Explore the Sun Cards

What's this activity about?

Objective:

- Provide visitors with ways to understand more about the Sun and its magnetic fields
- Provide presenters with illustrations to help answer visitors' questions about the Sun

Presenters: Cards can be used with or without a club facilitator.

Visitors: Cards are appropriate for families with older children, the general public, and school groups in fifth grade and up. Any number of visitors can participate.

Duration: A few minutes, up to a half hour, depending on the number of topics covered.

Materials:

What materials do I need?

Set of 11 *Explore the Sun* cards with accompanying props (optional): Sombrero, UV beads, Sunspot Tube, and Solar Viewer. If using this activity for the first time, see Activity set up, page 2.

Alternately, the remaining cards can be used without the cards that require props. This requires no set-up.

Instructions for "Why Do Sunspots Look Dark?" tube: cut below this line and remove © and below

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Why do Sunspots Look Dark?

INSTRUCTIONS:

1. **Let the Sun shine directly into the open end of the tube for 10 seconds.**
2. **Closing one eye, hold the tube over your open eye & point it toward the sky.**
   Do you see some dark spots? Those represent sunspots.
3. **Use your hand to cover the end of the tube, blocking the light from the sky.**
4. *See the spots glowing brightly!*

Sunspots are bright, but the Sun's surface is much brighter, making sunspots look dark.

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Copies for educational purposes are encouraged.
Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

Activity Set Up:

Within the "**Explore the Sun"** cards, you'll find 3 that require a little extra assembly before being used for the first time:

1) "**Can you see UV light?"** For this one you'll also need a shoelace, 4 UV sensitive beads, and a hat.
   - Put one bead on a string then put the string through the hole in the card and then back through the bead, as shown on the right. The card should be in the middle of the shoelace.
   - Then thread the shoelace through the top of the sombrero in two places.
   - Place three more UV beads on one end of the shoelace, under the hat and then tie the ends together in a secure knot, as shown here.

2) **"Why Do Sunspots Look Dark?"** You will need a 2"/5cm wide short cardboard tube, a cap for the tube, and a cord to attach it to the card.
   - Tape the Instructions Label from Page 1 on the side of the tube.
   - Place a few glow-in-the-dark stickers on the inside of the cap.
   - Put one end of the string in the tube and place the cap on to secure it in place. You may want to tape it to the side so it doesn't flip up. Tie the other end of the cord to the card.

3) "**Why are We Looking at the Sun?"** This card can be attached to a Solar Viewer card or solar glasses by punching a hole, as shown here.

Where do I get materials?

1. Print double-sided cards from this file, pages 4-25.
2. UV beads can be found many places including Educational Innovations: www.teachersource.com
3. Sombreros or small hats can be found at craft stores. Alternately, old baseball caps can work.
4. Solar Viewers can be ordered online. Search for Solar Viewers or eclipse glasses.
5. Cardboard mailing tubes can be found at shipping centers.
6. Glow-in-the-dark stickers can be found online. Small dots are best.

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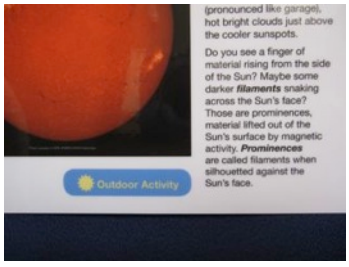
Activity Ideas

The *Explore the Sun* cards can be used in many ways. Use them all or choose a subset that pertains to your topic or theme that day. They are designed to be self-explanatory, so visitors can explore them on their own in a variety of settings. Alternately, they can be used in groups or individually as facilitated explanations. Each card has an eyelet so you can tie them to the leg of an observing table or tie them to a fence or just tie them together to keep them as a set.

Here are some suggested ways to use the cards:

- Hang in a line on a rope tied to a fence or other display area.
- Hand out to visitors waiting in line at the telescope.
- Use as props to illustrate answers to questions raised by visitors.
- Pick a few to present to visitors at a display table or at the scope.

These cards use analogies to explain visible phenomena, or set expectations of what visitors might see at the telescope. They explain filters and the solar cycle and expand on the concepts of magnetism. Some of the cards need to be used outdoors. You'll see this small Sun symbol on the back of those, indicating that it's an Outdoor Activity.



Some cards have QR codes, squares with a pattern of dots. They are codes that can be decoded using a smartphone. If you're not familiar with these, check the **Background Information** for an introduction.

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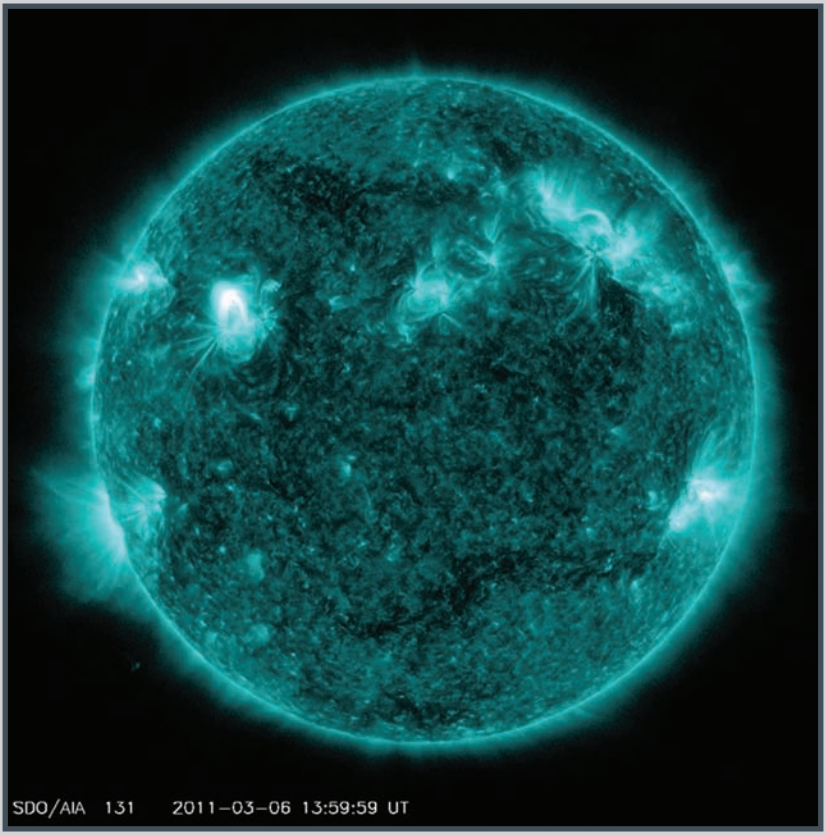
Can You See UV?

Can you SEE the Sun's ultraviolet radiation (UV) that can burn your skin?



Special cameras installed on spacecraft can detect UV energy and are used to produce images like this.

EXPLORE THE SUN!

Can you see UV (ultraviolet)?

No, our eyes cannot detect UV.

Too much UV can damage your skin and eyes. *If you're outside right now, how much UV is hitting you?*

See the hat near this card? What color is the bead on top of the hat? Peek under the hat — what color are those beads? Those are all UV beads, which turn from white to purple when exposed to UV light. The more UV is hitting them, the darker the beads get.

So do you see how a hat and sunglasses can protect you from UV radiation?

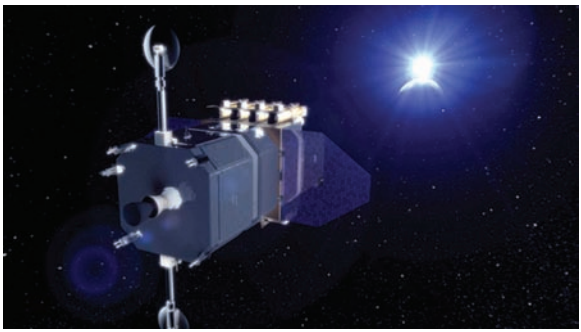
National Aeronautics and Space Administration

No Telescope?

No telescope with a proper filter to view the Sun? What can you do?

EXPLORE THE SUN!

See the Sun from a telescope in space!

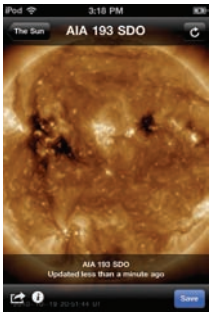


If you have a mobile device you can connect to the Internet, download NASA's *Space Weather Media Viewer* app or go to the Solar Dynamics Observatory (SDO) website to see the Sun as it looks right now.
http://sdo.gsfc.nasa.gov/data/

Use your smartphone to see the Sun Now!

If you ARE using a properly filtered telescope to look at the Sun, use the app or website to compare what you see in the telescope right now to images seen by space telescopes now!

NOTE: All times on the images are in Universal Time.

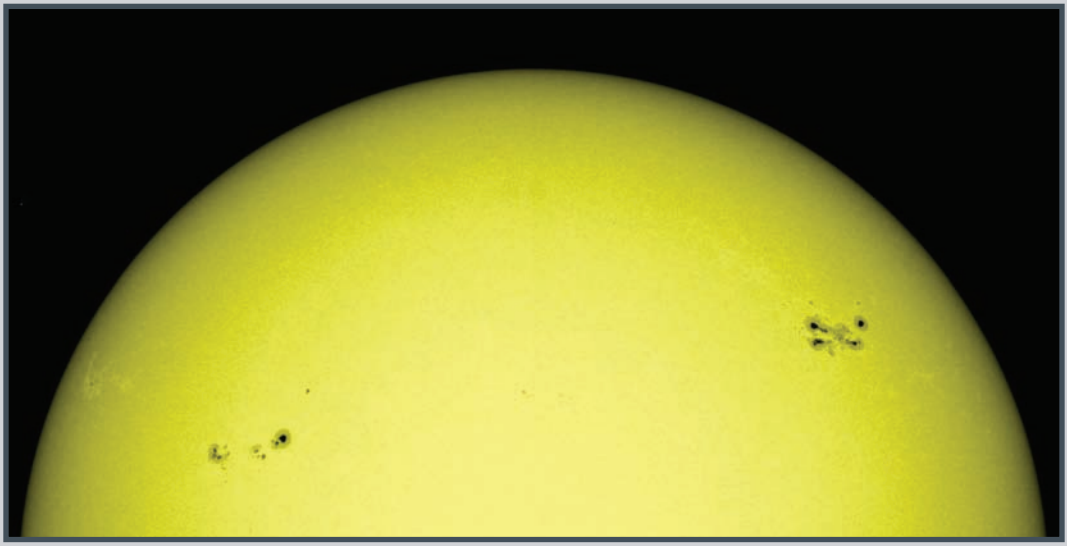


Get the free Space Weather Media Viewer app available for smartphones.

National Aeronautics and Space Administration

What Are Those Spots?

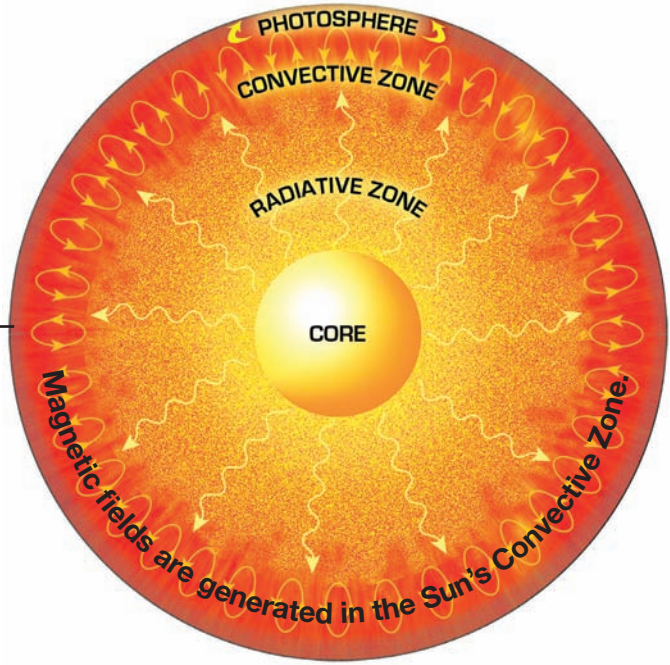
Did you see dark spots on the Sun today?

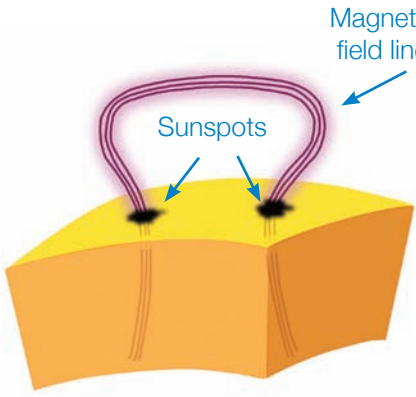


EXPLORE THE SUN!

What are those dark spots on the Sun?

Those are sunspots!





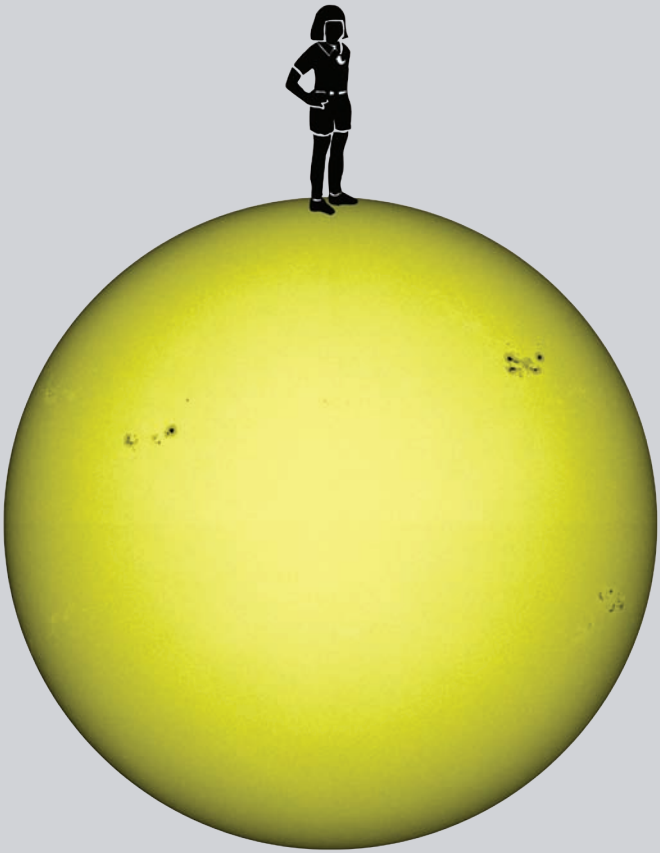
Like ropes, the magnetic field lines inside the Sun become twisted. Part of the magnetic field line may pop through the surface of the Sun, seen as two cooler spots on the Sun's surface, called **sunspots**.

The strong magnetic field that forms the sunspot pushes aside the hotter gases rising up from deep in the Sun, so the sunspot becomes cooler than the surrounding surface.

Use your smartphone to watch an animation of a pair of sunspots forming from magnetic fields lines poking through the Sun's surface
or visit http://www.astrosociety.org/sunspotsform.mov

National Aeronautics and Space Administration

If You Could Stand the Heat, Could You Stand on the Sun?



EXPLORE THE SUN!

Can you stand on the Sun?

No, you cannot stand on the Sun.

Why not? Well, can you stand on a cloud?

We can see the “surface” of a cloud like we can see the “surface” of the Sun.

A cloud is made of gases, not solids. The Sun is gaseous too.

Our bodies are much denser than a cloud and much denser than the gases at the surface of the Sun. So we would just fall through.

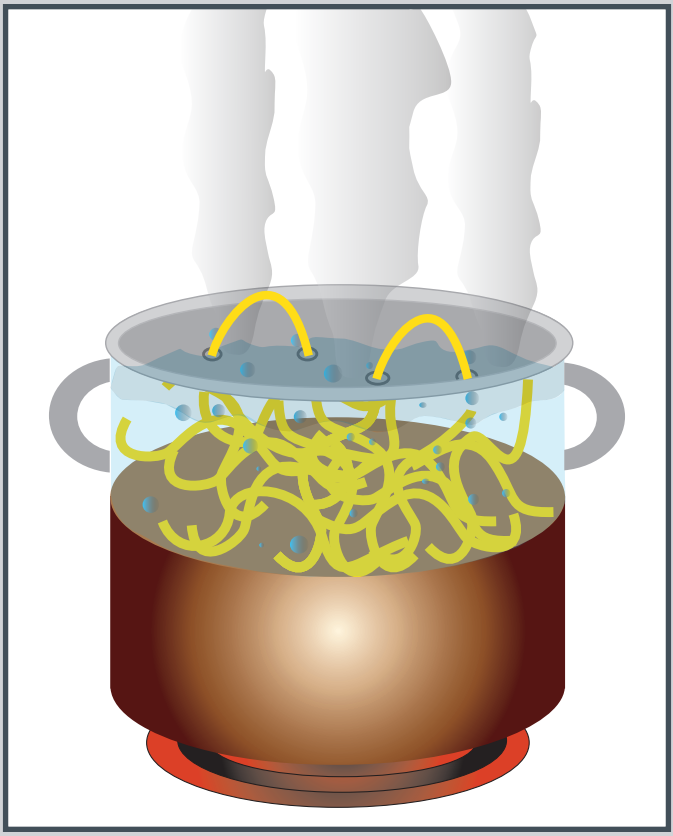
But in the Sun, we’d just keep falling toward the center. Of course we’d be vaporized long before that…

Use your smartphone to watch a music video about the Sun.

http://www.youtube.com/watch?v=3JdWISF195Y

National Aeronautics and Space Administration

How is the Inside of the Sun Like a Pot of Boiling Spaghetti?



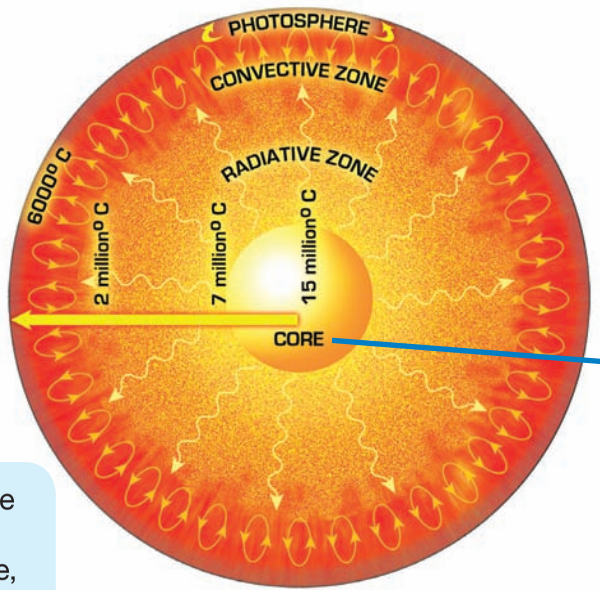
EXPLORE THE SUN!

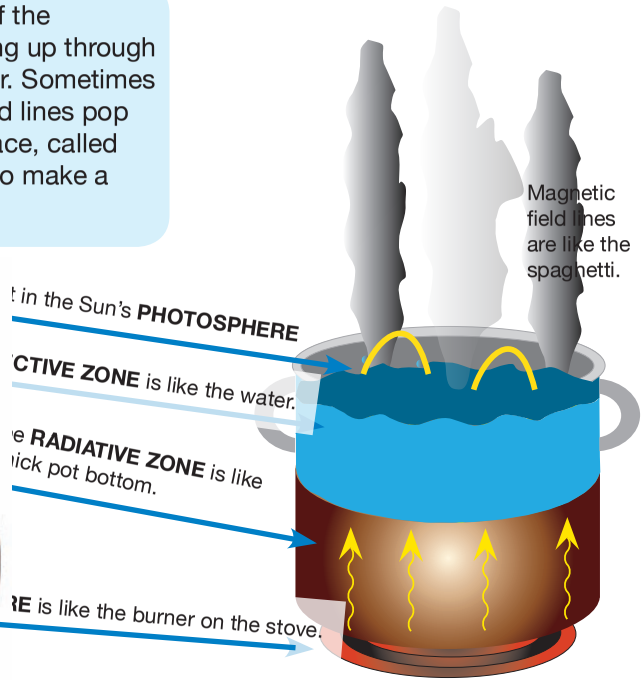
Let's use a thick-bottomed pot sitting on a stove as a model for the interior of the Sun. The pot is filled with boiling water and some strands of spaghetti.

3. Now we move out into the **CONVECTIVE ZONE** which is like the water boiling in that thick pot. Deep in the Sun's boiling convective zone is where the magnetic field lines are generated and then get twisted up (kind of like the strands of spaghetti in the boiling pot of water).

4. Imagine a strand of the boiling spaghetti looping up through the surface of the water. Sometimes the Sun's magnetic field lines pop through the Sun's surface, called the **PHOTOSPHERE**, to make a pair of **SUNSPOTS**.

2. The core blends into the **RADIATIVE ZONE** where energy continues to be transferred out through radiation. Like the thick bottom of the pot, the material is still very dense, but the heat still transfers up through the bottom of the pot.





1. You can think of the Sun's dense **CORE** as the burner on the stove, generating energy.

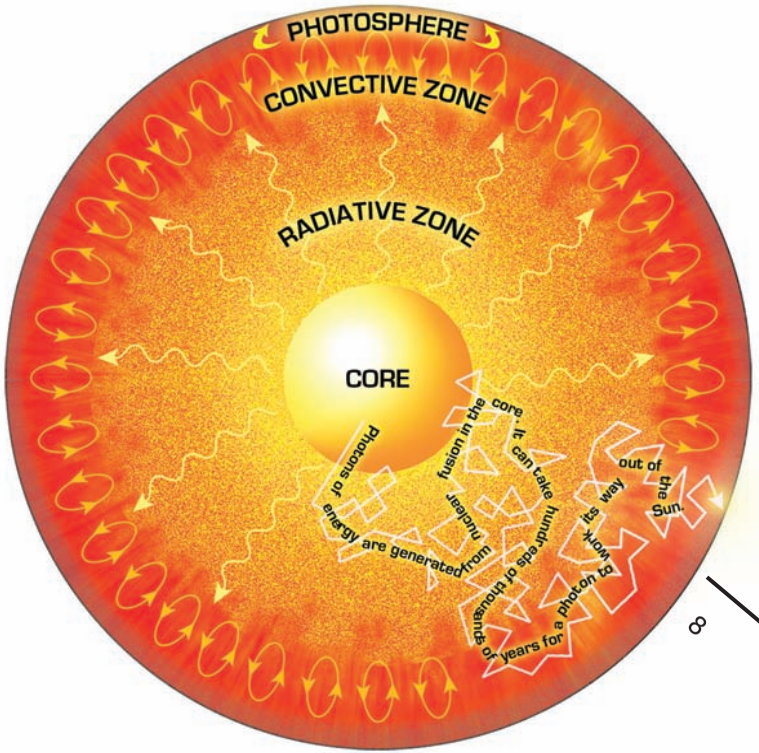
www.nasa.gov

National Aeronautics and Space Administration

How Does Energy Escape the Sun?

It's like trying to work your way out through a large crowd of people.

EXPLORE THE SUN!



How Does Energy Escape the Sun?

Very slowly.

Imagine being stuck in the middle of a large, deep crowd of people, trying to work your way out. In the Sun's dense core, packets of energy called photons are generated by fusing hydrogen into helium. The core of the Sun is so dense that a quart (or liter) of it would weigh more than a person.

But then each photon has to work its way out through dense layers of material inside the Sun. It can take *hundreds of thousands of years* for those photons of energy to escape the Sun.

Once out of the Sun, though, that energy zips across the 93 million miles to Earth in about 8 minutes to get to work warming our planet, driving our weather and making our plants grow.

8 minutes to reach Earth

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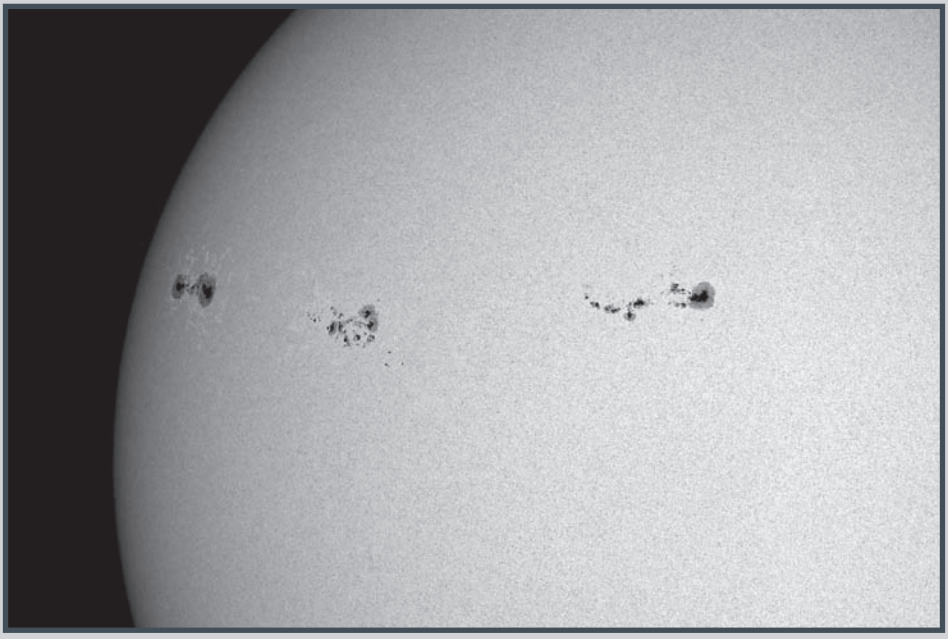
Why Do Sunspots Look Dark?



EXPLORE THE SUN!

Why Do Sunspots Look Dark?

The brightly glowing photosphere of the Sun is hot — about 6,000°C (10,000°F). Sunspots are somewhat cooler — about 4,000°C. By contrast, the cooler sunspots appear darker.

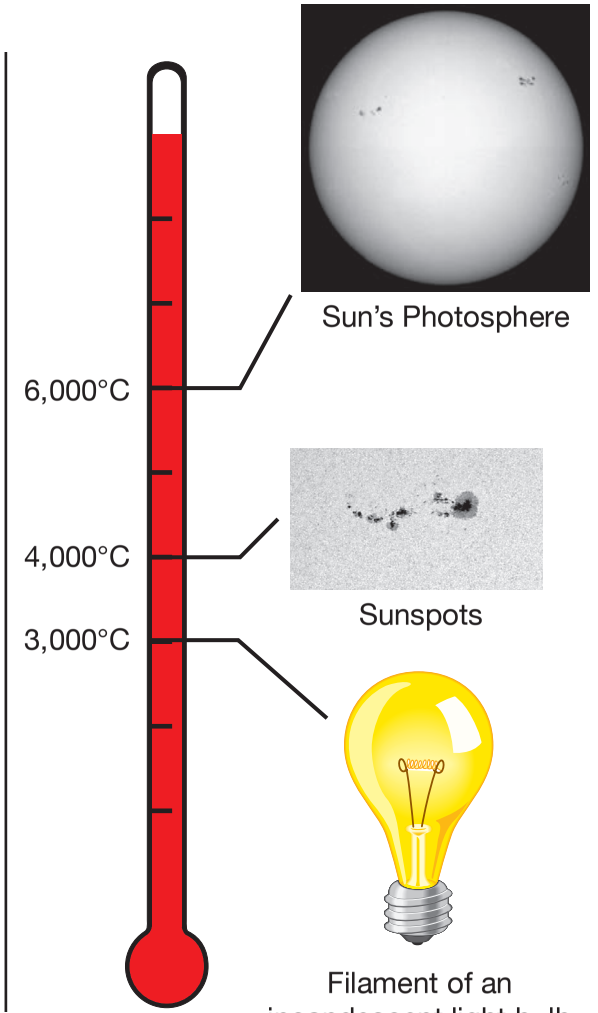
But is 4,000°C cool?!

The filament inside an incandescent light bulb can be hotter than 3,000°C and clearly produces plenty of visible light.

So sunspots are actually quite bright.

In fact, if we could block out all of the light from the normal photosphere of the Sun and just allow the light from sunspots to come through, our daytime sky would appear almost as bright as a cloudy day.

Outdoor Activity



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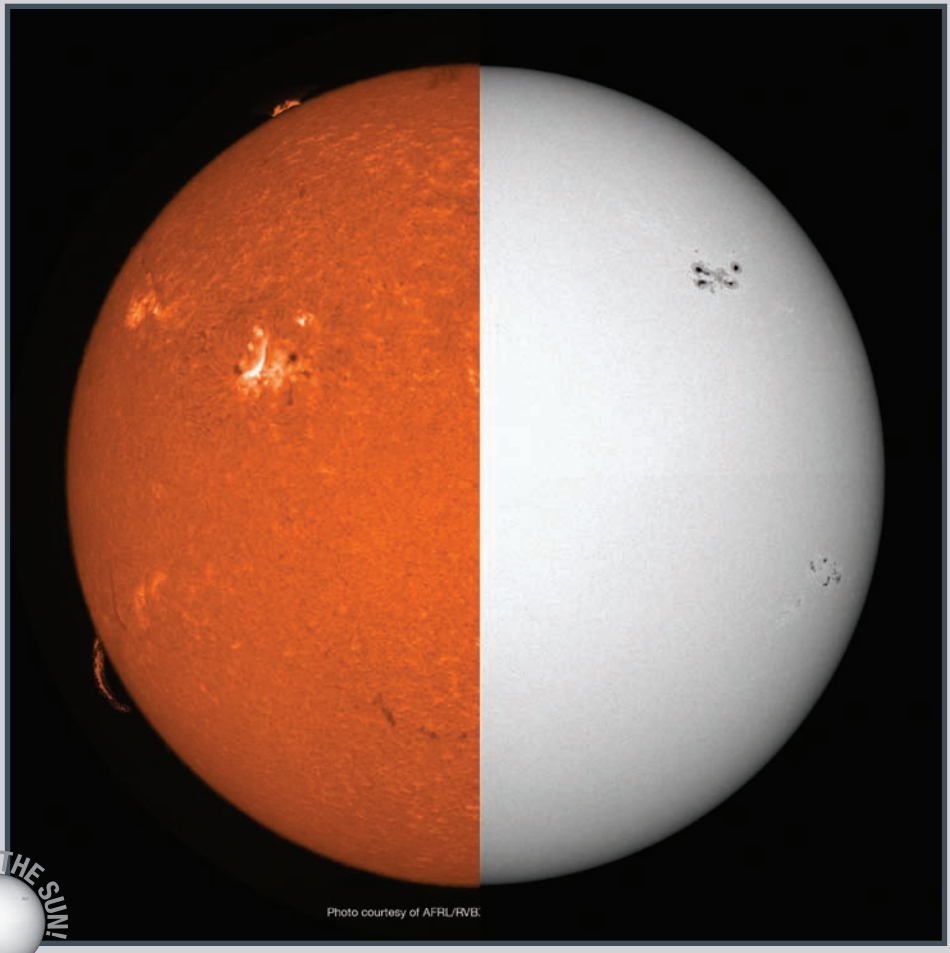
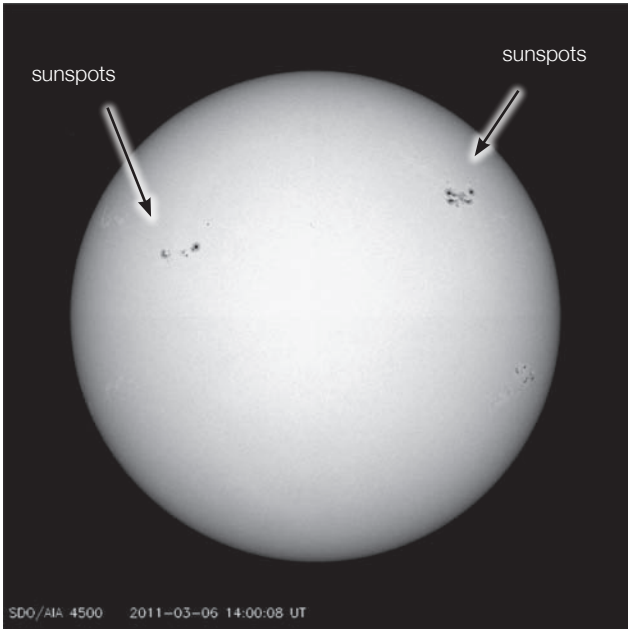
National Aeronautics and Space Administration

What might you see on the Sun today?



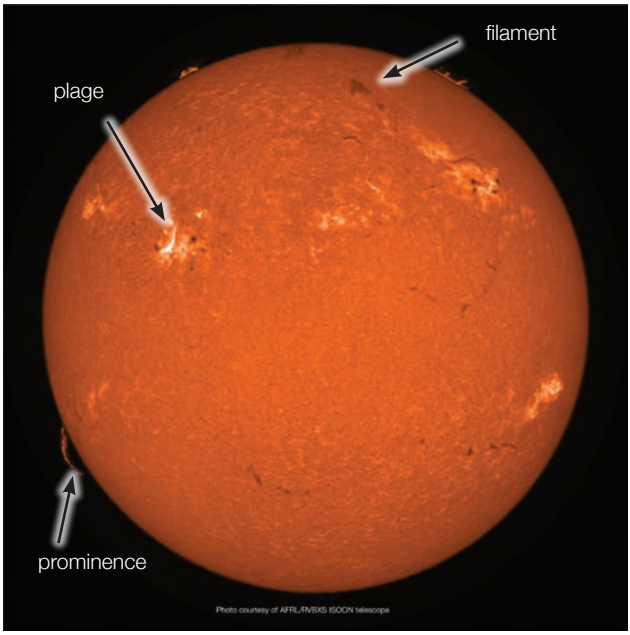
EXPLORE THE SUN!

If you look at the Sun through a properly filtered telescope, you may see some of these features caused by the Sun's magnetic activity.



Looking though a telescope with a white light filter…

Do you see any dark spots on the Sun? Those are ***sunspots***. They are caused by twisted magnetic field lines popping through the Sun's surface.



Looking through a telescope with an H-alpha filter...

Do you see any of those dark sunspots? Are there brighter areas around them? Sunspots are surrounded by bright areas called ***plage*** (pronounced like garage), hot bright clouds just above the cooler sunspots.

Do you see a finger of material rising from the side of the Sun? Maybe some darker ***filaments*** snaking across the Sun's face? Those are prominences, material lifted out of the Sun's surface by magnetic activity. ***Prominences*** are called filaments when silhouetted against the Sun's face.

Outdoor Activity

National Aeronautics and Space Administration

Why are we looking at the Sun? Isn't that dangerous?

R. Christian

EXPLORE THE SUN!

Safe Solar Observing

It is indeed dangerous to look at the Sun without the proper protection for your eyes. Don't ever look directly at the Sun through a telescope or in any other way, unless you have the proper filters.

Which of these can you use to safely look at the Sun?

Sunglasses

Paul Deans

Telescope or binoculars with solar filter

Solar viewer cards or glasses

Sunspotter

Unfiltered telescope

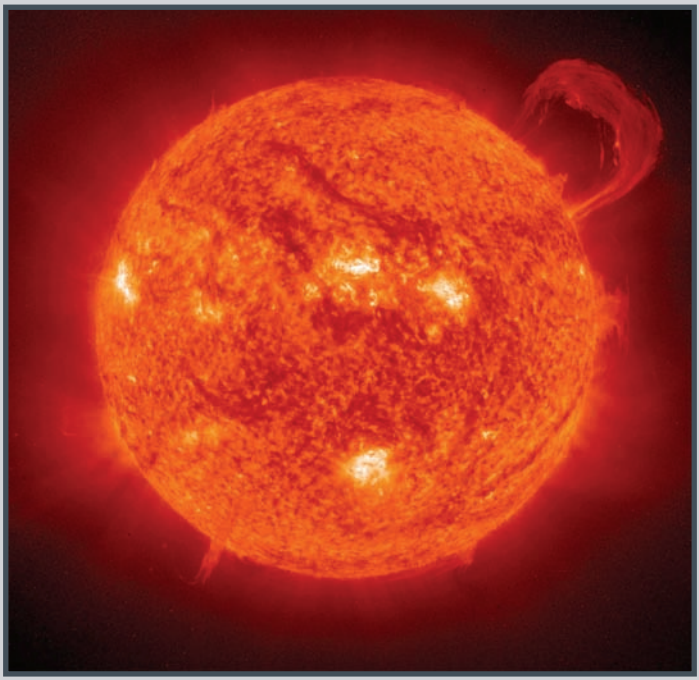
Mylar balloon

Use your smartphone to learn more about safe solar observing or visit http://youtu.be/BDwMEG-UW-4

Outdoor Activity

National Aeronautics and Space Administration

Magnetic activity gives the Sun its dynamic features.



SOHO (ESA & NASA)

How do *you* use magnetism?

EXPLORE THE SUN!

Everyday Magnetism

Without dynamic magnetic fields, the Sun would be pretty bland to observe. Magnetism also keeps life on Earth pretty interesting. In fact, life without magnetism would be pretty dull. Which of the things to the right uses magnetism?

Answer: All of them!

1. Magnets are in the starter motor and the alternator of a car. An electric car's motor uses magnets.
2. Electronic compasses in many smartphones can detect the Earth's magnetic field.
3. In stereo speakers, alternating currents through a wire coil located inside a magnet cause the coil to vibrate which produces sound.
4. Credit cards have magnetic strips that store information.
5. A computer disk drive uses magnets to store information.
6. Electric current causes magnets in a fan's motor to rotate, making the blades spin.

Where else do you encounter magnetism?

1. Car

2. Cell Phones

3. Stereo Speakers

4. Credit Cards

5. Computer Disk Drive

6. Electric Fan

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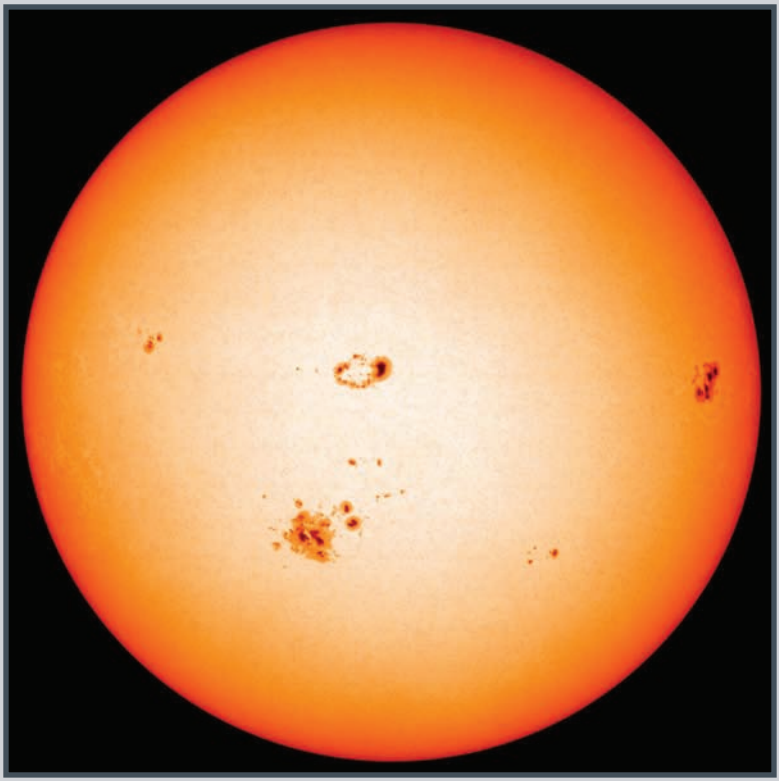
How Long Do Sunspots Last?



SOHO, NASA/ESA

Solar Cycles

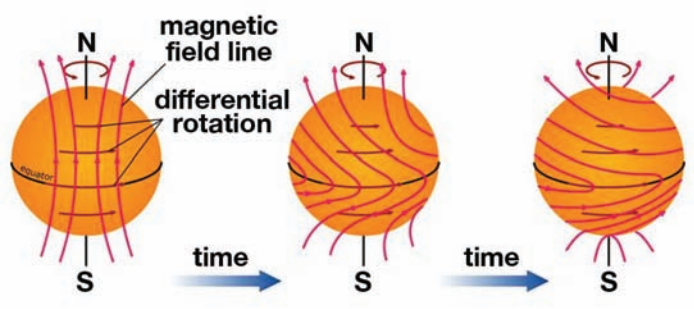
EXPLORE THE SUN!

How Long Do Sunspots Last?

All sunspots are different, but generally they last anywhere from days to weeks.

How fast does the Sun rotate?

The Sun spins faster at its equator than at the poles! The equator rotates every 25 days or so, but the poles take 31 days to make a full rotation. This causes the Sun's magnetic field to become twisted.



Are there always sunspots?

No, sunspots occur in cycles. About every 11 years, there is a sunspot minimum, where there are very few sunspots. Some weeks have none at all. In between the minimums are times when the Sun becomes more active and there are many more sunspots. There are also more solar storms during these active periods.