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Solar Investigation Project report

Introduction and Background:

The sun is a main sequence G type star with a surface temperature of 5578K (5505°C) that is at the centre of our solar system, and makes up 99.8% of its mass. [1] The sun is approximately 75% hydrogen, 25% Helium and 1.69% made up of heavier elements such as oxygen, carbon, neon and iron. [1a] The sun was formed around 4.567 billion years ago in the solar nebula, and it is thought that it will remain in its current phase for approximately another 5 billion years, by which time it will have used up the majority of its nuclear fuel and will become a red giant star. [1]

Sunspots are parts of the sun that are cooler than the surrounding area due to the magnetic field of the sun. [2] This means that they look darker, although they are still bright. Sunspots usually appear in pairs with the magnetic field coming out of one and going into the other like the poles of a bar magnet. The strength of the field is around 1000 times larger than the surrounding area. [2] All sunspot groups can be classified according to their magnetic structure. [9]

Solar flares are intense bursts of radiation that come from the sudden release of magnetic energy associated with sunspots. [4] [5]

In order for us to be able to look at the sun safely, we need to filter out 99% of its light before it reaches our eyes. [3] Ways to do this include creating a pinhole projection box, or letting the light fall through the eyepiece of binoculars onto a projection screen (e.g. a sheet of white paper); using a solar telescope; using solar observation glasses; looking through arcwelder's glass; or using a filter [3], such as the H-alpha filter used to take the images we received as data from the GONG* solar telescope in Tenerife.

*Global Oscillation Network Group

Target and Dataset:

The main purpose of our task was to determine the rotational period of the sun about its axis by observing the movement of sunspots on its surface, and also to analyse one hundred years of sunspot data, to see if any discernable patterns emerged from the data, and if so what the frequency of said patterns is and if there were any anomalous results within the data that was given to us.

The data we used to work out the period of the sun was taken by GONG's (Global Oscillation Network Group) [4] solar telescope, and all readings were taken as close to noon as the then meteorological conditions would allow. The GONG telescope in Tenerife is one of six identical stations around the world. They make up a community based program to conduct a detailed study of solar internal structure and dynamics. [9]

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Method of Analysis:

Investigating patterns in one hundred years of sunspot data

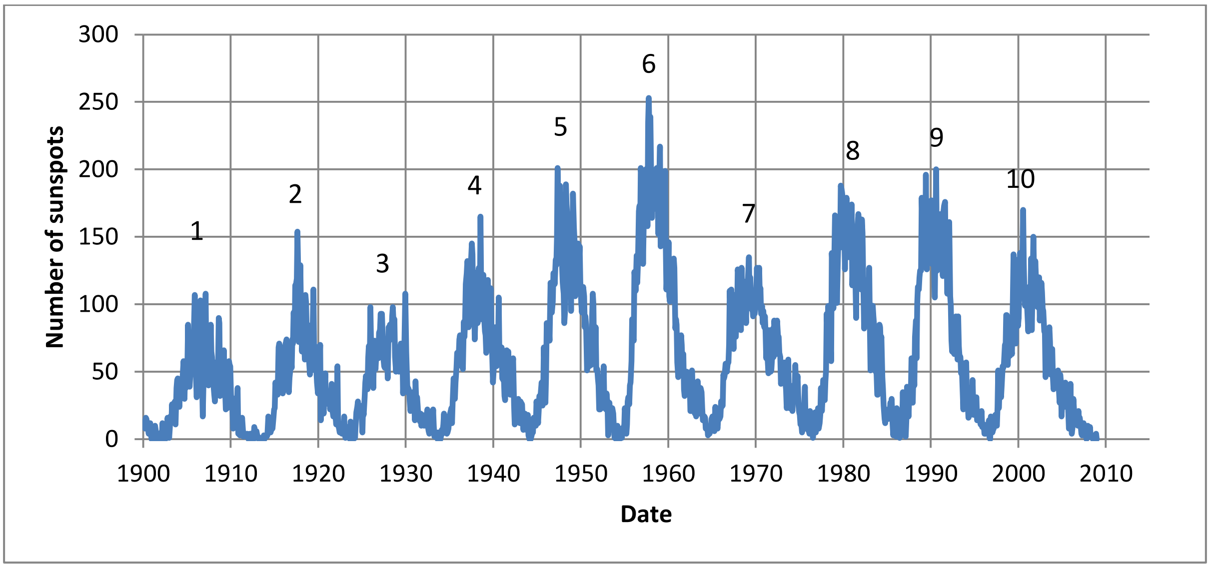

Figure 1 – A graph of sunspot numbers against date

To determine a pattern in the sunspot data from the last hundred years, we plotted a graph of the number of sunspots against the date (see Figure 1). As is clear from Figure 1, several peaks were present at similar time intervals, showing a pattern. We then took the date of the middle of each peak, as shown in Figure 2, and found the differences between consecutive values. We then took the mean of these, giving an average interval between peaks of 10.45 years.

Determining the rotational period of the sun using sunspots

Using the program Ds9, pictures of the sun from the GONG telescope were used to track a sunspot. Using DS9's inbuilt ruler function, we first measured the diameter of the sun, which came to 1800.31 lin. The distance from the edge of the sunspot to the edge of the diameter was measured (Figure 3).

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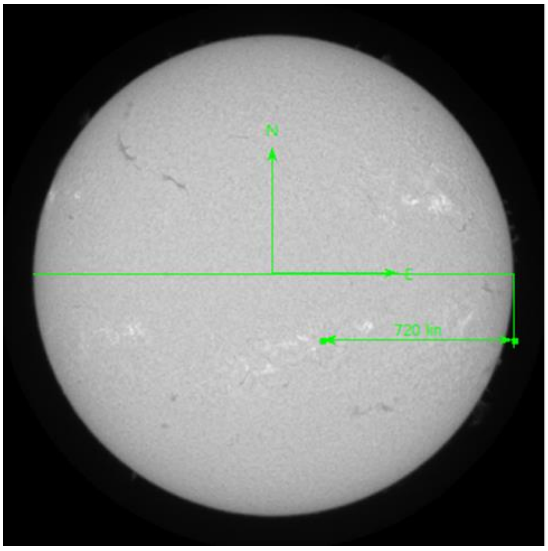

Figure 3 - Measuring the diameter of the sun and the distance to the sunspot.

The numbers for both pictures were plugged into this equation where A is the angle, D is the diameter of the sun and S is the sunspot measurement.

$$A = cos^{-1}(\frac{D - (2 \times S)}{D})$$

This gave us the angle that the sunspot moved through during the time between the pictures were taken. The angle moved through was then divided by the time taken to give the angular velocity. The angular velocity was then used to find the time period by dividing 360 by this value to give the time period for a whole rotation at that latitude.

Peak	Date of peak	Difference
1	1906.538	
2	1917.624	11.086
3	1928.539	10.915
4	1938.538	9.999
5	1948.287	9.749
6	1957.791	9.504
7	1969.205	11.414
8	1979.704	10.499
9	1990.623	10.919
10	2000.539	9.916
	$\bar{x}$	10.445

Figure 2 – A table of data from the main peaks in Figure 1

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Results:

Investigating one hundred years of sunspot data

Our results are shown in Figure 1 and Figure 2. Figure 1 shows ten clear peaks in the number of sunspots on the sun, from which we took data to make Figure 2. The mean of the time differences between peaks is 10.45 years. This shows that the sun spot cycle repeats on average every 10.45 years.

Determining the rotational period of the sun using sunspot data

Using the method detailed above, we found that the rotational period of the sun was 27.65 days, at the latitude of our chosen sunspot. As the sun is not a solid object, the period at the poles is different to the period nearer the equator, however we were unable to find any good quality images of sunspots near the poles of the sun so it was impossible to measure the period of rotation nearer the poles.

Conclusion:

Investigating one hundred years of sunspot data

Our results show that the suns solar cycle repeats every 10.45 years on average. This is close to the accepted value of 11 years.

Determining the rotational period of the sun using sunspot data

From the sunspot we measured near the equator, we concluded that the period of rotation of the sun at this latitude was just over 27 days and which is close to the accepted value for the rotation of the sun at the equator which is 25.6 days. [6]

References:

[1a] http://nineplanets.org/sol.html

[2] http://hyperphysics.phy-astr.gsu.edu/hbase/solar/sunspot.html

[3] www.skyandtelescope.com/astronomy-news/observing-news/how-to-view-the-sun-safely/

[4] www.almanac.com/sunspotupdate

[5] http://hesperia.gsfc.nasa.gov/sftheory/flare.htm

[6] http://www.enchantedlearning.com/subjects/astronomy/sun/rotation.shtml

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[1] http://www.space.com/58-the-sun-formation-facts-and-characteristics.html

[8] http://www.spaceweatherlive.com/en/help/the-magnetic-classification-of-sunspots

[9] http://gong.nso.edu/