Astro 121, Spring 2014
Important topics for midterm exam

This list is not necessarily complete, but it is my attempt to list the most important things we've discussed. Feel free to ask me about anything not listed here.

- Coordinate systems, angular distance, equinox, epoch.
- Time: local sidereal time, universal time, equation of time.
- Astronomical nomenclature.
- Error analysis; propagation of errors, basic probabilities; Poisson and Gaussian statistics.
- CCDs: characteristics, basic functionality, major noise sources, calibration observations, basic data reduction, how to calculate noise (and signal-to-noise) in a CCD observation.
- Photometry: observational techniques, data reduction, magnitudes, photometric systems, aperture photometry, point spread function.

Exam format and details:

The exam will be closed book, closed notes, with the following exception: the books *Data Reduction and Error Analysis in the Physical Sciences* by Bevington and Robinson, and *An Introduction to Error Analysis* by Taylor will be available for you to consult during the exam.

The written part of the exam will be held during our usual seminar time, 1:15 – 4:15 PM, on Thursday, March 6.

In addition, there will be a short CCD photometry data analysis question that you can complete any time next week. You will be provided with the location of some CCD images on the astro lab computers, and asked to answer a few questions about the images. This part will be open book / internet / notes, though you may not consult with other people. I will answer questions that are the result of some computer-related problem (e.g. if the file gets deleted, the disk fills up, etc.), though I won't answer general AstroImageJ or IRAF questions while you are working on the question.

Practice problems

Here are some practice problems. These certainly don't cover all of the concepts above, but they will give you practice with *some* of the concepts. In addition to these, you may want to work through some problems in Chromey, in the chapters we've covered. If you do that, I'd be happy to look over solutions with you for any given problem.

1. Suppose you take a CCD image (1° x 1°) of the north galactic pole. You then divide the image into ten equal subareas and count the number of galaxies in each, as listed below.

Area 1	10
Area 2	5
Area 3	9
Area 4	12
Area 5	9
Area 6	12
Area 7	22
Area 8	11
Area 9	7
Area 10	8

a) Suppose that you make the hypothesis that the parent distribution of galaxies on the sky is random with a mean surface density of 100 galaxies per square degree. Write a precise analytic expression for the probability distribution describing the number of galaxies in a subarea.

b) Based on the above data, what would you conclude about the spatial distribution of galaxies in the Universe? Explain your reasoning and be quantitative in your analysis.

2. At what time of year do local sidereal time and local solar time agree with each other? (You should be able to work this out without looking it up.)

3. What is the angular separation in arcseconds of stars located at 15:43:32.65 +45:32:21.2 and at 15:43:31.95 +45:33:01.8?

4. Explain how you could measure local sidereal time at a given location, equipped only with a catalog of stars' equatorial coordinates.

5. Star A has a right ascension of 4^h; star B has a right ascension of 2^h; both have a declination of 40°. Which star will rise earlier? Which star is farther to the east in the sky when both are up? What is the angular separation between the stars?

6. If you observe 10,000 ADU from a given star in 10 seconds, what is the signal-to-noise ratio of your measurement of its flux? Assume that the read noise is 8 electrons/pixel, the gain is 1.3 electrons/ADU, the star's flux is measured in a 5-pixel-radius aperture, and that the dark current and sky flux are both negligible. How does your answer change if the sky flux is 100 ADU / second / pixel? How long would you have to observe to double the signal to noise ratio of your measurement?

7. If two stars of the same spectral type yield 1000 photons/second and 3200 photons/second respectively, when observed with a V filter, how do their V magnitudes compare to each other? How do their B magnitudes compare to each other?

8. Two astronomers measure the brightness of a star to be 350 ± 50 photons/sec and 320 ± 20 photons/sec, respectively. Is the star variable? What is a better way to phrase that question?

9. Imagine an Earth-like planet orbiting a Sun-like star in another solar system. If the equation of time on that planet is always zero, in what way(s) must that solar system be different from our own? For each difference you give, explain why it must be the way it is in order to give zero equation of time.