STARS RESOURCES

Student workbook

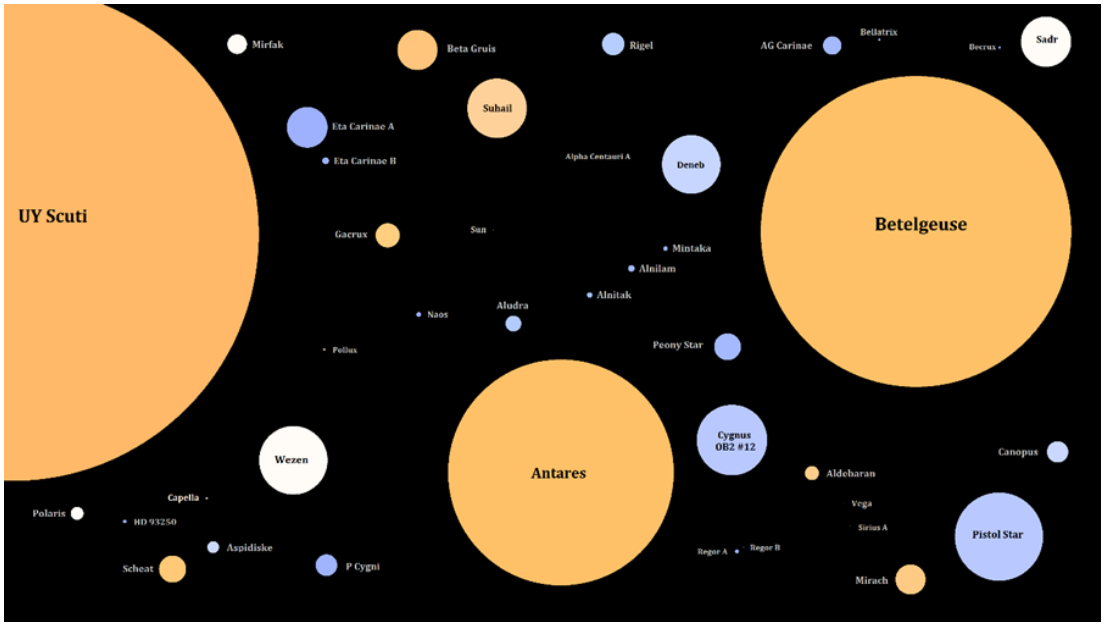
Solar observing

ACTIVITY

Observe the Sun to see features such as prominences and sun spots.

BACKGROUND INFORMATION

The Sun is a star. It is about 4.5 billion years old, and converts hydrogen into helium. This generates heat and an immense amount of light. The Sun is never calm and quiet; it's a ball of plasma that is always roiling and changing. However, even though we think of it as being huge, on a Universal scale it's quite tiny.

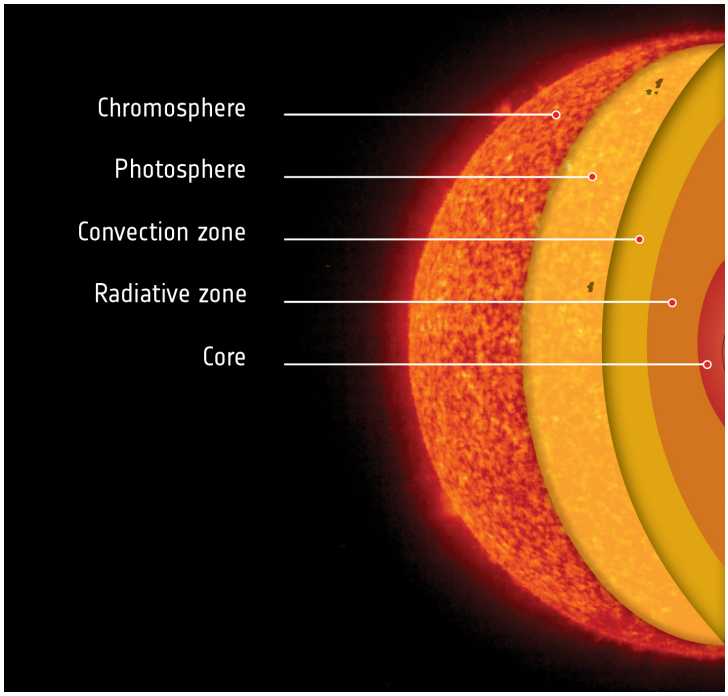


By GiovanniMartin16 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=45000639

What is a plasma?

Plasma is matter so hot that electrons are ripped away from the atoms. This creates lots of charged particles (i.e. electrons and ions), which make the plasma electrically conductive. Charged particles moving around generate a magnetic field. The Sun has a huge magnetic field.

BACKGROUND INFORMATION cont'd



ESA; (Sun's chromosphere based on SOHO image; credit: SOHO (ESA & NASA))

The surface of the Sun (called the photosphere) is highly active.

Electric currents within the Sun generate a magnetic field that spreads throughout the Solar System. The magnetic field generates activity in the photosphere and this activity increases and decreases in a regular 11-year cycle.

DID YOU KNOW?

If the Sun wasn't so very hot, it would all collapse inwards from the gravitational pull of all of its mass. It is the temperature inside the Sun (as hot as 15 million degrees Celsius at the core!) that creates outward pressure to counteract the pull of gravity.

The Sun's activity has always been an ever-interesting source of fascination for people, and without it life would never have begun on Earth. In particular, in this activity you will be looking at solar prominences, flares and sun spots.

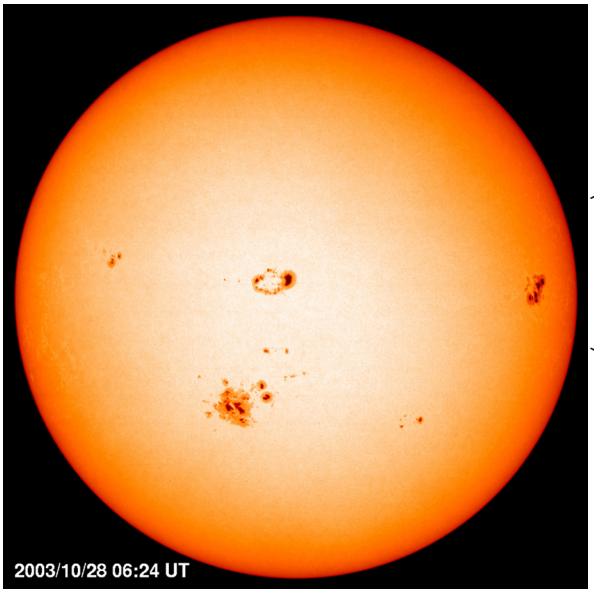
Temperature of the Sun

Interior (centre)	15,000,000 deg C
Photosphere (surface of Sun)	6,000 deg C
Sunspot	3,700 deg C
Chromosphere	4,000 to 6,000 deg C
Corona	800,000 to 3,000,000 deg C

BACKGROUND INFORMATION cont'd

Sun spots

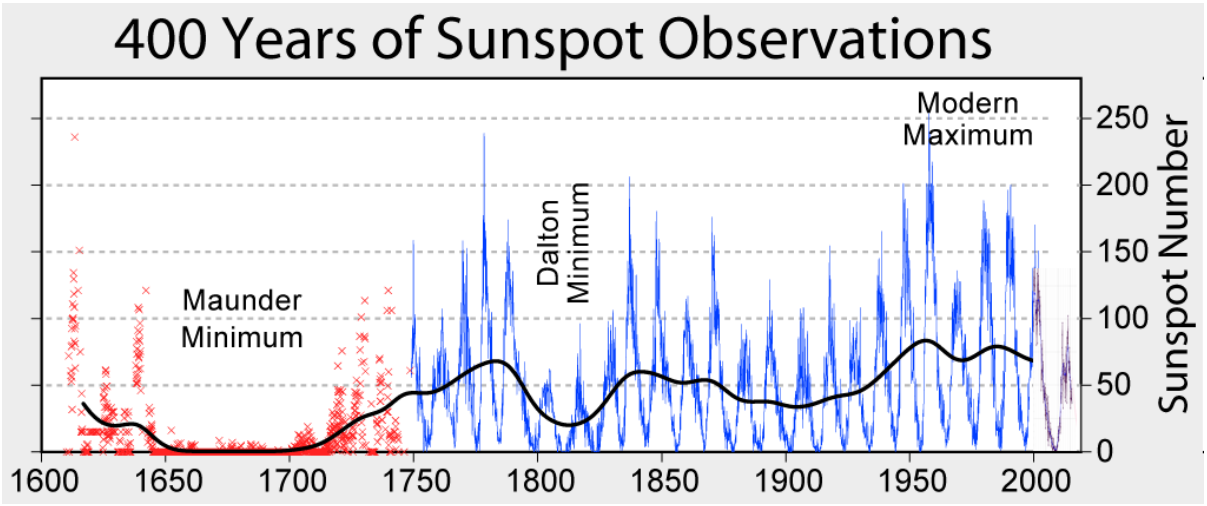
Sunspots are dark patches on the surface of the Sun. Sometimes there are many sunspots, sometimes there are virtually none. Some last for hours, some last for months. From here, they look tiny, but in fact some are up to 50,000 km across, twice the size of the Earth!



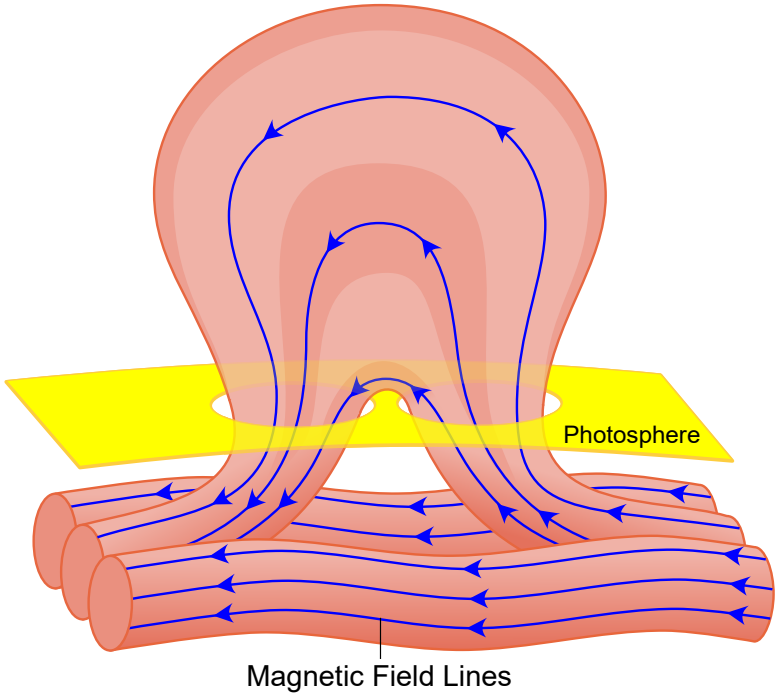
SOHO (ESA & NASA)

They're darker, because they're cooler than the average temperature of the surrounding surface of the Sun by about 1500 degrees Celcius. Sunspots are patches of concentrated magnetic field that have pierced the Sun's photosphere. The magnetic field in those patches is intense enough to inhibit the convection currents that would normally bring hot material to the surface from deep inside the Sun.

Being the result of magnetic forces, sunspots occur in pairs, each of a different magnetic polarity (i.e. north and south poles).



BACKGROUND INFORMATION cont'd



By !Original:Lmb at Spanish WikipediaVector: TilmannR - Own work based on: Solar flare diagram ES.png, CC0, https://commons.wikimedia.org/w/index.php?curid=77135572

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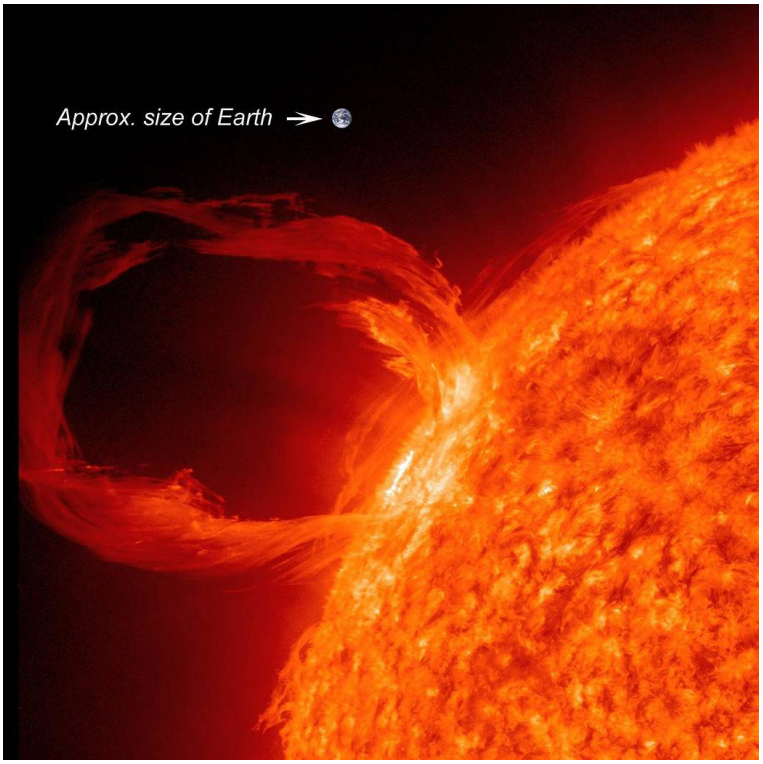
Prominences

A prominence is a huge loop of plasma that extends out from the surface of the Sun. Prominences remain attached to the Sun in the photosphere, and extend out through the corona. Some prominences are hundreds of thousands of kilometres long. These huge features result from tangles in the magnetic field lines of the Sun.

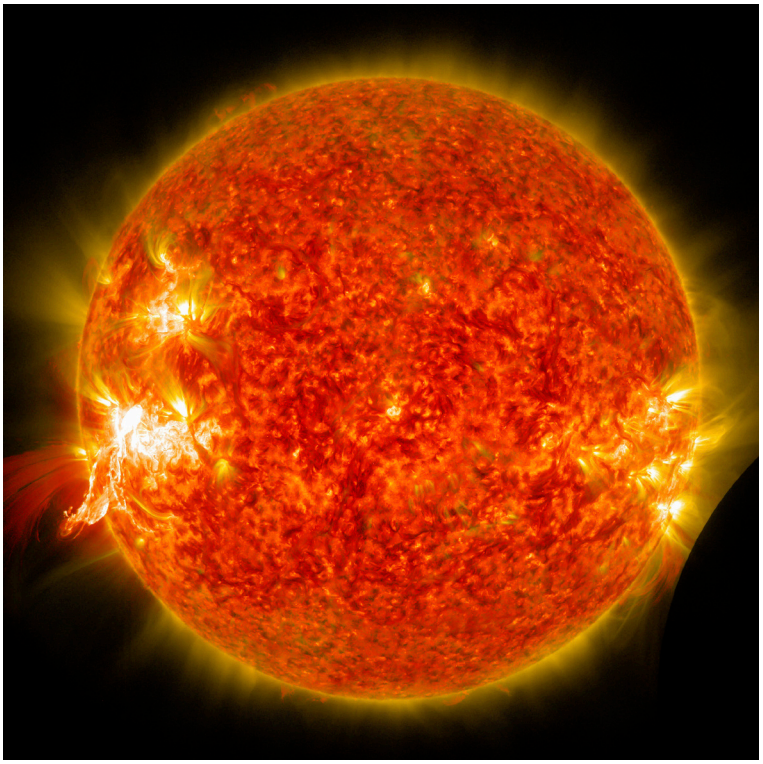


Credit: NASA/SDO

BACKGROUND INFORMATION cont'd

Flares

When the energy stored in magnetic fields (usually above sunspots) is released, it can cause giant explosions on the Sun called solar flares. Solar flares cause solar storms which affect satellite operation, communications and sensitive electronics here on Earth. They also pose a hazard to astronauts.



By Rawpixel Ltd - Eruption of a solar flare and a lunar transit captured by NASA's Solar Dynamics Observatory (SDO) on Jan 30th, 2014. Original from NASA. Digitally enhanced by rawpixel., CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=97439608

Scientists are constantly studying the Sun. There is a lot more to know!

Read more about the Sun (all websites accessed 21/3/22):

'Solar System Exploration', NASA Science website, https://solarsystem.nasa.gov/solar-system/sun/overview/ (26 October 2021)

'The Sun', NASA, Goddard Space Flight Center webite, https://imagine.gsfc.nasa.gov/science/objects/sun1.html (February 2014)

'What is the solar cycle?', NASA Science, Space Place, https://spaceplace.nasa.gov/solar-cycles/en/ (22July 2021)

'Sunspots and Sunspot Groups', Bureau of Meterology, Space Weather Services, https://www.sws.bom.gov.au/Educational/2/2/3/

'Curious Kids: why is the Sun's atmosphere hotter than its surface?', The Conversation website, https://theconversation.com/curious-kids-why-is-the-suns-atmosphere-hotter-than-its-surface-166747 (1 September 2021)

BACKGROUND INFORMATION cont'd

Watch some videos about the Sun (all websites accessed 21/3/22):

'Sun 101', National Geographic (5 mins), YouTube, https://www.youtube.com/watch?v=2HoTK_Gqi2Q (6 January 2018)

'Understanding the Magnetic Sun', NASA Goddard (1:56 mins), YouTube, https://youtu.be/2g1epPppIOM (30 January 2016)

'Two weeks in the life of a sunspot', NASA Goddard (1:33 mins), YouTube, https://youtu.be/SungFXUsoqw (4 August 2017)

'What are sunspots?', Science Channel (1:59 mins), YouTube, https://youtu.be/ZC2dfDS8g0Q (12 May 2015)

'A guide to Solar Flares', NASA Goddard (3:01 mins), NASA | X-Class, https://youtu.be/oOXVZo7KikE (10 August 2011)

'Sunspots migrating across the Sun', Wikimedia, https://upload.wikimedia.org/wikipedia/commons/0/00/Growing_Sunspots_Tracking_Closeup_-_February_2011.ogv

EQUIPMENT

You will need the following to complete this activity.

PART 1 - NOTE: This activity MUST be done with the supervision of a teacher due to the dangers posed by looking at the Sun.

- The telescope provided by your school
- A solar (also known as an H-alpha) filter correctly fitted to the telescope

OR

- The telescope provided by your school with **finder scope completely covered**
- A pen or pencil (optional)
- Large piece of white, stiff paper/cardboard
- Tripod (or similar) to attach the cardboard to
- A print-out of the Sun chart

PART 2

- The Internet

OBSERVATIONS

Each of these parts can be performed separately, or together. The sequence is optional.

PART 1

** Your teacher will set up the telescope safely before you use it, and will be present the entire time.

USING THE SOLAR FILTER

Looking through the telescope, the Sun may look redder than you expect it to. This is because of the solar filter that is protecting your eyes. The filter only allows through a very small portion of the light comes from the Sun. To be specific, light of wavelength 656.281 nm, which is red in colour.

Look closely at the face of the Sun, and at the edges of the Sun. Do you see any sunspots, flares or prominences?

Draw what you see on the Sun chart.

USING A PROJECTION ONTO PAPER

Alternatively, your teacher may have set up a telescope so that it shines an image of the Sun onto a piece of white card.

The Sun will appear as a white circle on the card. Sunspots will appear as dark patches. Prominences and flares will be more difficult to spot.

Draw what you see on the Sun chart.

PART 2.

You will need a computer to complete this section.

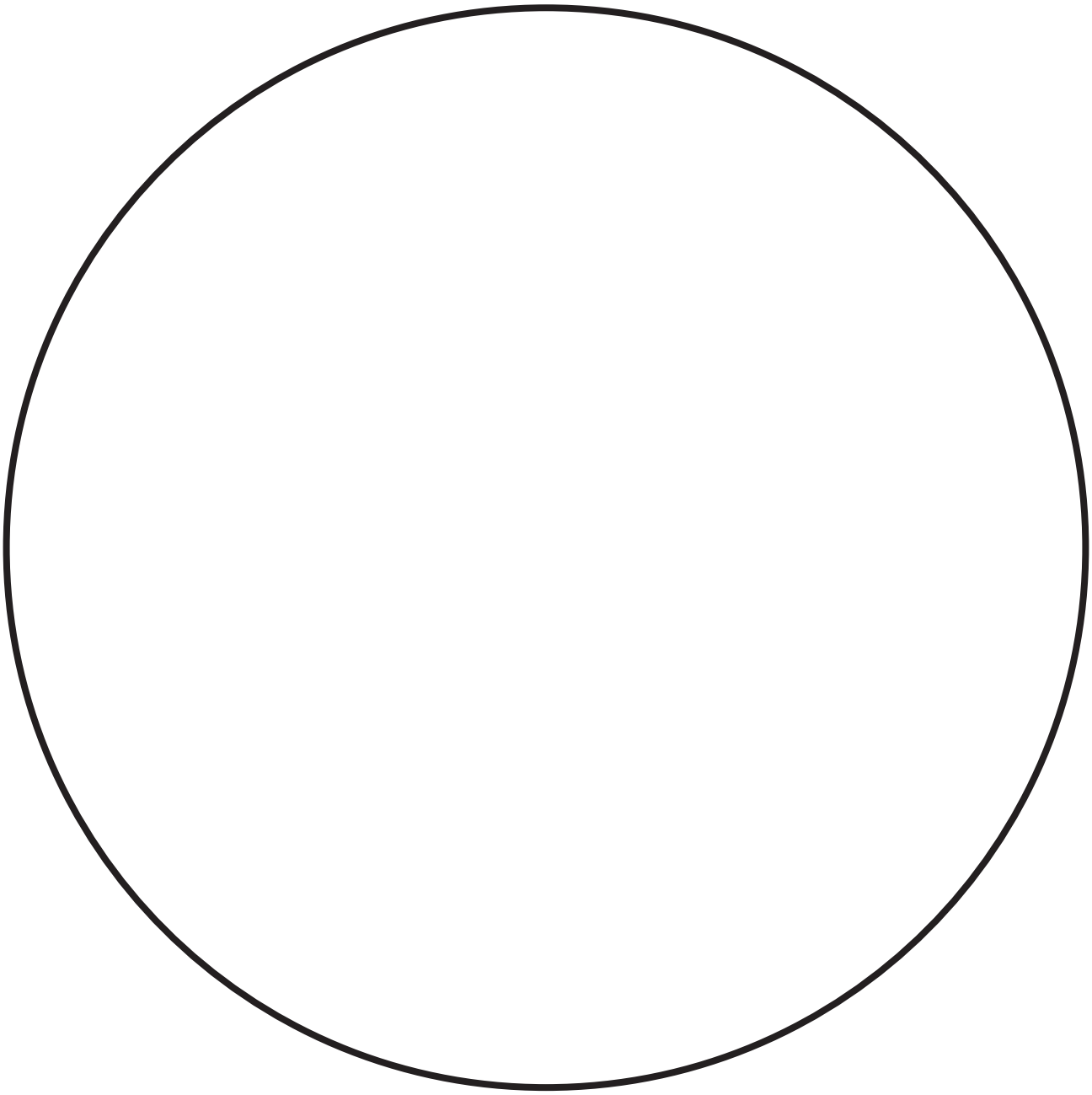
1. Download the daily total sunspot numbers (from 1st January 1818 until now) from here: https://www.sidc.be/silso/INFO/sndtotcsv.php (WDC-SILSO, Royal Observatory of Belgium, Brussels).

2. Plot these on a graph, with the number of spots on the y-axis and the date on the x-axis.

3. Study the trend you can see. Approximately many sunspots should be visible today?

4. Use your solar telescope or download an image from today taken by the SOHO (Solar and Heliosphere Observatory) (https://soho.nascom.nasa.gov/data/realtime/realtime-update.html) to check your prediction.

SUN CHART



FOLLOW-UP QUESTIONS

Visit the SOHO Movie Theatre page of the SOHO website (https://soho.nascom.nasa.gov/data/Theater/) and download images from the past **week** to make a movie. Choose **hmiigr** (visible light) in the 'image' drop-down list in order to download photos in the visible spectrum. 1. How do SOHO's and SDO's images compare to your observations? Think about the number of sunspots you saw compared to SOHO's and SDO's images. What advantages do these space telescopes have over you?

2. Choose any month's data from 2014, a solar maximum year.

a) How does that year's sunspots differ from this year's?

b) Watch a sunspot as it moves left to right in the movie. What do you notice about it? How many days did it take from appearing on the left to disappearing on the right?

3. Now download the **hmimag** images for the same time period. You are now looking at the Sun's magnetic field. How is this different, and the same, from the images taken using visible light? Why do you think scientists study the Sun's magnetic field?

EXTENSION QUESTIONS

1. The Carrington Event in 1859 was the largest solar storm ever observed. Read this article (https://cosmosmagazine.com/space/astrophysics/beware-solar-storms-scientists-warn/) and answer these questions.

a) If an event like this happened tomorrow, how would your daily life be affected?

b) If you were on the safety committee, what recommendations would you make to prepare your school to survive a similar event?

2. Watch this hour-long episode of ABC's Catalyst program (https://www.abc.net.au/catalyst/solar-storm-a-warning-from-space/13776860) called 'Solar Storms: A Warning From Space' and record three facts that surprised you.