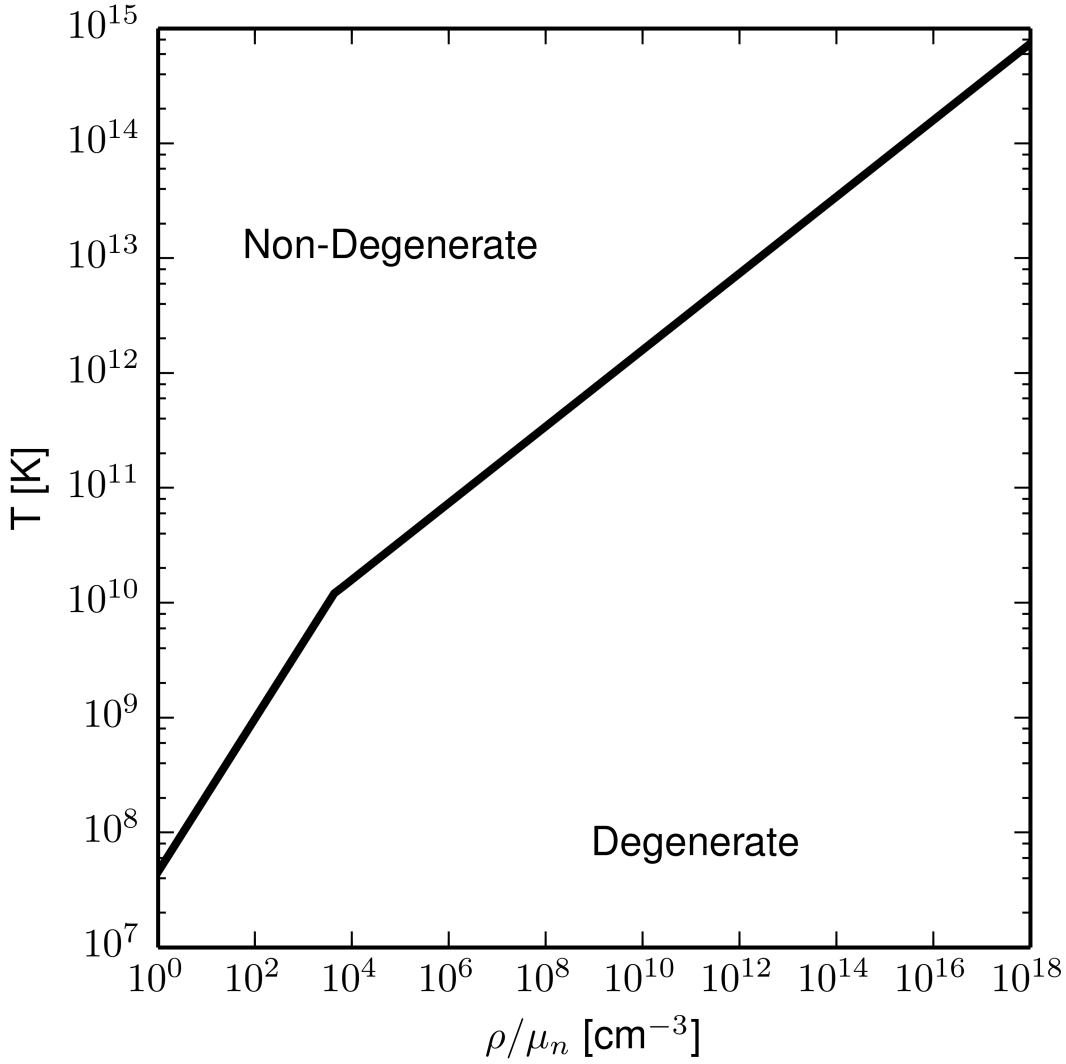
Homework 5

Astro 715 Elijah Bernstein-Cooper

1



2a

The rate of creation of Li from $^{7}Be + e^{-}$ is more than 2 orders of magnitude less than the destruction reaction rate $^{7}Li + {}^{1}H$ for typical are temperatures ~10^{7} K. Reaction rates were drawn from figure 6.9. Another way to think about the problem is that the only reaction that creates ^{7}Li requires ^{7}Be, which is much less dense than ^{1}H, which destroys Li.

2b

$$\frac{dn_{Li}}{dt} = - < \sigma v >_{Li\,1_H} n_{Li}\, n_{1_H}$$

$$\frac{dn_{Li}}{n_{Li}} = - < \sigma v >_{Li\,1_H} n_{1_H}\, dt$$

$$n_{Li} = Ce^{-<\sigma v>_{Li\,1_H} n_{1H}\, t}$$

where $< \sigma v >_{Li\,1_H} = 7.2\, x\, 10^{10}\, T_6^{-2/3}\, e^{-84.7\, T_6^{-1/3}}\, N_A^{-1}$ cm^3 s^{-1} and C is a constant. Setting t = 0, we know that $n_{Li} = n_{Li,0}$ where $n_{Li,0}$ is the primordial Li abundance. Thus C = $n_{Li,0}$.

$$n_{Li} = n_{Li,0}\, e^{<\sigma v>_{Li\,1_H} n_{1H}\, t}$$

2c

We can potentially explain the Li abundance seen today by looking at how long it would take this reaction to deplete Li. At the beginning of the solar convection zone, R ~ 0.62 R_{sun}, $n_1 = 1.6 * 10^{23}$ cm^{-3} and $T = 2.6 * 10^{6}\, K = 2.6\, T_6$. Today, $n_{Li} = \frac{n_{Li,0}}{140}$. Solving for t

$$t = \log\left[\frac{n_{Li}}{n_{Li,0}}\right][< \sigma v >_{Li\,1_H} n_{1H}]^{-1}$$

t = 7 x 10^{9} yr

This is the age of the sun! Using these models, the Li depletion can be well explained by this reaction. However literature suggests that we are unable to explain the amount of Li depletion, so perhaps the one-dimensional EZWEB models do not accurately reproduce the temperature profile of the Sun to the degree necessary to predict Li depletion.