Astronomy 1143 Final Review

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December 7, 2015

Galaxies

1. What are the different sizes of large scale structure?
    - Groups: comprise 3-30 bright galaxies
    - Clusters: 30-1000s of bright galaxies, often surrounded by many dwarf galaxies, extending 1-10 Mpc across
    - Superclusters: clusters of clusters!
    - (Note that the largest of these structures often form across filaments in the cosmic web)
2. What is the name for the structure that the Milky Way is a part of?
    - The Local Group
    - Milky Way and Andromeda are the key members out to about 1 Mpc
3. What are the main components of our Milky Way galaxy?
    - Central bulge
    - Spiral arms filled with star formation
    - Massive black hole at the center (10^6 the mass of our own Sun)
    - Large, extended halo with globular clusters and old stars
4. How far away is the Sun from the Galactic center?
    - About 8 kpc
5. What was the Shapley-Curtis debate?
    - Are these "spiral nebulae" external galaxies (meaning large universe) or inside the Milky Way (no other galaxies)?
    - Shapley: no, they are just globular clusters
    - Curtis: yes, they are galaxies just like the Milky Way, but far away "island" universes
    - Settled by Hubble's observations of Cepheids determining the "nebulae" were indeed very far away
6. How does the separation of galaxies in a cluster compare to the separation of stars in a galaxy?
    - In a galaxy, stars are incredibly far apart compared to their actual sizes
    - In a cluster, galaxies are separated by about 20 times their size
7. What are the various morphological types of galaxies? Do they have ongoing star formation?

- First appeared as Hubble's "Tuning Fork" classification
- Spirals - occasionally with bars, these feature a strong nucleus/bulge and then large, spiral arms with ongoing star formation; ranked by tightness of spiral arms
- Ellipticals - various axis ratios, but elliptical in shape, as the name suggests, without much star formation (used up all their gas and dust already); ranked by ellipticity (E0 = circular, E7 = very elongated)
- Irregulars - wonky shapes with chaotic structure and no ordered rotation

8. What is gravitational lensing by galaxies?
    - When a galaxy is located behind another along a line of sight, the gravity of the foreground galaxy can bend its light as it travels to us and create multiple images.

History of the Universe

1. What do overdensities in the CMB evolve into today?
    - Large superstructures such as galaxy clusters/superclusters
2. Why does the uniformity and isotropy of the CMB suggest an inflationary history for the early universe?
    - The CMB is too uniform- things that are far away know what temperature they should be despite light not having had time to reach them from the distant edge of the universe.
    - If everything was intitially "touching" and then expanded away very quickly (inflation), then it makes sense that temperature on one spot of the CMB knows about the temperature at another spot and is roughly equal.

Life and Exoplanets

1. What is the Drake equation set to estimate?
    - The number of other technologically advanced civilizations in the universe
    - By making assumptions about the number of stars, planets per star, frequency of habitability of planets, and conditions needed to grow, get an estimate of potential alien civilizations
2. What is the backbone of all reproduction as we know it?
    - DNA, which is used as the building block of life and passed on to successive generations
3. What different methods are used to find exoplanets? What is each sensitive to?
    - Direct imaging - good at finding planets around nearby stars where the planet is both large and far away from the star, but generally also very difficult to do because stars are so bright
    - Transits - good at finding large planets near their star as they pass in front of it, causing the light curve from the star to dip
    - Radial velocity - good at finding nearby, massive planets that cause Doppler shifts in the star's emission/absorption lines as the star moves around the barycenter of it and the massive planet
    - Microlensing - good at finding any planet, but has to have a chance crossing with a background star
4. What is a star's "habitable zone"?

- The distance from the star at which a planet would have temperatures we believe are conducive to life, such as ripe for liquid water formation
- This is a narrow band

5. Are exoplanets common?
    - Yes!
    - The Kepler space mission has discovered thousands
6. What is a "hot Jupiter"?
    - A star as massive as Jupiter but closer to its host star than Mercury is to the Sun
    - A big mystery as to how such a planet could form or get into this orbit!