AST 301 Spring 2008– Scalo—Review sheet for Exam 4

Exam 4 covers chapters 16 (the sun), 17 (properties of stars) and 18 (the interstellar medium); we are postponing 19 because of timing--it will be included on the next exam.

By now I assume you know what types of questions at the end of the chapters or at the textbook web site are relevant for exams; basically try them all unless they concern a topic we aren't covering (only a few such things—see below); just don't worry much about numerical problems, except for the simplest of them (see below).

Although all three chapters are covered, you should probably spend most time carefully reading Ch.17, because there is so much information in it that we will use later in the course. A substantial part of the exam will cover this chapter.

It will probably help if I summarize here a few things about each chapter.

Chapter 16 We discuss our first star, the Sun, before studying stars in general. In this chapter, remember that you don't have to study the (interesting!) sections on Solar Magnetism (sec. 16.4) or The Active Sun (sec. 16.5), although I hope you will look through it—it is our only chance to observe a star's complexity close-up.

Continue with sections 16.6, 16.7.

The way I suggest you review this material is: Begin at the center of the Sun and describe in as much detail as possible what is going on at each depth as you work your way out, concentrating on how energy is generated in the center, making its way through the radiative and convective zones (what do these words mean?), and eventually being emitted at the photosphere? At each point try to explain how we could know about these regions if we can't see into the sun. What is the photosphere anyway?

Look at Discovery 16-1 on p. 420. What is helioseismology and what has been learned from it?

Concerning the proton-proton cycle, the specific way in which the sun uses nuclear fusion, I *don't* expect you to memorize the steps in the reaction sequence, but I do expect you to know what's going on. For example: Explain why hydrogen is used as a stellar fuel instead of some other element. Does the newly produced helium have a different mass than the particles that went into making it? If so, where did this mass go?

Be able to describe briefly why the solar neutrino experiments are such an important test of our understanding of the sun. Is there any other way to "look" into the sun's interior?

I won't test you on More Precisely 16-1 p. 440, or 16-2 on p. 442.

Chapter 17

You won't be tested on Discovery 17-1 (p. 452), More Precisely 17-1 (p. 458), or More Precisely 17-3 (p. 472)

1. Don't spend much time trying to completely understand "proper motion," "tangential velocity" and how they, along with radial velocity, give the "space" (i.e. total) motion, but I do expect that you have read that section of the text and know what the terms mean. I just want you to understand that a star's velocity has two components that have to be measured using different techniques.

2. In sec. 17.2, don't read about "The Magnitude Scale" or the "More Precisely" on p.458 about this topic, unless you want to; i.e. it isn't on the exam. When you see "apparent magnitude" just think "apparent brightness." You *do* have to know how apparent and absolute brightness are related.

3. Concerning spectral types, memorize the letters OBAFGKM as a decreasing temperature scale, and try to understand why the most prominent spectral lines are different in each class (Table 17.2, p. 460). If someone said "Spectral type B (or K or any spectral class) star" you should be able to tell them something about their properties.

4. You SHOULD read the "More Precisely 17-2" on p. 463. Even though it is rather mathematical, it is important to understand it, because it is essentially the only way we can estimate the diameters of most stars. It is also covered in the class notes.

5. In sec. 17.6, the "Luminosity Class" discussion does not contain anything to be memorized, but you should understand that we can tell, for example, giants from main sequence stars using their spectra.

6. In sec.17.7, the main thing to understand is that it makes sense that Kepler's 3^{rd} law as modified by Newton allows us to get masses of stars in binary systems, but I won't ask you do any calculations. Let's skip the different types of binary stars and what information they give for this exam. What is the range of masses of main sequence stars (in solar units)? Where (along the main sequence) are the most massive stars? Least massive? What is the mass of a very red star on the main sequence? What is the mass-luminosity relation and how does that tell us something very important about how the lifetimes of stars depends on mass? (See end of sec. 17.8)

7. The most important concept in all this material that you will need again and again is the material on "**spectroscopic parallax**." Make sure you get the idea of needing other methods to get beyond trig. parallaxes.

Chapter 18

This chapter isn't long, but be sure you read it thoroughly. It appears to present an inventory of the gas and dust structures that are observed between the stars, especially their observational characteristics. But it is important to realize that there is only one interstellar medium, some parts denser than others, and a few regions dense enough to have formed stars within. When the gas is not too dense, so that starlight from the rest of the galaxy can penetrate, the region may be observed by certain techniques, while if it is so dense that starlight cannot penetrate it will appear differently, and must be studied using different techniques. Stars do form from this "interstellar medium", and that is the subject of the following chapter. So we are studying the very earliest phases of the formation of the stars, especially when we discuss the densest interstellar gas/dust structures. Also remember that these various types of regions (21-cm clouds, dark clouds, molecular clouds, emission nebulae, etc.) are often the same region, just observed in different ways, or observed in the dust rather than the gas, or else depending on whether a massive young star is nearby. You should understand that previous sentence by the time you are ready for the exam.

Don't worry if you don't understand "polarization" (p.483) and how that tells us the shapes of dust grains—I think it is too difficult a concept given the time we have. Concerning the "emission nebulae" (sec.18.2), I just want you to know why a gas cloud near a hot star would appear this way, and to appreciate it as a real-life example of the emission line physics we discussed in Ch.4. (Also, considering that it requires a hot star, why do you expect most emission nebulae to trace out the regions where the youngest stars reside in space?) Don't worry about "forbidden lines" unless you are interested—you would have to have a course in quantum mechanics to really understand it, so I will not ask about "forbidden lines" on the exam. But DO read 18.3, 18.4, and 18.5, as well as Discovery 18-1 (UV astronomy and the "Local Bubble")—they are short, and important.

Some sample questions are on the next page.

AST301 Spring 2008 Scalo. Sample questions for exam 4.

1. The pressure at the center of the sun is determined by
a. nuclear reactions.
b. the rate at which photons can diffuse through the overlying layers.
c. the fact that pressure balances the weight (due to gravity) of all the material outside the center.
d. the temperature and pressure in the photosphere.

2. How can we study the interior of the sun without using any exotic particles, just light?
a. Gamma rays from the sun's core.
b. Analyze spectral lines from the photosphere to estimate the relative abundances of different elements.
c. Interpret the complex vibrations of the sun.
d. There is no other way.

3. If we know the apparent brightness of an object, its luminosity may be calculated if we also know its
a) distance b) radial velocity c) surface temperature d) mass

4. If a star has a parallax of 0.05 seconds of arc, then its distance in parsecs is:
a) 0.05 b) 5 c) 2 d) 20 e) 200

5. The radius of a star can be estimated if the ___________ and ___________ of the star are known. (Assume no other information is available.)
a) parallax and spectral type b) temperature and luminosity
c) mass and temperature d) mass and luminosity

6. A certain star is observed to have a surface temperature of about 20,000K and a luminosity equal to the sun's luminosity. From this we can infer that the star is
a) more massive than the sun. b) less massive than the sun.
c) probably a young star. d) probably a white dwarf.
[Can you explain this in words?]

7. A spectroscopic binary is one in which
a) we can see both stars and obtain the spectrum of one of the stars.
b) the Doppler effect is used to infer that a star is a member of a binary.
c) the inverse square law is used to obtain the sum of the masses.
d) the spectral type of one or both of the stars is used to infer its luminosity class, and hence estimate its distance.
e) the spectral type of one or both of the stars is used to estimate their temperatures, and hence place them on the H-R diagram, allowing mass to be estimated from the mass-luminosity relation.

8. Most spectral lines of interstellar molecules are in the __________ part of the spectrum. [WHY?]
a) ultraviolet b) visible c) infrared d) radio

9. Emission nebulae like the Orion Nebula occur only near _____ stars.
a) red supergiant b) red main sequence c) massive d) old
[Try to exlain "to someone" why each of the incorrect choices are in fact incorrect.]

10. The most abundant molecule in a molecular cloud is:
a) NH_3 (ammonia) b) CO (carbon monoxide) c) H_2O (water) d) H_2