

Exercise	1	2	3	Total
100%	2	4	4	10
Points				

**Name:**  
**Stellar Astrophysics**  
 Homework - Lecture 11 - Excitation and Ionization  
**Due date: October 13**

## 1 Density of a White Dwarf

A White Dwarf star has typically a radius that is only 1% of the Sun's. Determine the average density of a  $1M_{\odot}$  White Dwarf star.

## 2 Boltzmann equation

For a gas of neutral hydrogen atoms, at what temperature is the number of atoms in the first excited state only 1% of the number of atoms in the ground state? At what temperature is the number of atoms in the first excited state only 10% of the number of atoms in the ground state?

Look into Section 8.1 in Carroll & Ostlie for hints and the formula you need.

## 3 Saha equation

Use the Saha equation to determine the fraction of hydrogen atoms that are ionized,  $N_{II}/N_{total}$ , at the center of the Sun. Here the temperature is  $1.58 \times 10^7$  K and the number density of electrons is about  $n_e = 6.4 \times 10^{25} \text{ cm}^{-3}$ . Use the partition function  $Z_I = 2$ . Does your result agree with the fact that practically *all* of the Sun's hydrogen is ionized at the Sun's center? What is the reason for any discrepancy?

Look into Section 8.1 in Carroll & Ostlie for hints and the formula you need.