Astronomy 102 — Recitation #9

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Review of lectures 16–17 and Ch. 8–9.

Sagittarius A*

- Sits at the exact center of the Milky Way galaxy
- Strongly emits (short) X-rays
- By mapping out the motion of stars and gas clouds around Sgr A*, it has been determined to have a mass of $4.154 \times 10^6 M_\odot$.

Active galactic nuclei (AGN)

- Quasars, radio galaxies, Seyfert galaxies, and blazars all have an AGN at their center (they are all the same object, just seen from different angles).
- Extremely luminous (10–1000 times brighter than a normal galaxy)
- The occasional appearance of some to be accelerating particles to speeds faster than the speed of light (superluminal motion) is the result of an optical illusion.
- Eddington rate — limit where gravity just barely overcomes the pressure due to X-ray emission
- AGN have a large accretion disk, the result of stars falling into the black hole and being torn apart due to strong tidal forces.

In-class problems

1. What is the Schwarzschild radius and circumference of a black hole that has the mass of Jupiter? If Ganymede is 1.07×10^6 km away from Jupiter, would it still be in orbit if Jupiter was replaced by the equivalent black hole?
2. The filling weight of the atom bomb "Fat Man," that was detonated over the city of Nagasaki, was 6.2 kg. The "TNT Equivalent" is a unit of energy defined to be 4.184 gigajoules, which is the approximate energy released in the detonation of a metric ton (1,000 kg) of TNT. If the entire filling weight of "Fat Man" was converted into energy, what was its TNT Equivalent?
3. If the luminosity of Betelgeuse is $90000 L_\odot$ and its age is $\sim 7.3 \times 10^6$ yr, how much energy has it produced so far during its life? Compare this value to the amount of energy expected to be produced by the Sun during its entire lifetime.
4. You measure the wavelengths of an absorption line for an eclipsing binary star system over time and find that the maximum wavelength is 5000.70Å, and the minimum wavelength is 4999.54Å. The orbital speed of the star is 35 km/s. What is the rest wavelength of the absorption line? What will the rest wavelength be if the system is approaching us at 10 km/s?