Observational Astronomy - Spring 2014
Homework 9 - Galaxies

1. Why are elliptical galaxies much redder than spiral galaxies?

   - Elliptical galaxies are no longer forming significant numbers of new stars. Since hot blue stars live for a very short time, once star formation ends, the blue stars qucikly die and we are left with just older red stars.

2. Why can we not see the center of our galaxy in visible light? What kinds of telescopes are used to image the stars at the center of our galaxy?

   - There is a large quantity of dust particles between us and the center of the galaxy. These dust particles scatter radiation, and since they scatter short wavelengths more effectively than long wavelengths, the visible light is effectively blocked. We can see through the dust using long wavelength infrared and radio telescopes.

3. The Andromeda Galaxy will collide with our galaxy in about 4 billion years. Will this make life in our galaxy impossible?

   - No! Mergers of galaxies are common, and our galaxy is currently merging with at least one other galaxy. Collisions bewteen stars are very rare, so the merger of the two galaxies will not be a catastrophic event.

4. How do we know there is a Super Massive Black Hole (SMBH) in the center of our galaxy? How massive is it? How do we know its mass?

   - We can see stars orbiting around it. We can calculate its mass using Kepler's laws, and we know it has a mass of about 4 million times the mass of the sun.

5. What is an H-II region? What causes the pink glow that we see?

   - An H-II region is a cloud of gas heated to luminescence by embedded hot blue stars. These stars emit large quantities of ultraviolet light which ionizes the hydrogen in the cloud. The pink color is caused by emission of light from excited hydrogen atoms, especially the Balmer $-\alpha$ or H $-\alpha$ line.

6. The sun is about 8 kpc from the center of the Milky Way galaxy. Assuming the mass of the Milky Way galaxy is about 10^{11} times the mass of the sun, estimate about how long it takes the sun to orbit the center of the galaxy. Give your answer in millions of years. This is just a rough estimate, but gives an idea of the time frame.

   - Using Kepler's laws, we know that the period of the orbit is given by:

$$\mathrm{T}^2 = \frac{4\pi^2 \mathrm{R}^3}{\mathrm{GM}}$$

- Plugging in the numbers:

$$\mathrm{T} = \sqrt{\frac{4\pi^2(8000\mathrm{pc} \times (3 \times 10^{16} \frac{\mathrm{m}}{\mathrm{pc}})^3}{6.7 \times 10^{-11} \frac{\mathrm{m}^3}{\mathrm{kg-s}^2} 10^{11} \times 2 \times 10^{30}\,\mathrm{kg}}} = 6 \times 10^{15}\,\mathrm{seconds} = 200\,\mathrm{million\,years}$$