Lab #4: Solar Observations

Intro: The Sun presents to us a constantly changing face. Sunspots form and disappear and are carried across its face as the Sun rotates. Careful drawings of sunspots have been made since astronomers first began looking at the sky with telescopes. Four centuries of sunspot observations have revealed complex variations in addition to the famous 11-year sunspot cycle. In this lab you will be producing your own drawings of the Sun. Include your answers to the questions, all calculations, and your original drawings. Use complete sentences in your answers.

1) Draw the Sun as seen through the Meade telescope on two days using copies of the printed circle provided on the last page of this lab. Their specific diameter was chosen for doing a later part of this lab. Your observations need to be separated by at least two days. Be sure to mark the N and E directions on your drawings (easier said than done!). We’ll start our observations the week of September 14th, weather permitting.

2) Log on to the Windows PC in the Physics addition, room A320; use the Astro 344L account. Go to the web site: sohowww.nascom.nasa.gov/data/latestimages. This is the SOHO satellite web page, which produces daily images of the Sun. Under “More Images and Data” click on “MDI Summary Data”. Then browse the list of dates under the “Continuum” column. Click on the date to bring up an image. Save the image with a name that includes the date to a folder with your name. Save images for the dates corresponding to your drawings plus three more from dates, before, in between, and after your observations. You will end up with five images spanning a range of at least nine days. Prepare a table listing the dates and times of the five images. Also while your on the web site find out the answers to the following questions: What does SOHO stand for? Name two instruments on SOHO, describe what part of the sun they observe and what wavelength they observe at. Include these answers in your lab report.

3) Open each image you saved in part 2 with Adobe Photoshop Elements 2.0, and print them at 75% size. You can do this by selecting “Print Preview” under the “File” menu heading. Before printing the images, you might want to increase the contrast to make the sunspots more visible.
In addition, you might have to reverse or invert the image to match the cardinal directions on your drawings.

4) How do your drawings compare to the SOHO images obtained on the same dates? Did you need to rotate or reverse the drawings to match the sunspot locations on the Big Bear images? Mark with a red ink pen on the printouts the locations of the sunspots from your drawings; note, your N-S axis does not necessarily have to match the N-S axis of the Big Bear images. How far off (in degrees) is your N-S axis relative to that of the images? Are you satisfied or dissatisfied with the quality of your drawing (i.e. comment on things like did you miss lots of features visible in the SOHO images and does the extent and shape of your sunspots match what is seen in the SOHO images?).

5) Try to identify some sunspots that you can follow on all the drawings/images. Prepare a new drawing showing the changing positions of the sunspots. Make sure you carefully align the NE axes. Apply the average angular offset from step 4) between the drawings and the images obtained on the same days to your three other SOHO images and include their sunspots in the new drawing. Label the sunspots with their dates. Connect the same sunspot groups with dashed lines.

6) From the combined drawing you prepared in the last step, estimate the locations of the Sun’s rotation axis and equator. Draw the rotation axis with a ruler; describe how you determined its location. What is the angle between the Sun’s rotation axis and the N-S axis? What does this tell you about the relative orientations of the Earth’s and Sun’s rotation axes (note: this is not an easy question; think carefully about the direction of the Earth’s rotation axis in space relative to the Sun at this time of year; you might find Voyager III helpful here). From your data, what direction does the Sun rotate (clockwise or counter-clockwise as viewed from the North)? Is this the same as the direction of the Earth’s rotation? The same as its orbit?

7) Continuing with the drawing from step 5), use a ruler to measure the distances between the two sunspot groups and the rotation axis for each date. Divide these distances by the radius of the
Sun on the drawing. Then, calculate the arc sine to determine angles. Draw a cross-section of the Sun showing the meaning of this angle.

8) You now have enough information to calculate the rotation period of the Sun. Prepare a table listing the angle for each sunspot you measured along with the corresponding date. Add another column giving the number of days from the first observation. Calculate the Sun’s apparent rotation period from these data.

9) This is not the Sun’s true rotation period, given that we are on a moving platform. In other words, while the Sun is rotating, the Earth is moving along in its orbit. To correct for the Earth’s motion, use the following equation:

\[ \frac{1}{T} = 1 + \frac{1}{O} \]

where \( T \) is the true period and \( O \) is the observed period. The observed and true periods must be expressed in years. What value for the true rotation period do you come up with? How does this compare with the accepted period? Is this an ambiguous question, why or why not (hint: what’s the Sun made of?)?

Once you’re done the lab be sure to take some time to peruse the SOHO web site there are lots of great images and movies of solar activity along with good explanations of the instrumentation and the physics behind the images.