Reading guide (and early review sheet) for Exam 4: Chapters 16, 17, 18.

The next exam will try to cover Chapters 16 (but not sections 16.4 or 16.5), 17, and 18. The syllabus includes chapter 19 (star formation), but we will probably not get to that until exam 5. For now, we concentrate on getting through 16, 17, and 18.

The material on the Sun (Ch16) is important because the description of the interior structure of the Sun, and how we (think we) know about it, energy transport through the sun, and nuclear reactions as the power source, apply to all stars, which are the subjects of Ch17, as well as later chapters on stellar evolution and death.

Chapter 17 is almost entirely concerned with the ways in which astronomers learn the properties of stars. This may be the most important chapter since the early chapters on light, since much of the rest of the book assumes you know about the basic properties of stars. There is a lot of material to read and understand, and even memorize, so I advise you to get to it as soon as possible.

Chapter 18 is (almost) completely separate, and is about the gas between the stars, the gas from which stars form (the subject of chapter 19, but probably not this exam).

Chapters 17 and 18 rely heavily on the use of spectral lines, both electron transitions in atoms (ch.17) and vibrational and rotational transitions in molecules (ch. 18), so if you feel unsure about this topic, it is time to go over it again. (Chapter 4)

Chapter 16. The Sun.

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 approach 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.

Textbook: RD: All except 13-17; TF, all except 8, 9, 17-19
MC1: 2, 3, 8, 11.
MC2: 1, 2, 4, 7, 12, 13, 14
T/F: 1, 2, 4, 5, 7, 9, 13, 14.

Chapter 17. The Stars

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 3rd 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.

Textbook:RD: all except 20 T/F: all except 14,15.
(You will be expected to answer questions like 11, 12, 13, 14.)
MC1: All except 9.
MC2: 3, 5, 7, 9, 11, 12
T/F: 1, 2, 5, 7, 8, 10-15, 17, 18, 20

Chapter 18. The Interstellar Medium: Gas and Dust Among the Stars

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.

Textbook: RD: All except 8, 9, 20. T/F: 1, 7-11, 14-17, 20.
MC1: All except 9.
MC2: All except 6-8, 10, and 14.
T/F: ALL except 5, 7, 11, 13, 17, 18.