PHYS 182 Fall 2019 Prof. R. Brandenberger

Readings and Homework for Week of Sept 30 2019

Readings

Textbook, Chapters 6, S2, S3, S4

Problems (due Oct. 9 in class)

1. In the center of our Milky Way galaxy there is a compact object of mass $10^6 M_o$, where M_o is the solar mass. This object does not emit any light. How could we know it is actually present?

2. If the object described in the previous problem is a black hole, then what is its maximal radius? Hint: In class I discussed the Newtonian argument for the existence of a black hole based on the escape velocity from the surface of the object not being allowed to be larger than the speed of light. For the sun, this gave a radius of about 10km.

3. An astronomer observes a bright star close to the center of the Milky Way and takes the spectrum of the light. The spectrum is similar to the spectrum of the sun, except that there are deep absorption lines at the frequency of a Level 1 hydrogen transition line. How would you interpret this result? Why is there this absorption line?

4/5. An astronomer observes a quasar (a quasar is a compact object which emits an amount of light comparable to that of all of the stars in a galaxy), takes its spectrum and observes that there are emission line peaks in the spectrum whose frequencies oscillate about the mean value by 1%. What could the source of these oscillations be? Give both a qualitative and a quantitative answer.

6. Much of the Orion Nebula looks like a glowing coud of gas. What type of

spectrum would you expect to see from the glowing parts of the nebula and why?

7. What is the energy (in Joules) of an ultraviolet photon with wavelength 120nm?

8. Suppose that all the energy from a 100 Watt light bulb came in the form of photons with wavelength 600nm. a) Calculate the energy of a single such photon. b)How many of such photons must be emitted each second in order to account for all of the energy released? c) Based on your answer to b), explain why we do not observe the particle nature of this light.

9. A traditional incandescent light bulb uses a hot tungsten coil to produce a thermal radiation spectrum. The temperature of this coil is typically about 3000K. a) What is the wavelength of maximal intensity? Compare with the 500nm wavelength of maximal intensity for the sun. b) Do you expect the light from the lightbulb to be redder or blue than the light from the sun? c) Do these light bulbs emit all of their energy as visible light? d) Fluorescent light bulbs emit emission primarily at fixed wavelengths as a line spectrum. Why? If the wavelength of such a bulb is in the visible range, then does a fluorescent light bulb emit more or less light than a tranditional light bulb with the same voltage?

10. Suppose you were looking at our own solar system from a distance of 10 light years. a) What angular resolution would you need to see the sun and Jupiter as distinct points of light? b) What angular resolution to see the Earth and the sun as distinct points of light? c) How does the angular resolution you obtain in parts a) and b) compare with the resolution of the Hubble Space Telescope? d) Comment on the challenge of making images of planets around other stars.