ASTR21200: Homework 2 (HW2)

1. **Equinox:** On the days of the equinox (day and night are equal length), at what azimuth angle does the Sun rise? Where does it set?

2. **LST and HA:** The celestial coordinates of the star Altair are approximately 19h50m,+08d52m:

   (a) What is the maximum altitude it can be seen from Sonoma, CA (i.e., near Stone Edge Observatory)?

   (b) What is its distance from the zenith then?

   (c) At a Local Sidereal Time (LST) of 18h50m, what is the hour angle of Altair? Is it to the East or to the West of the meridian?

3. **Culminate:** Orion culminates at 1am in September; at what time does it culminate 3 months later? Describe how you arrived at your answer.

4. **Magnitude to Flux:** What is the observed flux ratio between the faintest galaxies in the DES survey and the Sun? (Use the apparent magnitudes listed in the lecture slides.)

5. **Silicon CCDs**: At λ=900 nm Si has an index of refraction of 3.7 and an absorption coefficient alpha=0.01 μm^{-1}.

   (a) Estimate the quantum efficiency for a CCD that was 20 μm thick Si wafer at λ=900 nm?

   (b) Estimate the quantum efficiency for a CCD that was 250 μm thick Si wafer at λ=900 nm?

   (c) Given the properties of Silicon, at what wavelength will the absorption of Silicon drop off significantly, no matter the thickness? What property of the Silicon causes this?

6. **Photometry**: Observing on Magellan ($D = 6.5$m) with the Megacam CCD imager[1], the sky background in r-band varies between a magnitude of 21 to 20 per square arcsec during a new and full moon. Assume the following, the r-band is centered at λ=605 nm with a bandwidth $\Delta\lambda$=180 nm. The r-band magnitude, M_R, can be written as $M_R = -2.5 \log(f_R/f_0)$ where $f_0 = 3000$ Jy. The pixel scale is 0.08-arcsec per pixel, and the quantum efficiency of the detectors is about 0.8 at this wavelength. Note that 1 Jy = $1{\times}10^{-26}$ W m^{-2} Hz^{-1}.

   (a) Whats the ratio of photo-electrons per pixel that you expect to see for the new vs full moon?

   (b) Integrate for 100-sec. What is the average number of photo-electrons that you see per pixel during the new moon? You can either calculate this yourself (i.e., from first principles, given the above information), or use whatever information that you can find on the Magellan website (but cite your sources).

[1] https://www.lco.cl/magellan-instruments/