Astronomy II - Stars and Galaxies (Astr 1020)
Fall 2013
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REVIEW FOR THIRD EXAM

- *Stellar Evolution*
  - know about the idea of evolutionary tracks in the HRD
  - know about star clusters and the main sequence turn-off point, and how star clusters are relevant to understanding stellar evolution; know cluster types (globular vs galactic)
- *Death of Stars*
  - Termination of stars - why this happens and what stars become as a function of initial star mass: supernovae, planetary nebulae, white dwarfs, neutron stars, black holes
  - Pauli exclusion principle and degeneracy pressure (pressure that depends on density but not temperature)
  - White Dwarfs - electron degeneracy pressure, know typical size, know Chandrasekhar mass limit, connection with novae and cataclysmic variables
  - supernova events, why they happen, extremely bright, Type Ia versus Type II and their progenitors
  - Neutron Stars - neutron degeneracy pressure, typical size, mass limit, discovery, pulsars, rotation and magnetic field
  - Black Holes - properties, common misconceptions, Schwarzschild radius, event horizon, how they are found, example of Cygnus X-1
- *Interstellar Medium* - components, properties, nebulae (reflection nebulae, planetary nebulae, HII regions, supernova remnants)
- *The Milky Way Galaxy*
  - the characteristic size and shape of the MW
  - measuring distances in the MW
  - Attempts by Herschel and Kapteyn to find where we are in the MW, and why they were wrong
  - How Shapley used globular clusters to get the right answer!
  - Differential rotation of the MW and the rotation curve of the galaxy
  - How we map the spiral structure of the MW (what do we use as "tracers"?), and what is going on in the spiral arms? The spiral arms as a pattern, and relation of arms to star formation
  - evidence for dark matter in the halo of the MW, rotation curve of the galaxy, terminology such as "flat rotation curve", knowing how to recognize the edge of a galaxy in terms of the rotation curve
  - conditions at the Galactic center, evidence for a supermassive black hole

  - stellar populations (Pop I vs Pop II) and properties; know that different populations have different metallicities

- *Galaxies*
  - Clusters and the Local Group – know basics about the Large Magellanic Cloud (LMC), Small Magellanic Cloud (SMC), and M31
  - Types and general properties – spirals, ellipticals, irregulars (which are most common, which have young stars, which are metal-poor vs metal-rich, and so on)
  - know about galaxy formation and evolution (such as colliding galaxies and mergers)
  - know about dark matter and super massive black holes for other galaxies
  - know about the expanding universe – Hubble's law, redshifts, the idea that expansion is taking place everywhere in the universe

- *Distance Ladder* – the expanding Universe, Hubble's law, redshift, finding the Hubble constant, concept of standard candles: Cepheids, Type Ia SNe, Tully-Fisher relation

- *Expressions to be familiar with:*
  - Remember, "$\propto$" below means "goes like this"
  - Mass Luminosity Relation:
    $L_{\rm MS} \propto M^3$
  - Relation between stellar parameters
    $L \propto R^2\, T^4$
  - Main Sequence
    $t_{\rm MS} \propto \frac{M}{L}$
    $t_{\rm MS} = 10^{10}$ Gyr $\frac{1}{M^2}$
  - Cepheid pulsator stars: period-luminosity relation
    $P \propto L$
  - 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

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

  - Rotation curves: $M = r\, v_{\rm rot}^2/G$, where M is the interior mass of the orbit