Review for Test 2 —- AST 302

- NOVA The Ghost Particle
  1. What is a neutrino?
  2. Why was it introduced?
  3. How did the experiment contradict theoretical prediction?
  4. Science deals with ambivalence and uncertainty...eventually reaches firmer conclusions
- Ch. 13 (Measuring Properties of Stars)
  1. Distance measures: parallax, variable stars, standard candles
  2. Temperature: blackbody radiation, Wien's law
  3. Amount of light: luminosity versus brightness, radius measurement
  4. Apparent versus absolute magnitude
  5. Measuring stellar composition: absorption lines
  6. Measuring motion: Doppler shift of lines
  7. Binaries: how we use them to make measurements of radii, masses, etc
  8. HR Diagram:
     (a) general properties: luminosity versus temperature
     (b) stellar neighborhoods (e.g. white dwarfs, main sequence, variables, giants, etc)
     (c) other properties: size, mass, age, etc
  9. Mass-Luminosity relationship
- Ch. 14 (Stellar Evolution)
  1. Balance of gravity and pressure (thermal, degenerate, etc)
  2. Huge importance of mass on stellar evolution
  3. Division into high mass and low mass
  4. Stellar formation: interstellar cloud, collapse, flattening, spin-up, protostar
  5. Protostar: lots of IR radiation, gas outflows
  6. Stellar birth at fusion ignition
  7. Stellar death when fusion stops: either not enough mass to burn heavier elements, or reached iron
  8. Stellar mass limits: $0.1M.$ minimum for fusion; $30M.$ maximum else blow apart
  9. Low mass basic picture: burns H, swells until helium flash, burns, eventually kicks off outer layers leaving core as a white dwarf
  10. High mass basic picture: burns H via CNO cycle, then helium (no flash), then heavier and heavier elements; once iron synthesized, fusion stops, and core collapses in supernova
  11. Stellar lifetimes: depends on how much mass one has and how fast one burns through it
  12. Stellar lifetimes: high mass means short lifetime
  13. Why do heavier elements require a larger star to fuse? Why is iron stellar "poison?"
  14. Why do variable stars pulsate? Period-Luminosity Law and standard candle
  15. Stellar deaths
  16. Cluster turnoff as (i) test of stellar evolution theory and (ii) method of determining cluster ages
- Essay 2 (SR & GR)
  1. Special Relativity
     (a) What is Galilean relativity?

        (b) Why did Einstein first consider? Problems with Galilean relativity and light.
        (c) Single premise: speed of light is the same for all inertial observers
        (d) Implications: time dilation, length contraction
        (e) Difference between absolute and relative quantities
        (f) Simultaneity is no longer absolute
        (g) Twin paradox: what is the apparent paradox? How is it resolved?
        (h) Tests of: atmospheric muons, particle accelerators, GPS, etc
        (i) Difference between constant motion and accelerated motion

    2. General Relativity
        (a) What makes it general?
        (b) What problem was it meant to address?
        (c) Single premise: equivalence principle....what's equivalent?
        (d) Implications: curved spacetime, light bending
        (e) Astrophysical effects: grav. lensing, grav waves, BHs (more)

- Ch. 15 (Stellar Remnants)
    1. What balances gravity? Electron degeneracy, neutron degeneracy, nothing.
    2. Degeneracy pressure: not electromagnetic, instead, quantum mechanical from exclusion principle
    3. White dwarfs: hot, small, compact.
    4. Chandrasekhar limit: $> 1.4M.$ will overwhelm electron degeneracy
    5. Measure mass via gravitational redshift
    6. White dwarfs in binaries: hydrogen accretes onto surface and ignites: nova
    7. White dwarfs in binaries: mass accretes and brings star above Chandrasekhar limit: Type Ia supernovae
    8. Neutron stars: even more compact, electrons merged with protons, big ball of neutrons
    9. Neutron stars: hypothesized before observed as pulsars
    10. Pulsars: collapse spins them up, magnetic field unaligned with rotational axis emits in "lighthouse" effect
    11. Neutron star structure: rigid core, superfluid neutron interior
    12. Neutron stars play role in x-ray binaries, x-ray pulsars, and millisecond pulsars
    13. GWs: very weak, hard to detect, generated by large, orbiting masses
    14. BHs: complete collapse, conversion to grav. energy; Schwarzschild radius, event horizon
    15. Observing a BH: accretion, eclipsing, binary companions, Hawking radiation

- NOVA Death Star
    1. Hugely powerful events located even outside the galaxy
    2. Short time scales (especially in comparison to most things astrophysical)
    3. What powers them?
    4. Example of new, interesting, and unexpected things in Universe. What else awaits us?