Astronomy 102: Stars and Galaxies
Spring 2003

Review topics for Examination 2

This test will cover material from Chapters 4, 12, and 13. Some of the material in the text will not be covered on the test; see below for a list of topics that you should have some understanding of, broken down into details.

Note that you need to memorize no equations. Any equation listed below you should understand and know what it means when you see it, and you should be able to use it in simple problems. However, you do not need to memorize any of them.

- **Light**
  - Waves
    - Frequency, Amplitude, Wavelength
    - $f = \frac{c}{\lambda}$; c is the speed of the wave (the speed of light for light!)
  - The Electromagnetic Spectrum
    - It's all light; what we can see is "visible light"
    - Longer wavelength = lower frequency = redder
    - Radio, infrared = longer wavelength than red light
    - Ultraviolet, X-rays, Gamma rays = shorter wavelength than blue light
  - Photons
    - A "particle" of light
    - One photon's worth is the smallest non-zero energy you can have in light *of a specific frequency.*
    - A photon of a higher frequency has more energy than a photon of a lower frequency: $E = hf$, where h is Planck's Constant (a well known quantity that may be looked up, say on the front of the test)
  - Luminosity and Flux
    - Luminosity = how much energy per second an object puts out
    - Flux = how bright an object looks (i.e. how much energy a detector (telescope, eye, etc.) of a given size would collect per second
    - $F = \frac{L}{4\pi d^2}$ where d is the distance from an object of luminosity L to the observer, and F is the flux seen by that observer. How bright an object looks depends not only on its intrinsic luminosity, but also how far away it is.

- **Light and Matter**
  - Thermal Radiation
    - Thermal bodies emit at a wide range of wavelengths.
    - Anything above absolute 0 temperature emits (even you)
    - Hotter = bluer (a greater fraction of its emission is at shorter wavelengths)
    - For two objects *of the same size*, a hotter object is more lumionous.
    - $L = (4\pi R^2)(\sigma T^4)$: L, here, is the luminosity of a spherical body of radius R and temperature T. (Note! R is the radius of the emitting body, *not* the distance to the body!) σ is the Steffan-Boltzman constant, a well-known value that may be looked up.
    - Thermal Equilibrium: when the amount of heat absorbed equals the amount of heat radiated. Something which is closer to the Sun will need to be warmer; as it's closer to the sun, it sees a higher flux and hence absorbs more energy. Thus, it must emit at a higher temperature than something further from the Sun to shed energy at a commeasurate rate.
  - Atomic/Molecular Emission and Absorption
    - Atoms and Molecules have specfic energy levels
    - *Emission Lines* and *Absorption Lines*: Transitions between energy levels can lead to emission or absorption at a specific wavelength (i.e. color) for gas where the constituents behave like individual atoms or molecules. Seeing emission or absorption at specific wavelengths allows us to determine what types of atoms and molecules we are looking at.
    - A low density gas will typically show individual atomic lines. A high density gas where the particles can interact frequency will typically show thermal emission (above) rather than emission at a specific frequency.

- **Stars**
  - The H-R diagram. (Understand what is being plotted.)
    - Bluer stars are hotter (See also above)
    - The "Main Sequence" are stars like the Sun.
    - More massive main sequence stars (compared to the Sun) are more massive, hotter, more luminous, and shorter lived than the Sun.
    - Less masive main sequence (compared to the Sun) are less massive, redder, less luminous, and longer lived than the Sun.
    - Some stars are not main sequence stars; for isntance, they may have the temperature (and hence) of a cool, red main sequence star, but the luminosity of a hot, blue main sequence star. If you understand thermal emission (above), you could say something about their size from this.
  - Stars are made mostly of Hydrogen, with some Helium, and just a little bit of other elements. (A star's composition can be determined from the wavelenghts of absorption and emission see; see above.)
  - Determining Luminosity from flux (measured) and parallax. (See above)
  - Measuring the mass from orbits of planets or binary stars (conceptually).
  - Stars generate energy through fusion
    - Fusion requires very high temperatures and high densities
    - High pressure can lead to high temperature and densities, e.g. at the center of a star.
    - Fusion combines light elements into heavy elements; e.g., at the center of the Sun, Hydrogen (H) is fused to make Helium (He)
    - Fusion is a nuclear reaction that can release energy (just as what you normally think of as "burning" is a chemical reaction that can release energy).
  - Stars like the Sun transport energy generated at the core to the surface
    - The interior of the Sun is gaseous
    - The core is much hotter than the surface
    - Energy flows from high temperatures to lower temperatures
    - Energy transports via radiation and convection
    - Energy takes a long time to work its way out to the surface from the core of the sun; photons are being scattered, absorbed, and re-emitted all the time.
  - Above the "surface" of the Sun is the atmosphere: lower density gas that gives rise to the absorption and emission lines we can see in the Solar spectrum.