



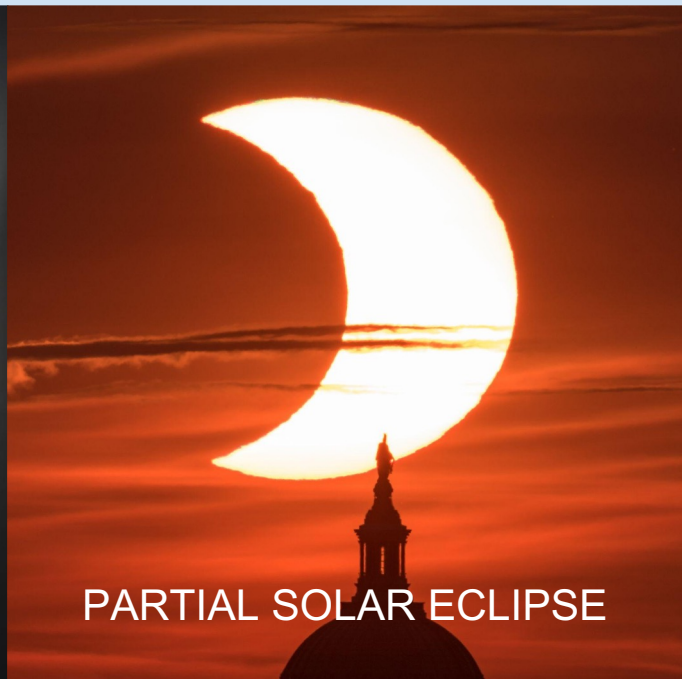
Eclipses and the Sun

Dr. Michael Kirk, NASA HEAT's Principal Investigator
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Saturday
October 14, 2023

Monday
April 8, 2024

Partial in all 48
states



Credit: NASA

Annular Solar Eclipse October 14, 2023

Total Solar Eclipse Monday, April 8, 2024



Partial Solar Eclipse

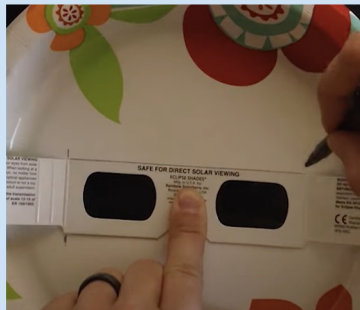


You must look through **safe solar viewing glasses** (“eclipse glasses”) or a safe handheld solar viewer at all times.

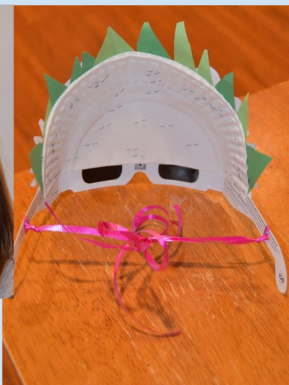
Eclipse glasses are NOT regular sunglasses; regular sunglasses, no matter how dark, are not safe for viewing the Sun.

A huge group of sunspots, about the size of Jupiter, appeared on the Sun during a partial solar eclipse over Santa Cruz, California on October 25, 2014. *Credit: Astronomy Picture of the Day, [Michael Bolte \(UCSC\)](#)*

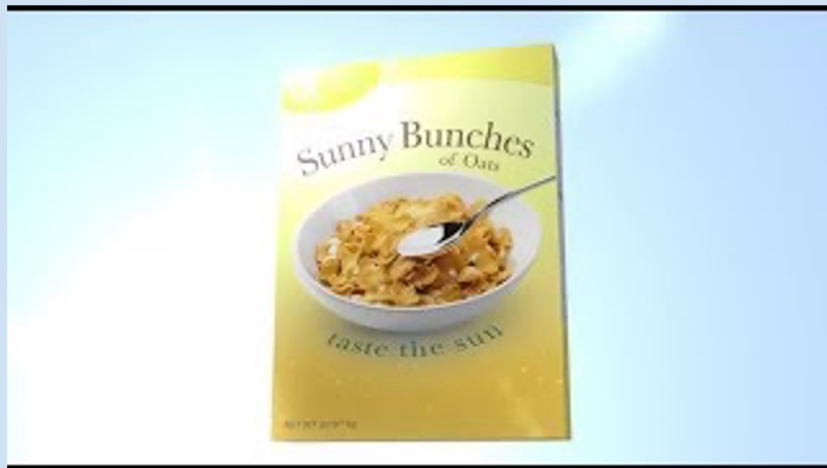
Glitter and Glam with Solar Eclipse Safety



This activity is not yet in our database, but will be added soon!



Pinhole Projector Activities

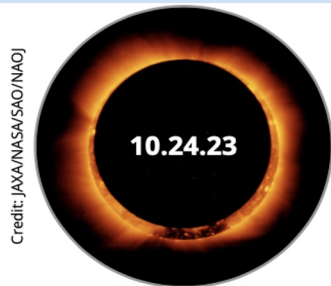


Build a cereal box pinhole projector
Credit: NASA



Allow light to filter through a colander to project many partial solar eclipse images on the ground. Credit: NASA/Joy Ng

USA NASA Pinhole Projector Activity



Your back should always be to the Sun when using a pinhole projector. Do NOT look at the Sun through the pinhole!

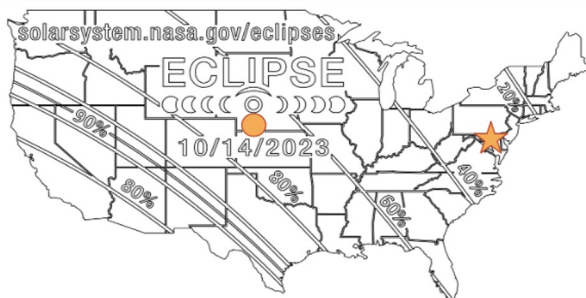


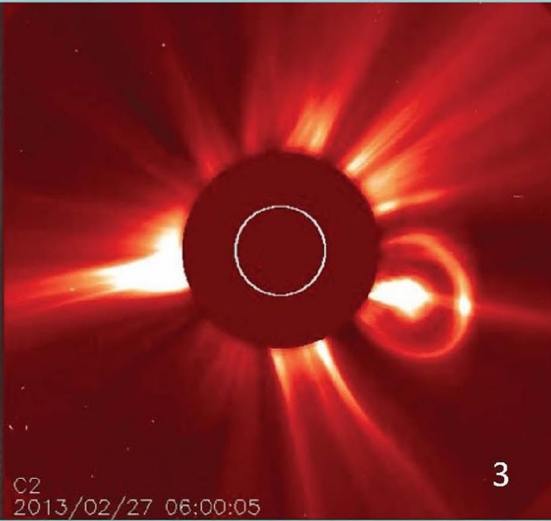
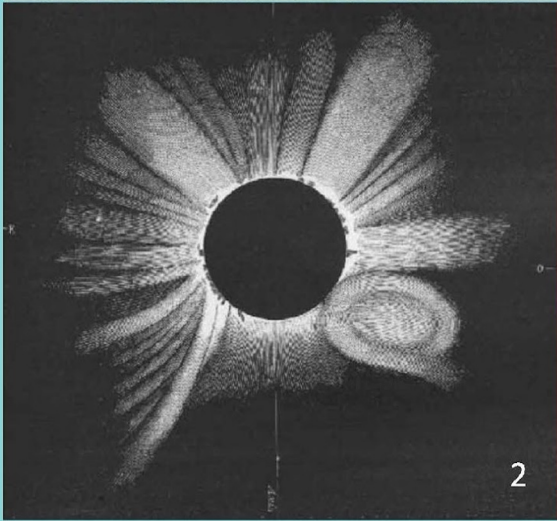
Figure 2. A 2D paper cut US map for the Saturday, October 14, 2023, annular solar eclipse. Not to scale. See Learner Handout. Credit: NASA HEAT/J. Patrick Haas

<https://nasa3d.arc.nasa.gov/detail/usa-eclipse-2023>



A 3D printed US map for the Monday, April 8, 2024 total solar eclipse. Not to scale. Credit: NASA HEAT/J. Patrick Haas

<https://nasa3d.arc.nasa.gov/detail/usa-eclipse-2024>



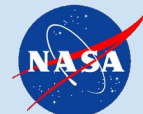
Counterclockwise:

1. Rock art from A.D. 1097 showing a possible solar eclipse in Chaco Canyon, NM.
2. Drawing of the 1860 eclipse by G. Tempel showed a peculiar feature in lower right portion of the corona.
3. A coronal mass ejection (CME) observed by the SOHO satellite. Credit: NASA & ESA
4. A total solar eclipse gives scientists a rare opportunity to study the Sun's inner corona. These observations can help us understand solar activity and the unexpectedly high temperatures in the corona. Credit: S. Habbal, M. Druckmüller and P. Aniol

Heliophysics “Big Year”

ECLIPSE
THROUGH THE EYES OF NASA

**2024 Total Solar
eclipse**
THROUGH THE EYES OF NASA



**ANNULAR
SOLAR ECLIPSE**

OCT. 14, 2023



**TOTAL
SOLAR ECLIPSE**

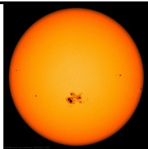
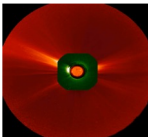
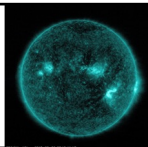

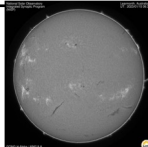
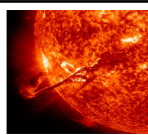
APR. 8, 2024



**CLOSEST
APPROACH TO SUN**

DEC. 24, 2024

Solar Features

| | | |
|--|--------------------------|--|
|  | Sunspot | A dark area on the solar surface that contains strong magnetic fields, moves along with the Sun's rotation, and lasts for days. |
|  | Coronal Mass Ejection | A cloud of magnetized solar material that erupts from the Sun's atmosphere, the corona, into interplanetary space. |
|  | Flare | An intense burst of light and radiation due to the release of magnetic energy on the Sun. |
|  | Filament | A cloud of plasma (charged particles) above the solar surface, like an eyebrow or a snake. It is a prominence on the Sun's limb. |
|  | Plage (French for beach) | A bright patch surrounding active regions known as sunspots. |
|  | Prominence | A huge arc of plasma over the Sun's limb or horizon that is supported in the Sun's atmosphere by magnetic fields. |

Plumes and Plumelets

Plumes are streams of solar material that stretch out from coronal holes – dark patches of open magnetic field – on the Sun. They appear bright in extreme ultraviolet views of the Sun, and are made up of many smaller streamers, called plumelets. Plumes play a role in creating the high-speed solar wind.



Scientists used image processing on high-resolution images from the Solar Dynamics Observatory (SDO) to reveal these plumes. Credit: NASA/SDO/AIA, et al.

Sunspots

Sunspots are cooler regions on the Sun's visible surface caused by a concentration of magnetic field lines. Sunspots are the visible component of active regions, areas of intense and complex magnetic fields on the Sun that are the source of solar eruptions. Lasting from days to months, sunspots typically stretch 1,000 to 100,000 miles across. The number of sunspots goes up and down as the Sun goes through its natural 11-year cycle.



Sunspots are the visible component of active regions on the Sun. Credit: NASA/SDO/AIA, et al.

Supergranules

Supergranules are networks of cells covering the Sun's visible surface that stretch some 18,000 miles across – more than large enough to frame two Earths side by side. They are caused by the convection of material in the Sun.



Close-up of Active Region 12593 through the SDO filter. Credit: NASA/SDO/AIA, et al.

Spicules

At any given moment, as many as 10 million wild jets of solar material burst up from the Sun's surface. Known as spicules, these grass-like tendrils of plasma erupt as fast as 60 miles per second and can reach lengths of 6,000 miles before collapsing.



Observation of spicules from NASA's Solar Dynamics Observatory (SDO). Credit: NASA/SDO/AIA, et al.

Flux Rope

A flux rope is kind of a magnetic structure that is thought to be at the heart of many of the Sun's eruptions. Flux ropes form in plasmas, such as the Sun's corona, when loops of magnetic field lines connect with each other. The resulting flux ropes are formed from bundles of magnetic fields that have a magnetic field wrapped around them, like the stripes on a candy cane. These twisted structures extend in a series of loops from the Sun's surface, and can be carried away from the Sun by a coronal mass ejection.



This image shows a series of magnetic field lines connecting with each other. Credit: NASA's Solar Dynamics Observatory.

Solar Wind

The solar wind is a gusty stream of material that flows from the Sun in all directions, all the time, carrying the Sun's magnetic field out into space. While it is much less dense than wind on Earth, it is much faster, typically blowing at speeds of one to two million miles per hour. The solar wind is made of charged particles – electrons and ionized atoms – that interact with each other and the Sun's magnetic field.



An artist's impression of the solar wind. Credit: NASA's Goddard Space Flight Center/Conceptual Image Lab/Johns Hopkins University.

Coronal Rain

Coronal, or plasma, rain is made of giant globs of plasma that drip from the Sun's outer atmosphere back to its surface. It occurs when particular conditions, such as magnetic field line configurations and local heating events in the corona, cause the plasma globes there to become cooler and denser than their surroundings, making them rain down.



NASA's SDO captures a coronal rain event. Credit: NASA/SDO.

Coronal Mass Ejection (CME)

Coronal mass ejections, or CMEs, are large clouds of solar plasma and embedded magnetic fields released into space after a solar eruption. CMEs expand as they sweep through space, often measuring millions of miles across, and can collide with planetary magnetic fields. When directed at Earth, a CME can produce geomagnetic disturbances that ignite bright aurora, short-circuit satellites and power grids on Earth, or at their worst, even endanger astronauts in orbit.



This image shows a coronal mass ejection released by an X1.1 flare. Credit: NASA/SDO.

Sunquakes

Sunquakes are seismic-like activity on the Sun that ripple across the visible surface, not unlike earthquakes. They are known to accompany some solar flares, but scientists are uncertain how exactly they are triggered.



This image shows the ripples caused by a sunquake on the Sun's cooling surface. Credit: NASA's Solar Dynamics Observatory.

Solar Flare

Solar flares are energetic bursts of light and particles triggered by the release of magnetic energy on the Sun. Flares are by far the most powerful explosions in the solar system, with energy releases comparable to billions of hydrogen bombs. The energetic particles accelerated by flares travel nearly at the speed of light, and can travel the 93 million miles between the Sun and Earth in less than 20 minutes.



The Sun emitted a significant solar flare, reaching an X1.1 flare on May 8, 2015. Credit: NASA's Solar Dynamics Observatory.

Coronal Hole

A coronal hole is a patch of the Sun's atmosphere with much lower density than elsewhere. In ultraviolet views of the Sun, coronal holes appear as dark splotches. These are regions where the Sun's magnetic field lines are connected directly to interplanetary space, allowing solar material to escape out in a high-speed stream of solar wind, leaving a dark "hole" near the surface of the Sun.



The dark area across the top of the Sun in this image is a coronal hole. This image was captured on Oct. 16, 2014, by NASA's Solar Dynamics Observatory.

Nanojets and Nanoflares

Nanojets are bright, thin tendrils of plasma that travel perpendicular to magnetic structures in the outer solar atmosphere, reaching lengths of thousands of miles. They are spawned by nanoflares, tiny explosions on the Sun caused by a process known as magnetic reconnection, which occurs in tangled magnetic field lines.



These images showing nanojets on the Sun were captured by NASA's Solar Dynamics Observatory on April 3, 2014. Credit: NASA's Solar Dynamics Observatory.

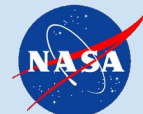
Filament Eruption

Filaments are strands of solar material, cooler and denser than their surroundings, suspended above the Sun by magnetic forces. They appear as dark lines when seen against the bright Sun. (When a solar filament is seen at the edge of the Sun, against the blackness of space, it is called a prominence.) When solar filaments become unstable they can either fall back onto the Sun or erupt into space, sending a coronal mass ejection away from the Sun.



Filament seen with SDO's Solar Dynamics Observatory.

Explain



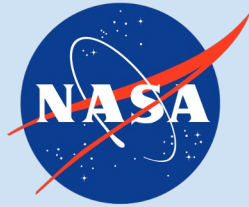
- What is a solar eclipse?
- Why do they happen?
- What are the different kinds of eclipses?
- What can be learned from an annular solar eclipse?
- What can be learned from a total solar eclipse?
- What features may be visible on the Sun?

- Experiencing an eclipse is one way that everyone can participate in NASA Science.
- Exploring our Sun and its interactions with Earth is possible through innovative NASA missions.



Learn more about the Heliophysics Big Year:
October 2023 to December 2024

Thank You!



Find more about eclipses: solarsystem.nasa.gov/eclipses

This presentation is supported by the NASA Heliophysics Activation Team (NASA HEAT), part of NASA's Science Activation portfolio.

Resources

Annular, Total, and Partial Eclipses

<https://solarsystem.nasa.gov/resources/2770/annular-eclipse-of-october-3-2005/?category=eclipse>

<https://solarsystem.nasa.gov/resources/2757/total-solar-eclipse-above-madras-oregon/?category=eclipse>

<https://solarsystem.nasa.gov/resources/2628/a-partial-solar-eclipse/>

The 2023 and 2024 Solar Eclipses: NASA Map and Data

<https://svs.gsfc.nasa.gov/5073>

Annular Eclipse

<https://solarsystem.nasa.gov/resources/2770/annular-eclipse-of-october-3-2005/?category=eclipse>

https://www.nasa.gov/mission_pages/hinode/hinode-sees-annular-solar-eclipse-from-orbit.html

Pinhole Projectors

<https://www.youtube.com/watch?v=vWMf5rYDgpc>

https://svs.gsfc.nasa.gov/vis/a010000/a012200/a012200/Colander4_JoyNg.jpg

<https://nasa3d.arc.nasa.gov/detail/usa-eclipse-2023>

<https://nasa3d.arc.nasa.gov/detail/usa-eclipse-2024>

Total Solar Eclipses - the Corona

<https://solarsystem.nasa.gov/resources/2757/total-solar-eclipse-above-madras-oregon/?category=eclipse>

Predict the Corona Activity - coming soon

Coronal Mass Ejection during a Total Solar Eclipse

<https://student.helioviewer.org/>

<https://mpt.pbslearningmedia.org/resource/buac17-912-sci-ess-nveoacme/wgbh-nova-eclipse-over-america-coronal-mass-ejections-from-the-sun/>

Heliophysics Big Year

go.nasa.gov/HelioBigYear

Resources

Sunspot - white light, also SDO HMI

SDO Sunspot 2014 latest_1024_hmiic_0.jpeg

<https://www.nasa.gov/content/goddard/sdo-observes-largest-sunspot-of-the-solar-cycle/>

Coronal Mass Ejection - SOHO LASCO and STEREO A

<https://www.nasa.gov/sites/default/files/thumbnails/image/7-23-2017-cme.gif>

<http://soi.stanford.edu/results/SolPhys200/Dere/index.html>

Flare - extreme ultraviolet (EUV), SDO AIA 131, 193

https://www.nasa.gov/sites/default/files/thumbnails/image/quick_double_x_flare-1041.gif

<https://sdo.gsfc.nasa.gov/gallery/main/item/133>

Filament - H-Alpha, SDO AIA

<https://www.stce.be/news/597/welcome.html>

<https://www.nasa.gov/content/goddard/sdo-sees-giant-filament-on-the-sun>

Plage - H-Alpha, Ca K

<https://gong2.nso.edu/HA/hag/202301/20230115/20230115041732Uh.jpg>

Prominence - H-Alpha, SDO AIA 304

<https://sdo.gsfc.nasa.gov/assets/img/site/spaceweather01.jpg>

NASA Heliopedia

https://www.nasa.gov/sites/default/files/thumbnails/image/features_of_the_sun_thumbnail_0.png

https://www.nasa.gov/mission_pages/sunearth/the-heliopedia