Sunspots

Reversed Polarity

When a character in TV science fiction faces a tough technical problem, one solution always seems to work: reverse the polarity.

That may not fix problems in real life, but for the scientists who study the Sun, reversing the polarity is a big event. It signals that the Sun has started a new 11-year cycle of magnetic activity.

A new cycle began in January, when telescopes on the ground and in orbit measured a small sunspot — a relatively cool, dark magnetic "storm" on the surface of the Sun. The observations showed that the polarity of the sunspot was reversed from that of the sunspot before it.

As the Sun spins on its axis, different layers of hot gas spin at different rates. That generates a powerful magnetic field around the Sun.

Over a period of several years, the lines of magnetic force get twisted and tangled. That produces many more sunspots. The lines can also cross each other, creating "short circuits" — powerful explosions of energy and particles. These outbursts can disrupt communications and electrical systems on Earth.

At the end of a cycle, the Sun's magnetic field flips over: magnetic north becomes magnetic south, and vice versa.

The Sun has been quiet for the last few years. But the start of a new cycle means that it'll get busier in the years ahead. The new cycle should peak around 2012, and end around 2019 — when scientists will once again be waiting for the Sun to reverse polarity.

This is the transcript of a StarDate radio episode that aired June 13, 2008. Script by Damond Benningfield, ©2008.

The Sun is a huge sphere of gas. The visible layer of the Sun, which we view as the surface, is the photosphere. Its temperature is about 6,200 degrees Celsius (10,340 degrees Fahrenheit). Above the surface are the chromosphere and corona. Sunspots are some of the most noticeable features of the Sun.

Materials

- Telescope (with finder covered)
- Piece of white cardboard mounted on a tripod

Preparation

The easiest way to position the telescope (since the finder is covered and you don't want to "sight" along the side) is to move the telescope until its shadow is smallest. If your telescope doesn't have a special motor, the image will slowly track across the cardboard as Earth rotates. You may use binoculars, although too much sunlight can cause heat to build up inside the binoculars and damage them. For binoculars, the standard size (7x35) works satisfactorily.

Experiment

Draw a circle around the edge of the Sun on some paper placed over the cardboard. Now quickly sketch the positions and sizes of all the visible sunspots. Write the time and date on the edge of the paper. Repeat your observations over several days or weeks. (If you trace the images on very thin paper, you can later overlap them to see changes.) Be careful to include the fine detail that surrounds some sunspots. An alternative is to download images from web sites each day to use for this activity or to compare to your own data.

Analysis

1. Can you identify any sunspots or sunspot groups? Did they change shape, size, or position over time?

2. If you move the cardboard screen farther away, what happens to the image?

3. (Advanced) The diameter of the Sun is about 1.4 million km (864,000 miles). Measure the diameter of your image and estimate the physical size of your largest sunspot. Earth is 12,700 km (7,900 miles). Compare your largest sunspot with the size of Earth. Find the size of the sunspot with a proportion equation:

$$\frac{1{,}390{,}473 \text{ km}}{\text{diameter of Sun's image in mm}} = \frac{\text{sunspot diameter in km}}{\text{sunspot image in mm}}$$

4. Why are sunspots dark?

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SAFETY WARNING

Do not look directly at the Sun, especially with a telescope. You can **PERMANENTLY DAMAGE YOUR EYES!** When working with students, it's best to cover the finder telescope completely so that they cannot look through it. Never trust filters that go into the eyepiece or that cover the objective.

ANSWERS

1. Sunspots change size and shape over a period of days. The Sun rotates on its axis in about 25 days (its equator rotates faster than its poles). Observations taken over a period of several days should show this.

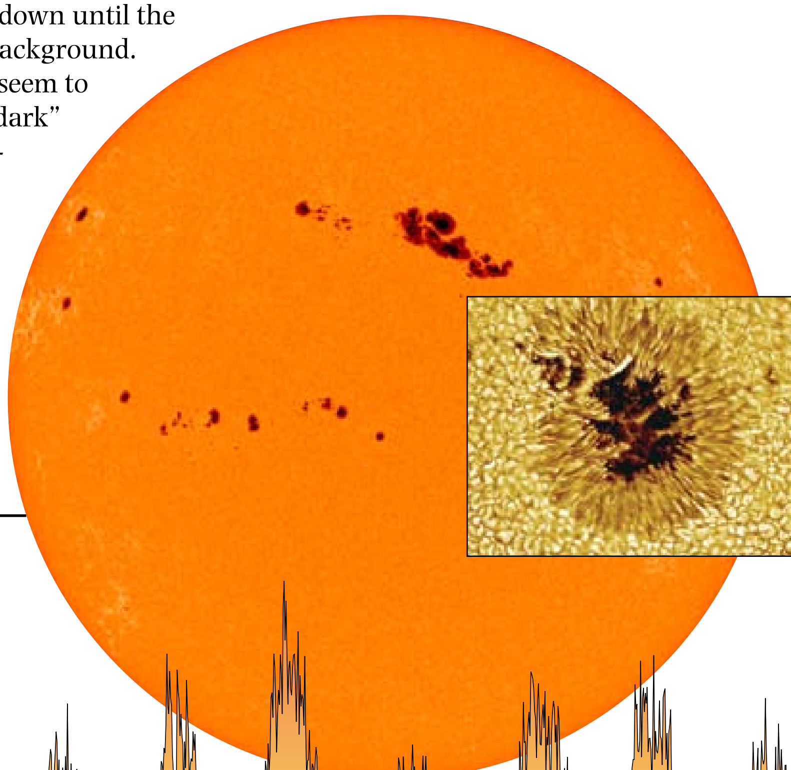
2. As you move the cardboard screen back, the image becomes fainter and larger.

3. Large sunspots can equal Earth in diameter.

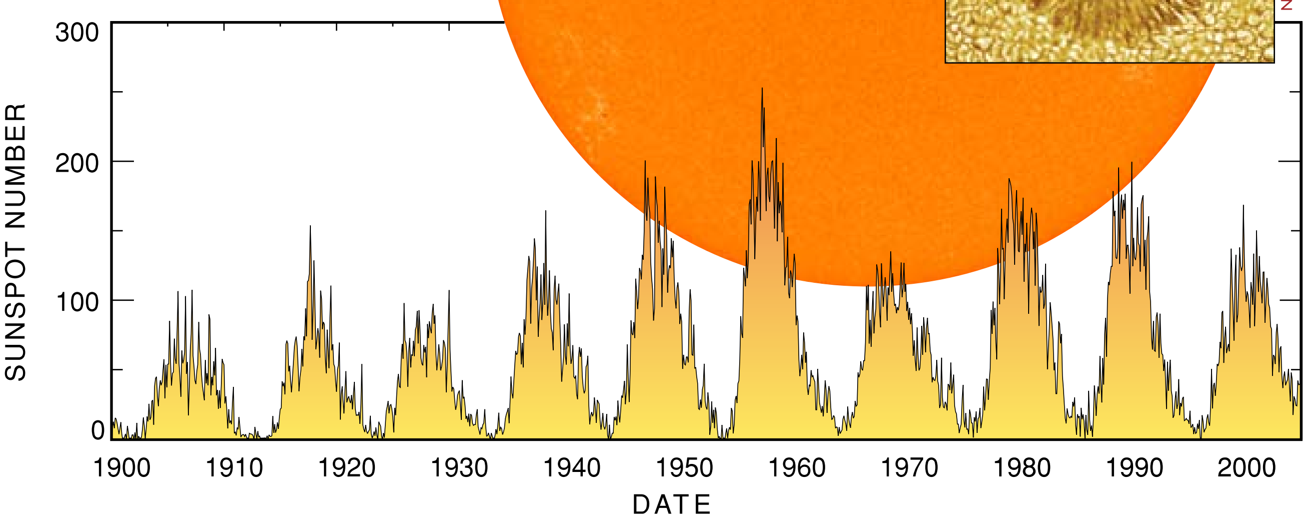
4. Do the following demonstration to illustrate that sunspots appear dark since they are cooler than the photosphere (they are about 4,500 degrees C/7,100 degrees F). Attach a dimmer switch or rheostat to a clear incandescent light bulb. Place the bulb on its side on an overhead projector. With the projector on, focus the bulb so that the filament appears as a sharp silhouette on the screen. Turn up the power until the filament glows against the screen, then turn the power down until the filament is just barely dark against the background. Turn off the projector and the bulb will seem to glow dimly by itself. Sunspots are only "dark" with respect to the hotter, brighter background of the photosphere.

NATIONAL SCIENCE EDUCATION STANDARDS

- Content Standard in 9-12 Science as Inquiry (Abilities necessary to do scientific inquiry, Understanding about scientific inquiry)



Spanning more than 13 times the total area of Earth's surface, this large group of sunspots photographed in 2001 coincided with the peak of the 11-year solar cycle (see sunspot number chart below). Inset: Close-up view of a typical sunspot.



Sunspots

Subjects: Our Solar System

Grade Levels: 6 - 12

Sunspots are some of the most notable features of the Sun. Use a telescope to track the changes in position and shape of sunspots over time. This activity requires adult supervision.

Texas Essential Knowledge and Skills

Science:

§112.18-20 grade 6-8 (b)-4(A) use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum.

§112.18-grade 6 (b)-11(A) describe the physical properties, locations, and movements of the Sun, planets, Galilean moons, meteors, asteroids, and comets.

Astronomy, grade 9-12:

§112.33(c)-10(A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun

§112.33(c)-10(C) describe the eleven-year solar cycle and the significance of sunspot

§112.33(c)-10(D) analyze solar magnetic storm activity, including coronal mass ejections, prominences, flares, and sunspots.