**INST 2403 STUDY GUIDE for Final Exam Fall 2017**

**Form of Exam**

* About 45 questions
* Mostly multiple choice
* Few short answer questions
* You have 2:45 hours
* Scantron sheets are used

**Suggestions**

* Review textbook readings, online Powerpoint slides
* Revisit the Warm-Up questions
* Look over the activities
* Take another look at the homework questions. In particular, check the solutions after you committed to an answer
* It might help to go to the library and study other astronomy texts. Often reading an independent explanation in slightly different wording helps to understand a complex concept.

**Topics** (also see syllabus)

* All topics, this is a comprehensive exam.
* A heavier weight is on the stuff we covered since Midterm 3, starting from: Dead Stars (Black Holes, Neutron Stars)

**Partial list of important concepts covered since Midterm Exam 3** (also see syllabus)

It’s probably a good idea to add to this list while studying for the exam.

* Dead stars
	+ White dwarfs, Neutron stars, Black holes are the “leftovers” of light, heavy and very heavy stars, respectively; they are terrestrial planet size, city size, and infinitely small, respectively; their density is incredibly big, nominally the density of a black hole is infinitely big
	+ Chandrasekhar limit: white dwarfs cannot have more mass than 1.4 solar masses
	+ White dwarfs can explode in a type I supernova if they accrete mass from a companion star
	+ White dwarfs can flare up multiple times in a nova if they slowly accrete mass from a companion star
	+ Black holes can only be seen indirectly due to the X rays emitted when mass of a companion stars spirals into the hole
* Variable Stars
	+ Most important types change physically & periodically; period is time from maximum to next maximum
	+ Cepheids: period luminosity relation exists; longer period🡪 larger luminosity; about 1000 to 20000x more luminous than the sun; periods from a few days to 100 days
	+ RR Lyrae stars: secondary maximum in lightcurve, 100x more luminous than the sun, period less than a day
* Cosmic Distance Ladder
	+ Many methods use the relation between brightness (apparent!) B, luminosity L and distance d: observe B, understand the object to figure out L, then calculate d
	+ Different methods must be used for different distances; methods for nearer objects are more accurate
	+ Order: Radar ranging, stellar parallax, spectral parallax, variable stars, Tully-Fisher relation, Hubble’s law
* The Milky Way
	+ Very large, about 100,000 ly diameter
	+ Distance to center and size measured via RR Lyrae stars in globular star clusters
	+ 3 parts: central bulge, spiral disk, halo of globular star clusters
	+ Sun is in the disk, very far off center (25,000 ly)
	+ Stars we see in the night sky are very close to us compared to the size of the milky way
	+ Spiral arms are blue, consist of very hot O & B type stars, very young, star formation happens in spiral arms
* Galaxies
	+ Different types, Hubble classification: Spiral, Barred Spiral, Elliptical, Irregular
	+ Typical galaxy contains 100 billion stars
	+ There are about 100 billion galaxies in the observable universe
	+ Galaxies have rotation curves that suggest the existence of dark matter; galaxies rotate faster than they should
	+ Galaxies form clusters, which form superclusters; our cluster is the local group
* Hubble’s Law
	+ Light of most galaxies is red-shifted
	+ Recessional velocity of galaxies grows linearly with distance from us: v = Hd
	+ Hubble constant is slope of this straight line in a velocity vs distance plot (Hubble plot)
	+ Inverse Hubble constant is proportional to the age of the universe
	+ Hubble’s law implies a big bang, when the content of the universe was very close together
* The expanding Universe
	+ The faster the expansion, the younger the universe
	+ If the universe expands then from any vantage point it looks like galaxies are receding faster the farther out they are
	+ Galaxies are moving away from each other, but they are not expanding themselves
	+ Olbers paradox (nightsky is dark!) implies that the universe is finite and/or changing over time
* Standard Cosmology
	+ Described by Einstein’s theory of general relativity
	+ Mass bends spacetime, spacetime tell mass how to move
	+ Cosmological principle: assumption that on very large scales the mass in the universe is evenly distributed (homogeneous, isotropic)
	+ Fate of the universe is determined by the amount of mass it contains, because mass slows down the expansion due to mutual gravitational attraction
	+ There is a critical mass density signifying a flat, open universe that eventually stops expanding
	+ More than critical mass: closed, finite universe with positive curvature, starts shrinking after some time to end in big crunch
	+ Less than critical mass: open universe, negatively curved, expands forever
* Modern Cosmology
	+ Cosmic microwave background of 3K supports Big Bang theory
	+ The universe is accelerating its expansion, this means that there must be dark energy that drives this acceleration; nobody knows what dark energy is, only what it does
	+ Universe also must contain 25% dark matter to explain galactic formation (and rotation)
	+ There must have been a period of inflationary (very fast) expansion to explain why the universe looks basically the same everywhere
	+ The universe is 13.8 billion years old; it is surprisingly young (sun: 5 billion years old)

**Sample Questions**

1. If a galaxy is a distance of 10 million light years from Earth, which of the following is true?
	1. We see the galaxy the way it will be in 10 million years.
	2. We see the galaxy the way it was 10 million years ago.
	3. We see the galaxy the way it was when the universe was 10 million years old.
	4. We see what our galaxy will be like in 10 million years.
	5. We cannot see so far into the universe, since it has a finite age.
2. What does the Hubble Law imply about the history of the universe?
	1. The universe started expanding at some time in the past; the universe has an age.
	2. The universe has been expanding forever; it is infinitely old.
	3. The Milky Way galaxy is at the exact location where the universe started to expand.
	4. Before the universe started to expand, it had collapsed and expanded many times before.
	5. There will be a big crunch at the end of the universe’s life.
3. Cosmologists have predicted three possible futures for the universe. The average density of matter in the universe will determine which one actually happens. Why is this?
	1. The density of matter determines the strength of gravity, which decelerates the expansion over time.
	2. The density of matter determines the rate of formation of black holes which will eventually collapse the universe.
	3. The density of matter tells astronomers whether new matter is constantly forming, thereby producing a steady-state.
	4. All of the above.
4. An acceleration in the rate of expansion of the universe could be explained by
	1. the cosmological principle.
	2. a cosmological constant a.k.a. dark energy.
	3. a cosmological density parameter greater than one.
	4. supermassive black holes.

2. 

1. 

1. The above photographs show
	1. 1−a spiral galaxy; 2-−an elliptical galaxy
	2. 1−a spiral galaxy; 2−an irregular galaxy
	3. both pictures show spiral galaxies but viewed from different angles
	4. 1−an irregular galaxy; 2−a spiral galaxy
	5. 1- a spiral galaxy; 2- a quasar
2. A typical Cepheid variable is 100 times brighter than a typical RR Lyrae star. On average, how much farther away than RR Lyrae stars can Cepheids be used as distance-measuring tools?
	1. Same distance, since they both have variable brightnesses
	2. 1/10 times as far
	3. 10 times as far
	4. 100 times as far
	5. It is not possible to use Cepheids, since we do not know their absolute brightness
3. The current best value for the Hubble constant suggests that the universe is
	1. 600 million years old.
	2. 1 to 5 billion years old.
	3. About 14 billion years old.
	4. more than 50 billion years old.
	5. infinitely old; the universe has always existed.

 8. Two stars have the same chemical composition, spectral type, and luminosity class, but one is 3 light years from the Earth and the other is 300 light years from the Earth. The farther star appears to be …

a) 100 times fainter.

b) 10,000 times fainter.

c) 100,000,000 times fainter.

d) the same brightness since the stars are identical.

e) None of the above

 9. Two stars have the same chemical composition, spectral type, and luminosity class, but one is 5 light years from the Earth and the other is 50 light years from the Earth. The farther star appears to be …

a) 100 times fainter.

b) 10,000 times fainter.

c) 100,000,000 times fainter.

d) the same brightness since the stars are identical.

e) None of the above

 10. Two stars have the same chemical composition, spectral type, and luminosity class, but one is 75 light years from the Earth and the other is 75000 light years from the Earth. The farther star appears to be …

a) 100 times fainter.

b) 10,000 times fainter.

c) 100,000,000 times fainter.

d) the same brightness since the stars are identical.

e) None of the above

1. Two stars have the same radius, but one has two times the temperature of the other star. How much brighter is the hotter star?
	1. 4 times
	2. 16 times
	3. 64 times
	4. 1/64 as bright
	5. None of the above
2. Two stars have a temperature that differs by a factor of two, and a radius that differs by a factor of four. How much brighter is the larger, hotter star?
	1. 4 times
	2. 16 times
	3. 64 times
	4. 1/64 as bright
	5. None of the above

**Short Answer Questions [3 points each]**

***(Please use the back side of the computer sheet to record your answers)***

13. Explain what the Hubble law is and what it implies for cosmology.

14. Characterize the three possible shapes of a universe that does not contain Dark Energy.

15. Why and how is galaxy formation and development different from the stellar formation and development?