AST 301--Scalo
Review for Exam #7

Exam 7 covers chapters 26 and 27. As on previous exams, emphasis is on understanding the basic ideas and their implications and connections, not on memorization of details or on numerical values. I will not test you on Discovery 26-2 (p. 709) or More Precisely 27-1 (pp. 724-725), but strongly suggest that you read them just because they are interesting (e.g. you will learn how strange "string theory" is). There will be a number of questions related to deuterium and helium as produced in the era of nucleosynthesis and how those provide tests of cosmological models. However you do not have to memorize any of the nuclear reactions involved.

As usual, a few of the exam questions will be versions of some of the questions found at the textbook web site multiple choice self-tests. Also as usual, I strongly suggest that you do not try these questions until you have thoroughly studied. Another suggestion that bears repeating: Test yourself by seeing if you could explain most of the material, or the answers to the questions at the end of the chapter, to someone who hasn't taken the course, without consulting the book at all. Not being able to do this (and it should be pretty clear when you can't) is a sure sign that you don't understand the material enough and need further study.

The end-of-chapter questions are also useful review tools. I am unable to give you a list of which ones are most important. You should look through all of them and see if you are familiar enough to answer them.

The TA Jarrett Johnson will have office hours Thursday 3-5. I have meetings on Thursday that will only allow me to have office hours from 12 to 1 and 2 to 3. Call me if you want to meet on Wed. But I will be available for phone consultation from 9am to 9pm Wed. and Thurs., if I am home—otherwise, leave a message, feel free to call back, etc.; you won't be disturbing me because I'll just be reading or working. But please don't call after 9pm.

Chapter 26 (Cosmology). Because this material has been discussed at length in lecture, I won't enumerate the sections--all of them are important. Don't be too worried if you feel like you don't understand the material on the curvature of space: very few people really understand that. But do remember the 2-dimensional analogies so that you'll know what we're talking about if you encounter the terms "closed" and "open" universe, the significance of Hubble law and CBR discovery.

Chapter 27 (The Early Universe). This is a challenging but extremely interesting chapter because of all the strange phenomena and physical conditions discussed. I am mostly concerned that you get the basic ideas. In particular, you don't have to memorize the numerical or other details of Table 27-1 (and I won't ask you about much terminology, like what is a hadron or a lepton, etc.). But we did go over a simpler version of this "time line" in detail in class, so I do expect you to know what went on and when (i.e. roughly how old the universe was when this or that occurred) during the following key phases: 1. Inflation; 2. Nucleosynthesis; 3. Decoupling of matter and radiation (and why that implies that there must be a cosmic background radiation); and 4. The formation of galaxies from fluctuations. Basically, understanding the significance of these eras of the universe, and the observational evidence they are related to, comprises most of what you have to learn for the exam. The horizon and flatness problems are difficult to understand intuitively for most people, but you should be able to say what they are, and why inflation solves them. You should also be able to explain the evidence that supports the big bang theory in general, and inflationary cosmological theory in particular, and which evidence indicates the presence of a large component of "dark energy." Finally, you should be able to explain what the cosmic background radiation is, and what properties of it are important as a test of the big bang theory, or as a diagnostic of dark matter and energy (for example its temperature, its spectrum, and especially the analysis of its "blotchiness").

We will try to get the scores at eGradebook by the night of the exam. Final averages will take a few days longer, but you can compute these yourself. Here is a prescription for computing your final average, using the fact that we are weighting your lowest score (score means percentage score) by half: Take your six highest scores and add them. Add to this half of your lowest score. Then divide by 650.

Sample questions follow.

Here are **seven sample review questions**; they are of the more difficult variety, so don't be too discouraged if you have to think a while to come up with the answer. On the other hand, if you think you are guessing at many of the answers, or if it seems to you like more than one answer could be correct, you probably need more studying.

1. Whether or not the universe will expand forever can, in principle, be determined by
a. an accurate measurement of the Hubble constant.
b. an estimate of the average density of the universe.
c. observations of the cosmic background radiation.
d. measurements of the helium abundance in very old stars.

2. If the expansion age of the universe was determined to be 8 billion years,
a. it would be difficult to understand how galaxies had time to form.
b. it would be difficult to understand how globular cluster stars could be as old as we think they are.
c. it would be difficult to understand the cosmic background radiation in terms of the big bang theory.
d. it would be difficult to understand the observed abundances of the elements.

3. Five billion years in the future the predominant wavelength of photons in the cosmic background radiation will be _______ (Assume the universe will expand for at least this long.)
a. ultraviolet   b. visible   c. infrared   d. radio

4. What happened during the epoch of the big bang that gave rise to the cosmic background radiation?
a) Strong, weak, and electromagnetic forces were no longer one single force.
b) Neutrons and protons were formed.
c) Dark matter and baryonic matter no longer interacted.
d) Electrons and nuclei combined to form atoms.
e) Galaxies formed, emitting large amounts of light.

5. What primary role was played by dark matter in the early universe?
a) It gave rise to the period of inflation.
b) The cosmic microwave background radiation is the result of dark matter decoupling from baryonic matter.
c) Its density fluctuations determined the overall large-scale structure of the universe.
d) It limited the nucleosynthesis of heavy elements during the Big Bang.

6. The density fluctuations in the normal (not the "dark") matter component of the early universe must have been very small because otherwise
a) the deuterium abundance would be larger. b) the deuterium abundance would be smaller.
c) their imprint on the cosmic background radiation would have been larger than observed by COBE.
d) galaxies and larger structures would have formed too early compared to observations.

7. The current deuterium abundance tells us that
a) the dark matter cannot be baryons.   b) a phase transition probably took place.
c) the universe is probably closed.   d) the universe is probably open.