

Astronomy 3 Laboratory Number 2

Solar Rotation and Spectrum

I. Introduction

This astronomy laboratory shows how we can measure different properties of the sun as a star and is in three parts:

1. In the case of the sun and many other objects, we can use the motion of spots on the surface to determine the period of rotation.
2. Spectroscopy also reveals motions as well as chemical compositions and many other facts about the source. Once the nature of the lines can be identified. The spectrum of the sun is typical for stars and contains a beautiful forest of Fraunhofer lines.
3. We can directly observe the sun's photosphere and outer layers which are in common with other stars.

We define the rotation period of any rotating body to be the time that it takes for a fixed point on that body to make one complete circuit about the axis of rotation and return to its original position. Note that as described elsewhere there are different kinds of period, e.g. apparent and sidereal. Such information contains important information on the physical nature of the body being observed. Take a look at Chapter 13 in the text.

II. Determining the solar Rotation Period

A. General comments.

While the sunspots themselves are interesting, here we will use them as “landmarks” on the sun’s surface to follow the rotational velocity of the sun’s “surface” on photosphere. If you observe the sun’s disk, in general you will see several sunspots (Figure 1a).

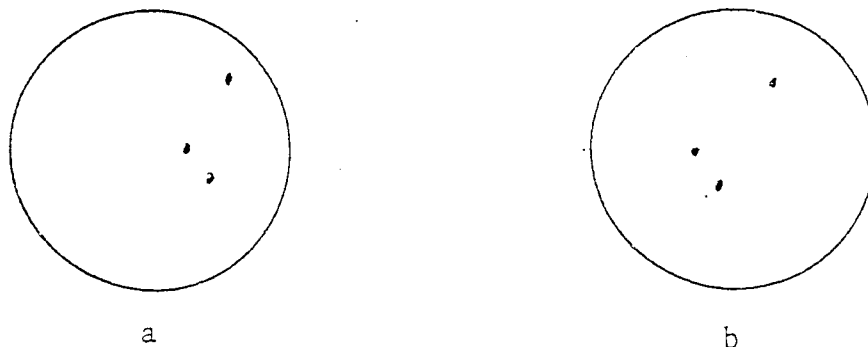


Figure 1

Observations made a few days later (Figure 1b) will reveal that these spots have moved. This shift is due to the rotation of the sun.

In principle you could time how long a given spot takes to move across the visible face of the sun, wait until it crosses the back side of the sun, and reappears, returning to its original location. However, in practice this is difficult. Note that the sketches are a simplification. The spots will change shape and some sunspots may completely vanish and new ones will form in just a few days' time. Thus a better way to determine the solar rotation period is to use the motions of some spots on the visible face of the sun covering a few days which is just part of the rotation period.

The basic problem then boils down to understanding the geometry of the situation. This involves what is really meant by the sun's "disk" or "visible face" how this relates to the solar "surface" which is very close to being a sphere.

If we plot the position of one sunspot across the face of the sun for several days, we would see a series of positions that lie along a line parallel to the sun's equator (see Figure 2).

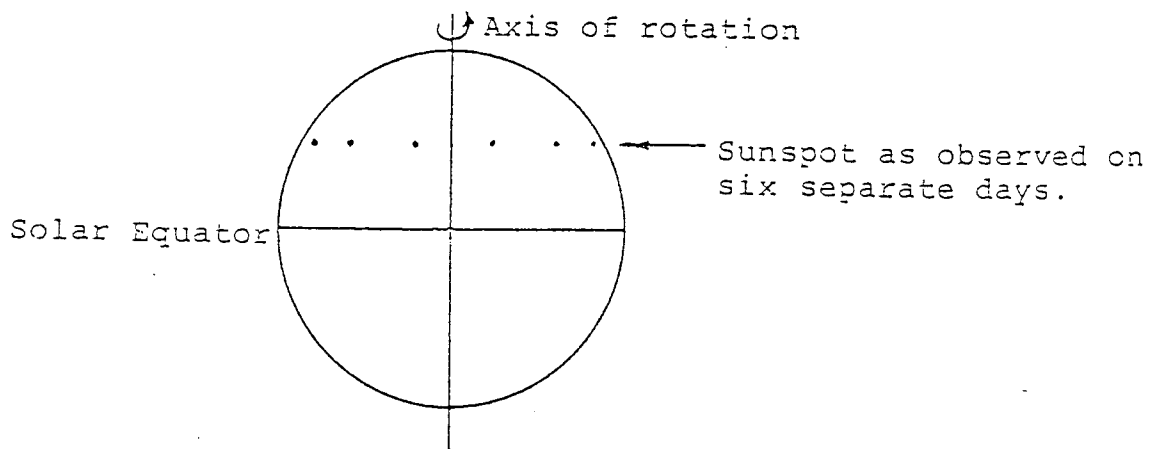


Figure 2

Just as in the case of a map of the earth, this is a two-dimensional projection of a sphere, so that the "mapped" sunspot position is a projection of the true sunspot location on the globe of the sun onto the plane of the sky.

A more helpful way to determine the rotation period of the sun is to redraw their positions using a polar projection as shown in Figure 3. You should employ this method when you reduce your data.

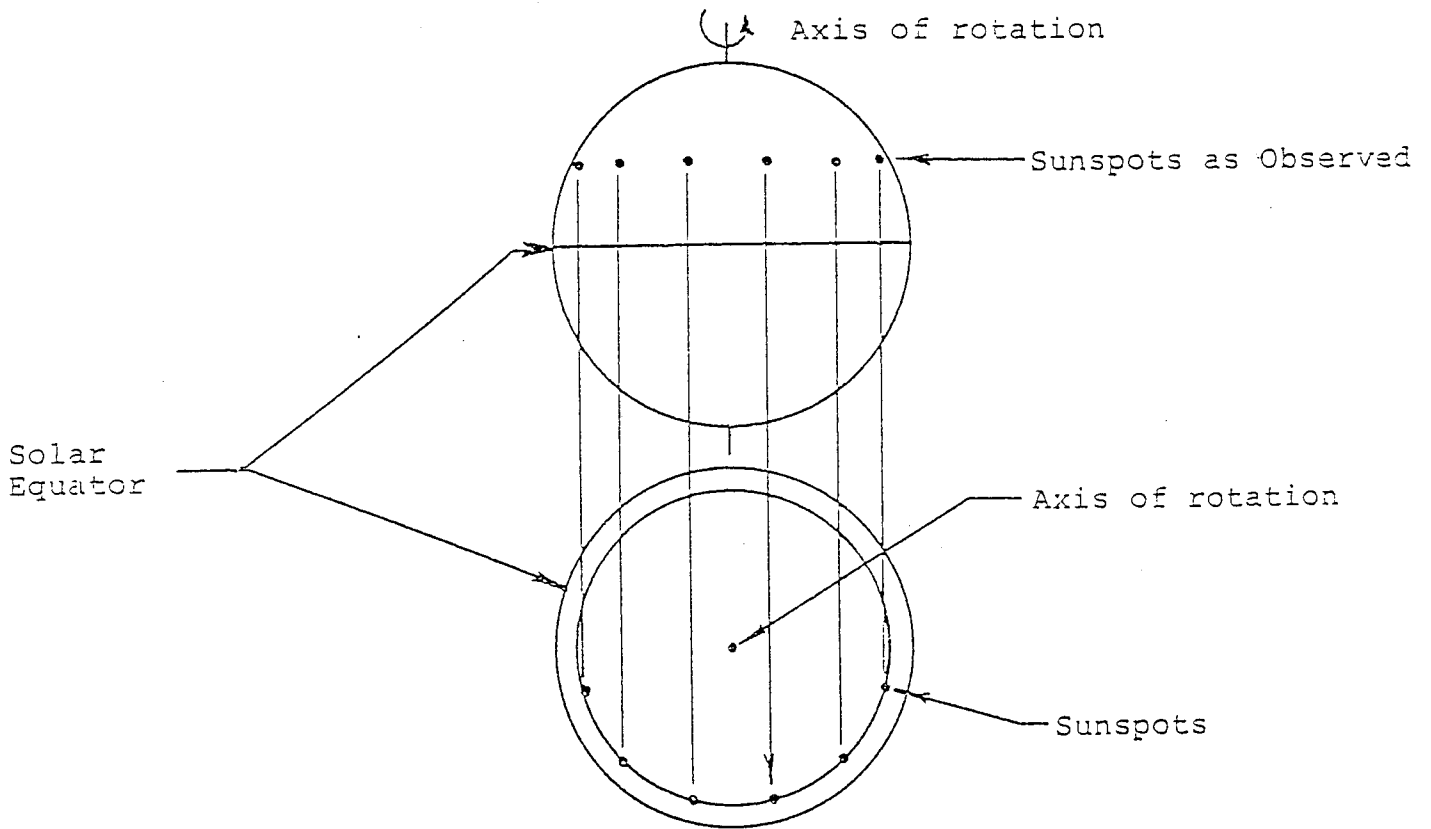


Figure 3

A graph like this one can connect the observed sunspot positions (and thus their true angular separations) on the sun's spherical surface. Also knowing the sun's diameter, their speed of rotation can be computed.

B. The measurements

Daily observations of many kinds of the sun are made world wide and examples can be found on the World Wide Web.

We will use white light images of one sun. In the lab, you will be provided with a set of daily sunspot pictures from one of these sites and any other relevant data.

Use the circle on the plotting paper provided to plot the positions of a few given spots over several days as they cross the sun's face. Be careful to orient the circle the same way with respect to NS, EW on the sun. Your lab instructor has a table of the angle between the north poles of one sun and the earth for every day of one year (Why does this change? Include an explanation in your write-up.) Construct a drawing similar to Figure 3 for each spot and compute a rotation period for each spot. Give a scale for your diagram in km. Do you notice any systematic difference in the rotations rate as a function of distance from the sun's equator?

To complete this part of the lab report you must include:

1. All of your raw measurements.
2. Your calculations of the solar rotation, including all drawings and formulae used.
3. The answer to the question on why the relative orientations of the polar axes of the earth and sun change over the course of the year.

III. The Solar Spectrum

Your lab instructor will have a spectroscope set up so that (weather permitting) you can view the dark absorption or Fraunhofer lines in the spectrum of sunlight and will instruct you in its use. The spectroscope is equipped with a micrometer scale so that the wavelengths of the lines can be measured.

For this part of the lab:

1. Make a sketch of the solar spectrum showing some of the strongest lines.
2. Make a table of their wavelengths and give identifications of the substance causing these lines, using the charts and tables made available in the lab room.
3. You will also be shown the emission line spectra of some elements in lamps. Measure the wavelengths of the strongest lines and comment below on whether these elements are in the sun.

To complete this part of the lab you must include:

1. All of your measurements.
2. Your drawings of the solar and lamp spectra.
3. Your identifications of what elements produce the strongest lines.

IV. Observations of the Sun in White Light and H α

Following the instructions of your TA, make observations of the sun in white and H α light (CAUTION: NEVER LOOK AT THE SUN WITHOUT PROPER PROTECTON TO YOUR EYES - BLINDNESS COULD RESUTL).

On the observing forms provided make sketches of the sun in

- A. White light. Show the locations of sunspots and any other features. Be sure to determine E-W and N-S directions. In order to provide a proper observation, you need to record the date, time, and instrumental details such as telescope and magnification.
- B. H α light. Make a sketch of the sun using this filter.

To complete this part of the lab, you must include:

1. All your drawings.
2. A list of indication of what you saw on the sun.
3. Explain why the H α image of the sun is different than the white light image and why some features only show up in H α .

SOLAR OBSERVING FORM

Name: _____

Date: _____

Time: _____

Telescope details: _____

Type Observation (white or H α): _____

