Astronomy 301 – Fall 2019

Homework 9

Due Date: Wednesday, November 6, 2019, 9:00 AM

You must turn in your homework answers electronically via Canvas. A .pdf or .docx file would be best, but if you can get a good image of your hand-written homework, a .jpg or .png file would okay also. Make sure your name and eid appear at the beginning of your homework.

We encourage you to work together on the homework but you are not allowed to copy from each other. You must write out the answers in your own words.

1. The mass of a black hole is 5 $M_\odot$. What is its radius? Does a black hole have a solid surface at that radius? What, then, is the significance of a black hole's radius?

2. Suppose you measure the gravity from a black hole with a mass of 1 $M_\odot$ at a distance of 1 AU from its center. How does the gravity compare to the gravity from the sun at 1 AU? What are the maximum masses of white dwarfs, neutron stars, and black holes?

3. The mass transferred from a normal star to a white dwarf, neutron star, or black hole typically forms a disk of gas called an accretion disk. Use Kepler's third law to calculate the orbital period (in seconds) of gas in an accretion disk that is just skimming the surface of the white dwarf. Assume that a white dwarf has a mass of 1 $M_\odot$ and a radius of 0.01 $R_\odot$. From class notes, what is the orbital period of gas in a disk that is just skimming the surface of a neutron star or black hole (do not try to calculate this!). Why do accretion disks get hot? Which is more likely to be hotter, a disk around a white dwarf or one around a neutron star or black hole?

4. Suppose we observe some stars in our galaxy that are 4000 parsecs from the galactic center. We find that they are moving in roughly circular orbits around the galactic center with speeds near 200 km/sec.

   (a) Calculate how long it takes the stars to go around the center of the galaxy once.

   (b) Using Kepler's Law, calculate the mass of the galaxy out to 4,000 parsecs.

   (c) This is not the total mass of the galaxy. Why not?

5. Make a table comparing the properties of objects in Populations I and II of our Galaxy. The table should compare at least five different properties.