Astronomy 3
Lab 1: The Sun
Due Feb. 5

In this lab you'll use observations of the Sun to show how different properties of a star can be measured. This lab has three parts: two in the lab and one part at the observatory (which will require good weather).

Note: You can do the first two parts of this lab even if the weather is bad! It's best to get these two parts finished and then come back to do part 3 on a clear day (if you have to).

1 Solar Rotation Period

Figure 1 shows two white light pictures of the Sun taken with the MDI instrument on the Solar and Heliospheric Observatory (SOHO). The dark spots on the surface are called sunspots and are associated with active regions on the Sun (capable of producing solar flares). Notice that the positions of the sunspots change from one day to the next. You will determine the solar rotation period by tracking sunspots as they move across the Sun.

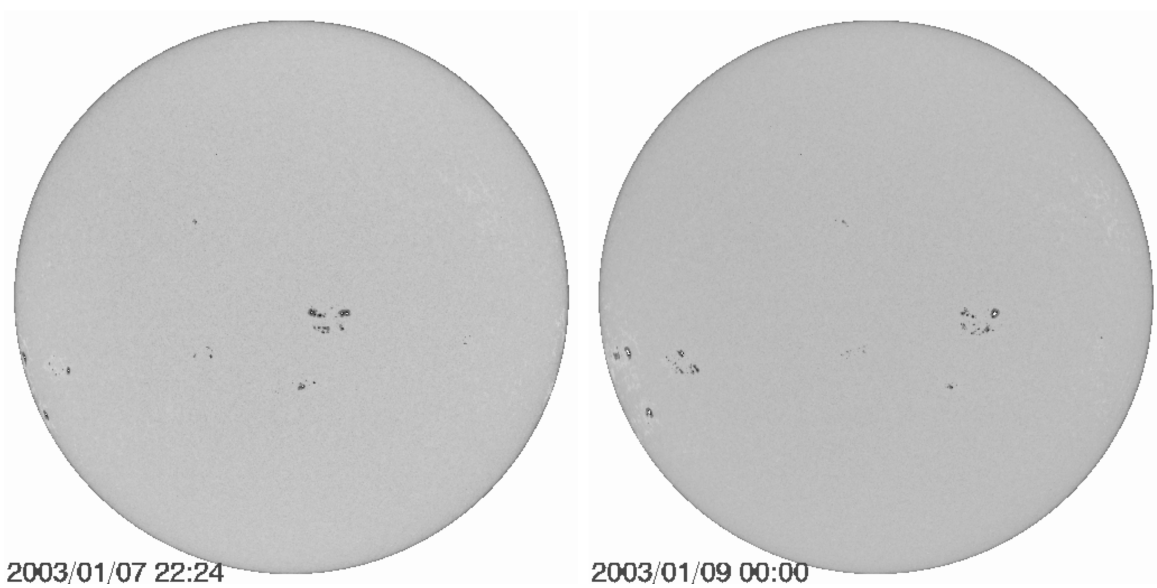

Figure 1

Look at the full size images of the Sun provided by your T.A. and identify the sunspots.

a. Draw a picture showing the positions of your chosen sunspots each day. Choose at least three sunspots and try to choose them at three different latitudes. Include a scale in km for your diagram. Approximately how big are the sunspots?

b. Using the transparency grid provided by your T.A., determine the positions of these three sunspots on each day and make a table of your results.

Now you will use your data to determine the rotation period of the sun. The longitude of a sunspot at different times allows you to determine how many degrees the sunspot has moved around in a given time. For example, if you waited a full rotation period, the sunspot would make one full rotation coming back to its starting point and would have traveled an angular distance of 360°. So, for example, if a sunspot takes two hours to move 1°, then it will take 720 hours to move the full 360°. We can generalize this with an equation. If A is the angle your sunspot moved (in degrees) and t is the time it took, the rotation period, P_{rot} is given by:

$$P_{rot} = \frac{360}{A} t \tag{1}$$

Ask your T.A. for help if this doesn't make sense to you. Ok, so here's the catch! Since we are observing the Sun at different times, the motion of each sunspot is actually due to both the Sun's rotation AND the fact that Earth is moving around the Sun. Consider what would happen if the Sun didn't rotate at all. The Earth moves around the Sun, so in 6 months time, we would be looking at the back side of the Sun! If we were looking at a particular sunpot, it would appear to move backwards (to the left in your pictures) by about 0.99° each day (since it takes 365 days for the Earth to go all the way around the Sun, the sunspot would move a little less than one degree per day). So, this means you need to correct your measurement of each sunpot's motion by adding 0.99° per day. If your measurements are separated by less than a full day, you'll have to add a smaller amount.

c. What is the rotation period determined from each of your sunspots? Show a sample calculation of how you determined the rotation period. Does the solar rotation period increase or decrease with latitude? Why do you think its possible for the Sun to have different rotation periods at different latitudes, while the Earth has the same rotation period at all latitudes (∼24 hours)?

2 Spectroscopy

In this part of the lab, you will use a spectroscope to analyze the spectrum of a couple of different light sources, including the Sun. The spectroscope is similar to a prism in that it spreads out the different wavelengths of light. Your T.A. will set up the spectroscope so you can view the spectrum of sunlight. The micrometer scale will allow you to measure the wavelength of each aborption line in the solar spectrum.

a. Describe the solar spectrum (in words) and make a sketch showing some of the strongest lines. What causes the dark lines?

b. Make a table of their wavelengths and identify the atomic elements responsible for each line using the charts and tables provided in the lab room.

c. Using the spectrum of sunlight in part (a), estimate the range of wavelengths visible to your eye.

d. Your T.A. will now show you the emission spectra of several lamps. Measure the wavelengths of the strongest lines and comment on whether these elements are in the Sun.

3 At the Observatory

For the final part of the lab, you'll observe the Sun in white light and using an Hα filter. Make sure to follow the instructions of your T.A. and NEVER LOOK AT THE SUN WITHOUT PROPER EYE PROTECTION: BLINDNESS COULD RESULT!

a. Make a sketch of the sun as it appears in white light, identifying sunspots and any other features. Label your drawing with N-S and E-W directions, the date, time, and any other details of the observation (such as telescope, magnification, filters, etc.)

b. Make a sketch as in part (a), but now using the Hα filter.

c. How do your sketches differ? Why does the Sun look different with the Hα filter in place?

d. Go to the SOHO webpage (http://sohowww.nascom.nasa.gov/) and click on "The Sun Now" icon at the top left corner. This will take you to a page showing the latest images from different instruments on the SOHO spacecraft. Click on "More MDI Continuum' and find the image closest in time to your observations. Compare your sketch to the SOHO drawing.

Extra Credit Look at the MDI magnetogram and EIT 195 images taken near the same time as your observation. Desribe these images and how they relate to your observations. A magnetogram measures the magnetic field strenth and EIT takes pictures of the solar corona at Extreme Ultraviolet wavelengths. Note: This part isn't about getting something right or wrong...just noting what you see.