Ay 7B – Spring 2010
Section Worksheet 5
Magnitudes and Coordinates on the Sky

1. **Exposure times**
   While at Lick Observatory on top of Mount Hamilton just outside of San Jose, you take a 10 second exposure of an 8th magnitude star and get about 10,000 counts. How long would you have to expose on an 11th magnitude star to get the same number of counts?

2. **Supernovae vs. Asteroid**
   The asteroid belt is a collection of small rocks and boulders in between Mars and Jupiter which never coalesced to form a planet. Like the planets, they orbit the Sun in the plane of the ecliptic. When searching for transient objects such as gamma ray bursts or supernovae, it is useful to have a plot of where asteroids are located in the sky as not to confuse an asteroid for a more interesting object. On a plot with right ascension on the x-axis and declination on the y-axis, sketch the position of the asteroid belt. Could a supernova candidate found at a RA=18:00 Dec=+00:01 actually be an asteroid?

3. **Into the belly of the beast**
   If you wanted to study the galactic center of the Milky Way, would you be better off using radio wavelengths or optical wavelengths? Why? For reference, a typical dust grain size would be about 1 micron.

4. **Dusty Skies**
Looking out into the sky one night you find a hole with no stars! But after a bit of research you find that its just a cloud of dust and gas known as Barnard 68 (see gure 12.7 in your book). It only looks like a hole because it is blocking the light from the many many stars behind it. But youre still curious about it and so make a bunch of observations to see what you can learn. For the purposes of this problem, assume that the cloud is a uniform density sphere and there is no other source of extinction along the line of sight except for that cloud.

(a) Thinking more about the Sun-like star behind the cloud, if you measure the apparent magnitude of the star to be 18.1, what is the extinction, A along the line of sight to that star? By measuring the parallax angles, you determined the star is 143pc away from us. What is the optical depth? (Hint: The absolute magnitude of the Sun is +4.74.)

(b) If you measure the cloud to be $\theta = 260$ arcseconds in diameter, what is its radius in pc? The cloud is 130pc away from us.

(c) The line of sight to the star does not pass through the center of the cloud, but is displaced from the center by about half a radius. How long is the distance, L through the cloud along this line of sight? (Hint: It will likely help to draw a picture.)

(d) Now let's think about the dust in the cloud that is causing the extinction. At visual wavelengths, the cross section for the extinction by dust in clouds like this is typically about 1.5 times their geometric cross section. If the dust grains are spheres with radii of about $a = 0.5\mu m$, then $\sigma \approx 1.5\pi a^2 = 1.2 \times 10^{-12}\mathrm{m}^2$. What must the number density of dust particles be in the cloud in order to produced the observed amount of extinction?