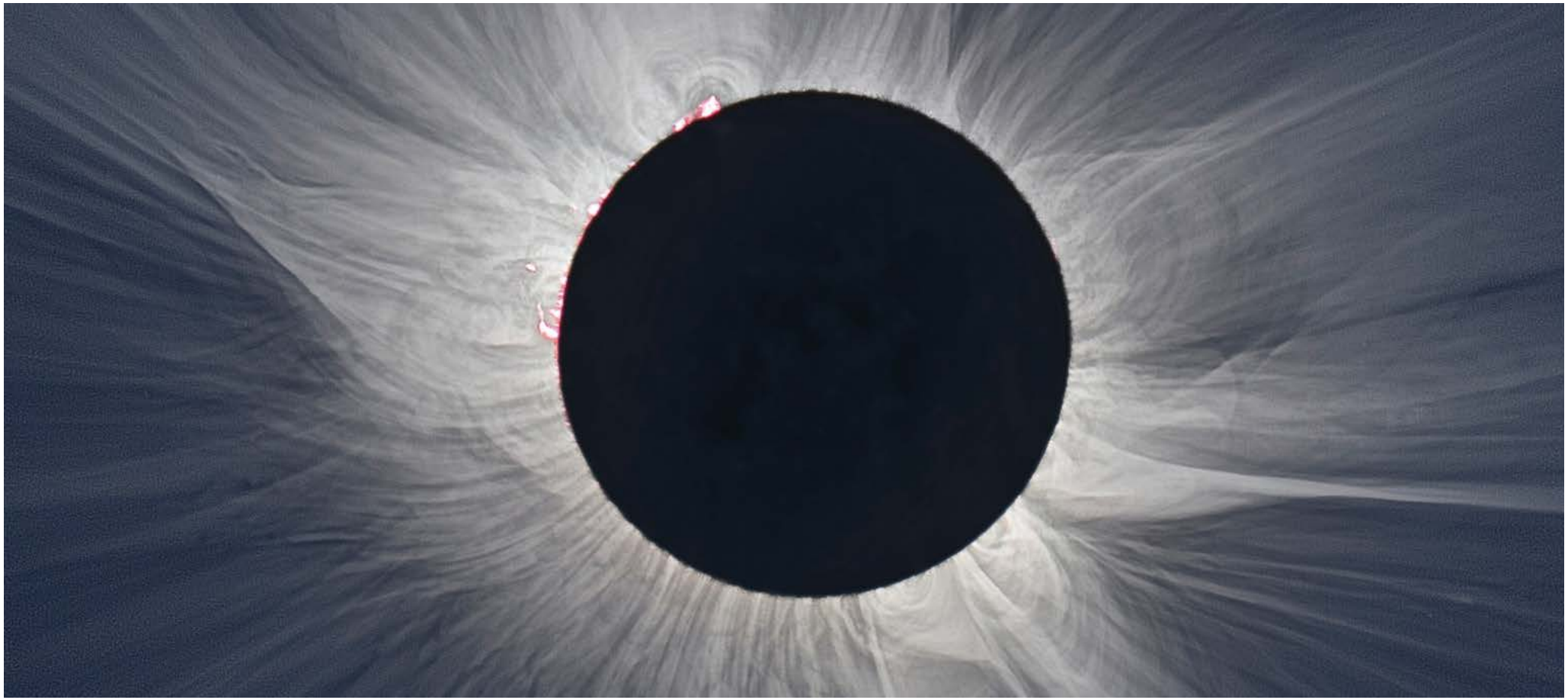
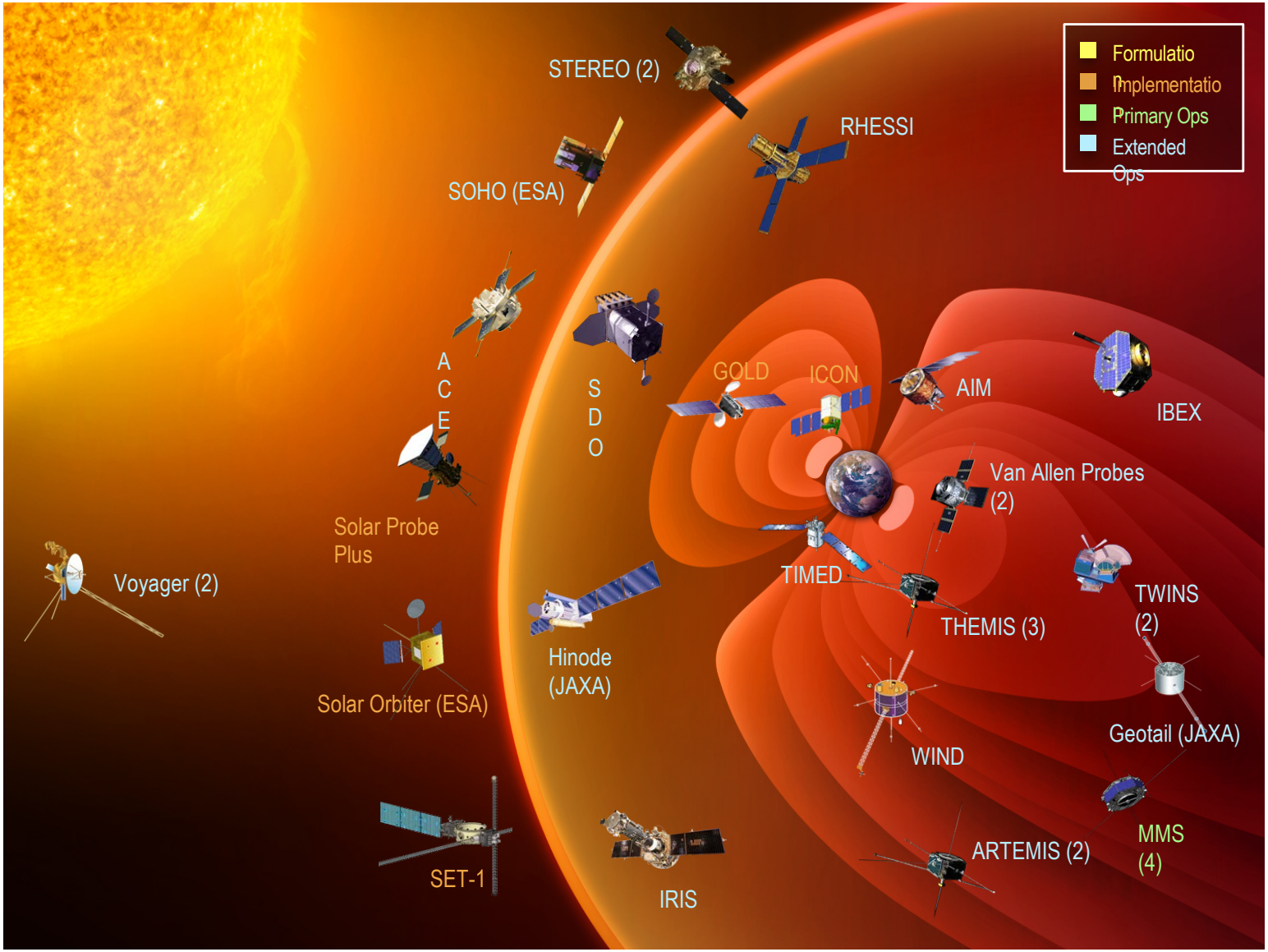
Catch some Sun with NASA!

Learn about the Sun, Experience the Great American Eclipse



Why NASA?

Multiple active missions in space to monitor and study the Sun



Noticing the Sun…

NOTICE	WONDER	KNOW

How to View the 2017 Solar Eclipse Safely

A solar eclipse occurs when the moon blocks any part of the sun. On Monday, August 21, 2017 a solar eclipse will be visible (weather permitting) across all of North America. Those who combined will experience a partial eclipse lasting 2 to 3 hours. Halfway through the event, anyone within a 60 to 70 mile-wide path from Oregon to South Carolina will experience a total eclipse. During these brief moments when the moon completely blocks the sun's bright face for up to 2 minutes 40 seconds, daywill turn into night, making visible the otherwise hidden solar corona (the sun's outer atmosphere). Bright stars and planets will become visible as well. This is truly one of nature's most awesome sights.

Looking directly at the sun is unsafe except during the brief total phase of a solar eclipse ("Totality"), when the moon entirely blocks the sun's bright face, which will happen only within the narrow path of totality.

The only safe way to look directly at the uneclipsed or partially eclipsed sun is through special-purpose solar filters, such as "eclipse glasses" (example shown at left) or handheld solar viewers. Homemade filters or ordinary sunglasses, even very dark ones, are not safe for looking at the sun. To date these manufacturers have certified that their eclipse glasses and hand-held solar viewers meet the ISO 12312-2 international standard for such products: Rainbow Symphony, American Paper Optics, and Thousand Oaks Optical.

- Always inspect your solar filter before use; if scratched or damaged, discard it. Read and follow any instructions printed on or packaged with the filter. Always supervise children using solar filters.
- Stand still and cover your eyes with your eclipse glasses or solar viewer before looking up at the bright sun. After glancing at the sun, turn away and remove your filter — do not remove it while looking at the sun.
- Do not look at the uneclipsed or partially eclipsed sun through an unfiltered camera, telescope, binoculars, or other optical device. Similarly, do not look at the sun through a camera, a telescope, binoculars, or any other optical device while using your eclipse glasses or hand-held solar viewer — the concentrated solar rays will damage the filter and enter your eye(s), causing serious injury. Seek expert advice from an astronomer before using a solar filter with a camera, a telescope, binoculars, or any other optical device.
- If you are within the path of totality (where your solar filter only when the moon completely covers the sun's bright face and it suddenly gets quite dark. Experience totality then, as soon as the bright sun begins to reappear, replace your solar viewer to glance at the remaining partial phases.

An alternative method for safe viewing of the partially-eclipsed sun is pinhole projection. For example, cross the outstretched, slightly open fingers of one hand over the outstretched, slightly open fingers of the other. With your back to the sun, look at your hands' shadow on the ground. The little spaces between your fingers will project a grid of small images on the ground, showing the sun as a crescent during the partial phases of the eclipse.

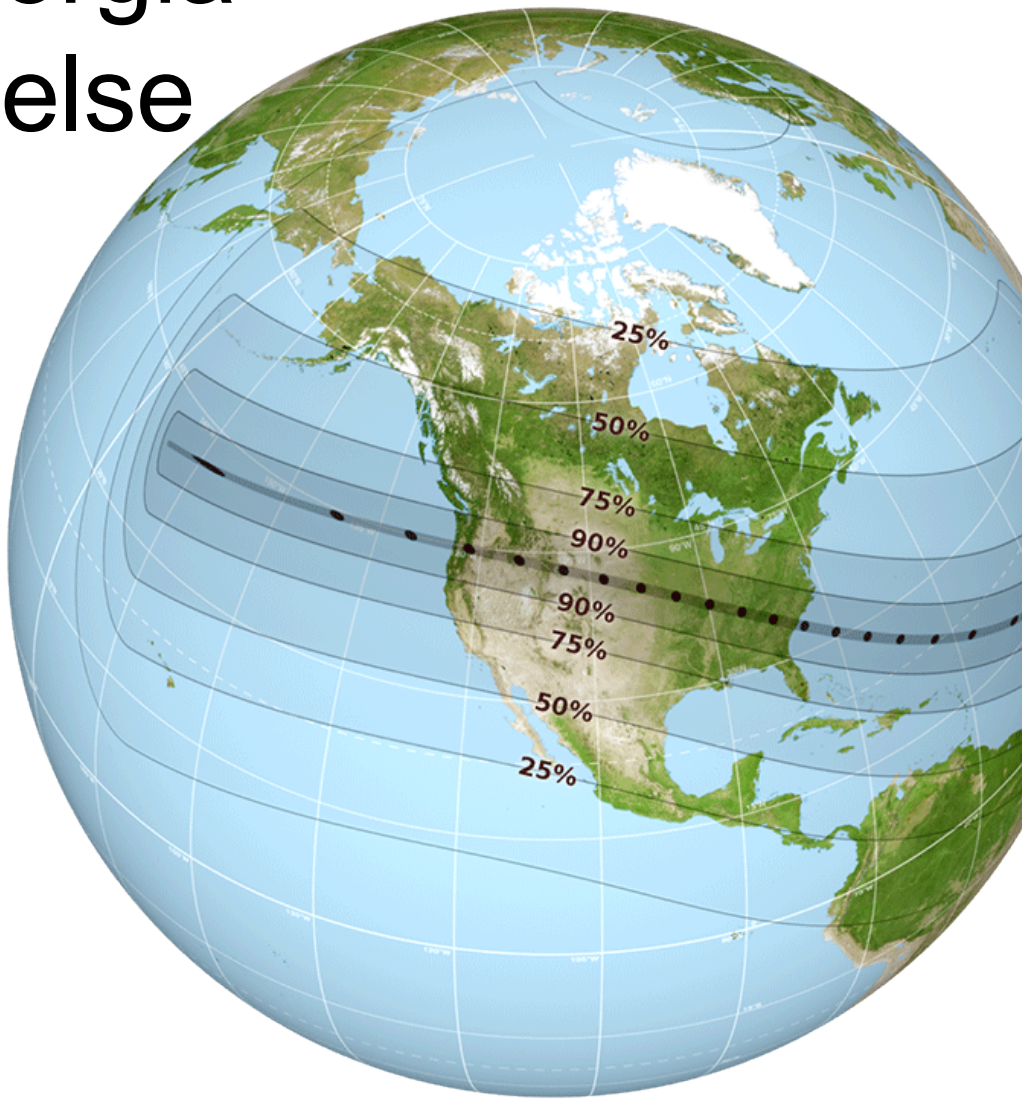
A solar eclipse is one of nature's grandest spectacles. By following these simple rules, you can safely enjoy the view and be rewarded with memories to last a lifetime.

For more information visit www.nasa.org and http://eclipse2017.nasa.gov

Aug 21: Eclipse Across the US

Total: Oregon to Georgia

Partial: everywhere else



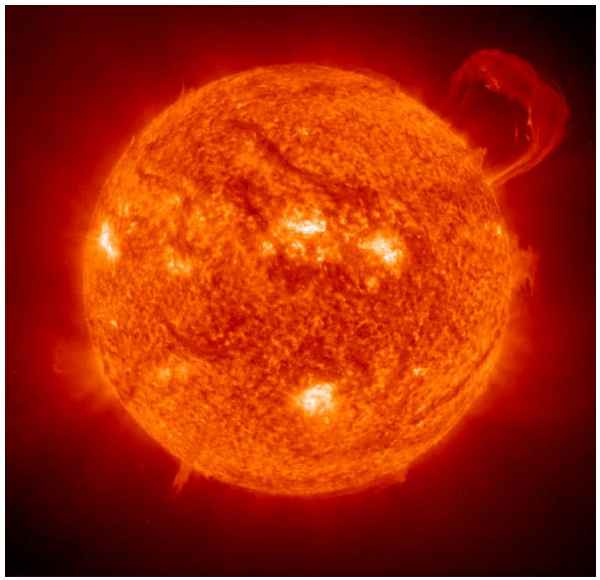
So Cal:

Start: 9:05 am

Maximum: 10:21 am

End: 11:44 am

Eclipses are SAFE!



The Sun is <u>not</u>.

Activities in the Sun

Required:

- Safety
- Activities
- Enthusiasm

Car Safety

Planning to Drive the Eclipse

https://www.ready.gov/car

Camping Health and Safety

https://www.cdc.gov/family/camping/

http://www.recreation.gov/recFacilityActivitiesHomeAction.do?goto=camping.htm&activities=9

Heat and Children in Cars

http://www.safercar.gov/parents/InandAroundtheCar/heatstroke.htm

http://www.safercar.gov/parents/InandAroundtheCar/heat-involved.html

Federal Emergency Management Agency – Are You Ready

Food and Water Safety

Hazards to Outdoors Workers

Heat and Hydration

Hiking Safety

Large Crowds Safety

Personal Safety – At Home, On the Street, While Traveling

Sun Safety: Save Your Skin

https://eclipse2017.nasa.gov/safety

Make it a summer-long experience!

Sequence of activities for youth to learn:

- Our very own star: the Sun
- What *is* an eclipse?
- Scale model of Sun and Earth size and distance
- Telling time with the Sun
- Detecting and protecting us from UV rays
- How to observe the Sun safely

https://eclipse2017.nasa.gov/k-12-formal-education

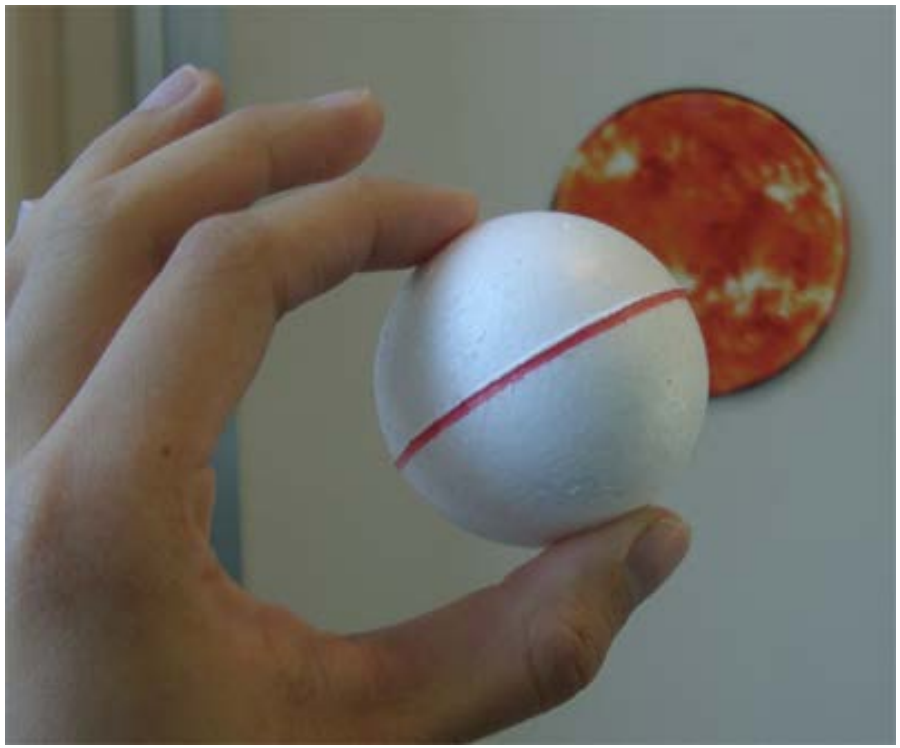
Activity 1: Our Very Own Star

Table Experts:

- 2 per table
- Read 1 page
- Discuss main points at table
- Share with whole group
- Put on chart

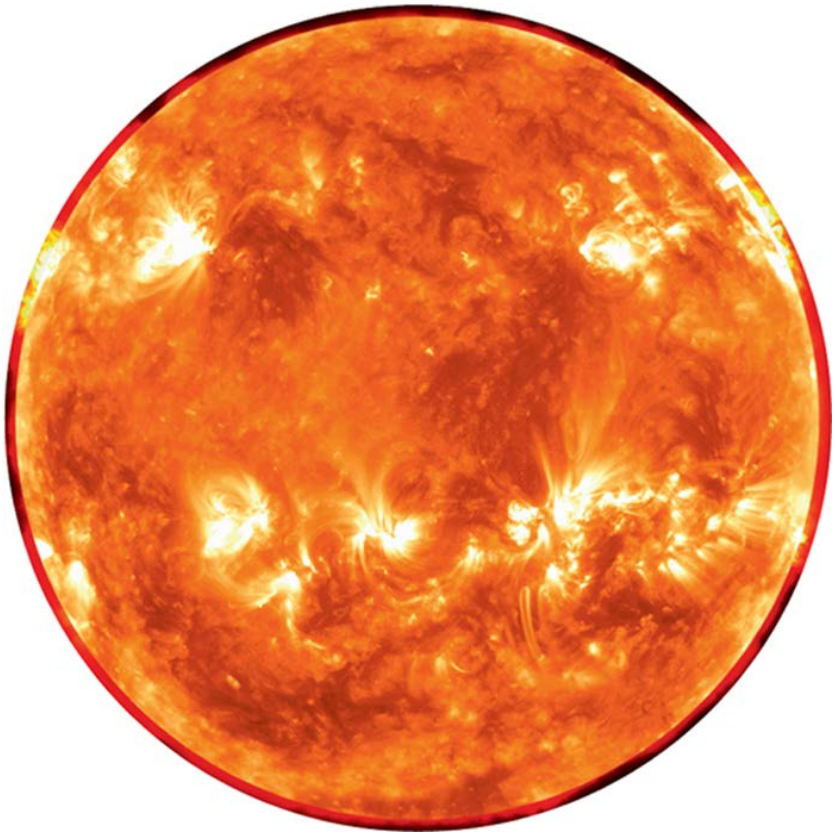
https://www.nasa.gov/pdf/136204main_Our.Very.Own.Star.Eng.pdf

Activity 2: How can the little Moon hide the giant Sun?



https://sunearthday.nasa.gov/2007/materials/eclipse_smallmoon_bigsun.pdf

Activity 3: Scale Model of Sun and Earth

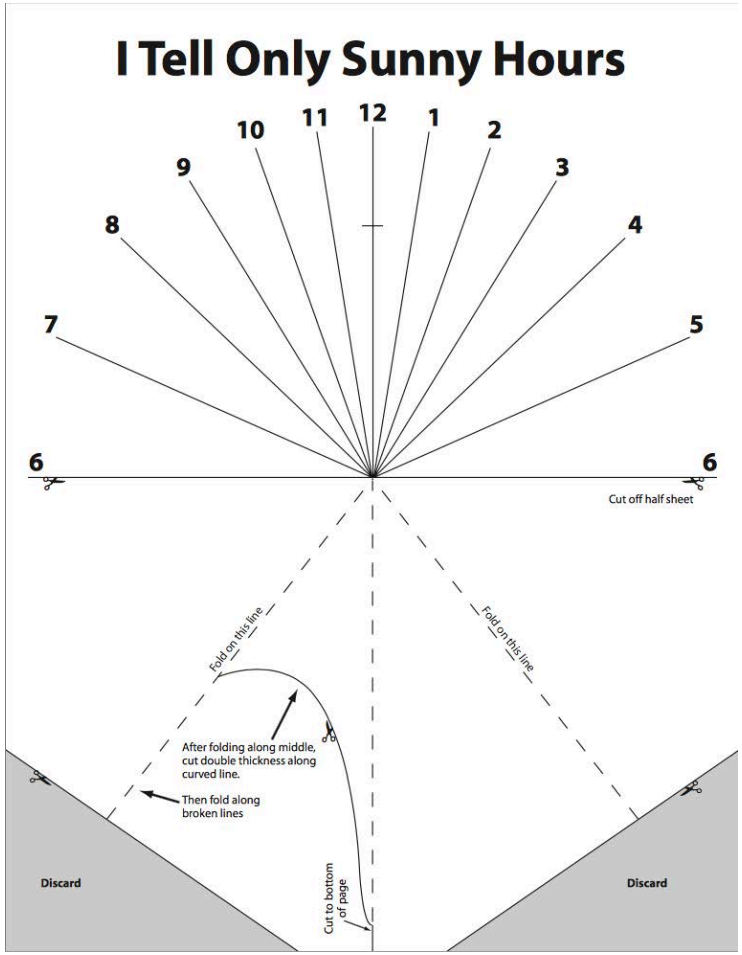


https://sunearthday.nasa.gov/2007/materials/solar_pizza.pdf

Activity 4: Paper Sundial

Teams of 4:

- Builder
- Installation Manager
- Orienteer
- Timekeeper



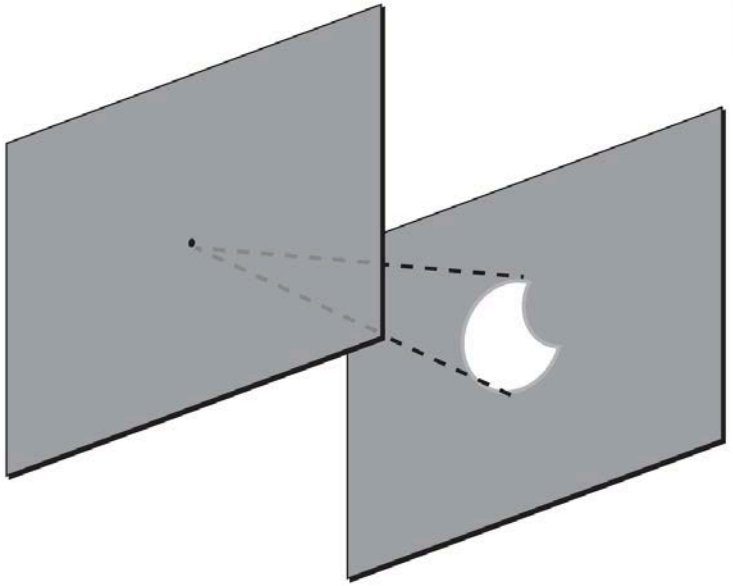
https://sunearthday.nasa.gov/2005/images/Sun_Dial_pdf.pdf

Activity 5: Exploring Ultraviolet (UV) light from the Sun

https://sunearthday.nasa.gov/2007/materials/UVdetector.pdf

Activity 6: Safe Solar Observing

Shadows of leaves



Pin-hole projector

Eclipse glasses

Let’s Go Outside!

Equipment List:

- Sunglasses, hat
- Beads, cup, water
- Index card, pen/pencil
- Blank piece of paper
- Sun dial

Knowing the Sun…

NOTICE	WONDER	KNOW

Special Offer! Solar Viewers for your group!

To get a packet (up to 100) of FREE solar glasses, send an email to Leslie.L.Lowes@jpl.nasa.gov listing information about how you will use them:

1. Date(s) you will use activities related to the sun and the eclipse

2. Venue(s) for your event(s), for example, Summer Camp@North County YMCA

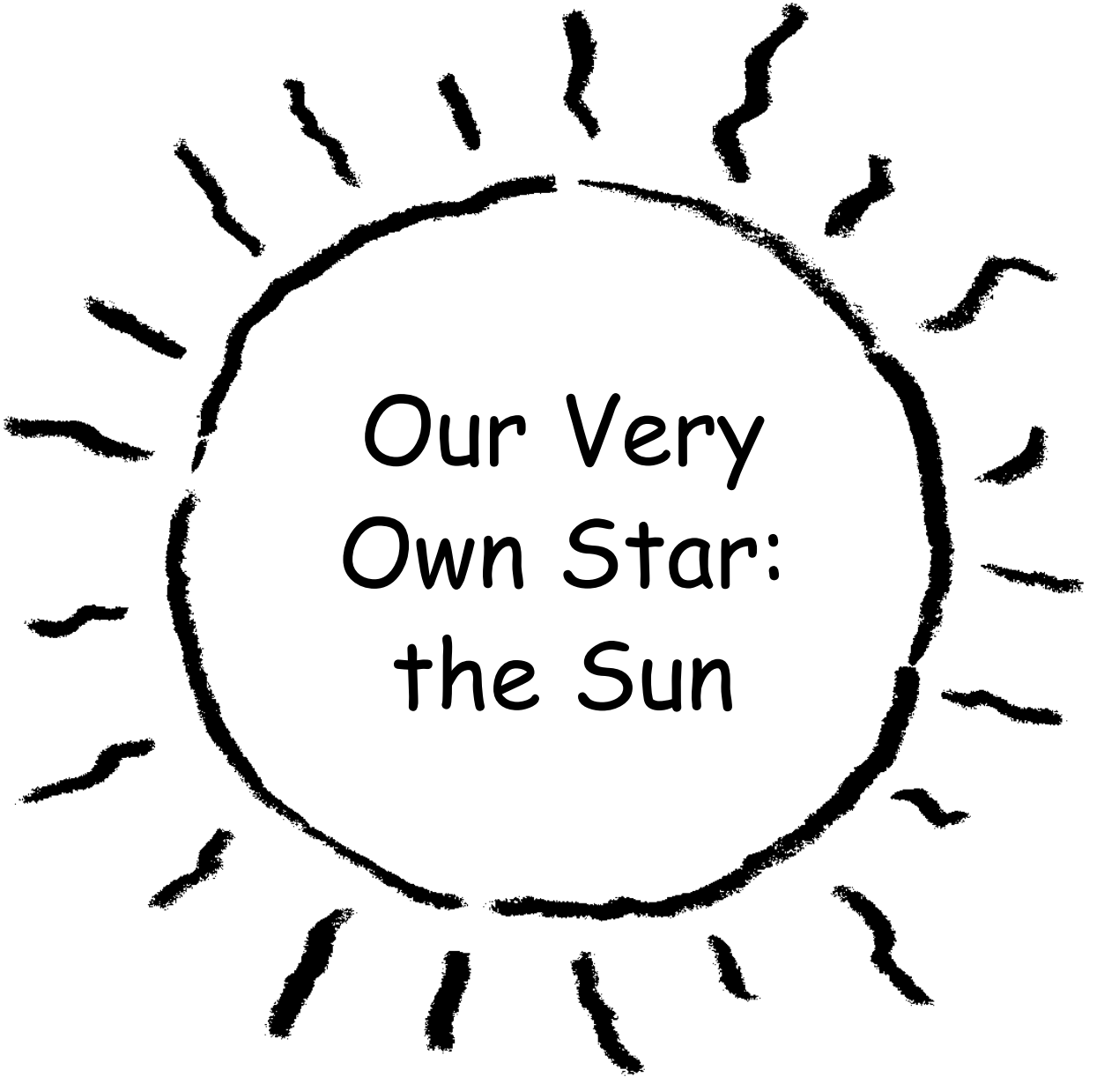
3. List of the activities from the workshop you plan to use

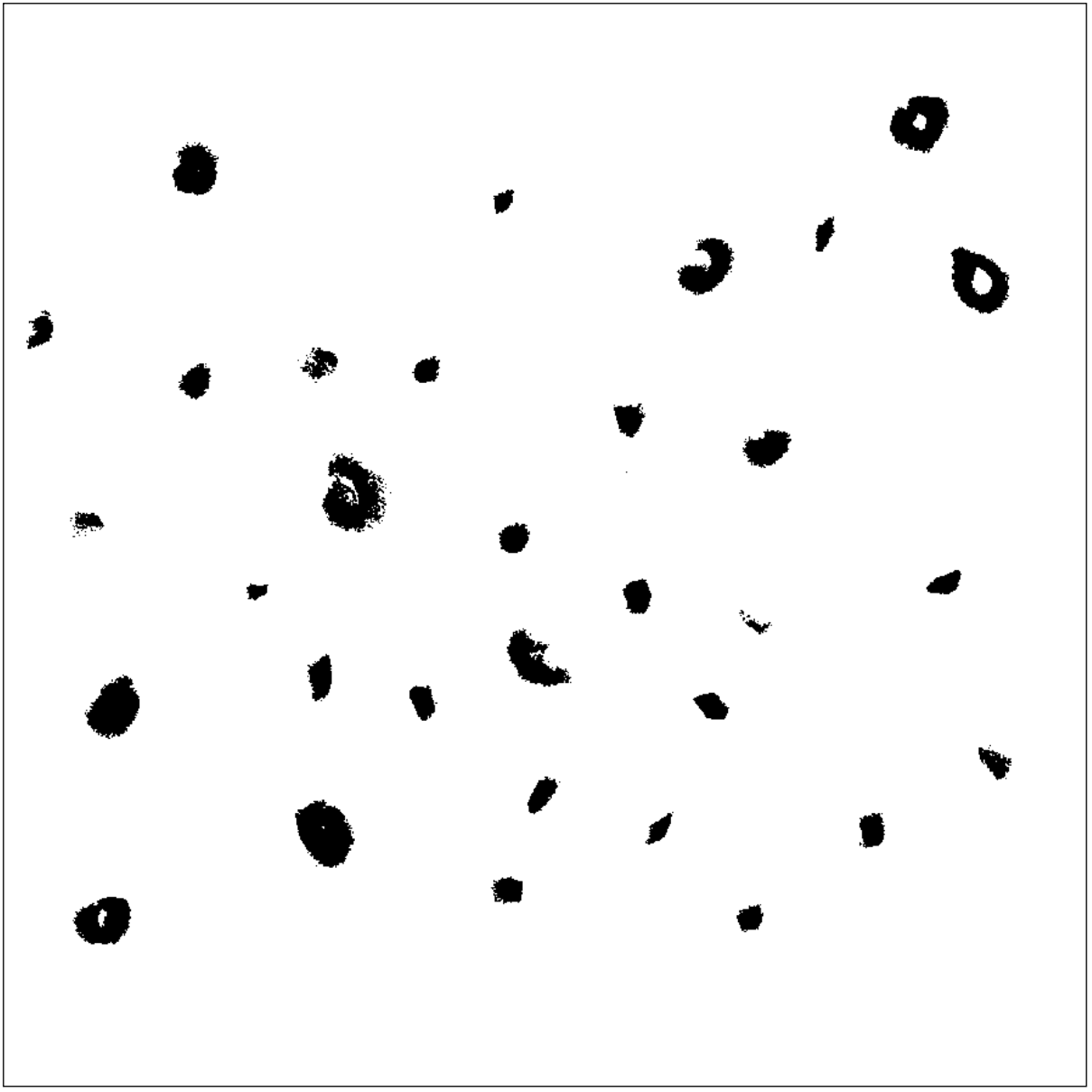
4. How many kids/adults will be at your event(s)

Don’t Miss Out!

Your presenter today:

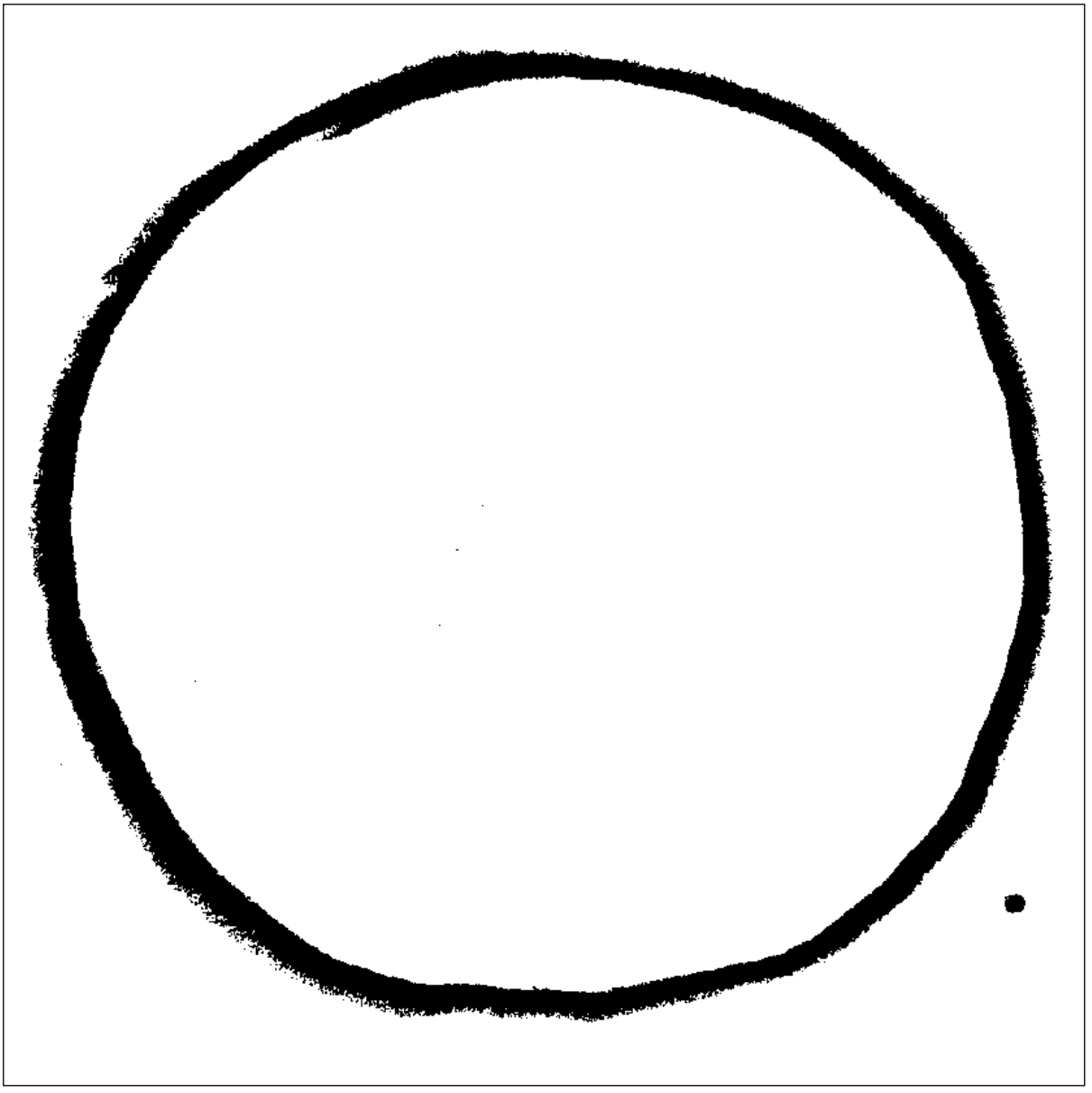
Leslie.L.Lowes@jpl.nasa.gov


Our Very
Own Star:
the Sun

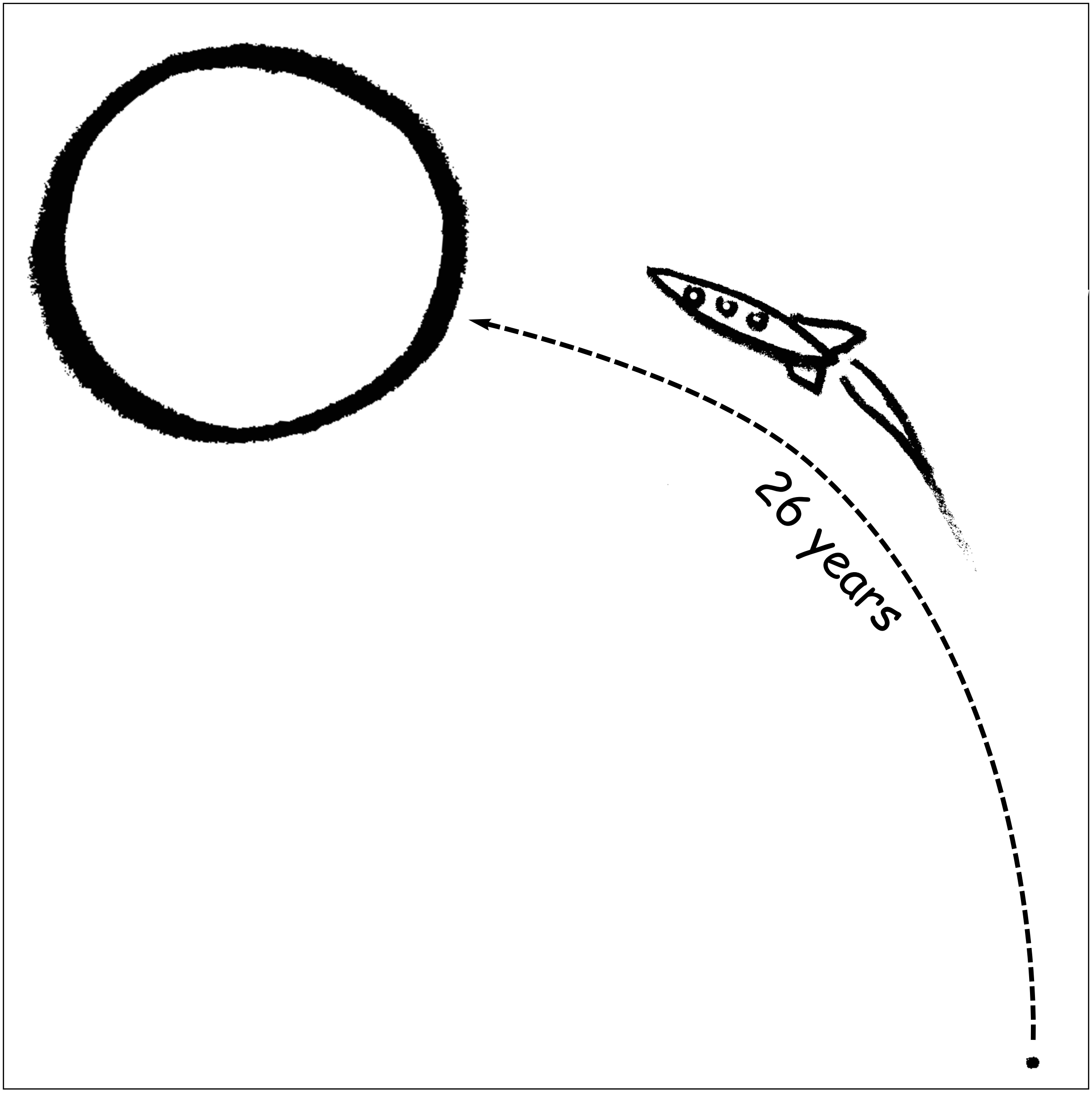


When you look at the night sky filled with stars, have you ever wondered what a star is?

Walk outside on a clear day and say, "Hello!" to our very own star - the Sun! (But don't ever look directly at the Sun. You may damage your eyes.)

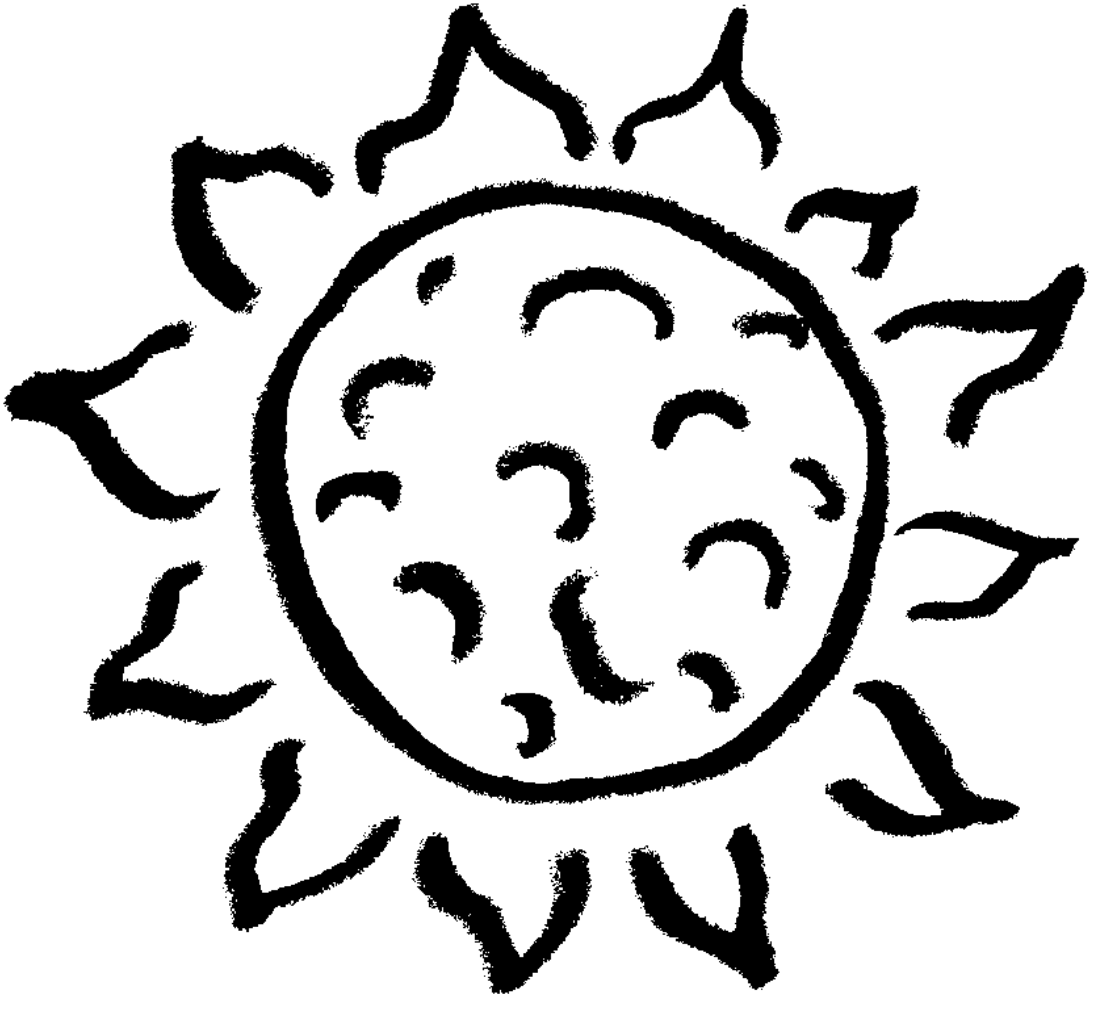


The Sun is very big! Imagine this large circle is the Sun. Then the little dot would be the size of the Earth. Of course, the Earth is not this close to the Sun.

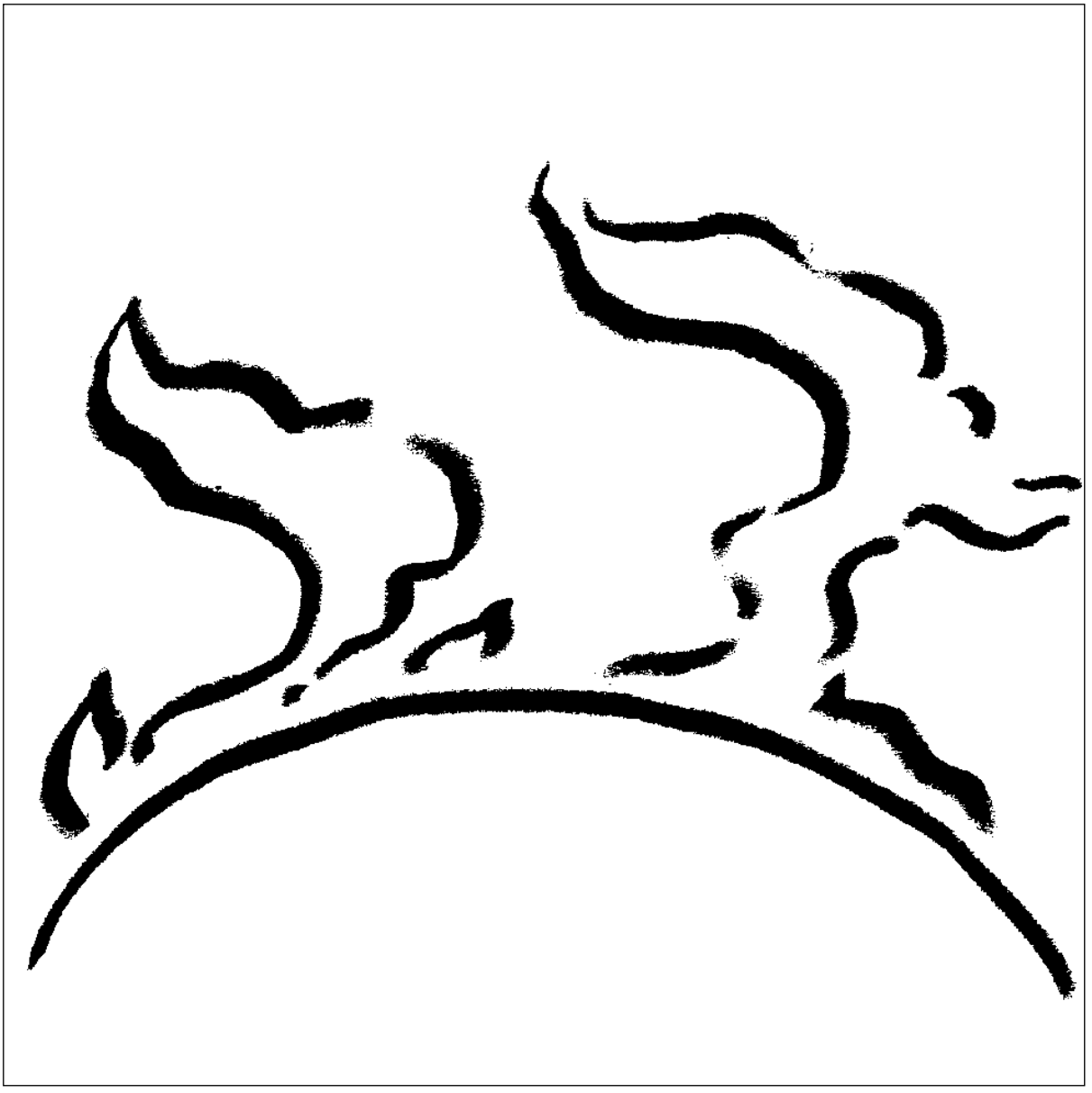

26 years

The Sun seems small when we look at it because it is very far away. The Sun is 93 million miles from Earth! If somehow you could fly an airplane to the Sun, it would take you 26 years. How old would you be when you got to the Sun? How old would you be when you got back?

What do we get from the Sun? The Sun gives us heat and light necessary for us to live. Without the Sun, the Earth would be a frozen ball of ice.

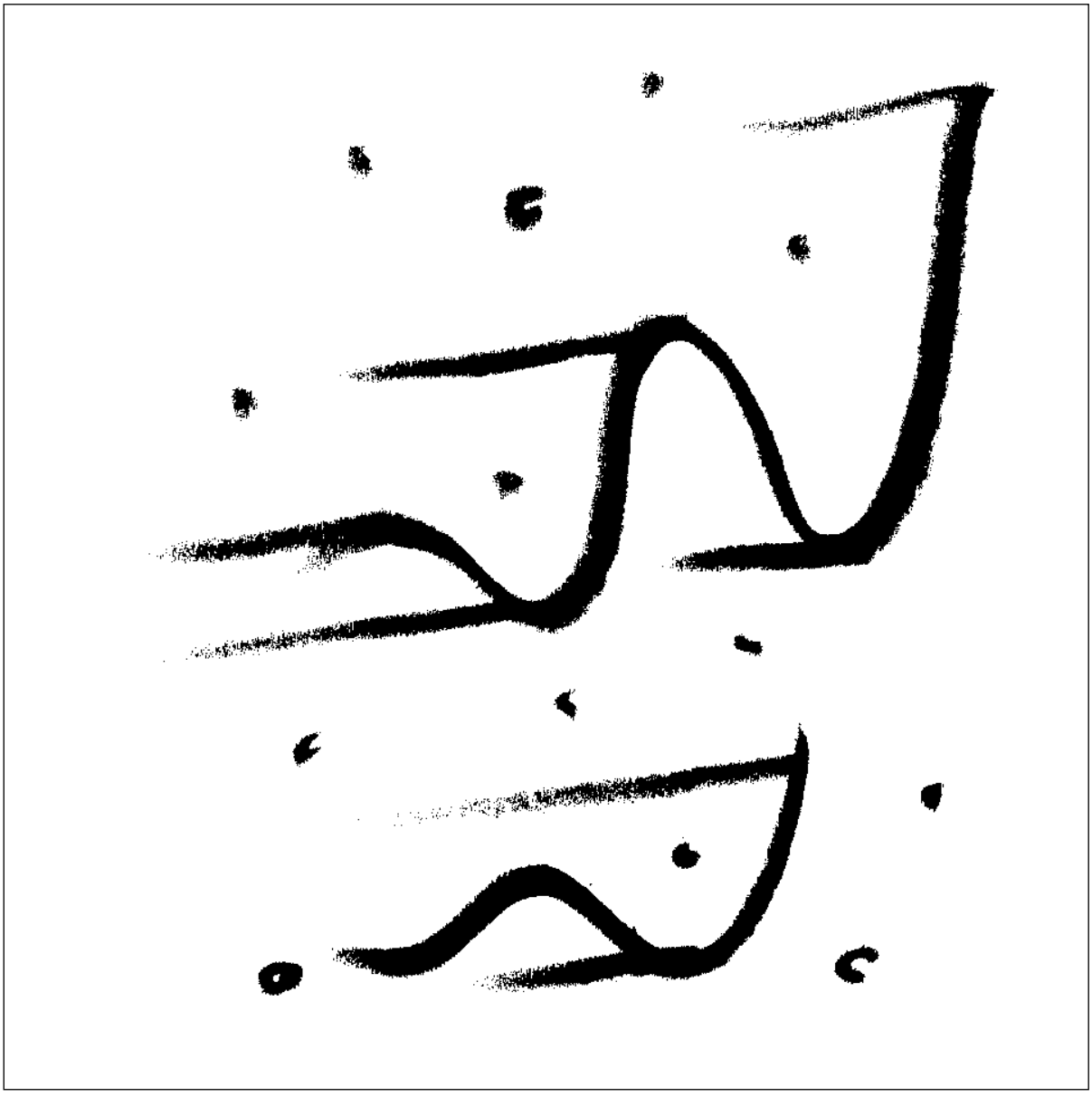


The Sun is a very big ball of hot gases. The flame of a candle is also hot gases. If you look closely at the candle, you can see brighter and darker spots in the flame. The hot gases of the Sun also show darker and lighter spots, and the gases move and flow.



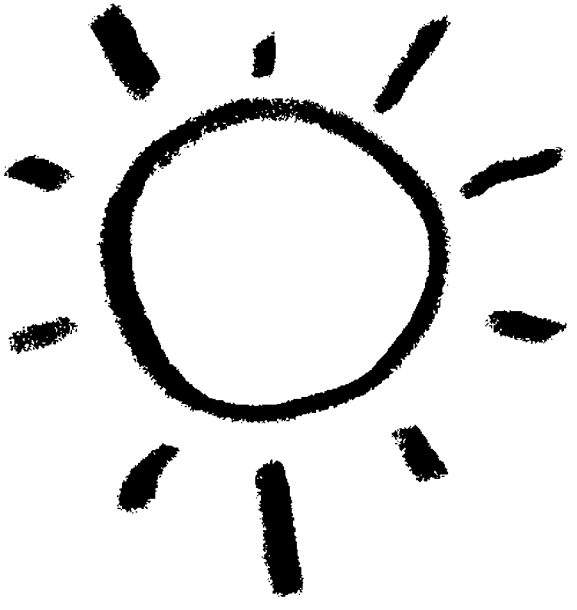
The dark spots on the Sun are large storms called sunspots. They look small on the Sun but are, in fact, as large as the Earth or bigger. Can you imagine a storm as big as the Earth?

There are also huge explosions called solar flares in which the hot gases are spit away from the Sun - like spaghetti sauce that bubbles and spatters. These great storms blast material out of the Sun and into space.

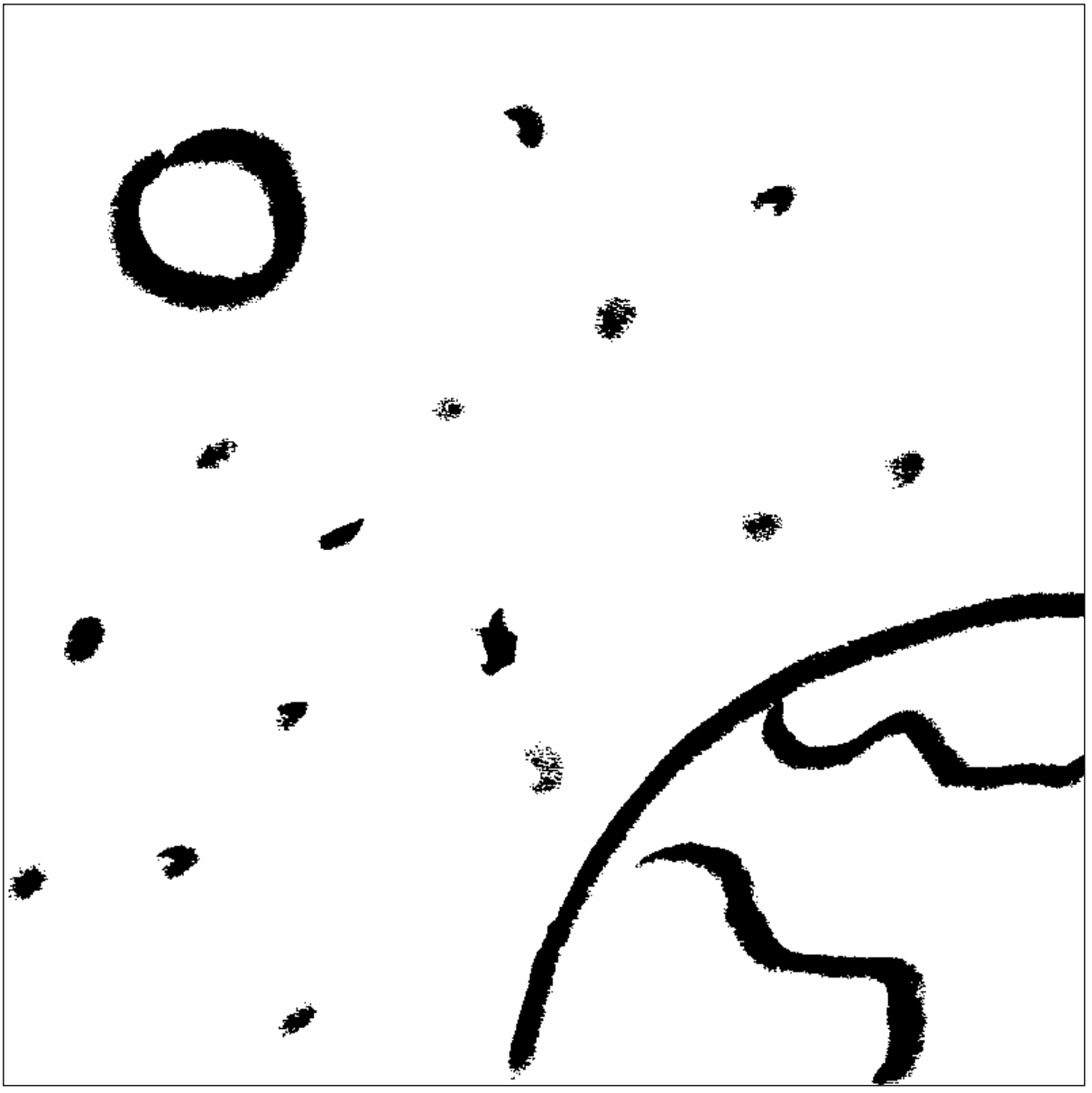


Tiny particles that scientists call matter are always leaving the Sun. It is somewhat like the wind blowing. In fact, this stream of tiny particles is called solar wind. It takes one to five days for this wind to reach Earth. Sometimes the solar wind causes beautiful lights in the night sky, called auroras. These lights look like moving sheets of colors high in the sky.

Sometimes the solar winds can disrupt electricity, telephones, televisions, and radios. This can be very dangerous for police, firefighters, airplanes, and ships at sea.



The Sun is important to us because we need its warmth and light. Scientists also study the Sun to learn more about the Earth's weather and climate. NASA helps us to learn more about the Sun by sending satellites into space to study the space weather. Perhaps one day you can work for NASA, too!



The Sun - our very own star. It lights the daytime sky and gives us warmth just as the nighttime stars give the sky a special beauty.

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

Educational Product	
Educators	**Grades K-4**

EP-2002-1-014-GSFC

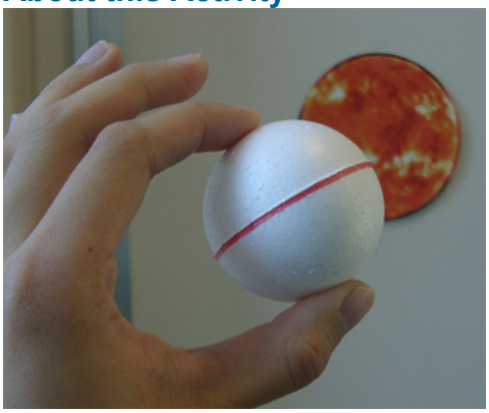
Families, enjoy the on-line interactive version of "Our Very Own Star: the Sun" on the Solar Terrestrial Probes Education and Outreach homepage! http://stp.gsfc.nasa.gov

Design & Illustrations by Daniel Vong

Public Outreach
- Make and Take Activities

Eclipse: How can the little Moon hide the giant Sun?

About this Activity



Although this activity isn't a "make and take", it offers great hands-on exploration of how distance can affect the way we perceive the size of an object. It makes a good introduction to solar eclipse as well as Sun and Moon's sizes and distances from Earth. The idea behind this activity is very simple and the activity itself is easy to do, making it accessible even for young kids.

Left: A participant eclipsing an image of the Sun with a small styrofoam ball. Here, the image is 8.5" in diameter while the small ball is 2" in diameter.

Below Right: Observing the effects of distance on perceived size.

What You'll Need

- ping-pong balls, one for each participant
- two larger balls in different sizes (e.g. a baseball and a basketball would work well)
- (optional) image of a total solar eclipse
- (optional) scale model of Sun, Earth, and Moon

Preparation

Little preparation is needed for this activity besides gathering the necessary materials. It is optional but very helpful, however, to have a scale model of Sun, Earth, and Moon on hand. Instructions for making such a model are available via a web-link at the end of this activity.

To Do and Notice

1) Ask participants to share what they know about solar eclipses. Show an image of a total solar eclipse if you have one handy. If no one has mentioned it yet, explain that a solar eclipse happens when the Moon crosses between the Earth and the Sun, blocking the Sun's light.

2) Ask participants to share what they know about the Sun and the Moon. How big are they? Which one is bigger? How big are they relative to Earth?

3) Hold up a large ball and hand smaller balls to the participants. These balls do not need to be to scale for the Sun and the Moon (the big difference in size makes using balls at a true scale very difficult for this activity). Challenge participants to eclipse the larger ball with their smaller ones. It sometimes helps to cover one eye.

4) Ask participants to share what they noticed. Were they able to eclipse the large ball?

5) Now hold up an even larger ball and ask participants to eclipse this new ball. Were they able to do it this time? What did they have to do to eclipse the larger ball? They might tell you that they had to step further away from the larger ball, making it appear smaller, just enough to be eclipsed. They might also tell you that they had to bring the small balls closer to their eyes, making them appear bigger until they are big enough to eclipse the larger ball.

6) If you have a scale model, compare the size of the Sun and the Moon. Ask participants to guess how far they would need to take this model Moon before they can eclipse the model Sun.

Eclipse: How can the little Moon hide the giant Sun?

(continued)

Activity Notes

Here's a quick way to estimate the actual distance that you would need to separate the Moon and the Sun for a scale model:

- If the model Sun is *D* inches in diameter, the model Moon's diameter is roughly (*D*÷436) inches.
- At this scale, the model Moon should be roughly (*D*x108) inches away from the model Sun. You might need to convert this distance to feet or yards to make it more understandable.

Here is an example that is not exactly to scale. However, it uses familiar objects that might help participants visualize the sizes and distance:

If the Sun is a basketball (9" to 9.5" across), the Moon would be roughly a pinprick or a dot made with a sharp pencil (1/50 of an inch). At this scale, the Sun and Moon would be about 86 feet apart. This is equivalent to having the basketball at one end of a basketball court while the pinprick is under the backboard/basket on the opposite side. (The length of a basketball court is about 92 feet, just a bit too long). If you were to try this, the small pinprick Moon should be able to eclipse the basketball Sun when you put it about 3" in front of your eye. (You would looking at the Sun and Moon from the perspective of the Earth of course, and 3" is roughly to scale for the Earth/Moon distance.)

This activity is adapted from Eye on the Sky: lesson 12 of Our Star the Sun. See links below for the classroom version of this activity.

Related Websites

Eye On The Sky: classroom version of this activity and related content
http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html

Eye On The Sky: Sun/Earth/Moon scale model as a classroom activity or to make ahead of time as a prop for this eclipse activity
http://eyeonthesky.org/lessonplans/03sun_howbig.html

Sun-Earth Day 2006 (Eclipse – In a different light): eclipse images, content, and resources
http://sunearthday.nasa.gov/2006/index.php

Public Outreach
- Make and Take Activities

Scale Model of Sun and Earth

About this Activity

This activity explores the relative size of Sun and Earth as well as the distance between them.

Below right: Looking toward the model Sun from the model Earth. A pre-measured piece of string was used to mark the appropriate distance for the scale model.

What You'll Need

- copies of the Sun and Earth handout sheet (see next page)
- measuring tape
- a large room or a long hallway where you will be able to walk 65 feet in a straight line without many obstacles
- (optional) scissors
- (optional) 65 feet length of string

Note: Copies of our readymade cardstock version of this Sun-Earth scale model are available for free by request. If you need copies for a specific event or education program, email us at outreach@cse.ssl.berkeley.edu

Both English and Spanish versions available.

Preparation

Measure 65 feet (the distance between Sun and Earth in the scale of our model) from where you will be doing this activity and mark the distance for later reference. If you do not have a fixed location, we find it helpful to have a piece of string cut to exactly 65 feet in length for you to use as a reference during the activity.

If you want your participants to guess the size of the Earth, you might want to keep the image of Earth out of sight by cutting off the top of the hand-out page along the dash line.

To Do and Notice

1) Show participants the image of the Sun. (This is a good opportunity to notice what the Sun's surface look like and to point out that the Sun is not as featureless and uniformly bright as it might look to our eyes.) Ask participants to guess how big the Earth would be if the Sun is the size of this image.

2) Reveal the answer by showing the image of Earth. (Optional: you might want to let the participants cut out the Earth and the disc of the Sun instead of using the 2 sections of the handout sheet.) Ask participants to guess how far the model Earth should be from the model Sun. We suggest allowing participants to walk to where they think the distance should be. We find it helpful to tape the model Sun to a spot around eye-level at the starting point and have the facilitator walk with the participants. The model Earth should be 65 feet away from the model Sun. Use the marker you placed earlier (or the cut piece of string) to guide you.

3) (Optional) At 65 feet away, look back towards the model Sun. Notice how big it looks to you at this distance. At this scale, the model Sun should be about the same size as the actual Sun would appear to us here on Earth. (It is always a good idea to remind participants not to look directly at the Sun.) Since this part requires a basic understanding of ratio and scale model, it might not be appropriate for all participants.

Activity Notes

"Why does the Sun I see in the sky look different from this picture?" is a common question. The Sun image here was taken by a telescope that is mounted on a satellite in space (the TRACE mission to be exact). Besides being able to see farther than we can and without the clouds and Earth's atmosphere in the way, this telescope also looks at a different kind of light. The Sun gives off different kinds of energy, only part of that is in the form of visible light which we can see. The telescope that took this picture looks at the extreme ultraviolet (EUV) light coming from the Sun.

Related Websites

TRACE Education Resources: the Sun, its structure, and the satellite mission.
http://trace.lmsal.com/Public/eduprodu.htm

Stanford Solar Center: About the Sun
http://solar-center.stanford.edu/about/

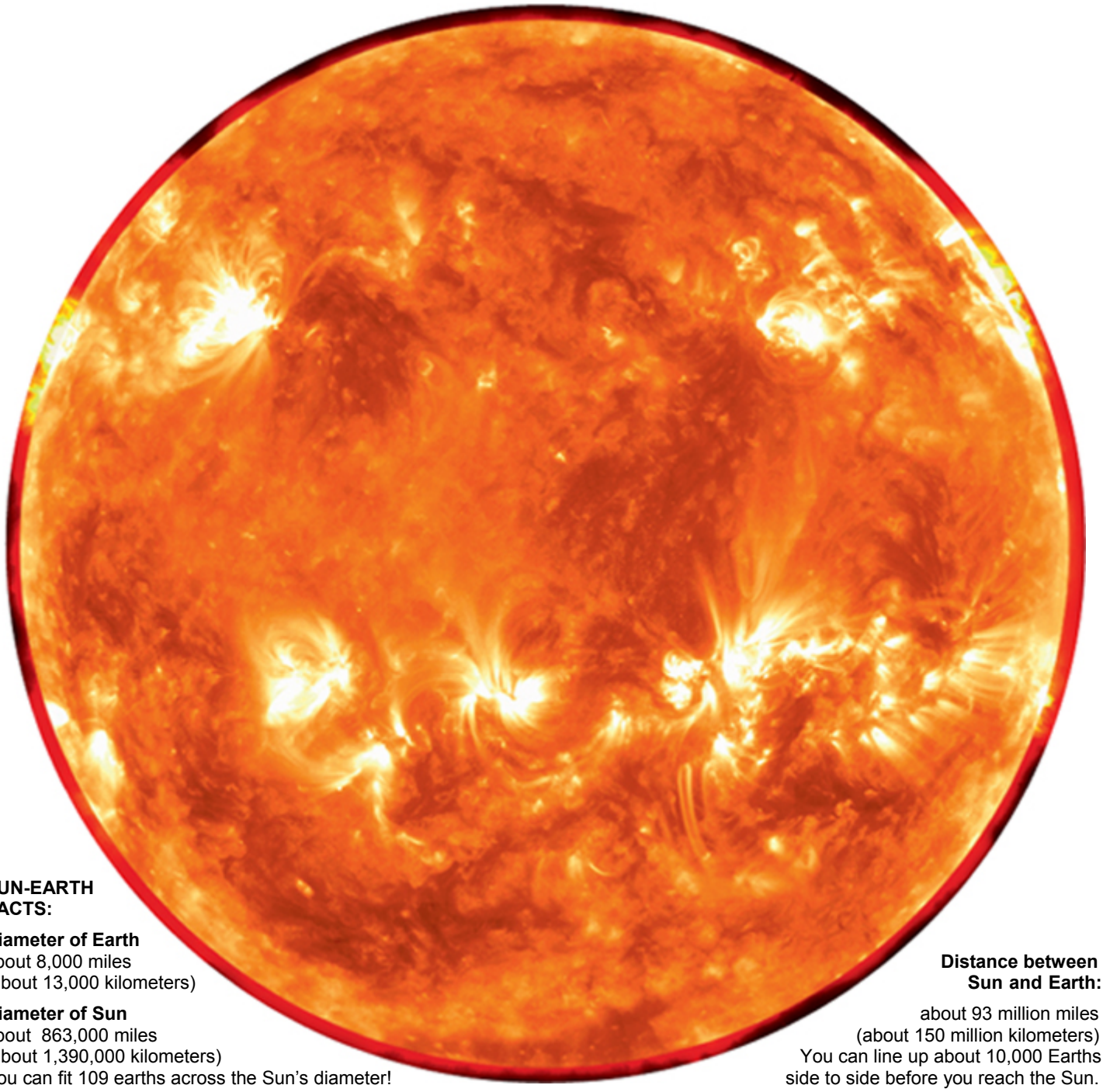
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

http://sunearthday.nasa.gov

1. Cut out the images of the Sun and the Earth.
2. To demonstrate the distance between Sun and Earth at this scale, separate the images 65 feet (about 20 meters) apart. This distance represents approximately 93 million miles (150 million kilometers).

This image of Earth is scaled to the proper size in relation to the image of the Sun below.

Earth



SUN-EARTH FACTS:

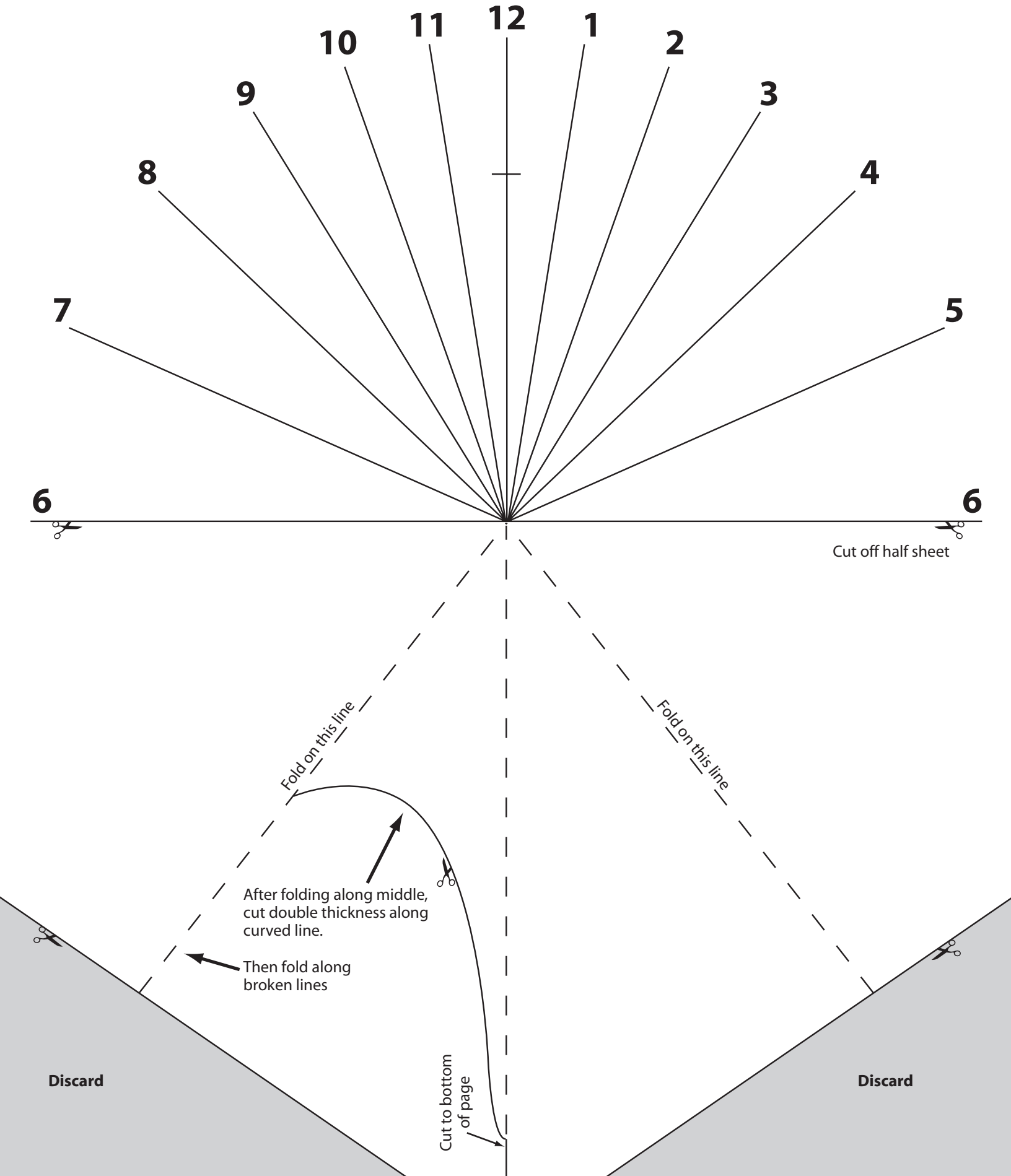
Diameter of Earth
about 8,000 miles
(about 13,000 kilometers)

Diameter of Sun
about 863,000 miles
(about 1,390,000 kilometers)
You can fit 109 earths across the Sun's diameter!

Distance between Sun and Earth:

about 93 million miles
(about 150 million kilometers)
You can line up about 10,000 Earths side to side before you reach the Sun.

I Tell Only Sunny Hours

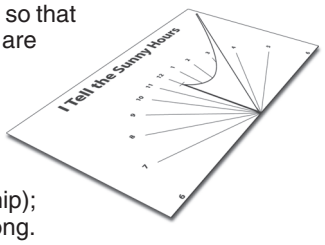


Instructions (from **http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm**; more there.)

1. Cut the paper along the marked line: one half will serve as **base**, the other will be used to construct the **gnomon**.
2. In the gnomon part, cut away the two marked corners.
3. **Fold** that part at the broken line at its **middle, to get paper of double thickness**. The two other broken lines (leading to the cut-off corners) should remain visible. The line of the fold is the gnomon.

   Note: In stiff paper, straight folds are helped by first scoring the paper: draw the line with a black ballpoint, guided by a ruler and pressed down hard.
4. With the gnomon sheet folded at its middle, **cut out along the curved line**, cutting a double thickness of paper in one cut. The cut begins near the top of the gnomon-fold and ends on the secondary (broken) line. **Do not cut along the broken line** but connect the cut with the edge ("Cut to bottom of page"). No pieces come off.
5. **Fold** the gnomon sheet at the other two broken lines, in directions **opposite** to the one of the earlier fold. These folds should form 90-degree angles, not produce a double thickness.

   If the two pieces on the outer side of the fold are placed flat on the table, the gnomon should rise above them.
6. In cut (4), the fin of the gnomon was separated from two pieces with curved outlines. **Fold** those pieces so that they, too, are flat with the table. One goes above the other, then fit the fin to fit into slots they form near the broken lines.
7. You are almost done. Take the **base** sheet, and note the **apex** where the hour-lines all meet (that is where the bottom corner of the fin will go). Carefully cut the sheet from this point along its middle line, up to the small cross-line marked on it. Do not cut any further!
8. **Slide the fin** into the cut you made, so that all horizontal parts of the first sheet are **below** the base sheet; only the fin sticks out. Its bottom corner should be at the apex. **Very important:** the fin must be **exactly perpendicular** to the base (you may have to widen the slot with a second snip); otherwise, the sundial's time is wrong.



   The sundial is now ready, but you might use tape on the bottom of the base-sheet to hold the two pieces together firmly. For further stability, and to prevent the sundial from being blown away, you may attach its base with thumbtacks, tape or glue) to a section of a wooden board or a piece of plywood.
9. Finally, **orient the fin** to point north. The shadow of the tip of the fin now tells the time.

A sundial should work equally well at any time of the year. Equinox is special because

(1) The Sun rises exactly in the east and sets exactly in the west, both directions perpendicular to north; north could be defined as the direction of a flagpole's shadow when it is shortest. You may not get students to observe at sunrise but maybe they could do so at sunset. They could in any case use the shadow of a flagpole to determine north.

(2) The length of the shadow at noon changes most rapidly at equinox. Draw a northward line from the flagpole on the ground, and mark on it the tip of the shadow. If students make 2 marks per week, they probably will see changes.

(3) The location on the horizon of sunset (and sunrise) changes fastest at equinox.

The outlines of this sundial can also be downloaded from the world-wide web, at the above URL http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm The site is part of an extensive educational exposition on **astronomy, space, spaceflight, the Sun** and **Newtonian mechanics,** titled "From Stargazers to Starships." It contains 90 main sections, plus a math course, glossary, timeline, lesson plans and more.

"From Stargazers to Starships" found at URL http://www-spof.gsfc.nasa.gov/stargaze/Sintro.htm was written by Dr. David Stern, a scientist working in space research, at roughly the high school level. It follows the historical thread of humanity's quest into space, from the early Greek astronomers to NASA and Sputnik, and to ideas still on the drawing boards.

Public Outreach
- Make and Take Activities

Exploring Ultraviolet (UV) light from the Sun

About this Activity

The Sun gives off different kinds of energy: including heat, visible light, and invisible light in the form of ultraviolet (UV) rays. While the Earth's atmosphere protects us from most of the Sun's harmful UV rays, there is still an abundance of UV rays around us. This activity explores UV rays from the Sun and ways we can protect ourselves from these potentially harmful UV rays.

Left: Comparing UV detectors with and without the covering of a pair of eye-glasses.

Below Right: Examples of materials that can be used for this activity.

What You'll Need

- "UV detectors" a.k.a. UV beads. These can be ordered inexpensively from http://www.teachersource.com
- container or covering to prevent the Sun from hitting the detectors prior to the activity. (Black film canisters work very well, so does a closed fist or a pocket!)
- a cup with water
- sunscreen and a zip-lock bag
- sunglasses
- Sun and shade (When doing this activity indoor, you can use a UV lightbulb / blacklight or an opened sunny window – the glass in the window might block out most of the UV rays!)
- (optional) pipecleaners or strings to hold the "UV detectors" if distributing beads to participants to take away.

  (We suggest our participants to hang the beads from a purse or shoelace to continue detecting UV wherever they go.)

Preparation

Set up 5 stations: a sunny spot, a shady spot, sunglasses, a cup with water, and sunscreen. For the sunscreen station, squeeze a little sunscreen into the zip-lock bag and drop in a bead (this keeps sunscreen from getting all over.) If doing this activity indoor, use an opened sunny window (the glass in the window might block out most of the UV) or use a UV lightbulb / blacklight to imitate the Sun.

To Do and Notice

1) Explain that you have "detectors" (UV beads) which turn color when they are exposed to UV rays. The beads detect the ultraviolet coming from the Sun and the more UV there is, the darker the beads become. We prefer using beads in only one color and in a deeper color, like purple, to make the color changes and comparisons more obvious.

2) Ask participants to make predictions. Some questions to consider:

- Where do you think the bead will turn the darkest?
- What happens in the water?
- Do sun glasses protect eyes from UV? What about regular glasses?
- What do you think happens to UV on a cloudy day?
- Is the shade really free of UV?

3) Demonstrate or ask the participants to try out the UV detectors at different stations.

4) Ask your participants if there are other conditions that they think will block UV. They may want to test out other materials that they have on hand, such as clothing and regular glasses.

5) The beads will turn back to the original color when no longer exposed to UV. Give away "UV detectors" so participants can attach them to their jackets or purses to continue detecting UV!

Activity Notes

This activity demonstrates that different materials will block UV rays to different extends. When proper Sun protection is not used, UV can damage our skin and eyes. To learn more about UV, other forms of energy emitted by the Sun, or how UV affects our skin, follow the links under Related Websites below.

Related Websites

NASA's Imagine the Universe: Electromagnetic Spectrum
http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html

American Academy of Dermatology: UV Index
http://www.aad.org/public/Publications/pamphlets/UltravioletIndex.htm

Classroom Activities

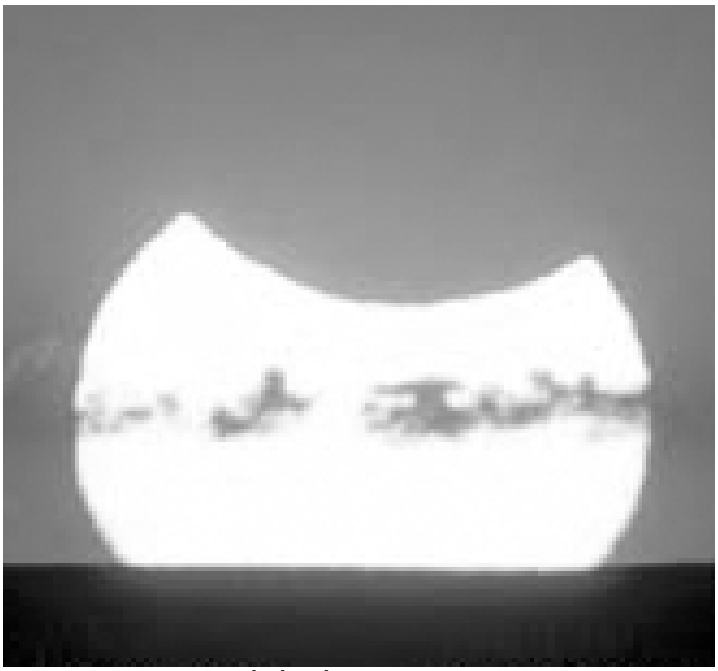
Hands-on activities for use in the classroom.

Observing the Sun for Yourself

http://solar-center.stanford.edu/observe/observe.html

Classroom Activities
Grade Level 3-5*

Courtesy of the
Stanford Solar Center



Partial solar eclipse image from Fred Espenak's Eclipse Home Page at NASA's Goddard Space Flight Center.
http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

CAUTION!
Don't EVER look directly at the Sun, with or without a telescope
(unless you have the proper filters).

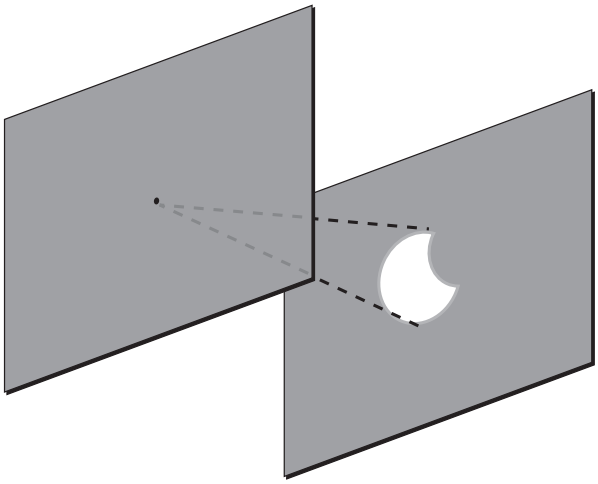
There are several ways you can observe the Sun, and hopefully sunspots, for yourself. The easiest and safest is to project the Sun by building your own pinhole camera. If you have a telescope, you will have to equip it with a solar filter or use a solar telescope that you can access via the Web.

*These lessons can be adapted for higher grade levels by including telescope mirrors and observing eclipses. Teachers can also project the Sun's image through a telescope resulting in a larger image for tracking sunspots and other solar activity.

Classroom Activities

Activities courtesy of the Stanford Solar Center
http://solar-center.stanford.edu/observe/observe.html

Projecting the Sun



You can easily and safely observe the Sun by projecting it through a tiny hole onto a white sheet of paper. This simple device is called a "pinhole camera."

You'll need:

- **2 sheets** of stiff white paper
- **1 pin**
- **A sunny day**
- Perhaps **a friend** to help

1. With the pin, punch a hole in the center of one of your pieces of paper.

2. Go outside, hold the paper up and aim the hole at the Sun. (Don't look at the Sun either through the hole or in any other way!)

3. Now, find the image of the Sun that comes through the hole.

4. Move your other piece of paper back and forth until the image rests on the paper and is in focus (i.e., has a nice, crisp edge). What you are seeing is not just a dot of light coming through the hole, but an actual image of the Sun.

Experiment by making your hole larger or smaller. What happens to the image? What happens when you punch two holes in the piece of paper? Try bending your paper so the images from the two holes lie on top of each other. What do you think would happen if you punched a thousand holes in your paper, and you could bend your paper so all the images lined up on top of each other?

In fact, optical telescopes can be thought of as a collection of millions of "pinhole" images all focused together in one place!

You can make your pinhole camera fancier by adding devices to hold up your piece of paper, or a screen to project your Sun image onto, or you can even make your pinhole camera a "real" camera by adding film.

If you want to learn more about how light works, you can join artist Bob Miller's Web-based "Light Walk" at the Exploratorium. It's always an eye-opening experience for students and teachers alike. His unique discoveries will change the way you look at light, shadow, and images!

Related Resources

Bob Miller's Light Walk
http://www.exploratorium.edu/light_walk/lw_main.html

Several sites give instructions for building more exotic pinhole cameras for observing the Sun:

Cyberspace Middle School
http://www.scri.fsu.edu/~dennisl/CMS/sf/pinhole.html

Jack Troeger's Sun Site
http://www.cnde.iastate.edu/staff/jtroeger/sun.html

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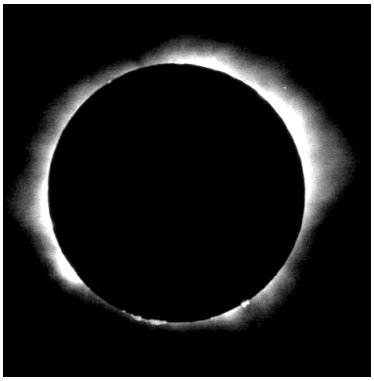
(unless you have the proper filters).

Classroom Activities

Activities courtesy of the Stanford Solar Center
http://solar-center.stanford.edu/observe/observe.html



Solar Eclipse © 1999 Paul Mortfield
http://www.backyardastronomer.com

Using Remote Solar Telescopes

Using Mike Rushford's robotic solar observatory in Livermore, California, you can get a real-time view of the Sun by controlling a telescope from your Web browser. At cloudy times, there are other things to do as well!

Related Resources

Eyes on the Skies
http://sunmil1.uml.edu/eyes/index.html

Using Your Own Telescope

The safest way to look at the Sun through your own telescope is **NOT** to! Looking at the Sun can cause serious damage, even blindness, to your eyes, unless you have proper filters.

Galileo Galilei used telescopes to observe and track sunspots c.1600. Picture from The Galileo Project.
http://es.rice.edu/ES/humsoc/Galileo/

Related Resources

Viewing the Sun With a Telescope
http://www.sunspot.noao.edu/PR/answerbook/telescope.html#q15

Dr. Sunspot gives more detailed information about safely viewing the Sun with a telescope and filters.

Observing the Sun in H-Alpha
http://www.4w.com/pac/halpha.htm

This site gives technical information on how to observe the Sun with your own telescope using an H-alpha filter. Includes detailed information on what features of the Sun are best seen in H-alpha. By Harold Zirin, Peter V. Foukal, and David Knisely.

The safest practical way to see the Sun is by eyepiece projection. Line up your telescope with the Sun, but instead of looking through the eyepiece, hold a sheet of white paper behind the eyepiece. You'll see a solar image projected onto the paper. What happens when you move the paper farther back?

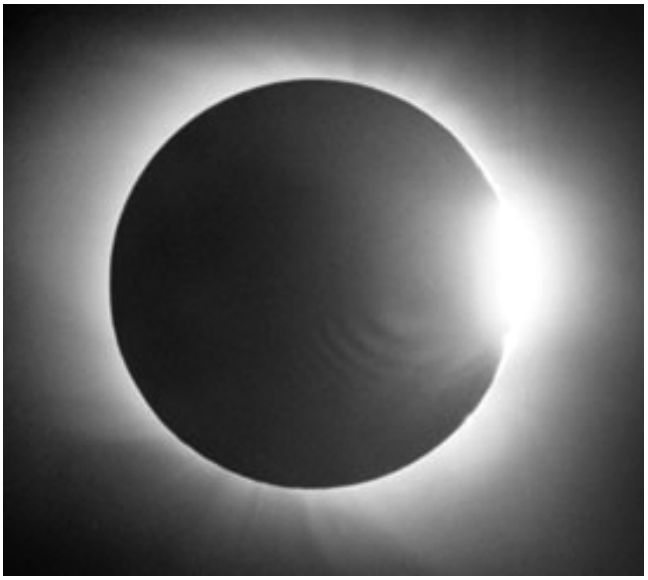
Experiment with the paper to get a sharp viewing contrast. You should be able to see the largest sunspots with this method.

CAUTION!
Don't EVER look directly at the Sun, with or without a telescope
(unless you have the proper filters).

Activities courtesy of the Stanford Solar Center
http://solar-center.stanford.edu/observe/observe.html

Observing Solar Eclipses

A solar eclipse occurs when the Moon, during its monthly revolution around Earth, happens to line up exactly between Earth and the Sun. Why isn't there an eclipse every month? Because solar eclipses occur during a new moon, but not at *every* new moon. Most often the Moon passes a little higher or a little lower than the Sun. There is a solar eclipse about twice a year, when the Moon's and the Sun's positions line up exactly.



Solar eclipse image from Fred Espenak's Eclipse Home Page at NASA's Goddard Space Flight Center.
http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

The glory of a solar eclipse comes from the dramatic view of the Sun's corona, or outer atmosphere, which we can see only when the brilliant solar disk is blocked by the Moon. The corona is not just light shining from around the disk: It is actually the outermost layer of the solar atmosphere. Although the gas is very sparse, it is extraordinarily hot (800,000 to 3,000,000 Kelvin), even hotter than the surface of the Sun! (The heating of the corona is still a mystery.) The corona shows up as pearly white streamers, their shape dependent on the Sun's current magnetic fields. Thus every eclipse will be unique and glorious in its own way.

A solar eclipse is only visible from a small area of Earth. It's unlikely that, during your lifetime, you will ever see a total solar eclipse directly over the place you live. Many people travel long ways to experience a total solar eclipse. If you're lucky, you might someday see a partial solar eclipse (one where the Moon doesn't quite cover all the Sun's disk) nearby.

Related Resources

Fred Espenak's Eclipse Home Page
http://sunearth.gsfc.nasa.gov/eclipse

Eclipse: Stories From the Path of Totality
http://www.exploratorium.edu/eclipse

Solar Data Anaylsis Center Eclipse Information
http://umbra.nascom.nasa.gov/eclipse

Eclipse Paths
http://umbra.nascom.nasa.gov/eclipse/predictions/eclipse-paths.html

You can safely observe a TOTALLY eclipsed Sun with the naked eye, but you will need a pinhole camera, an appropriate type of welder's glass, or special Mylar glasses to safely observe the beginning and ending of a full or partial eclipse.

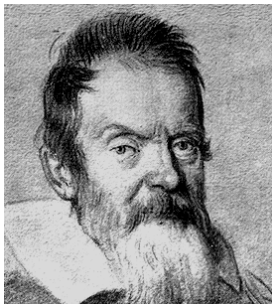
CAUTION!
Don't EVER look directly at the Sun, with or without a telescope
(unless you have the proper filters).

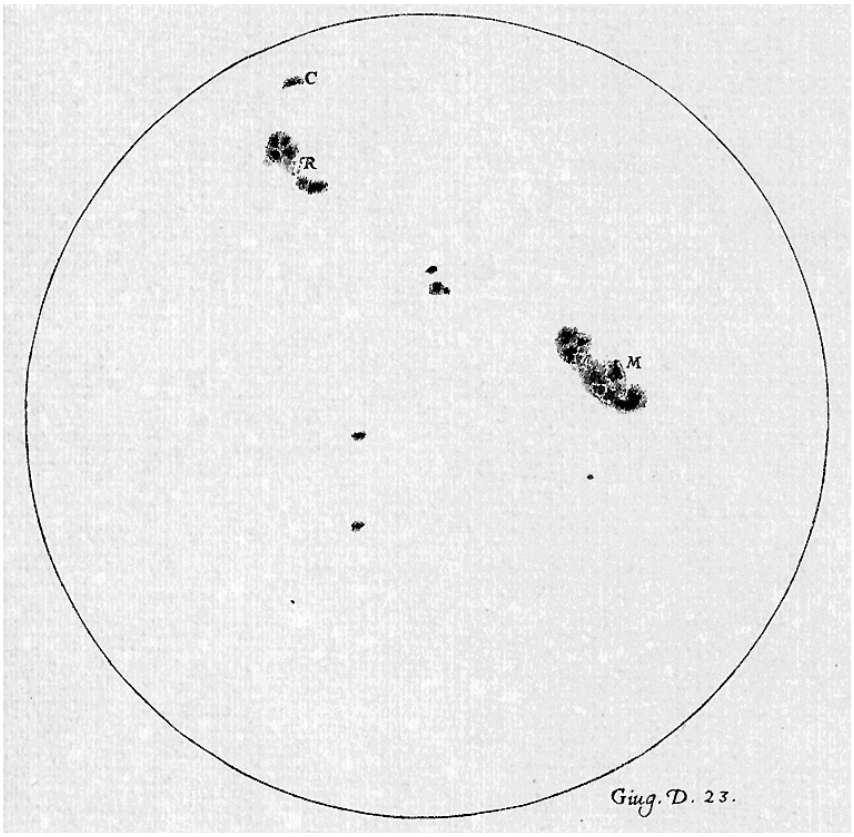
Classroom Activities

Activities courtesy of the Stanford Solar Center
http://solar-center.stanford.edu/observe/observe.html

Sunspot Drawings

Until recently, astronomers have had to rely on drawings or sketches to document what they've seen. Charge-coupled device (CCD) cameras and other technological wonders have changed all that. Historic drawings, however, are still very important. And even today, drawings are still more accurate at recording exactly what the eye sees, unaltered by the processing of fancy electronics.





Galileo Galilei (left) and sunspot drawings (above) from The Galileo Project. http://es.rice.edu/ES/humsoc/Galileo/

Related Resources

Daily Sunspot Drawing Observations at Mt. Wilson
http://www.astro.ucla.edu/~obs/150_draw.html

Daily Sunspot Images from SOHO
http://sohowww.nascom.nasa.gov/latestimages

Galileo's Sunspot Drawings
http://es.rice.edu/ES/humsoc/Galileo/Things/g_sunspots.html

Sunspots at the Exploratorium
http://www.exploratorium.edu/sunspots

These classroom activities can be found at:
http://solar-center.stanford.edu/observe/observe.html
Created by Deborah Scherrer, April 1997. Last revised by DKS on 2 December 1997.

Galileo's drawings of sunspots (c. 1600) still survive today. And the solar telescope at Mt. Wilson, above Pasadena, California, has been collecting sunspot drawings since 1917. The tradition continues. You can check current sunspot drawings each day at the Websites listed here, and compare them with your own.

CAUTION!
Don't EVER look directly at the Sun, with or without a telescope
(unless you have the proper filters).

Safety

How to View the 2017 Solar Eclipse Safely
(/sites/default/files/Solar_Eclipse_Safety_RTFv14.pdf)

A solar eclipse occurs when the moon blocks any part of the sun. On Monday, August 21, 2017 a solar eclipse will be visible (weather permitting) across all of North America. The whole continent will experience a partial eclipse lasting 2 to 3 hours. Halfway through the event, anyone within a 60 to 70 mile-wide path from Oregon to South Carolina will experience a total eclipse. During those brief moments when the moon completely blocks the sun's bright face for up to 2 minutes 40 seconds, day will turn into night, making visible the otherwise hidden solar corona (the sun's outer atmosphere). Bright stars and planets will become visible as well. This is truly one of nature's most awesome sights.

Looking directly at the sun is unsafe except during the brief total phase of a solar eclipse ("totality"), when the moon entirely blocks the sun's bright face, which will happen only within the narrow path of totality.

The only safe way to look directly at the uneclipsed or partially eclipsed sun is through special-purpose solar filters, such as "eclipse glasses" (example shown at left) or handheld solar viewers. Homemade filters or ordinary sunglasses, even very dark ones, are not safe for looking at the sun. To date three manufacturers have certified that their eclipse glasses and hand-held

solar viewers meet the ISO 12312-2 international standard for such products: Rainbow Symphony, American Paper Optics, and Thousand Oaks Optical.

Always inspect your solar filter before use; if scratched or damaged, discard it. Read and follow any instructions printed on or packaged with the filter. Always supervise children using solar filters.

- Stand still and cover your eyes with your eclipse glasses or solar viewer before looking up at the bright sun. After glancing at the sun, turn away and remove your filter — do not remove it while looking at the sun.
- Do not look at the uneclipsed or partially eclipsed sun through an unfiltered camera, telescope, binoculars, or other optical device. Similarly, do not look at the sun through a camera, a telescope, binoculars, or any other optical device while using your eclipse glasses or hand-held solar viewer — the concentrated solar rays will damage the filter and enter your eye(s), causing serious injury. Seek expert advice from an astronomer before using a solar filter with a camera, a telescope, binoculars, or any other optical device.
- If you are within the path of totality, remove your solar filter only when the moon completely covers the sun's bright face and it suddenly gets quite dark. Experience totality, then, as soon as the bright sun begins to reappear, replace your solar viewer to glance at the remaining partial phases.

An alternative method for safe viewing of the partially eclipsed sun is pinhole projection. For example, cross the outstretched, slightly open fingers of one hand over the outstretched, slightly open fingers of the other. With your back to the sun, look at your hands' shadow on the ground. The little spaces between your fingers will project a grid of small images on the ground, showing the sun as a crescent during the partial phases of the eclipse.

A solar eclipse is one of nature's grandest spectacles. By following these simple rules, you can safely enjoy the view and be rewarded with memories to last a lifetime. For more information visit https://eclipse.aas.org (https://eclipse.aas.org) and eclipse2017.nasa.gov.

This document does not constitute medical advice. Readers with questions should contact a qualified eye-care professional.

Additional Safety Information

An eclipse is a rare and striking phenomenon you won't want to miss, but you must carefully follow safety procedures. Don't let the requisite warnings scare you away from witnessing this singular spectacle! You can experience the eclipse safely, but it is vital that you protect your eyes at all times with the proper solar filters. No matter what recommended technique you use, do not stare continuously at the sun. Take breaks and give your eyes a rest! Do not use sunglasses: they don't offer your eyes sufficient protection. One excellent resource for safe solar eclipse viewing is here: http://www.nasa.gov/content/eye-safety-during-a-total-solar-eclipse (http://www.nasa.gov/content/eye-safety-during-a-total-solar-eclipse)

Viewing with Protection -- Experts suggests that one widely available filter for safe solar viewing is number 14 welder's glass. It is imperative that the welding hood houses a #14 or darker filter. Do not view through any welding glass if you do not know or cannot discern its shade number. Be advised that arc welders typically use glass with a shade much less than the necessary #14. A welding glass that permits you to see the landscape is not safe. Inexpensive eclipse glasses have special safety filters that appear similar to sunglasses, but these do permit safe viewing.

(/event-locations)

(/node/137)

(https://www.facebook.com/NASASunScien

(https://twitter.com/NASASun)

(https://www.youtube.com/playlist?list=PLF14609877EF3419B)

(https://www.instagram.com/NASAGoddarc

(//www.flickr.com/groups/nasa-eclipse2017)

(https://www.snapchat.com/add/nasa)

Telescopes with Solar Filters – Eclipses are best viewed directly when magnified, which means a telescope with a solar filter or solar telescopes. These will give you a magnified view that will clearly show the progress of an eclipse. Never look through a telescope without a solar filter of the scope. And never use small solar filters that attach to the eyepiece (as found in some older, cheaper telescopes.)

Pinhole projectors (http://solar-center.stanford.edu/observe/) -- Pinhole projectors and other projection techniques are a safe, indirect viewing technique for observing an image of the sun. These provide a popular way for viewing solar eclipses.

Related projection methods -- One viewing technique is to project an image of the Sun onto a white surface with a projecting telescope. This is explained further here: http://www.astrosociety.org/education/publications/tnl/05/stars2.html (http://www.astrosociety.org/education/publications/tnl/05/stars2.html). The Exploratorium demonstrates how to view a planet in transit or an eclipse safely by projecting the image with binoculars: http://www.exploratorium.edu/transit/how.html (http://www.exploratorium.edu/transit/how.html). There are commercially available projection telescopes as well.

Besides eye protection during solar eclipse viewing, one needs to pay attention to their personal needs and surrounding. Below are some additional safety tips for eclipse observers before, during and after the August 21, 2017 solar eclipse.

Car Safety
Planning to Drive the Eclipse (http://ops.fhwa.dot.gov/publications/fhwahop16085/index.htm)
https://www.ready.gov/car (https://www.ready.gov/car)

Camping Health and Safety
https://www.cdc.gov/family/camping/ (https://www.cdc.gov/family/camping/)
http://www.recreation.gov/recFacilityActivitiesHomeAction.do?goto=camping.htm&activities=9 (http://www.recreation.gov/recFacilityActivitiesHomeAction.do?goto=camping.htm&activities=9)

Heat and Children in Cars
http://www.safercar.gov/parents/InandAroundtheCar/heatstroke.htm (http://www.safercar.gov/parents/InandAroundtheCar/heatstroke.htm)
http://www.safercar.gov/parents/InandAroundtheCar/heat-involved.html (http://www.safercar.gov/parents/InandAroundtheCar/heat-involved.html)

Federal Emergency Management Agency (https://www.fema.gov/pdf/areyouready/areyouready_full.pdf) – Are You Ready
Food and Water Safety (http://wwwnc.cdc.gov/travel/page/food-water-safety)
Hazards to Outdoors Workers (https://www.cdc.gov/niosh/topics/outdoor/)
Heat and Hydration (https://www.cdc.gov/extremeheat/)
Hiking Safety (http://www.recreation.gov/recFacilityActivitiesHomeAction.do?goto=hiking.htm)
Large Crowds Safety (http://www.med.navy.mil/sites/nmcphc/Documents/health-promotion-wellness/injury-violence-free-living/Injury_Prevention_Fact_Sheet_Series/Safety-in-Large-Crowds.pdf)
Personal Safety (http://www.state.gov/m/ds/rls/rpt/19773.htm) – At Home, On the Street, While Traveling
Sun Safety: (http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm049090.htm) Save Your Skin