Astronony II - Stars and Galaxies (A1020)
Fall 2013
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REVIEW FOR FOURTH EXAM

1. *Active Galaxies* -
   - know the types (Seyferts, Blazars, Radio galaxies, Quasars, etc)
   - properties (jets, radio emission, broad/narrow lines, IR or X-ray)
   - know about the Unified model and our understanding of these in terms of mass infall onto black holes (and the relevance of the Eddington limit for this)
   - what are the arguments for SBH's (high luminosities from compact volumes!)
2. *Large Scale Structure* – basic description in terms of voids, filaments, and sheets
3. *Cosmology*
   - Special Relativity and postulates, the idea that speed of light is absolute and so events are not generally simultaneous as perceived by different observers, General Relativity, the Equivalence Principle, curvature of space, gravitational lensing
   - Olber's paradox - what is the question and what are potential resolutions
   - the expanding universe, the Hubble law, the age of the Universe from Hubble's constant
   - the Cosmological Principle – concepts of isotropy and homogeneity, what is the "steady-state model"
   - Some 'highlights' – early Universe filled with light, formation of Helium, 'decoupling', formation of galaxies
   - Cosmic Background Radiation (CBR) – Gamow's fireball model, discoverers Penzias and Wilson, relevance to the Big Bang model
   - Critical Density and relation to curvature of space (positive, negative, zero/flat) and the 'fate' of the Universe
   - the Inflationary universe - what is it, and what does it solve?
   - Dark Energy - evidence for it from Type Ia SNe, the cosmological constant, quintessence; dark energy represents 70% of the 'content' of the universe, and dark matter represents 30%; the dark energy is accelerating the expansion of the universe
4. *Exoplanets*
   - know about the different search techniques: eclipse, Doppler shift, astrometric, photometric, (microlensing)
   - know that the Doppler shift method had yielded most discoveries, but that the transit method (especially the Kepler mission) is has since produced more exoplanet candidates

- know basic characteristics of detected planets: tend to be Jupiter mass, some are very odd in being in small short-period orbits (so-called hot Jupiters), some are multi-planet systems; super-Earth planets have been discovered as well

5. *Life in the Universe*

   - Essentials for life – water, carbon-based, radiation and heat; know about the habitable zone
   - Searching for life – know about SETI; searches for life in the solar system; the rationale behind radio searches
   - Fermi question: "Where are they?", and why this is relevant
   - Galactic colonization – relevant issues, typical time required
   - Drake equation – a useful way to estimate the number of inhabitable planets and intelligent civilizations based on assigned probabilities

6. *Expressions to be familiar with:*

   - The Schwarzschild radius for a black hole is

     $$R_S = 2GM/c^2$$

   - The Hubble law

     $$v = Hd$$

   - Relation of the Hubble constant to the age of the universe

     $$\text{age} \approx 1/H$$

   - z is redshift with

     $$z = \Delta\lambda/\lambda_0$$

   - Ignoring dark energy, for density ρ of the universe, and critical density for closure ρ_{cr}, cosmologists define the parameter Ω_M as

     $$\Omega_M = \rho/\rho_{cr}$$

     The value of Ω_M is dominated by dark matter (DM).
   - The total "content" of energy and mass in the universe is Ω. The contribution by dark energy (DE) is Ω_Λ. Then

     $$\Omega = \Omega_M + \Omega_\Lambda$$

     It is currently accepted that $\Omega_{total} = 1$, with DM 30% of it and DE 70% of it.