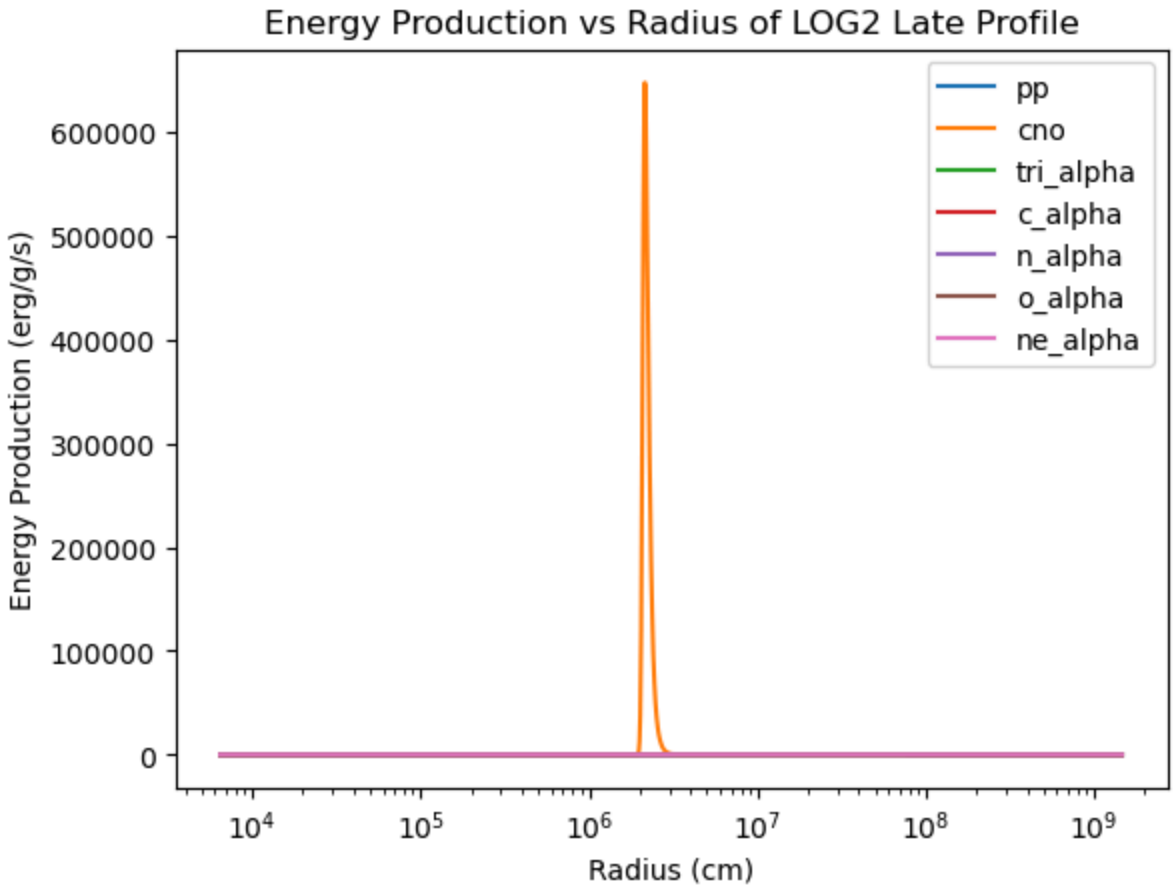


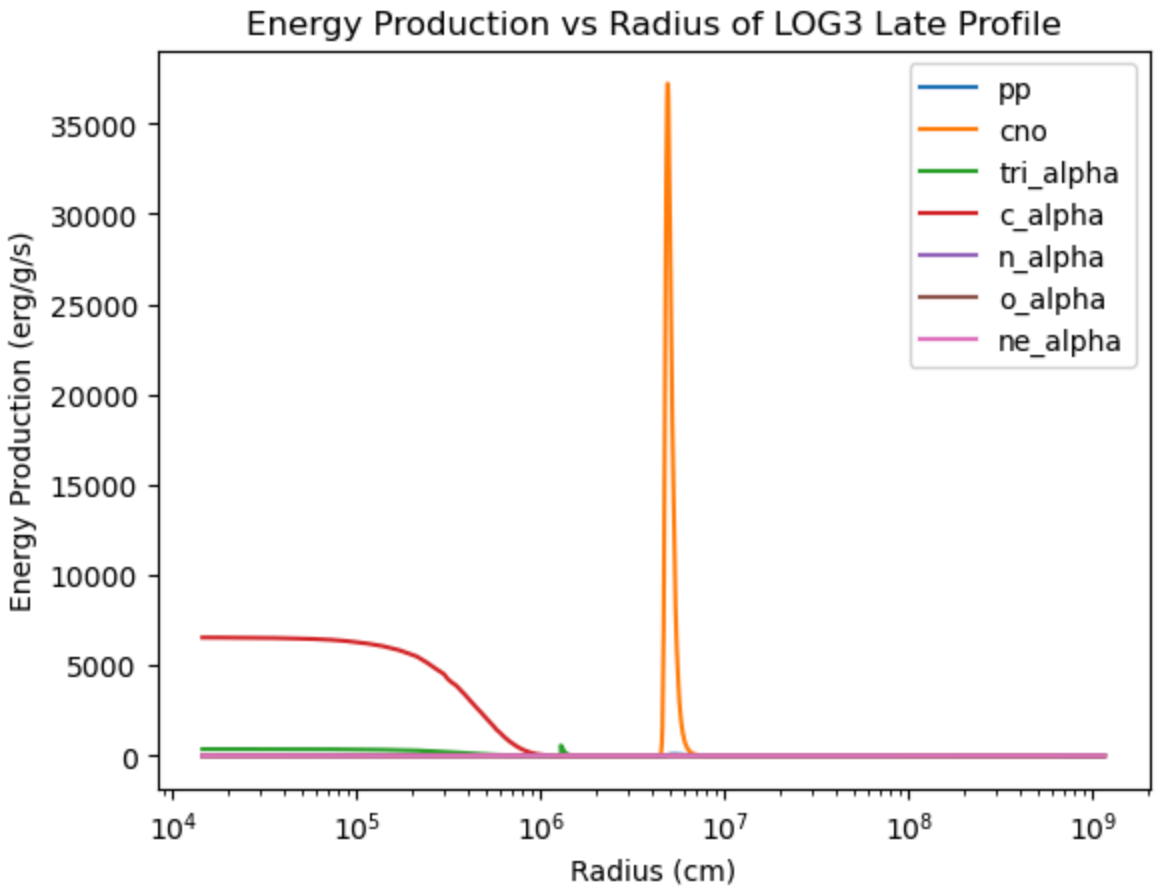
In [38]:

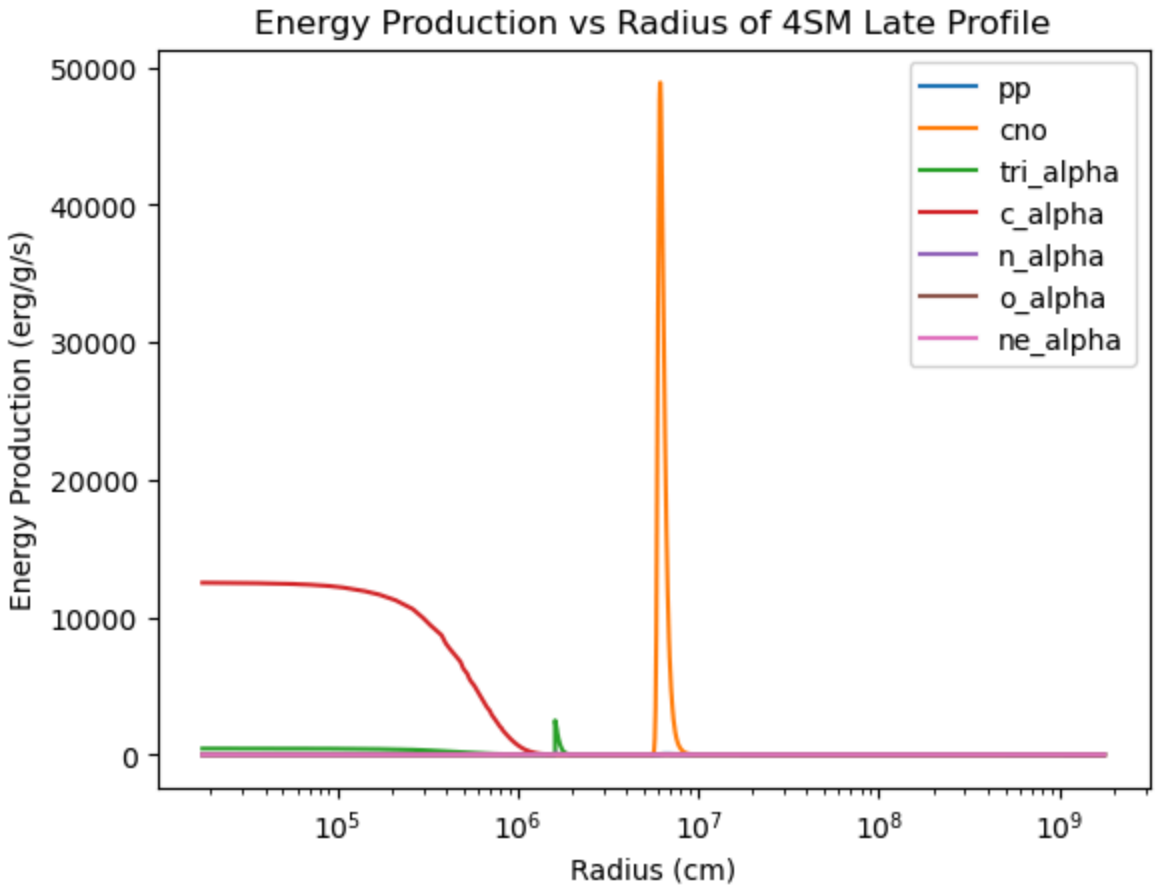
```
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("pp"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("cno"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("tri_alpha"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("c_alpha"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("n_alpha"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("o_alpha"))
plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of LOG1 Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("pp"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("cno"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("tri_alpha"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("c_alpha"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("n_alpha"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("o_alpha"))
plt.semilogx(prof2.data("radius")*6.957e7, prof2.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of LOG2 Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("pp"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("cno"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("tri_alpha"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("c_alpha"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("n_alpha"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("o_alpha"))
plt.semilogx(prof3.data("radius")*6.957e7, prof3.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of LOG3 Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("pp"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("cno"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("tri_alpha"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("c_alpha"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("n_alpha"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("o_alpha"))
plt.semilogx(prof4.data("radius")*6.957e7, prof4.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of 4SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("pp"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("cno"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("tri_alpha"))
```

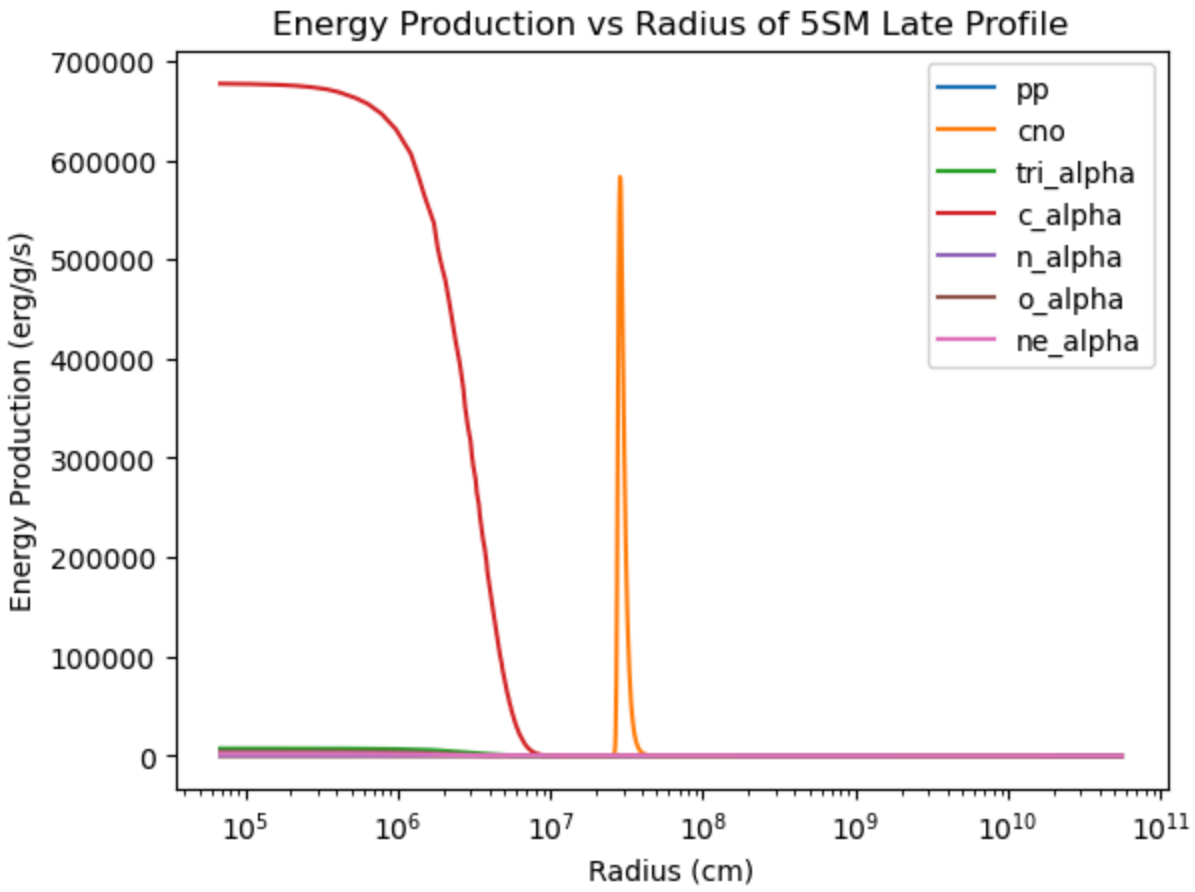
```
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("c_alpha"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("n_alpha"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("o_alpha"))
plt.semilogx(prof5.data("radius")*6.957e7, prof5.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of 5SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("pp"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("cno"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("tri_alpha"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("c_alpha"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("n_alpha"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("o_alpha"))
plt.semilogx(prof21.data("radius")*6.957e7, prof21.data("ne_alpha"))
plt.legend(["pp", "cno", "tri_alpha", "c_alpha", "n_alpha", "o_alpha", "ne_a
plt.title("Energy Production vs Radius of 5SM Late Profile")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();


plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("cno"), color = 'blue'
plt.semilogx(prof3.data('radius')*6.957e7, prof3.data('cno'), color = 'green
plt.semilogx(prof4.data('radius')*6.957e7*10, prof4.data('cno'), color = 're
plt.semilogx(prof5.data('radius')*6.957e7, prof5.data('cno'), color = 'pink'
plt.legend(["Star experiencing mass loss (5 -> 1)", "Constant 3.25 solar mas
plt.title("CNO Energy Production vs Radius of Late Profiles")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();

plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("cno"), color = 'blue'
plt.semilogx(prof3.data('radius')*6.957e7, prof3.data('cno'), color = 'green
#plt.semilogx(prof4.data('radius')*6.957e7*10, prof4.data('cno'), color = 'r
plt.semilogx(prof5.data('radius')*6.957e7, prof5.data('cno'), color = 'pink'
plt.legend(["Star experiencing mass loss (5 -> 1)", "Constant 3.25 solar mas
plt.title("CNO Energy Production vs Radius of Late Profiles")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();


plt.semilogx(prof1.data("radius")*6.957e7, prof1.data("c_alpha"), color = 'b
plt.semilogx(prof3.data('radius')*6.957e7, prof3.data('c_alpha'), color = 'g
plt.semilogx(prof4.data('radius')*6.957e7, prof4.data('c_alpha'), color = 'r
#plt.semilogx(prof5.data('radius')*6.957e7, prof5.data('c_alpha'), color = '
plt.legend(["Star experiencing mass loss (5 -> 1)", "Constant 3.25 solar mas
plt.title("C_Alpha Energy Production vs Radius of Late Profiles")
plt.xlabel("Radius (cm)")
plt.ylabel("Energy Production (erg/g/s)")
plt.show();
```

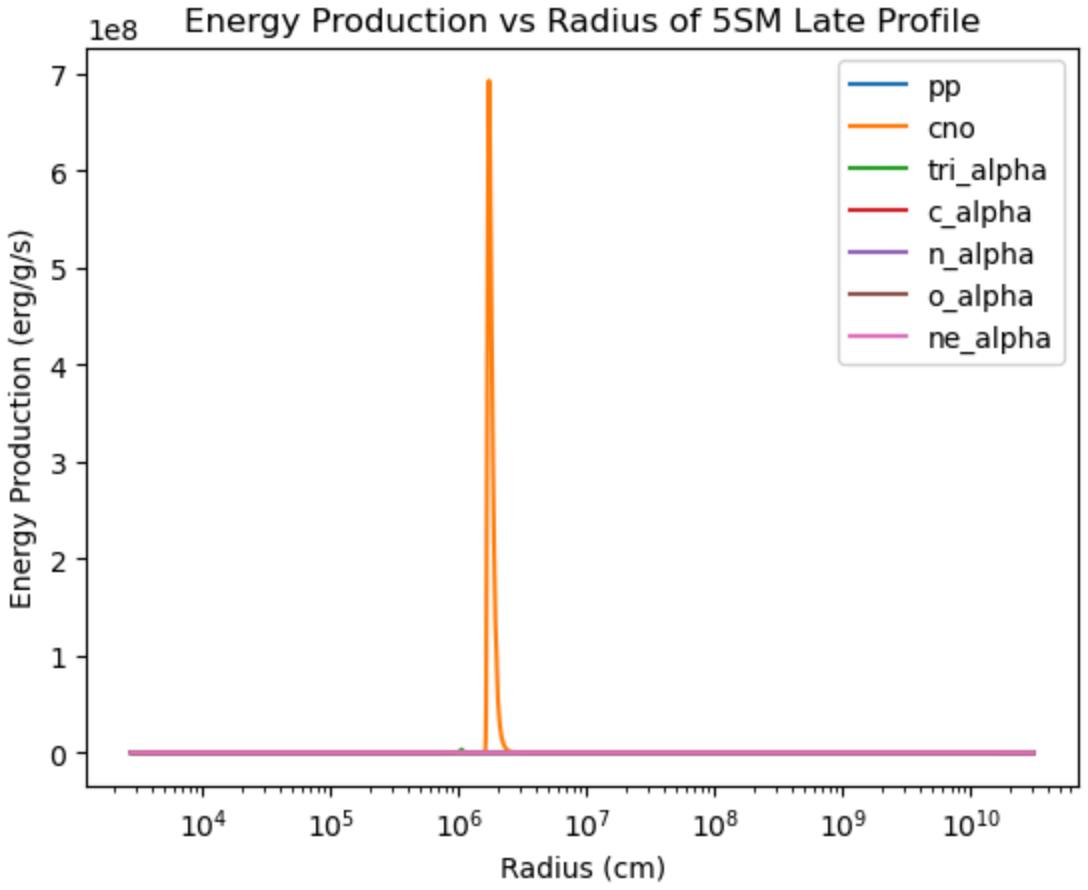


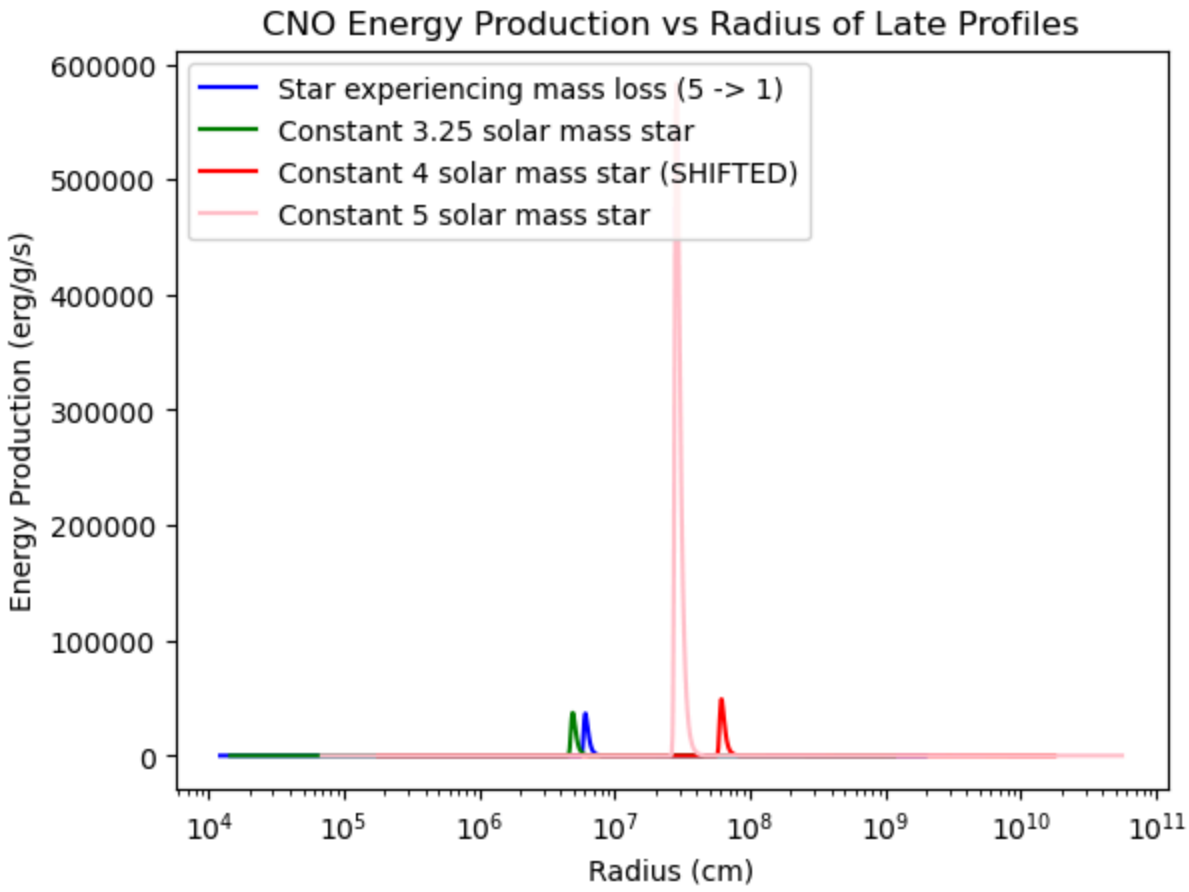


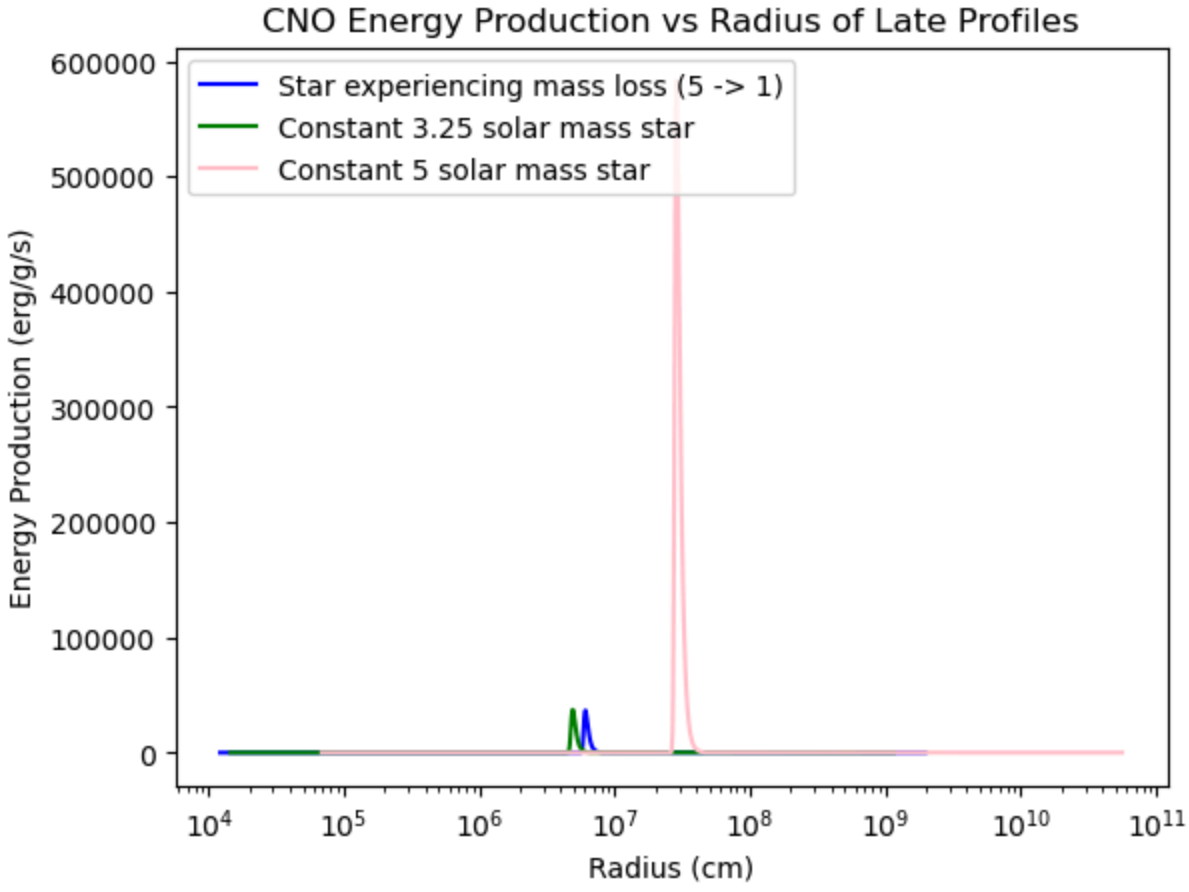


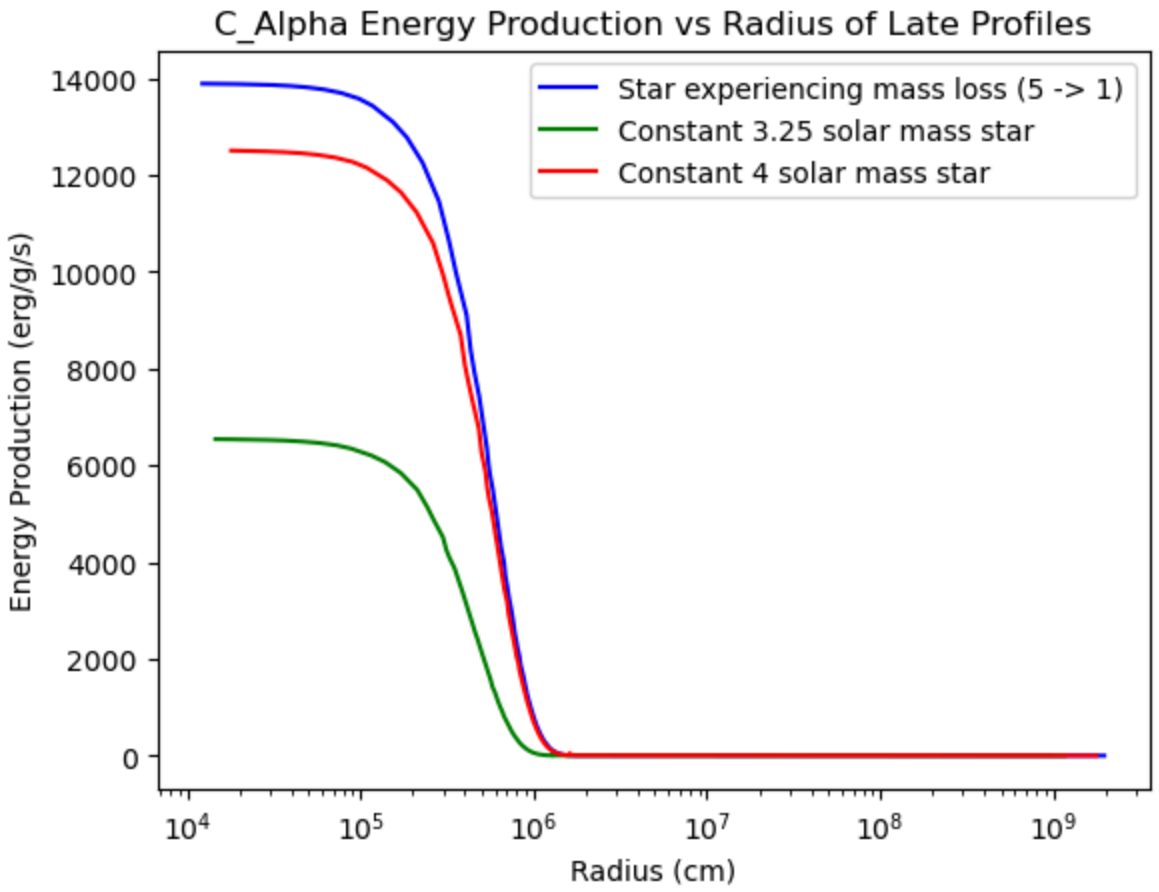






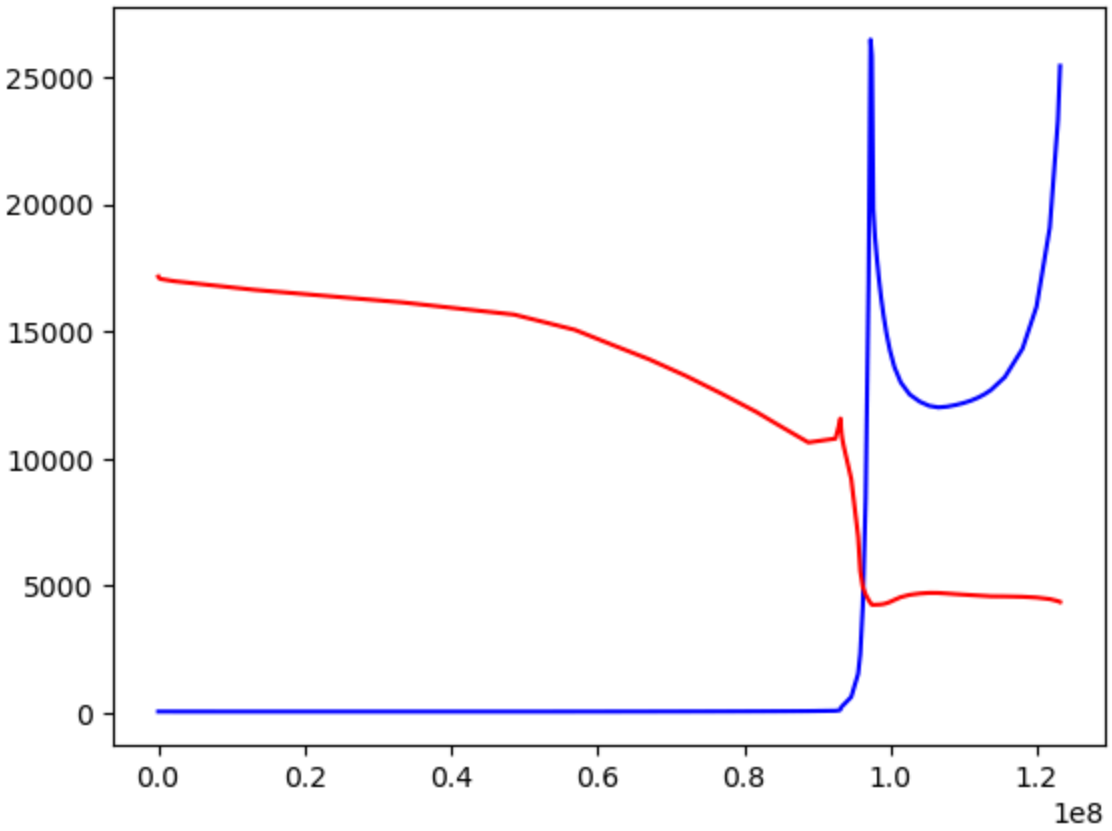






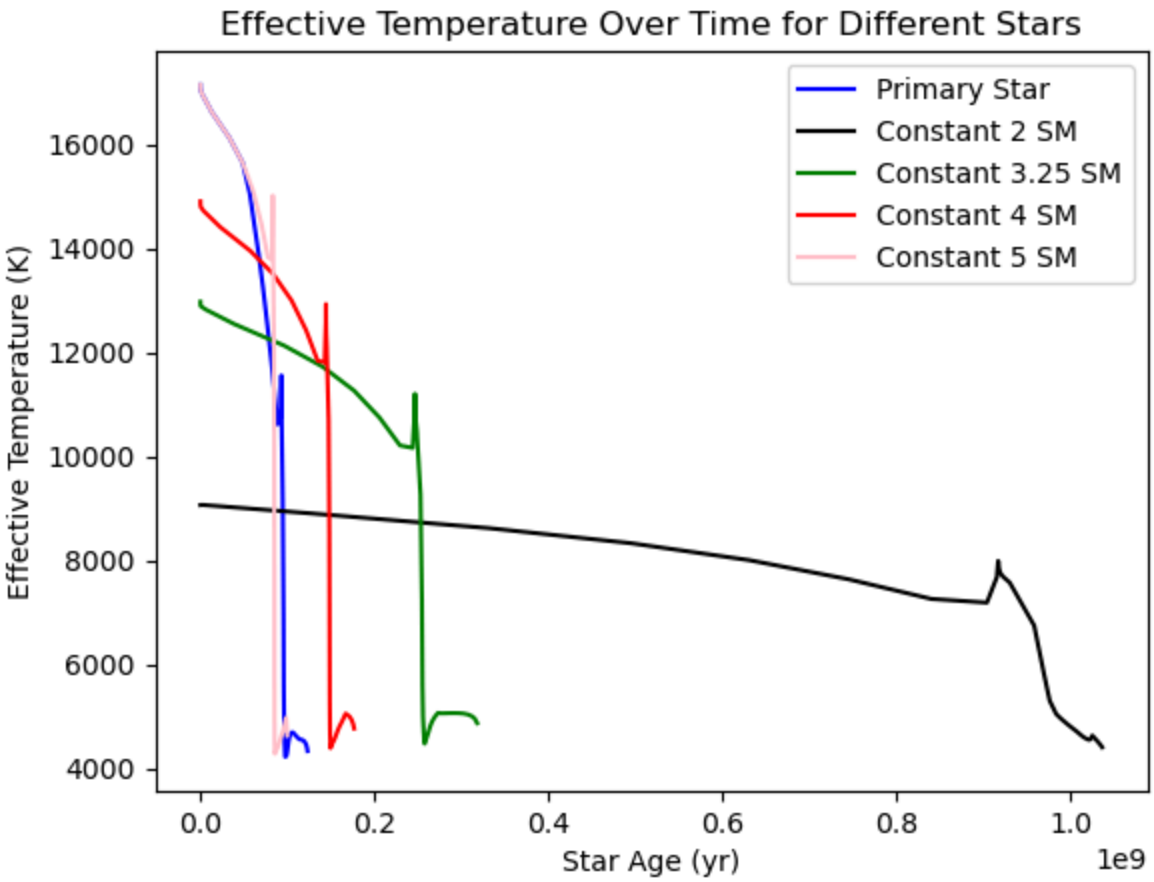
In [21]:
```
plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_center_Rho"), color =
plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_Teff"), color = 'red'
#plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_center_P"), color =
```

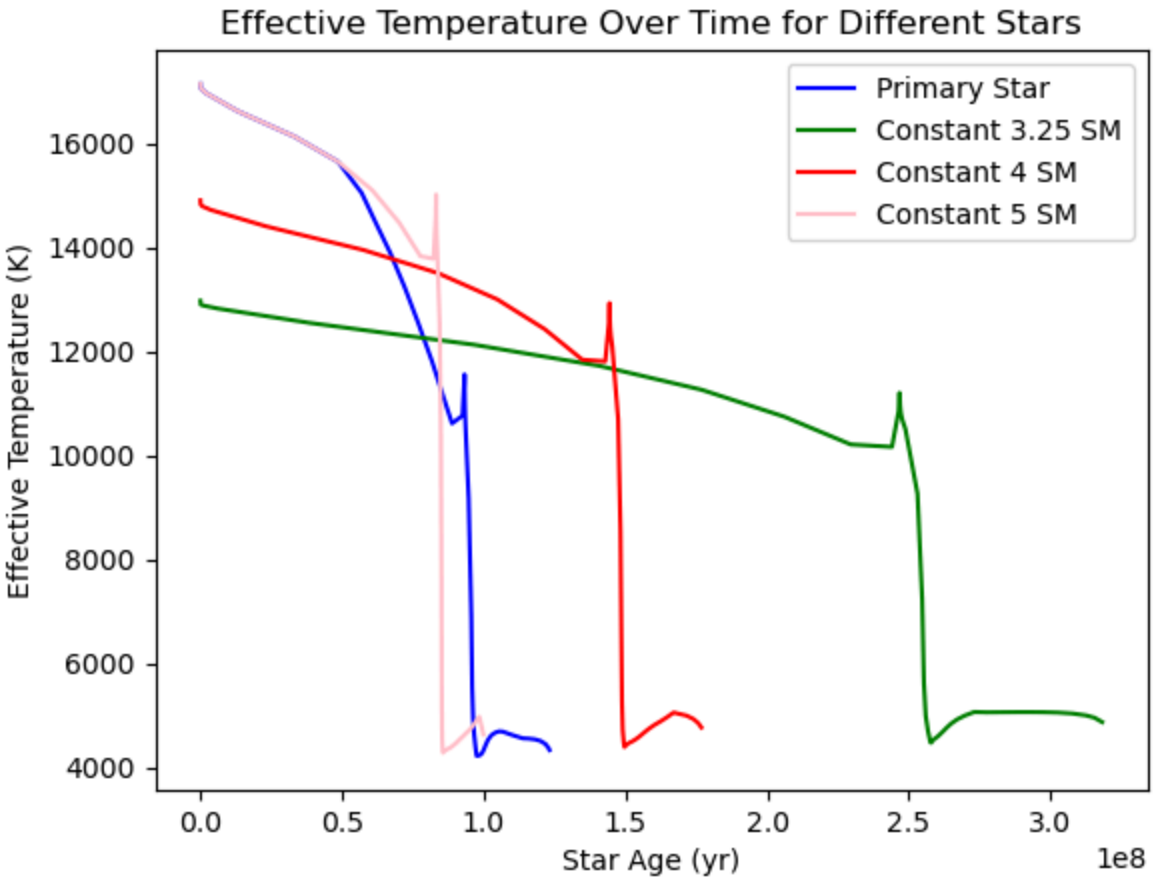
Out[21]:
```
[<matplotlib.lines.Line2D at 0x7f484b302940>]
```



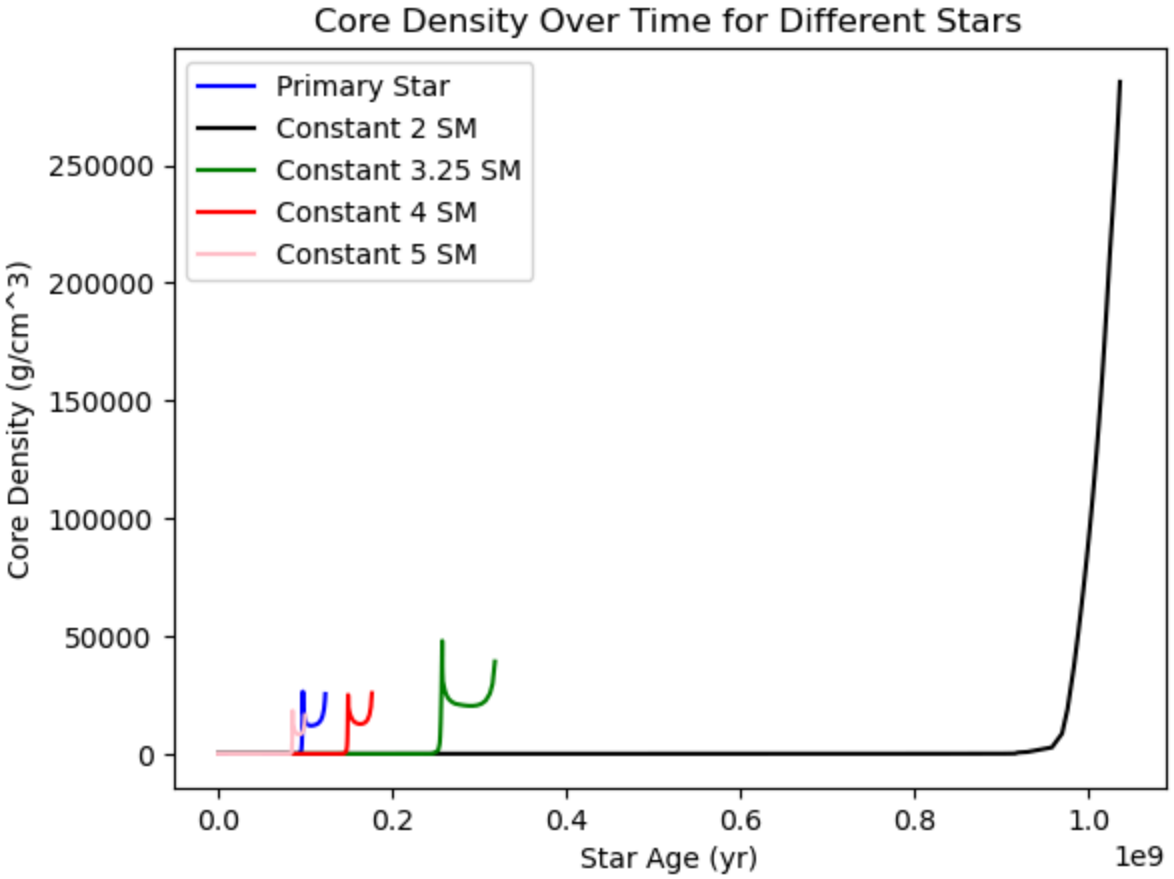
Helium flash corresponds to rapid jump in core density and pressure (pressure excluded because it's way too large of a scale)

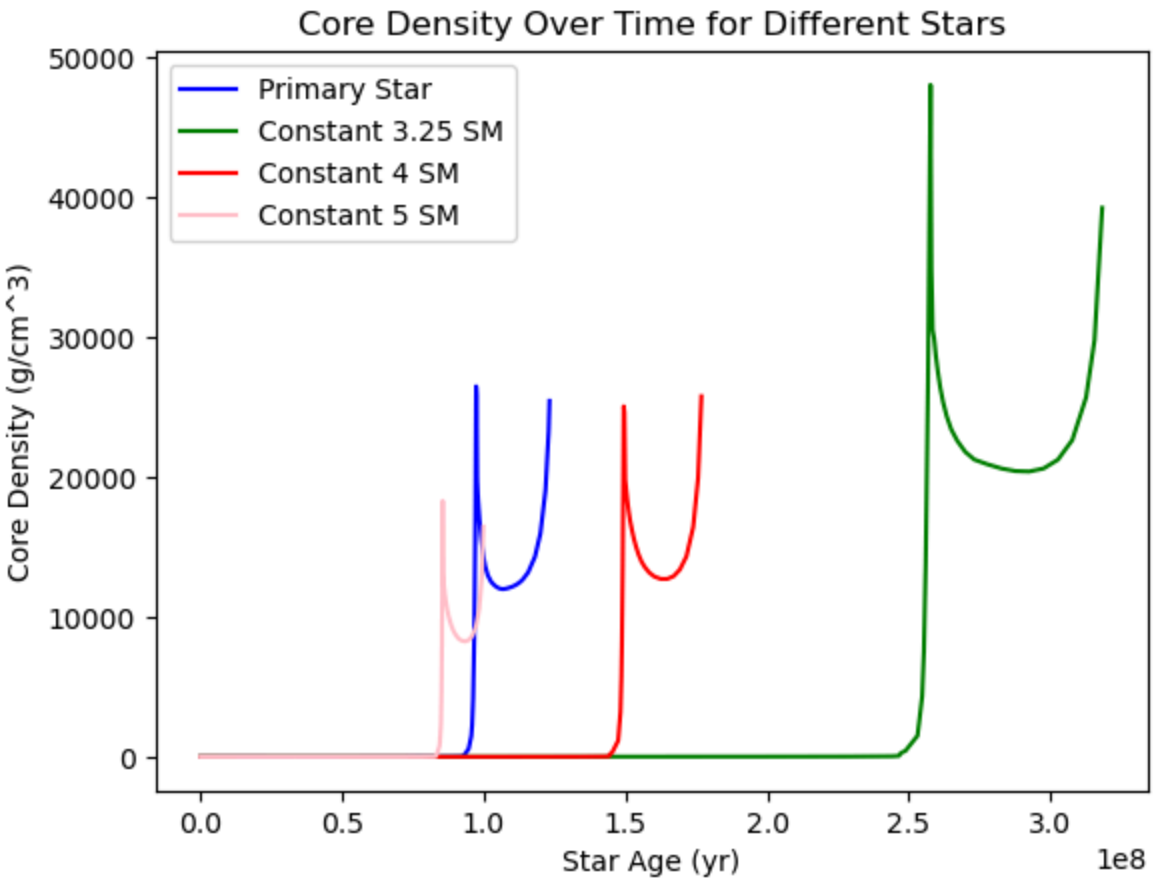
In [39]:
```
plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_Teff"), color = 'blue
plt.plot(hist2.data("star_age"), 10 ** hist2.data("log_Teff"), color = 'blac
plt.plot(hist3.data("star_age"), 10 ** hist3.data("log_Teff"), color = 'gree
plt.plot(hist4.data("star_age"), 10 ** hist4.data("log_Teff"), color = 'red'
plt.plot(hist5.data("star_age"), 10 ** hist5.data("log_Teff"), color = 'pink
plt.xlabel("Star Age (yr)")
plt.ylabel("Effective Temperature (K)")
plt.title("Effective Temperature Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 2 SM", "Constant 3.25 SM", "Constant 4
plt.show();

plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_Teff"), color = 'blue
plt.plot(hist3.data("star_age"), 10 ** hist3.data("log_Teff"), color = 'gree
plt.plot(hist4.data("star_age"), 10 ** hist4.data("log_Teff"), color = 'red'
plt.plot(hist5.data("star_age"), 10 ** hist5.data("log_Teff"), color = 'pink
plt.xlabel("Star Age (yr)")
plt.ylabel("Effective Temperature (K)")
plt.title("Effective Temperature Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 3.25 SM", "Constant 4 SM", "Constant 5
plt.show();

'''
plt.plot(hist21.data("star_age"), 10 ** hist21.data("log_Teff"))
plt.xlabel("Star Age (yr)")
plt.ylabel("Effective Temperature (K)")
plt.title("Effective Temperature of LOG21 Over Time");
''';
```





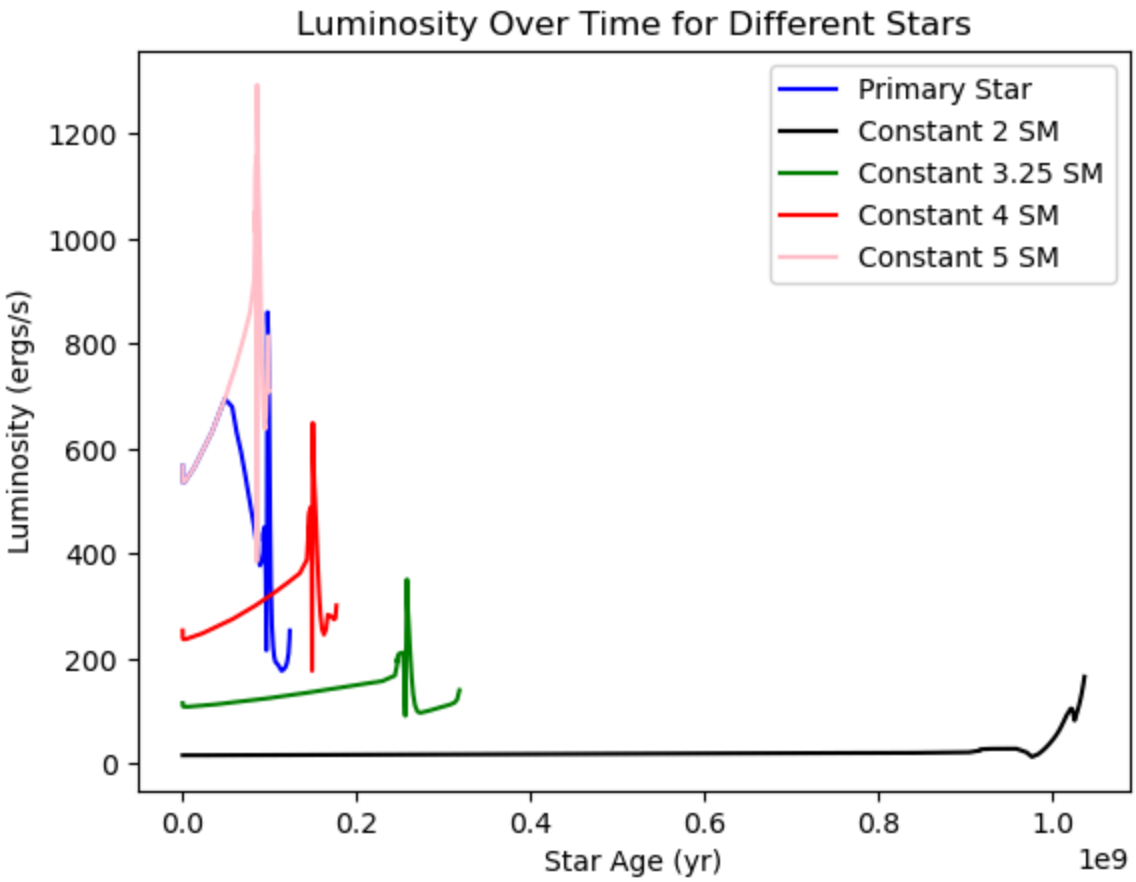
In [40]:
```
plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_center_Rho"), color =
plt.plot(hist2.data("star_age"), 10 ** hist2.data("log_center_Rho"), color =
plt.plot(hist3.data("star_age"), 10 ** hist3.data("log_center_Rho"), color =
plt.plot(hist4.data("star_age"), 10 ** hist4.data("log_center_Rho"), color =
plt.plot(hist5.data("star_age"), 10 ** hist5.data("log_center_Rho"), color =
plt.xlabel("Star Age (yr)")
plt.ylabel("Core Density (g/cm^3)")
plt.title("Core Density Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 2 SM", "Constant 3.25 SM", "Constant 4
plt.show();

plt.plot(hist1.data("star_age"), 10 ** hist1.data("log_center_Rho"), color =
plt.plot(hist3.data("star_age"), 10 ** hist3.data("log_center_Rho"), color =
plt.plot(hist4.data("star_age"), 10 ** hist4.data("log_center_Rho"), color =
plt.plot(hist5.data("star_age"), 10 ** hist5.data("log_center_Rho"), color =
plt.xlabel("Star Age (yr)")
plt.ylabel("Core Density (g/cm^3)")
plt.title("Core Density Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 3.25 SM", "Constant 4 SM", "Constant 5
plt.show();
```

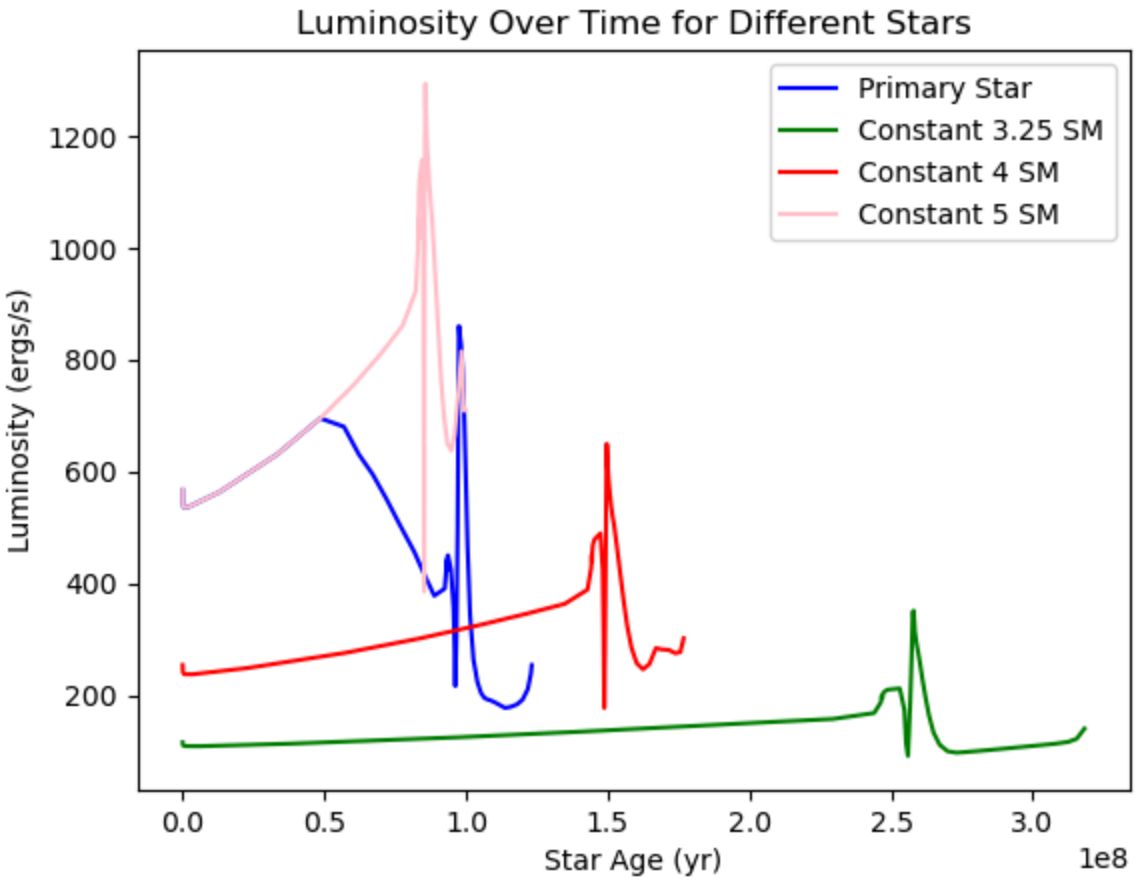




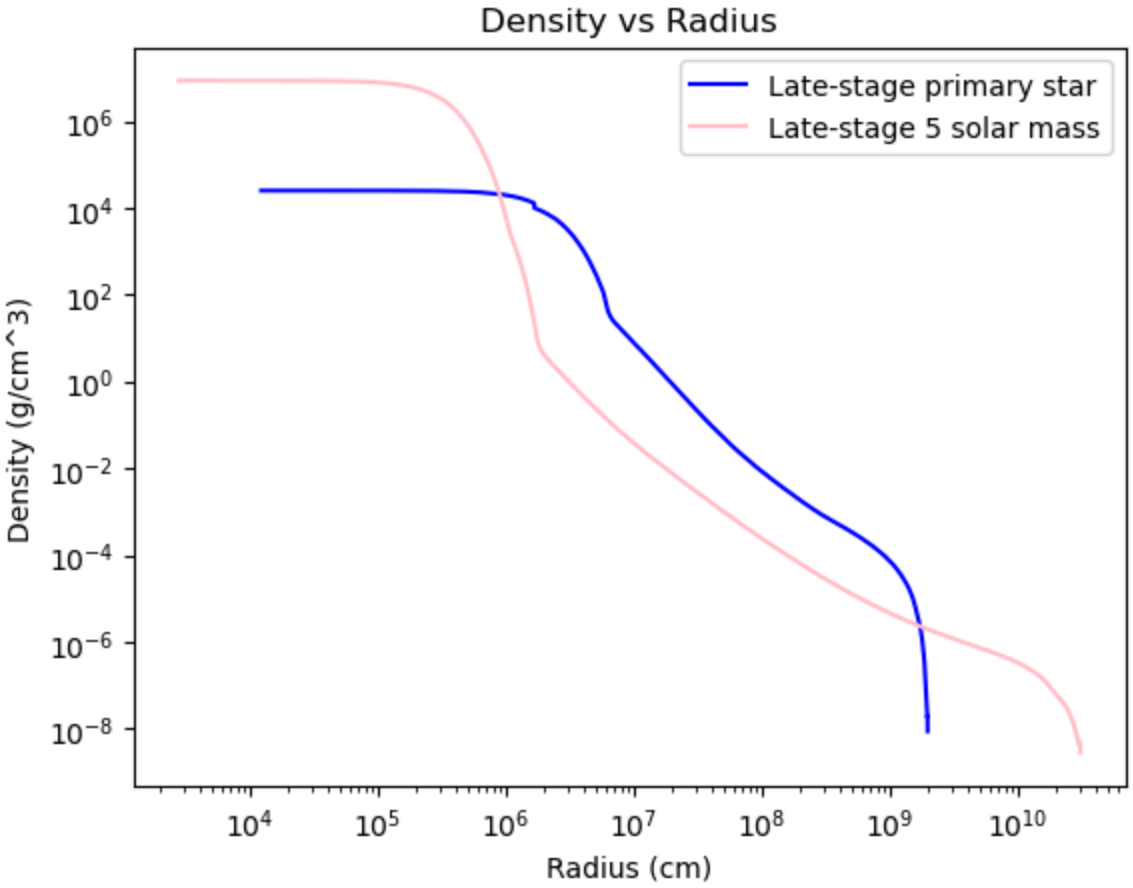
Honestly no idea what's going on here. These seem like incredibly high levels for core density, and 5SM being the lowest seems strange to me. Wonder if I'm plotting something different.

In [41]:
```
plt.plot(hist1.data("star_age"), hist1.data("luminosity"), color = 'blue')
plt.plot(hist2.data("star_age"), hist2.data("luminosity"), color = 'black')
plt.plot(hist3.data("star_age"), hist3.data("luminosity"), color = 'green')
plt.plot(hist4.data("star_age"), hist4.data("luminosity"), color = 'red')
plt.plot(hist5.data("star_age"), hist5.data("luminosity"), color = 'pink')
plt.xlabel("Star Age (yr)")
plt.ylabel("Luminosity (ergs/s)")
plt.title("Luminosity Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 2 SM", "Constant 3.25 SM", "Constant 4
plt.show();

plt.plot(hist1.data("star_age"), hist1.data("luminosity"), color = 'blue')
plt.plot(hist3.data("star_age"), hist3.data("luminosity"), color = 'green')
plt.plot(hist4.data("star_age"), hist4.data("luminosity"), color = 'red')
plt.plot(hist5.data("star_age"), hist5.data("luminosity"), color = 'pink')
plt.xlabel("Star Age (yr)")
plt.ylabel("Luminosity (ergs/s)")
plt.title("Luminosity Over Time for Different Stars")
plt.legend(["Primary Star", "Constant 3.25 SM", "Constant 4 SM", "Constant 5
plt.show();
```



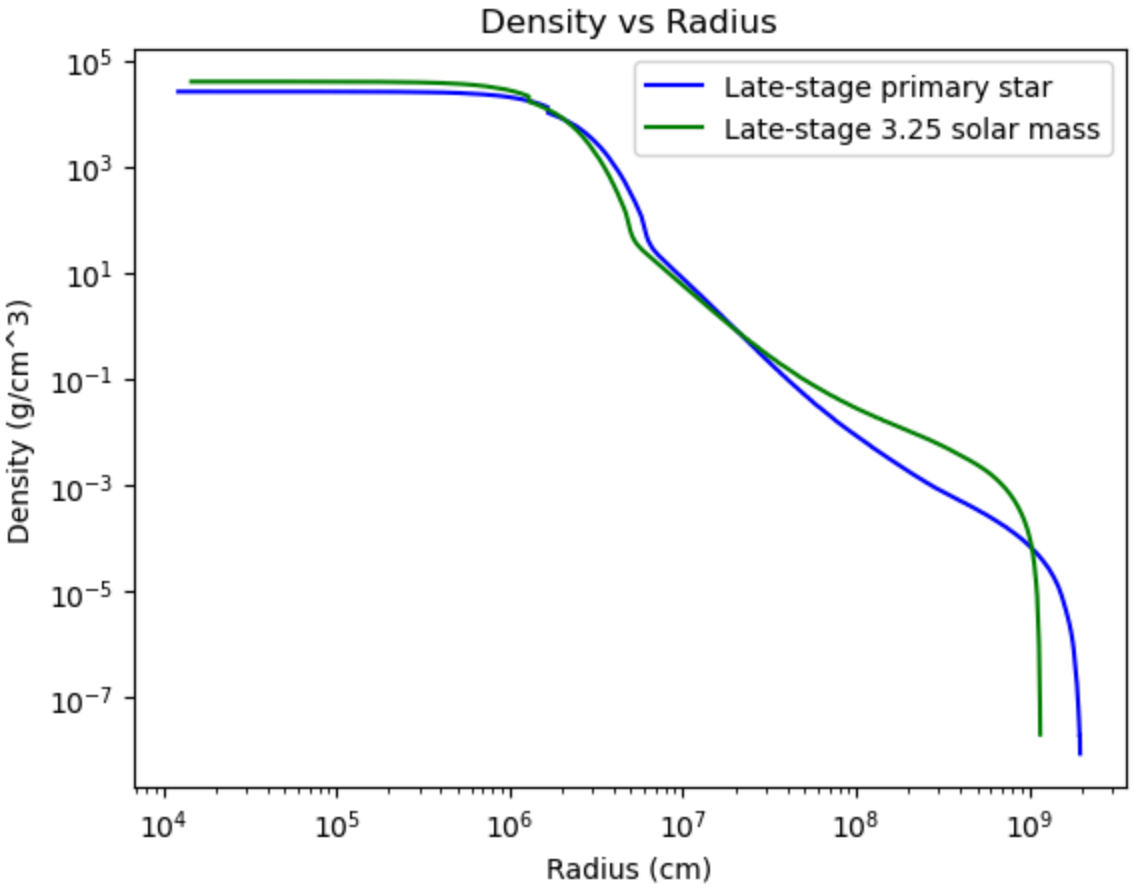


In [29]:
```
plt.loglog(prof1.data("radius")*6.957e7, 10**prof1.data("logRho"), color = '
plt.loglog(prof21.data('radius')*6.957e7, 10**prof21.data('logRho'), color =
plt.xlabel('Radius (cm)')
plt.ylabel('Density (g/cm^3)')
plt.title('Density vs Radius')
plt.legend();
```

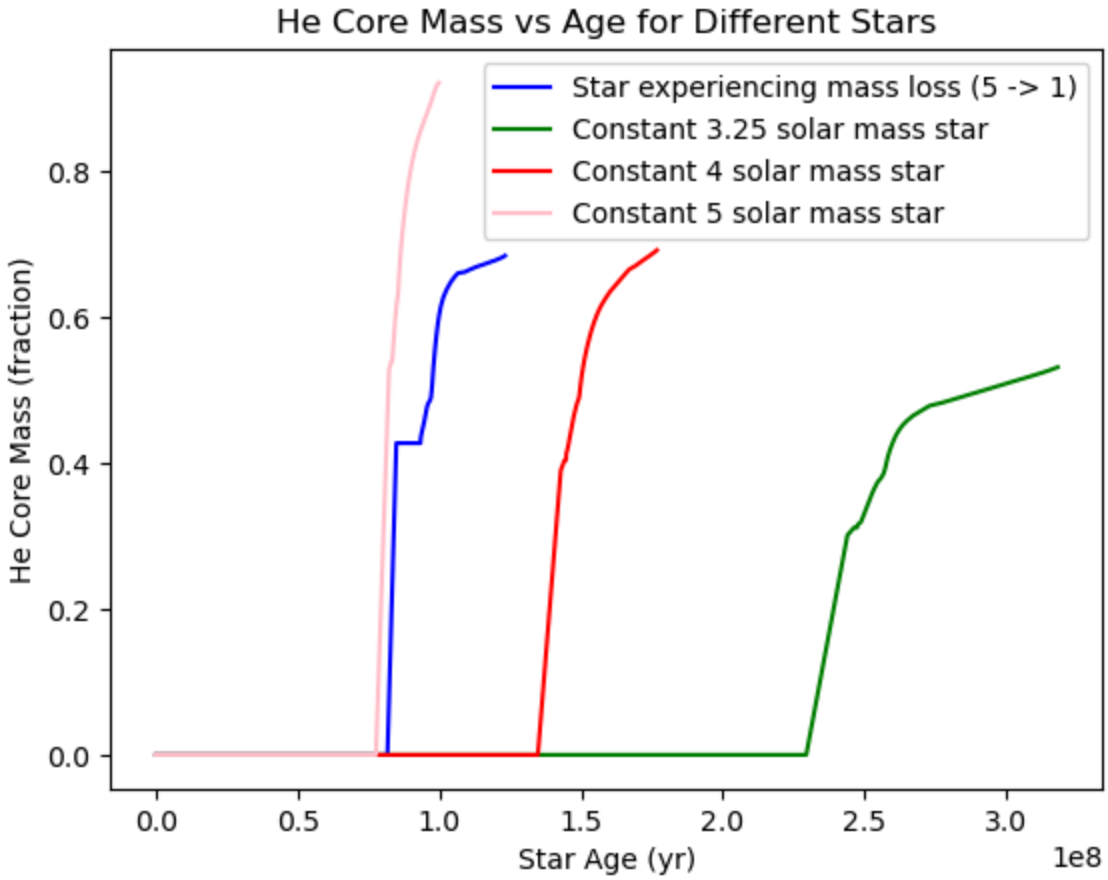


Our 1.5 solar mass star is acting like a star of 3-5 solar masses. It's evolution is sped up, likely due to the long amount of time it spent in the stage where it was a 3-5 solar mass star. This meant that at 5 solar masses it was able to consume its fuel efficiently enough and quickly enough to become a red giant before it lost a substantial amount of mass. Extrapolating from this, if mass loss occurred quickly enough, and at the same time did not substantially disturb the workings of the star (fusion occured as normal), then a partial tidal disruption event could move a larger mass star to the same as effectively a lower mass star.

In [45]:
```
plt.loglog(prof1.data("radius")*6.957e7, 10**prof1.data("logRho"), color = '
#plt.loglog(prof21.data('radius')*6.957e7, 10**prof21.data('logRho'), color
#plt.loglog(prof4.data('radius')*6.957e7, 10**prof4.data('logRho'), color =
plt.loglog(prof3.data('radius')*6.957e7, 10**prof3.data('logRho'), color = '
plt.xlabel('Radius (cm)')
plt.ylabel('Density (g/cm^3)')
plt.title('Density vs Radius')
plt.legend();
```



In [27]:
```
plt.plot(hist1.data('star_age'), hist1.data('he_core_mass'), color = 'blue')
plt.xlabel("Star Age (yr)")
plt.ylabel("He Core Mass (fraction)")
plt.title("He Core Mass vs Age for Different Stars")
plt.plot(hist3.data('star_age'), hist3.data('he_core_mass'), color = 'green'
plt.plot(hist4.data('star_age'), hist4.data('he_core_mass'), color = "red")
plt.plot(hist5.data('star_age'), hist5.data('he_core_mass'), color = "pink")
plt.legend(["Star experiencing mass loss (5 -> 1)", "Constant 3.25 solar mas
```



In [ ]: