AST 301, Fall 2015 **Introduction to Astronomy**

Comments on Homework 4
<u>Part A</u>

A1. See Seeds, Fig. 6-3
AM, FM, IR, visible, X-ray, Υ ray
A2. **a.**
A3. LGP ∝ Area ∝ Diameter-squared of primary mirror
LGP ∝ $32^2 = (4 \times 8)^2 = 16 \times 8^2$
Answer: 16 8-meter mirrors
A4. **b.**
A5. **d**. $L \propto R^2T^4$. Here $L \propto R^2$ for two BBs of same T. $L \propto 4^2 = 16$
A6. **a.**
A7. **c. H^+** Atoms and ions have line spectra because their electrons provide a family of Bohr orbits and electron jumps/transitions between orbits give rise to lines. The Bohr orbits and transitions are absent if there are no electrons.
- He^+ has one electron.
- He has two electrons.
- C^{+2} has four electrons.

A8. d[parsecs] = 1/p[secs arc]
d = 1/0.25 = 4 parsecs
A9. 16 times brighter
Recall $B \propto L/d^2$ and d = 1/p. Then, $B \propto p^2$ for same L. The parallaxes are in the ratio 0.1/0.025 = 4 to 1. Then, B are in the ratio 4^2 or 16 to 1.
A10. A
A11 TiO
A12. **d**. Wien's Law
A13. O5V, A2V, G2V, G5V, KOII, and M3III
Two points: (i) Each letter class # is subdivided, as in G0, G1,…, G8, G9 from higher to lower temperature, and (ii) We shall suppose that the luminosity class (I to V) does not alter the temperature, i.e., M3V, M3III, and M3I have the same temperature.
A14. **c.**
A15. **c.**
A16. **c.** With $L \propto M^4$ (apologies for the typo)
A17. Hottest = O, reddest = M, brightest = O, most massive = O, most like the Sun = G
A18. 4.5 billion years
A19. 10 million years. See Classnotes 13
A20. Hydrogen and helium

Part B

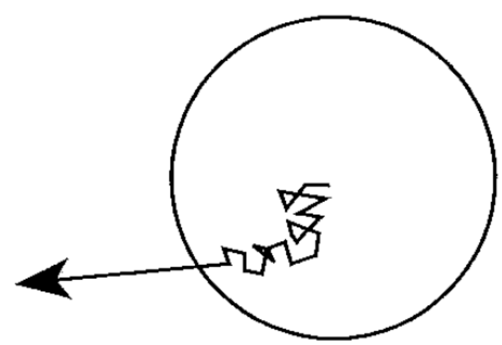
B1. a. See Seeds Sec. 9-1. It's helpful to point out that Fig. 9-2 does NOT reflect the reality that the actual shifts of even the nearest stars are very small, much smaller than suggested by the inserts in Fig. 9-2. A distance of 1 parsec is an angular shift of 1 sec. arc relative to very distant stars. For ground-based telescopes, stellar images as blurred by the atmosphere are about 1 sec. arc. in diameter.

b. (i) Images of stars are much sharper than as observed on the ground. Therefore, easier to measure the small parallax shift. The orbiting telescope is NOT closer to the stars.
(ii) One benefits from the advantage outlined in (i) PLUS the use of a longer baseline because Jupiter's orbit has a radius of just over 5 AU.

B2. a. See Classnotes 13

b. Ditto.

c. Radiation/light at the center of the Sun does not travel directly outwards. It is trapped. Photons are scattered (redirected) off free electrons. Photons may also be absorbed by ions whose electrons are kicked out a Bohr (permitted) orbit or two. Shortly thereafter the orbiting electron jumps down to a lower Bohr orbit and another photon or photons is emitted. The direction of emission is random and so the photons may head back to the center of the star. (See Seeds p. 240 where he speaks of 'opacity'.) The diagram sketches the random walk undertaken as energy travels out by radiation.



B3. a. Wien's Law: peak wavelength $\propto 1/T$. Ratio of 20,000 to 2000 is 10:1 with the 2000Å BB being the hotter one.

b. Stefan-Boltzmann Law: total radiation scales as T^4. Thus a 10:1 ratio for T is 10^4 = 10,000 ratio for total radiation

c. 2000Å → blue. 20,000Å → red.

d. But the 2000Å BB emits more red light. (Would the answer differ if the BBs were not of the same size?)

e. This is an exercise involving $L \propto R^2T^4$.

$L_{WD} / L_{\odot} = (R_{WD} / R_{\odot})^2 (T_{WD} / T_{\odot})^4$

$0.01 = (R_{WD} / R_{\odot})^2 (24,000/ 6,000)^4$

$(R_{WD} / R_{\odot})^2 = 0.01 (6,000/ 24,000)^4$

$R_{WD} / R_{\odot} = 0.1 (6,000/ 24,000)^2 = 0.1 (1/16)$

$R_{WD} = 0.00625 R_{\odot}$

B4. a. See Classnotes 10