Final Topic Summary - Astronomy 110 – Spring 2015

The final will cover the entire course, but material already covered on the first three tests will not be covered in as much detail as the more recent material. The final will have two or three sections: 20-30 short answers (very basic material), approximately 80-90 multiple-choice questions, and a few short written questions. In addition, **you will have to identify 6 kinds of objects from pictures**: open star clusters, globular star clusters, planetary nebulae, H II regions, spiral galaxies and elliptical galaxies. This will NOT be multiple choice, nor will you be provided with a list of possible object types. The ratio of points on previously tested material to points on new material will be *very approximately* 50:50. Chapter 12 (part), Ch. 13 (part), Ch. 14, Ch. 15, chapter 16, and Ch. 18 have not been covered already on one of the midterm exams.

Old Material

Chapter 1: the celestial sphere; rotation and orbit of the Earth (day and year); apparent motion of the Sun, Moon, and stars; the seasons, precession, phases of the Moon and the lunar month, eclipses (but don't worry about penumbral eclipses).

Chapter 2: scientific method and theories, geocentric and heliocentric cosmology; Copernicus; Tycho; Galileo's astronomical observations; Kepler's laws of planetary motion; Newton's law of gravity (the force depends on what?); the four forces (see Ch. 18). Nothing will be asked about opposition, conjunction, or sidereal vs. synodic periods. You should know about inertia, but you don't have to remember Aristotle's incorrect ideas about why objects move.

Chapter 3: light as colors, light as particles and waves (energy depends on what?); electromagnetic radiation; the electromagnetic spectrum; reflection, refraction, and diffraction (those crosses on the stars);the main benefits of using telescopes.

Chapter 4: black bodies; color and brightness depend on temperature; Wien's law and the Stefan-Boltzman law; spectral lines of different elements; Kirchoff's laws (emission, absorption, and continuous spectra); atomic structure and its relation to spectral lines; the Doppler shift.

Chapter 5: age of the solar system; the structure and formation of the solar system from a rotating disk. You don't need to memorize the detailed properties of the planets. You should know where the big, low-density ones are and where the small, high-density ones are. What are their names in order? What are they made of?

Chapter 6: the Moon's surface and formation (craters and maria). (exclude 6-1 through 6-4 and tides)

Chapter 9: asteroids, meteoroids, and comets. Understand the dangers of asteroid collisions (exclude 9-4)

Chapter 10: (exclude everything about sunspots and magnetic fields) photosphere, chromosphere, and corona (but all details and the names of the different features in those layers given in 10-1 through 10-3 are not necessary); nuclear reactions in the sun (hydrogen burning - the proton-proton cycle: it is not necessary to know the individual steps for the final); anti-matter and its role in nuclear reactions; solar neutrinos (and nuclear reactions), pressure, density, and temperature; conduction, convection, and radiation; the meaning of $E=mc^2$ and its relationship to energy generation in the Sun

Chapter 11: parallax; the inverse square law, the H-R diagram; the main sequence; giants; supergiants; white dwarfs; very roughly, the sizes, temperature, colors, and luminosity of stars (but no numbers); the various ways we learn about the properties of stars. What are magnitudes?

Chapter 12: the main stages of stellar evolution (but not in the detail that they were included on the midterm); helium burning; lifetimes of stars; H II regions and reflection nebulae; measuring the ages of stars with H-R diagrams of old and young clusters (globular clusters vs. galactic (open) clusters)

Chapter 13: (We covered 13-1 through 13-2 on the last midterm.); white dwarfs –the end of stars like the Sun; Lifetime of a white dwarf. The Chandrasekhar limit.

New Material

Chapter 12: Sections on Cepheid variables should be included. Although we skipped them at the time we covered chapter 12, we will cover them now.

Chapter 13: (We covered 13-1 through 13-2 on the last midterm. Include from 13-4 on, but exclude 13-12 through the end.

Beyond the White Dwarf - Supernovae in low mass stars when the Chandrasekhar limit is exceeded.

High mass star evolution is rapid; elements through Fe are made, and energy is emitted; the "onion skin" model.

Supernovae – the end result of the evolution of massive stars or of the addition of extra mass to a white dwarf; The 1^{st} is rapid nuclear burning followed by core collapse. The second starts with the collapse of the white dwarf. Both lead to explosions.

What happens if you try to "burn" iron?

Core collapse; $p + e^- = n$ + neutrino; explosion; formation of heavy elements; distribution of the heavy elements into the gas of the Galaxy.

Neutron stars and pulsars (rotating magnetic neutron stars)

Supernova 1987A – what it showed us.

Crab nebula – what it showed us.

End points of stellar evolution; white dwarfs; neutron stars; black holes (what makes the difference?)

Chapter 14 (exclude 14-1 (we didn't cover special relativity) & 14-9 through the end)

Newtonian gravity fails at atomic sizes, at infinite size scales, and near very large masses. General relativity will work for two of these.

General relativity; a theory of gravity; curved space; bending of light; gravitational lensing.

Black holes; highly curved space; singularity; formed when degenerate neutrons cannot provide enough pressure to keep an object from undergoing gravitational collapse (greater than 3 solar masses in a stellar core). We're not going to distinguish between a Kerr black hole and a Schwarzchild black hole. Forget the ergoregion.

Detection of a black hole by gravitational effects in a binary star, X-rays.

Chapter 15. Much of the material on Shapley and Curtis is not in the book.

The Shapley-Curtis debate; size and shape of the galaxy; nature of the spiral nebulae (galaxies). What evidence did each astronomer use?

Cepheid variable stars (but don't worry about the difference between type I and type II Cepheids). The use of Cepheids as distance indicators. Period-Luminosity relationship.

Galaxy formation; early or late star formation (actually found in chapter 18, but I talked about it prior to discussing the structure of the Milky Way). How is the gas moving when the stars are formed? How does this affect whether the galaxy is an elliptical galaxy or a spiral galaxy?

The Milky Way

Dust – blocks our view of stars (IR and radio go through the dust.)

Galactic structure (bulge, disk, halo, and spiral arms). Sizes and shapes of the different parts.

Differing heavy element contents in old and young stars; open clusters vs. globular clusters.

Spiral arms; density waves; bright young stars, gas, and dust trace the spiral arms (the spiral arms are star formation regions).

In 15-3 exclude details of 21-cm radiation, but know that radio waves from hydrogen gas (and some molecules) can get through the dust that blocks our view. What detail of galactic structure do radio observations reveal?

Super-massive black holes in galactic centers. How do we find them?

Dark matter in the Galaxy; found by gravitational effects; galactic rotation curves (this is also discussed in chapter 16) or gravitational lensing.

Chapter 16 (we discussed some of these topics mixed together with ch. 15)

General properties of elliptical and spiral galaxies and barred spirals. Skip the "tuning fork" diagram in 16-6 BUT know how star formation, color, and gas content differ between spirals, ellipticals, and irregulars.

How spiral density waves affect gas

The Local Group, clusters, superclusters, and voids (we didn't distinguish the different types of clusters that are discussed in 16-9).

Dark matter – the invisible mass in clusters.

Standard candles; the inverse square law, Cepheid variables, supernovae, (we didn't discuss the Tulley-Fisher relation)

The Hubble law; the Hubble constant; receding galaxies indicate the Universe is expanding.

Chapter 18 We are not discussing inflation in this chapter.
The expanding Universe
Big bang; one instant of creation; homogeneous and isotropic
Steady state; continuous creation of matter – an alternate theory.
How the Big Bang theory is a better match to observations than the Steady State theory.
Overview of the big bang (from the beginning to the microwave background).
The creation of particles and atoms depends on the temperature of the Universe. Anti-particles are annihilated.
The microwave background – leftover radiation from shortly after the big bang. It fills the whole sky uniformly.
The age of the Universe (know that number). You can estimate age of the Universe from the distance of galaxies and their recession speed. The galaxies at high redshift (large recession velocity) have different appearance from nearby galaxies (because we see them as they were when they were young.)
We covered galaxy formation when talking about chapter 15.
The fate of the Universe; collapse or infinite expansion; how the fate depends on average density of the Universe and the cosmological constant; dark matter's role. The amount of visible matter suggests that the Universe should slow down a little - but not much.
The Universe is accelerating! The cosmological constant provides the repulsive (anti-gravity) force.

General topic for short written question(s).
What has been our understanding of the Earth's place in the solar system/Galaxy/Universe from Ptolemy to the present?

Some Homework Questions from Previous Years.

2) If the Sun suddenly became a black hole (no supernova explosion, just pretend it just happened), how would the Earth's orbit be affected? Why?
3) If you were inside a black hole, how fast would you have to travel to escape? Is that possible?
4) Shapley and Curtis debated two important properties of the Milky Way and the Universe. What did Shapley have correct? What did Curtis have correct? How did the ideas of this debate affect our idea about our place in the Universe?
5) Why are there no massive O and B stars in the globular clusters of the Milky Way?
6) What property of a galaxy determines how fast a star will orbit the galaxy's center?
7) Why do spiral arms stand out (visually) from the rest of the disk of a spiral galaxy?
6) What does the Hubble law tell you (in words, not the equation)?
7) Why are Cepheid variable stars a good tool for measuring the distances to galaxies?

Review Questions for the New Material

See the review sheets for the three tests for review questions on earlier material.

Ch. 12: 17
Ch. 13: 3, 5, 6, 9, 10, 12, 17, 20 WDYT: 3, 5.
Ch. 14: 1, 2, 4, 5, 6, 7, 9, 10, WDYT: 1, 2, 3.
Ch. 15(8^{th} and 9^{th} editions): 1, 2, 3, 4, 5, 7, 9, 10, 12, 13, 18, WDYT: 1, 2, 3.
Ch. 15(10^{th} edition): 1, 2, 3, 4, 6, 9, 10, 11, 12, 17 WDYT: 1, 2, 3.
Ch. 16: 1, 2, 3, 5, 7, 10, 15, 17, 19, 27, WDYT: 1, 2, 3, 4.
Ch. 18: 3,4,6 – 12 (11a only),WDYT: All.