Safely Observing the Sun for Yourself

Never look directly at the Sun with your eyes or through a telescope or in any other way, unless you have the proper filters.

The Great American Eclipse of 2017

On 21 August 2017, millions of people across the United States will enjoy nature's most grandious show – a total eclipse of the Sun. Everyone in the contiguous 48 states will be able to see at least a partial eclipse. But you have an opportunity to drive, perhaps within 1 day, to see the eclipse from its line of totality! Don't miss this!

- **http://GreatAmericanEclipse.com**
- **http://www.greatamericaneclipse.com/eclipse-2017/**
- **http://www.eclipse2017.org/2017/path_through_the_US.htm**
- **http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html**

Eclipse Glasses – for anytime!

For very little money you can purchase a pair of paper eclipse glasses. They'll be great for the 2017 eclipse, but they work anywhere, anytime you can see the Sun! Available on the web for a few dollars apiece.

Projecting the Sun by Pinhole Camera

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
- A pin
- A sunny day
- Perhaps a friend to help

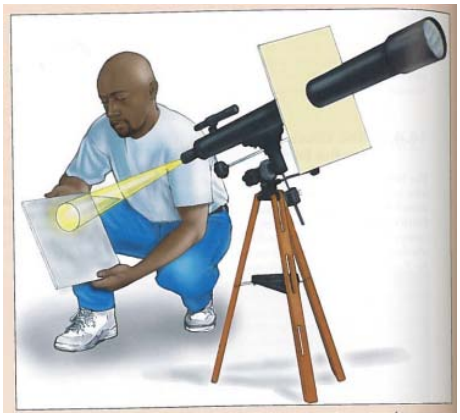
With the pin, punch a hole in the center of one of your pieces of paper. Go outside, hold the paper up and aim the hole at the Sun. (**Don't look at the Sun either through the hole or in any other way!**) Now, find the image of the Sun that comes through the hole. Move your other piece of paper back and forth until the image looks best. What you are seeing is not just a dot of light coming through the hole, but an actual image of the Sun!

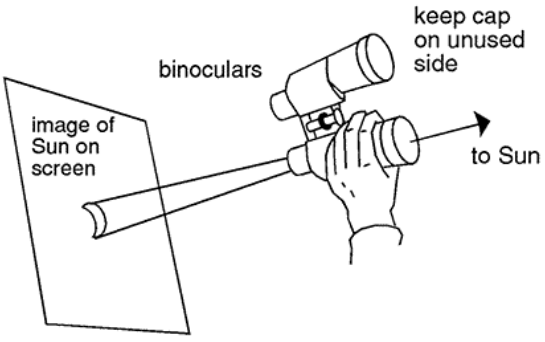
Experiment by making your holes larger or smaller. What happens to the image? What do you think would happen if you punched a thousand holes in your paper, and you put little lenses in front of each hole to refract (e.g. bend) the solar images to all fall on top of each other. What do you think you'd see? In fact, optical telescopes can be thought of as a collection of millions of "pinhole" images all focused together onto one place!

If you want, 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 adapt your pinhole camera into a "real" camera by adding film. Google “pinhole camera” for lots of ideas!

Projecting the Sun by Binoculars or a Small Telescopes

You can also project an image of the Sun using a pair of binoculars or small telescope:
http://resources.yesican-science.ca/trek/eclipse0602/pinhole2.html
http://astrosociety.org/edu/publications/tnl/05/stars2.html
http://pwg.gsfc.nasa.gov/istp/outreach/sunobserve1.pdf





However, **take note**, when projecting you can easily burn out the optics in your telescope of you are not careful. There are two things to watch for; both relate to the intensity of the image at the prime focus of your telescope. This will be very hot -- brighter than sunlight

by the square 107 (the angular size of the Sun) divided by the f/ratio of the telescope (f/ratio is the ratio of the focal length/objective diameter). So in a 6-inch telescope that has a 4-foot focal length (like many Dobsonian mounts) it is f/8. The sun is f/107, so the intensity of the image is (107/8)*(107/8) = 179. So the spot is about 180 times hotter than unfocused sunlight.

a) If that hot spot drifts off to the side of the telescope tube while you are not keeping it pointed correctly it can burn or ignite the inside of the telescope tube.
b) If your best eyepiece is being used to project the image to a screen or paper, note that the eyepiece must be moved out from the normal focus position **BEFORE** pointing at the Sun. When the eyepiece is all the way in it may well be that the hot image will actually be at the eyepiece and it could crack the lenses. So move it out an inch or more first. And, obviously, keep everybody from actually looking into the eyepiece.

We often cover most of the telescope aperture with cardboard to reduce the lit area of the mirror. Cutting it to 30% or 40% will leave a bright enough projected image. But note that the front of the telescope tube is often very near prime focus if the Sun drifts off the diagonal mirror - we have lit the mask on fire by not paying attention and that really gets people's attention. Obviously, if you ever smell smoke, stop what you are doing!

Projecting the Sun by Sun Funnel

There is also an easy-to-make cone device you can attach to a telescope so that multiple people can easily view your projection device. Really awesome, and your friends will love it! Instructions at**:** **www.astrosociety.org/tov/Build_a_Sun_Funnel2.pdf**

Using the little Sunspotter Telescope

A safe and inexpensive solar telescope of your own! The Sunspotter is an innovative, wooden, folded-Keplerian telescope that uses a system of mirrors and a powerful 62mm objective lens to project a brilliant 3" solar image onto a white viewing screen. Especially good for kids and school groups, since they can set it up by themselves. Cost is $350-$400. Available on the web.

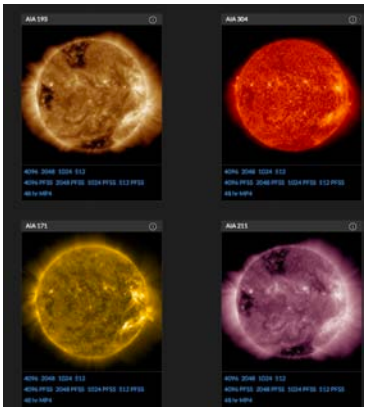
Filter Your Own Night Sky Telescope

If you or a friend have a night-sky telescope, you can often adapt it for solar viewing by using a solar filter. Baader filters are best, but others are available as well.
http://oneminuteastronomer.com/999/choose-solar-filter/

Your Own H-alpha Telescope

There's a particular color of red (called H-alpha, coming from hydrogen atoms) that is good for viewing the Sun's chromosphere, the part of the Sun directly above the surface, and that shows the best solar activity. You can purchase a telescope to observe in H-alpha! Shows prominences, filaments, sunspots, plages. About $700, available on the web. Plus you'll need to add a tripod.

View the Sun Through NASA's Solar Dynamics Observatory

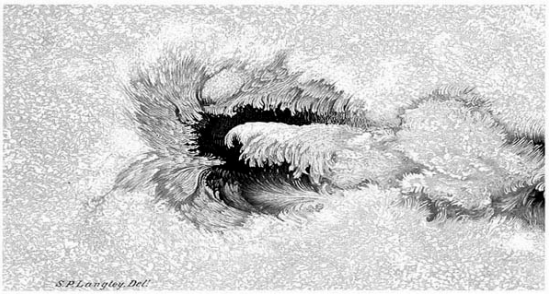


If you can't afford your own NASA space telescope, you can at least view the glorious imagery that NASA's Solar Dynamics Observatory produces:
http://sdo.gsfc.nasa.gov/data/

There is even a special tool that allows you to access this imagery and generate your own videos. It's called JHelioviewer: **http://www.jhelioviewer.org/** If you would REALLY like to get into JHelioviewer, or you end up having to teach a community college course in astronomy, you can learn how to use this tool for yourself or for student laboratories at:
http://solar-center.stanford.edu/activities/SDO/

Drawing Sunspots

Did you say you liked to draw? Before the advent of exotic cameras and other technological wonders, astronomers had to rely on drawings or sketches to document what they had seen. Humans have been sketching sunspots for hundred of years (see **http://obs.astro.ucla.edu/resource.html**).



An English monk named John of Worcester made the first drawing of sunspots in December 1128. Galileo's drawings touched off a huge controversy about whether the blotches were on the Sun or small planets orbiting it. Sunspot drawings have been going on since 1611. Historic drawings are still very important. And even today, drawings are still most accurate at recording exactly what the eye sees, unaltered by the processing of fancy electronics.

Galileo's Sunspot Drawings:
http://galileo.rice.edu/sci/observations/sunspot_drawings.html

You can do your own sunspot drawings by observing sunspots using any of the above techniques. Then you can compare your sketches to those at Mt. Wilson (in Pasadena, California), an observatory that has been collecting sunspot drawings since 1917. This tradition still continues: Daily Sunspot Drawings at Mt. Wilson:
http://obs.astro.ucla.edu/150_draw.html

Ranking Sunspots - Zooniverse

This is a citizen-science, Zooniverse project to rank the complexity of current sunspots. You too can participate! **http://www.sunspotter.org/**

Counting Sunspots

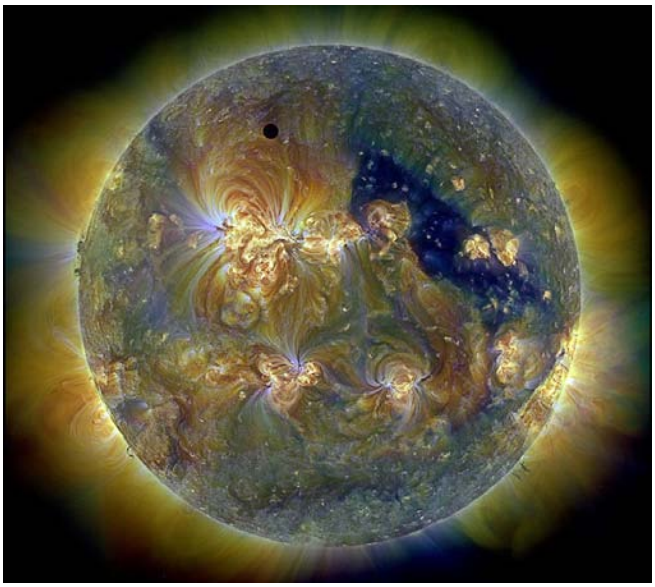
In 1843 an amateur German astronomer named Samuel Schwabe discovered the rise and fall of yearly sunspot counts. We now call this the sunspot cycle. Daily counts have been done since 1849, and still continue. You can do your own, although counting sunspots is not as straightforward as it sounds. You have to figure out how many spots there are, as well as how many groups. And it's hard to determine what qualifies as a sunspot group! How to follow this procedure and count your sunspots is explained at:
http://solar-center.stanford.edu/activities/Sunspots

Viewing Transits

Occasionally the planets Mercury and Venus line up with our view of the Sun and appear to transit across its disc. (Thought for the day: why can't you see other planets transit the

Sun?) Mercury will transit the Sun on 9 May 2016 and 11 November 2019. You can view transits with any of the techniques above.
For viewing the next Mercury transits, see
http://eclipse.gsfc.nasa.gov/transit/catalog/MercuryCatalog.html

This image shows Venus transiting the Sun in June of 2012.The next occurrence will be in December 2117. Encourage your grandchildren to witness it!



See also:

Sun Observer's Guide by Pam Spence, Firefly Book. A practical guide to observing the Sun, how to project an image, how to use filters for safe observations, how to draw and photograph the Sun, and how to observe and photograph solar eclipses.