ASTR 323
Astrophysics III: Extragalactic Astronomy and Cosmology

Spring 2009, Eric Agol, University of Washington

Final Review

- Covers: chapters 24-29, 17; Lectures, homework; emphasis on latter half of course
- 4-5 multi-part problems
- Know: dimensional analysis, basic derivatives/ integration (power law, sine, cosine, exponential)
- Give answers with correct units; put a box around answer; show work; must be legible
- Allowed: calculator, pen/pencil, scratch paper
- Disallowed: notes, books, other electronic devices

Be familiar with:

- Lecture 1: Galaxy definition; interstellar extinction, measuring distance to Galactic center, components of Milky Way (& other disk galaxies)
- Lecture 2: Determination of thin & thick disks & halo properties from star counts; bulge properties from infrared emission; other components of spiral galaxy: spiral arms, globular clusters, ISM, dark matter halo (NFW profile), satellites

Be familiar with:

- Lecture 2/3: how circular velocity scales with enclosed mass; Galactic coordinates; LSR; relation between kinematics & spatial distribution of stars; asymmetric drift – why does it occur?; relation between local stellar density & surface density; stellar collisions – why is probability low? Be familiar with derivation; definition of escape velocity; definition of Oort constants (def. given on exam) how to measure, why important; tangent point method to measure interior rotation curve; how to constrain exterior rotation curve

Be familiar with:

- Lecture 3/4: Galactic center – Paradox of youth (& possible resolutions), measurement of black hole mass, black holes/dark matter at Galactic center, hypervelocity stars
- Lecture 4/5: Black holes – definition & 3 characteristics of black holes; how escape velocity defines event horizon; what metric means; gravitational redshift (know how to interpret formula) & tidal destruction; why & how to image a black hole

Be familiar with:

- Lecture 5/6: Hubble tuning fork; how properties vary along sequence; definitions of surface brightness/ intensity; meaning of Sersic law, and two limits (exponential, de Vaucouleurs); derivation/meaning of Virial theorem; how it relates to Tully-Fischer/ fundamental plane
- Lecture 7: What rotation curves tell us about galaxies; what is an epicycle & when is it valid; difference between orbital frequency, radial/vertical epicyclic frequencies; density wave model for spiral arms & how it results in structure of arms; Schechter function

Be familiar with:

- Lecture 8/9: impulse approximation, dynamical friction meaning/derivation; ELS/ monolithic collapse vs. hierarchical merger (meaning of cooling time & free-fall time); missing satellite problem; origin of ULIRGs/ ellipticals from mergers; how tidal tails form & what affects their strength/structure

Be familiar with:

- Lecture 10: luminosity & angular diameter distances; Galactic distance ladder; extragalactic distance ladder: cepheids, Type Ia supernovae; definition of redshift; cosmological principle; origin of cosmological redshift; Hubble's Law; finite age of Universe; Hubble time

Be familiar with:

- Lecture 11: definition & properties of galaxy groups & clusters; baryonic vs. dark matter; dark matter in clusters – inferred from X-ray temperature/luminosity & hydrostatic equilibrium; mapping Universe with Hubble Law – fingers of God resulting from peculiar velocities; general structure of Universe

Be familiar with:

- Lecture 12: general characteristics of active galaxies; permitted vs. forbidden lines, narrow vs. broad lines; ingredients of AGN; Type I vs. Type II AGN; Unification of these two types; Eddington limit; accretion efficiency; relation between luminosity, temperature & black hole mass; diagnosing broad-line region size from reverberation mapping

Be familiar with:

- Lecture 13: megamasers – how they can be used to measure distances; superluminal motion – why it does not indicate that matter can go faster than light speed; gravitational lensing – how light is bent by gravity, lensing by isothermal sphere (constant bending angle); definition of Einstein radius; magnification; measuring enclosed mass with lensing; measuring H0 from time delays

Be familiar with:

- Lecture 14-15: scale factor; comoving coordinates; Hubble parameter vs. Hubble constant; definition of H in terms of scale factor; Friedmann equation in its many guises; properties of CMB; definition of critical density; how the density of radiation, matter & dark energy change with scale factor (& why); density parameter; equation of state parameter, w; how to compute distances & times versus scale factor & redshift; evidence for accelerating Universe; lumionsity distance vs. angular diameter distance vs. comoving distance;

Memorize

- Newton's law, gravitational constant G (with dimensions), centripetal acceleration, volume and area of sphere, speed of light c (with dimensions).
- Derivation of tidal disruption
- Basic integration (power-law, exponential, parameter substitution)
- Schwarzchild radius
- Hubble parameter in terms of scale factor

Will be given on exam:

- Any complicated integrals
- Conversions between parsecs, solar masses, solar luminosities to m, kg, W (J/s), etc.
- Other necessary constants (with units) as need arises; e.g. k_B, σ,