AY4 Homework #4, Sprint 2008

1. **Label each of the following statements about the solar wind true or false.**

   F The solar wind is composed of energetic photons – x-rays and gamma rays (protons & electrons)

   T The Earth's surface is protected from the solar wind by the Earth's magnetic field

   T The northern and southern lights are due to the solar wind

   F The solar wind is made mostly of neutrinos

2. **How is the solar cycle connected to the number of sunspots observed?**

   When we are at Solar maximum, we observe an increase in sunspots compared to Solar minimum

3. **What is the Solar Neutrino Problem?**

   The measured number of neutrinos is about a factor of 3 (less than) what is predicted to be produced by the pp-chain. This points to our lack of knowledge of neutrino physics, not to a lack of solar physics knowledge.

4. **What is the equilibrium in a collapsing protostar?**

   ___Gravity balanced by thermal pressure.

   ___electrical attraction forces between the electrons and protons.

   ___Nuclear fusion balanced against gas pressure.

   ✓ There is no hydrostatic equilibrium established for protostars. (this is why they collapse)

5. **Why is there a lower limit of around $0.08M_\odot$ to the mass of main-sequence stars?**

   Below 0.08M⊙ the center of the protostar will never get hot enough for fusion to start. Therefore, these objects will never become actual stars. These are called Braun Dwarfs.

6. **Where is the site of star formation?**

   ___Only in the most distant parts of the Galactic halo where temperatures are cold enough for gas clouds to collapse.

   ___In the outer parts of the solar system where it is cold enough for gas clouds to collapse.

   ___In gas clouds where electron degeneracy is the pressure source.

   ✓ None of these is correct.

7. **Why is a high temperature required for Hydrogen fusion?**

   Protons need to overcome the repulsive electromagnetic force to bind via the strong force. They can only do this if they get sufficiently close together, i.e. their velocity need to be high which means the temp. must be high.

8. **What is the energy source for a Red Giant star?**

___Core helium fusion.

___Core Hydrogen fusion.

✓Core contraction plus Hydrogen fusion in a shell around the core.

___Core contraction plus electron degeneracy.

9. **When the Sun becomes a Red Giant which of the following statements will be true, which false?**

T it will be producing more energy than it does now

T it will have a larger radius than it does now

F it will have a higher mass than it has now

T it will have a higher core temperature than it has now

10. **Giant elliptical galaxies are thought to be made up of stars which were all formed about 12 billio years ago in a single burst of star formation (note that this may or may not be the correct story, but assume for now that it is). Which of the following objects would you expect to be present in an elliptical galaxy (answer True) and which would you not expect to present (answer False)?**

✓red giants

___blue main-sequence stars

✓planetary nebulae

✓low-mass main sequence stars

11. **The Sun will eventually go through which of the following phases?**

✓white dwarf

✓red giant branch

___nova

✓horizontal branch

12. **Which of the following statements about White Dwarfs are true?**

✓They were once the core of an asymptotic giant branch star

✓They are supported against gravity by e^- degeneracy

✓They are steadily cooling off as they radiate energy

___They are all at least $1.4M_\odot$

13. **What is the equilibrium in a white dwarf?**

✓Gravity balanced by electron degeneracy pressure.

___Gravity balanced by thermal pressure.

___Electrical attraction forces between the electrons and protons.

___There is no hydrostatic equilibrium established for white dwarfs.

14. **What is the Chandrasekar limit?**

$M_{CH} \simeq 1.4 M_\odot$: If a white dwarf (He, C star core) exceeds this limit, electron degeneracy can no longer support its collapse due to gravity => Nova!?

15. Review. **Star A and Star B have the same trigonometric parallax and the apparent brightness of A is four times that of B.** (Assume no dust toward either star)

a) What are their relative distances

$p_A = p_B$ & $d \propto \frac{1}{p}$ $\Rightarrow \frac{p_A}{p_B} = \frac{d_B}{d_A} = 1$

$\Rightarrow \boxed{d_B = d_A}$

b) what are their relative luminosities?

$L = 4\pi D^2 \cdot F \Rightarrow \frac{L_A}{L_B} = \left(\frac{D_A}{D_B}\right)^2 \cdot \frac{F_A}{F_B} = \frac{F_A}{F_B}$ ($D = 1$)

$\Rightarrow \frac{L_A}{L_B} = \frac{4F_B}{F_B} = 4 \Rightarrow \boxed{L_A = 4L_B}$

Doppler Shift: $\frac{\lambda_v - \lambda_0}{\lambda_0} = \frac{\text{velocity}}{c}$

Wien's Law: $\lambda(\text{max}) = \frac{0.29}{\text{Temp}}$

16. Review **Suppose you take a spectrum of a distant galaxy that is moving toward the Earth at 5000 km/sec. You see the hydrogen emission line corresponding to an electron dropping from the second excited level to the first excited level. The "rest" wavelength of this photon is = 6365 Å.**

(a) Will the measured emission line be red or blue shifted?

Since galaxy is moving towards us, the wavelength will be decreasing $\Rightarrow$ Blueshifted

(b) What wavelength will it be measured at (note, c=5 × 10^5km/sec)?

$\frac{v}{c} = \frac{\lambda_{obs} - \lambda_{rest}}{\lambda_{rest}} \Rightarrow \lambda_{obs} = \left(\frac{v}{c}\right)\lambda_{rest} + \lambda_{rest}$

$\Rightarrow \lambda_{obs} = \frac{5000\ km/s}{5 \times 10^5\ km/s} \cdot 6365\text{Å} + 6365\text{Å}$

$\Rightarrow \boxed{\lambda_{obs} = 6429\text{Å}}$