David Sang

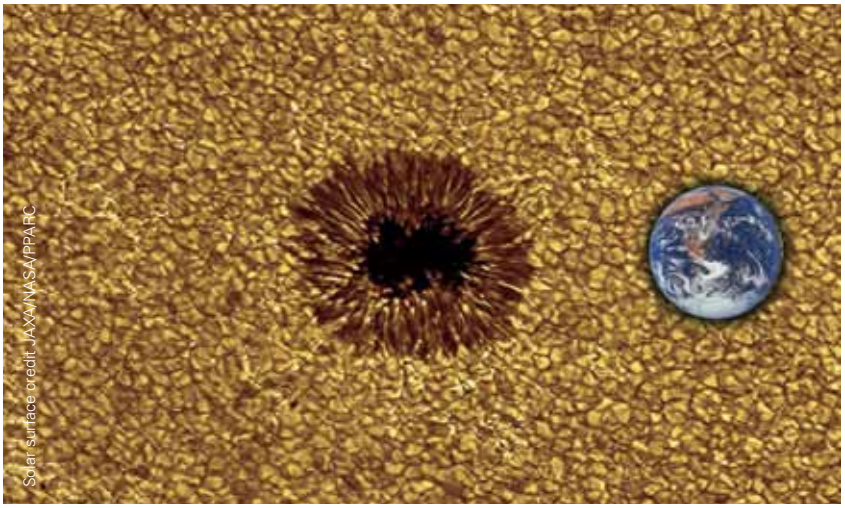
Solar surface
Learning from sunspots

The surface of the Sun – a sunspot as seen by the Japanese Hinode solar observatory.

5800 K is approximately 5500°C. Sunspot temperatures are between 3000 K and 4500 K.

How do you think of the Sun? As a searingly hot ball of glowing gas? That's right, but there is more to it than that. For over two millennia, people have observed darker patches on the Sun's bright surface. These are sunspots.

The Sun's surface is hot, about 5800 K. Sunspots look dark because they are a thousand degrees or so cooler than their surroundings – that means they are still pretty hot. They are regions of strong magnetic activity. The picture at the top of this page shows gases leaping upwards, following the lines of the Sun's magnetic field.



A single sunspot, photographed by the Hinode spacecraft. The granular surface of the Sun arises from convection currents; hot gases well up from below (lighter areas) and cooler gases sink back down (darker areas). The Earth is superimposed for scale.

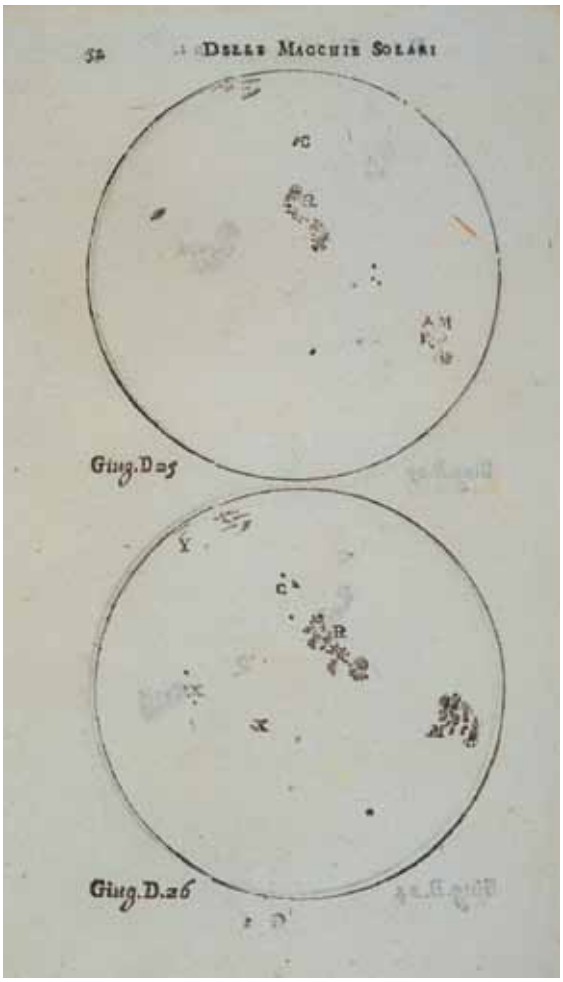
Early observations

Sunspots were recorded by ancient Chinese observers many centuries before they were noted in the west. It's thought that this may have been for a cultural reason. In the west, it was considered that the Sun was a heavenly body and thus must be perfect. Any defects on its surface would be inconsistent with the idea of its perfection.

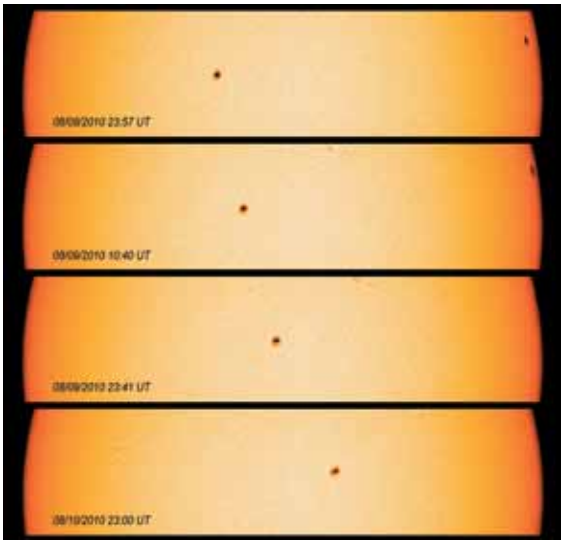
The double picture on the left shows Galileo's drawings of the Sun, made on consecutive days. He got into a hot debate with the German astronomer Christoph Scheiner (pictured on the opposite page) about the nature of sunspots. Scheiner, a devout Jesuit, claimed that the Sun was unspotted and that the apparent spots were, in fact, planets passing in front of the Sun.

Over several days, Galileo noticed that the pattern of spots moved across the Sun's disc. From this he deduced that the Sun is spherical and that it rotates.

Careful observations have since shown that the Sun rotates more rapidly at its equator than at the poles. Its period of rotation is about 25 days at the equator and 35 days at the poles. That's good evidence that the Sun is not a solid object.



Galileo made these drawings on 25 and 26 June 1611. As the Sun rotates, you can see the group of spots gradually coming into view.



In this recent sequence of images, you can see one sunspot moving steadily to the right while another disappears on the right. You can use these images to estimate the rate of rotation of the Sun.

Solar activity

Sunspots give a good guide to the activity of the Sun. You might expect that, since sunspots are cooler than their surroundings, a large number of spots corresponds to a cooler Sun with less energy output. In fact, the opposite is true.

At present, the Sun's face is almost spotless (that's very unusual), and so its energy output is relatively low.

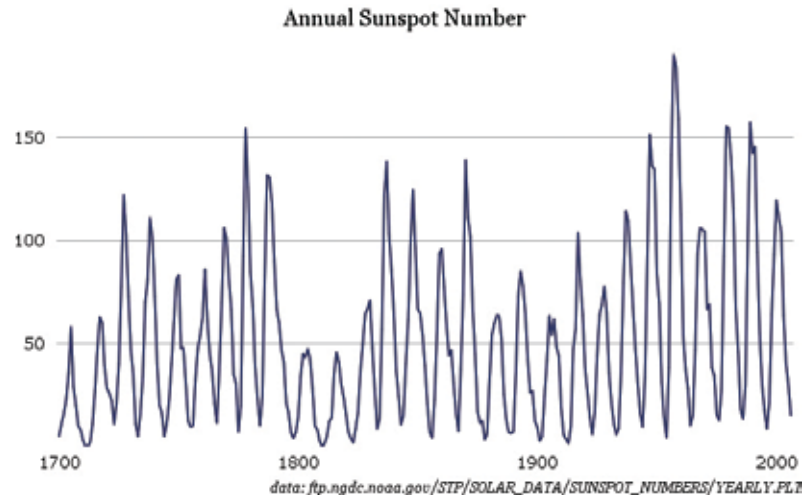
Astronomers have counted and tracked sunspots for over 400 years. This means that we have good data for sunspot numbers and can look for patterns in the data. The graph shows the cyclical pattern in sunspot numbers, with 27 complete cycles in 300 years, giving a period of roughly 11 years.

The graph shows that there are other, longer-term trends in sunspot numbers, indicating that the Sun has long periods of greater and lesser activity

Observing sunspots

It's dangerous to look directly at the Sun. Fortunately, we have a reflex action which makes it impossible to do so. However:

Under no circumstances should you look directly at the Sun, either with the naked eye or with binoculars or a telescope.



Three centuries of sunspot observation – although the Sun's activity is clearly cyclical, there are also long-term variations.

Here is how to observe sunspots safely:

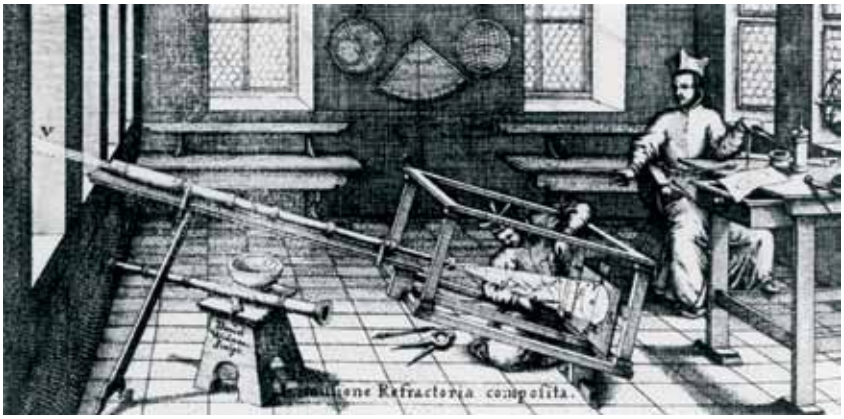
Mount a pair of binoculars (or a telescope) on a tripod. Tip the binoculars so that the larger objective lenses are directed towards the Sun.

Hold a piece of stiff white card a few centimetres behind one of the eyepiece lenses. If your alignment is correct, you should see a bright spot (an image of the Sun) on the screen. Adjust the alignment of the binoculars until you do.

Move the card slowly backwards, away from the binoculars, keeping the spot on card. It should widen into a circular image. You may need to adjust the focus of the binoculars.

The bigger the image of the Sun on the card, the bigger will be the sunspots. However, a bigger image will also be dimmer because the light is spread over a bigger area. To overcome this, mount the card screen in the base of an open-topped cardboard box. Tip the box so that the image on the screen is circular.

You can use this arrangement to track the changing numbers and positions of sunspots over a period of days – weather permitting, of course.



The German astronomer Christoph Scheiner was among the first westerners to study sunspots. Here he and his assistant are using a telescope to observe spots in the way described on this page.

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