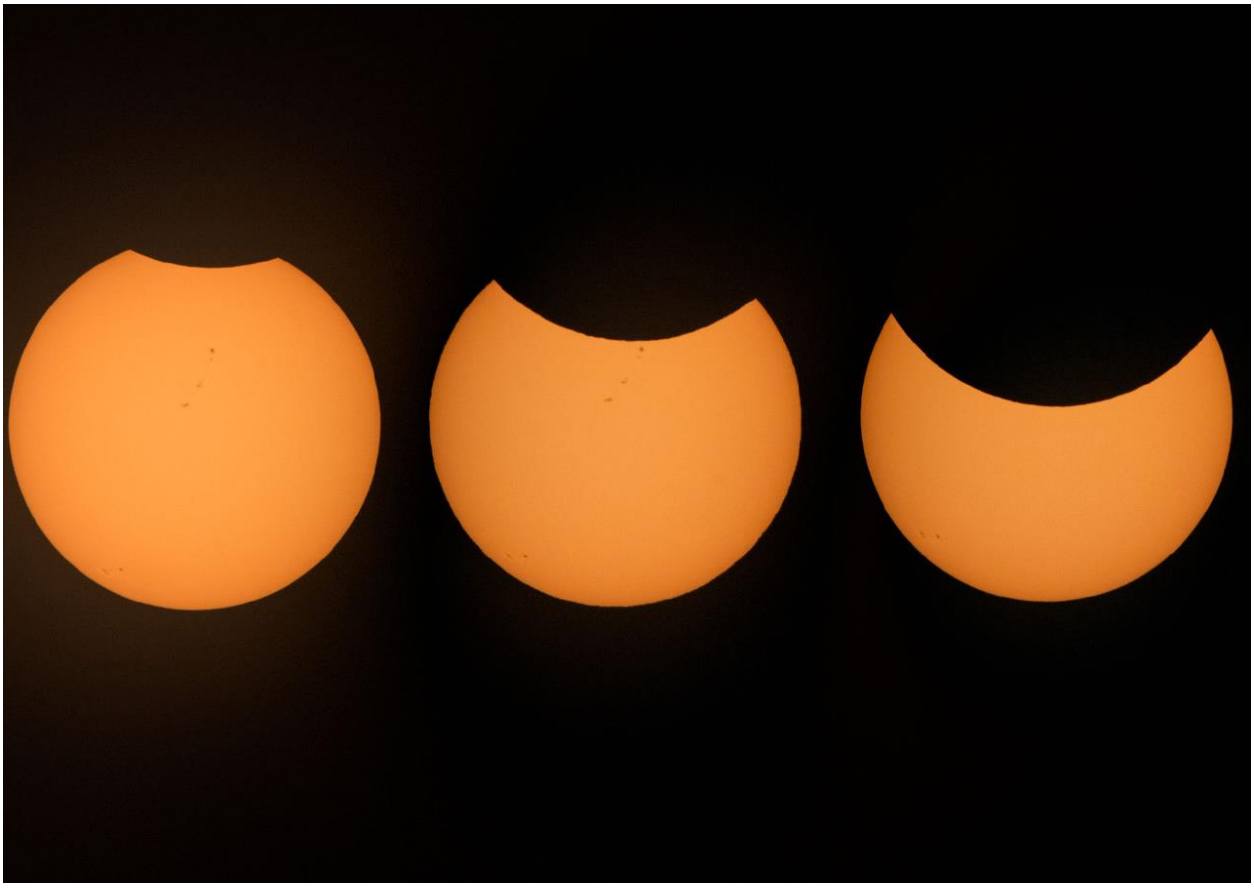
Observing a Partial or Total Solar Eclipse with Students

Grades 4 and up

2024 Edition



By
Dr. W. Maynard Pittendreigh
Astronomical League Observing Program Director
National Coordinator of the Astronomical League's
Outreach Award Program

WHAT IS A SOLAR ECLIPSE? A solar eclipse occurs when the Moon passes between Earth and the Sun, thereby obscuring the view of the Sun from a small part of the Earth, totally or partially.

WHAT TYPES OF ECLIPSES ARE THERE, AND WHAT WILL BE SEEN IN MY COMMUNITY? There are various types of solar eclipses.

- In a **total eclipse** the sun is completely blocked by the moon for a few minutes during the eclipse event. During a total eclipse, the sky turns dark, the stars are visible, and the corona of the sun becomes visible.
- In an **annular eclipse** the moon covers all but the outer edges of the sun's surface so that a "ring of fire" is seen with solar eclipse glasses.
- A **partial eclipse** is when the moon covers some, but not all, of the sun.
- A **hybrid eclipse** refers to a combination of all of these, so that people in various places will enjoy a total eclipse while in other places they will see an annular eclipse.

SAFETY – THE SUN CAN DAMAGE YOUR EYES

Safety is very important when observing the sun. We cannot over-emphasize this when working with students. The ultraviolet light (UV) and infrared light (IR) enters the eye and is focused through the eye's lens onto the retina at the back of the eye. Once this happens, injuring the eye takes place. This damage can occur in as little as a few seconds of staring directly at the sun.

Most people will not feel any pain while the damage is taking place. In most cases, a person will not immediately notice any symptoms or vision changes. It can take up to 12 hours for a person to have symptoms.

How do we demonstrate this safety issue to students in a way in which they understand the real dangers of looking at the sun directly? A simple way is to take a lens, such as a magnifying glass, and focus the sun's energy onto an object to show the power in the sunlight. We can roast a marshmallow or pop a small balloon.

Take your students outside on a sunny day. You will need one or more magnifying glasses. You will also need a few balloons, or some marshmallows, and something to hold the marshmallow (a long fondue fork is a good choice). The leaders will need to decide if everyone is going to have his or her balloon or marshmallow, or if there will be only one per group.

For the balloon demonstration:

1. Step 1: Blow up a balloon. Be sure the balloon is filled with plenty of air.
2. Step 2: Stand so that the Sun is behind you.
3. Step 3: Hold the balloon in front of you with one hand. With the other hand position the magnifying glass to focus the Sun's light into a very small, bright spot on the balloon. You might ask your students what they think will happen.
4. Step 4: Keep the Sun's energy focused on a single spot on the balloon until it pops. Be patient and know that you may need a minute or so to focus the sunlight to its smallest, most perfect point of focus.

You follow essentially the same steps for the marshmallow but with a long holder for the snack. You don't want to burn your hands or fingers! Instead of a holder, you can simply put the marshmallows on a plate.

Remember that the point of the balloon or the marshmallow is to demonstrate that the eye also has a lens, similar to the lens of the magnifying glass. Just as the marshmallow is permanently cooked, or the balloon is destroyed, our eyes can be permanently damaged.

SAFELY OBSERVING THE SUN

If the sun's energy can permanently damage our eyes, how can we safely observe the sun? We need to use a proper solar filter system (as with certified solar eclipse glasses) and/or projection devices.

To observe the sun directly you will need to secure solar eclipse glasses certified by the International Organization for Standardization (ISO). Do not buy products that claim to be certified by NASA, because NASA does not certify any solar eclipse glasses. Sadly, some notorious vendors may claim to be ISO-certified but are not. How can you tell you are purchasing glasses that are actually ISO-certified? Go to the American Astronomical Society's web page and look for their list of where to buy safe, ISO-certified, eclipse glasses. Any of the vendors they list can be trusted.

1. **Know WHEN to use the glasses:**
    - **For a partial eclipse:** All of the time.
    - **For a total solar eclipse:** Throughout all of the partial stages. You can take them off only during totality. Pay attention to the appearance of "Baily Beads" when a few crumbs of sunlight begin to glare on one edge – this is sunlight showing through the mountainous areas on the lunar limb. Teachers and leaders need to be ready to call out – "glasses off" and more importantly "glasses on" during totality.
    - **For an annular eclipse**: All of the time, even during the "ring of fire." Keep in mind that the ring of fire will not be visible anyway without the solar glasses.

Practice using eclipse glasses. You can be in a classroom and have students put them on to try them out. Most of these glasses will be made of cardboard frames so the students will need to know they have to hold them in place with both hands.

2. When outside, look down at the ground, put them on, then look up. Avoid having students look at the sun and then put the glasses in place!

3. **Eclipse Glasses should ONLY be used to observe with your eyes. Do not use eclipse glasses with binoculars or telescopes.** These instruments will need to use filters that are specially made for the size of the telescope or binoculars. Because of the power of the sun, you have to have them placed onto the instrument correctly so that light does not damage the optics of the telescope. Ask your local astronomy club for help or contact the author at maynard@pittendreigh.net.

OBSERVING THE SUN WITH PINHOLE PROJECTION

There are many ways to make a pinhole projector for safely observing a solar eclipse. These are particularly helpful when a group cannot secure enough solar eclipse glasses. You can make several different types of projection devices: a Paper Plate system and a Projection Box are the easiest to construct. You can also take a simple colander from your kitchen or look at the ground near a leafy tree.

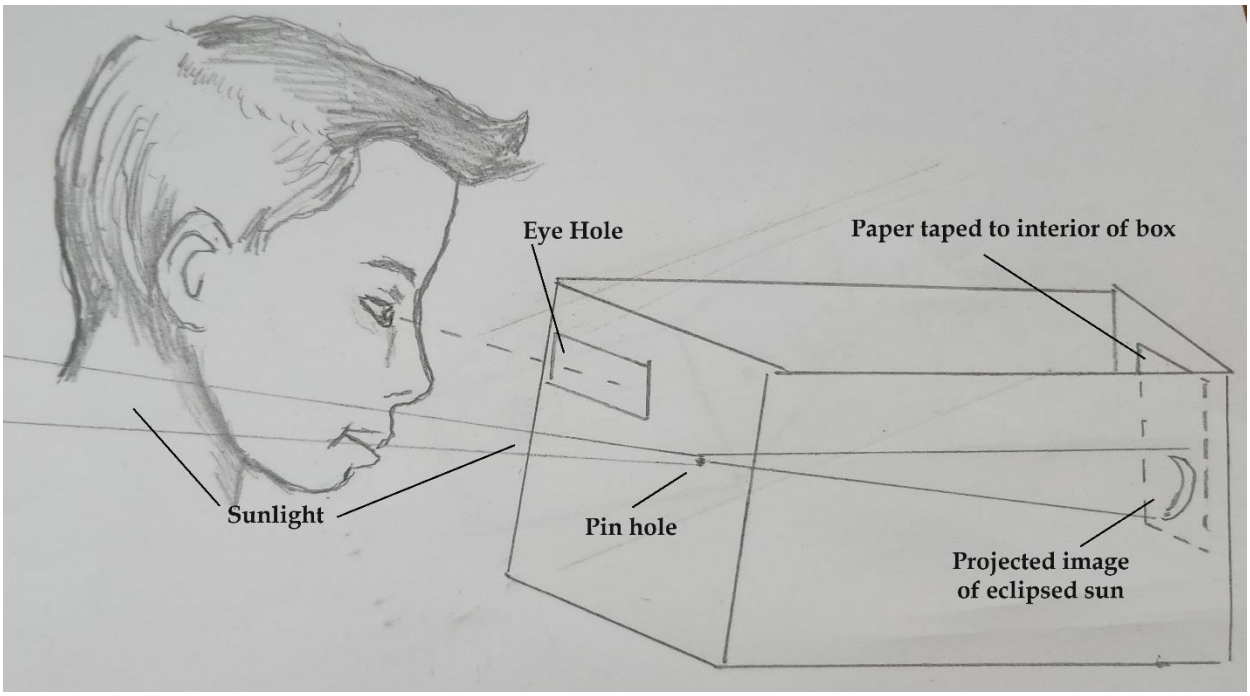
The Paper Plate System

This is the easiest project and can be done in the days before the eclipse event. You will need two sturdy paper plates, and a thumb tack or some other device with which to poke a small hole into one of the two plates. The student holds one plate above a shoulder and lines it up with the other plate, thus projecting an image of the sun on the second plate. The student will move the plates further apart or closer together until a crescent image of the eclipsed sun is in focus.

The disadvantage is that the sun will shine onto the plate and diminish the view of the projected image, so having the second plate under an awning, or blocked by the student's body will help.

The great advantage of this system is that students can make designs on the first plate. Instead of one pinhole, make several in the form of a heart, a school logo, or with the student's name. This will make a great pre-eclipse event for the students and will help build excitement.

The Projection Box



You can use a shoebox or other small box to create a simple pinhole projector. Tape a clean, white piece of paper on the inside of one end, then cut two holes in the other end, one larger opening for looking into and one small opening for creating the actual pinhole projection.

As sunlight streams through the pinhole, it will create an image of the eclipsed Sun on the paper. You will want to put the lid on the box to ensure it's dark enough to see the Sun's image.

This will take time, and you will need to consider if it is an age-appropriate craft that your students can make. Teachers and leaders may decide to use this system, but not having each person make his or her box. The leader can easily make one or two of these for the entire class to use.

A Colander

Projection systems can be very complicated or very simple. The easiest projection system to use is a colander. These are not only good for straining spaghetti, but also providing safe views of a partial eclipse. The advantage, of course, is that there is no assembly required. It also produces a lovely array of projected images.

One activity students might be interested in is holding the colander so that it projects onto their shirts or blouses. This could be a good photo opportunity that can become a souvenir for the students and a way to share school activities with parents and friends.

The Trees

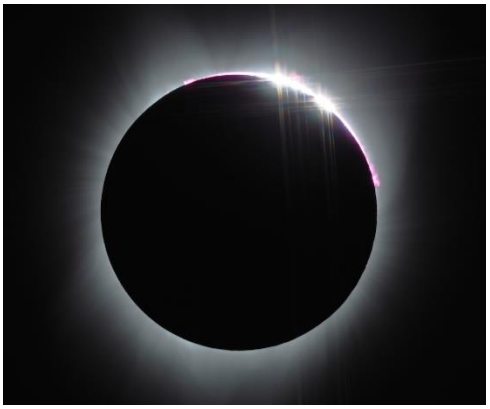
If a tree is casting shade on a sidewalk or parking area at your observing area, the leaves on the tree will also act as pinhole projectors.

OTHER ACTIVITIES TO OBSERVE DURING TOTALITY

1. The primary activity should be to enjoy the moment and to look at the corona of the sun.

2. Planets and stars can be seen during totality. See if you can spot Mercury, Venus, or bright stars.

3. Baily Beads is the phenomenon in which the sun's disappearance before, or reappearance after totality, is seen through the lunar mountains and valleys along its limb or edge. This is a sign to get ready to remove your eclipse glasses (before totality) or to put the solar eclipse glasses back on (at the end of totality).



4. The Diamond Ring is the moment at the start of totality when the sun is disappearing or the moment at the end of totality when the sun is reappearing from behind the moon. There have been stories that romantic individuals have chosen this moment to ask another person, "Will you marry me." It is also a time for teachers and event leaders to shout, "Get those glasses back on!"

5. Record the temperature every 5 minutes from the beginning of the eclipse event until the end. Be sure to include a recording during totality. The temperature can drop several degrees as the eclipse event gets closer to totality.

6. Observe farm animals or wildlife. Chickens may run to the hen house and then roosters will crow a few minutes later with the reappearance of the sun. Crickets may begin chirping. Orb weaver spiders take down their webs at night and will do the same during totality.

FUN FACTS

- A Canadian astronomer named J. W. Campbell traveled around the world for 50 years to try to see 12 different eclipses. Unfortunately, he ran into cloudy skies every time.
- There is never a total solar eclipse at the north and south poles.
- A solar eclipse will last over an hour, but the totality phase will last from less than 10 seconds to almost 7½ minutes.
- There are four parts of a total solar eclipse – Contact 1 is when the moon begins to move across the sun. Contact 2 is the beginning of totality and Contact 3 is the end of totality. Contact 4 is when the observer can no longer see any part of the moon covering the Earth.
- The sky only gets dark during the few minutes of totality. It takes about 90% coverage of the Sun for us to notice any darkening during a solar eclipse. Even at 99%, the sky is no darker than civil twilight.
- A total solar eclipse happens because the sun is 400 times larger than the moon AND the sun is also 400 times farther from Earth, making the two bodies appear the same size in the sky.
- About two to five solar eclipses happen somewhere on Earth each year. However, at any specific location on Earth, a total solar eclipse will only happen about once every 360 to 410 years on average. On the other hand, Carbondale, Illinois, beat the odds: A total solar eclipse happened there on August 21, 2017, and again on April 8, 2024.
- After the 2024 event, the United States will need to wait until August 12, 2045, for a Total Eclipse.