



# Pinhole Slides for Display or Presentation

Supporting Visuals for the 3-Hole-PUNCH Pinhole Projector



**Activity:** *See Pinhole Magic - Indoors and Outdoors*

**Contact:** [punchoutreach@gmail.com](mailto:punchoutreach@gmail.com)



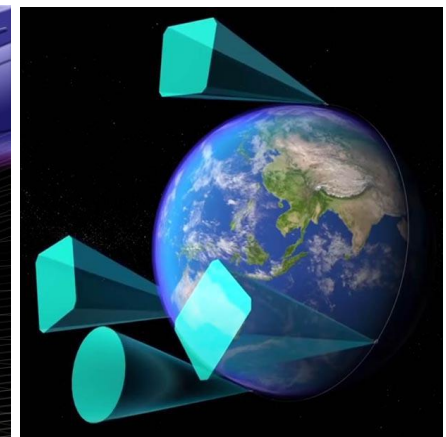
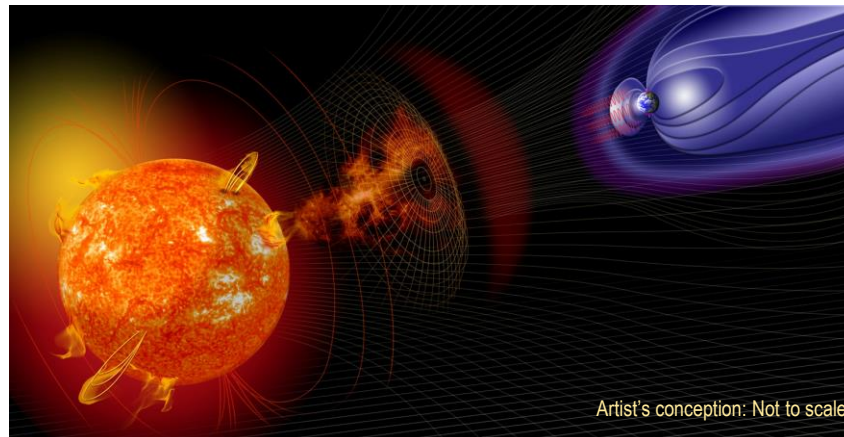
# The NASA PUNCH Mission

PUNCH = Polarimeter to UNify the Corona and Heliosphere



PUNCH studies the Sun and the space between Sun and Earth as one *UNIFIED* system.

PUNCH studies the Sun's outer atmosphere (called the solar *CORONA*) and how it expands to become the "solar wind" that fills the space between Sun and Earth (called the inner *HELIOSPHERE*).



PUNCH uses *POLARIZED LIGHT* to study the science of "Space Weather." Its four cameras (each one on an Earth-orbiting satellite) combine to track solar storms better than ever before!

## Activity CONNECTION: See *Pinhole Magic*

- \* The PUNCH mission outreach theme is Ancient and Modern Sun-watching
- \* Your *personal* Sun-watching is an important part of the theme
- \* Learning to observe pinhole images of the Sun in our everyday environments (both indoors and outdoors) is a fun way to stay connected to the star on which all life depends!



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# 3-Hole-PUNCH Pinhole Projector:

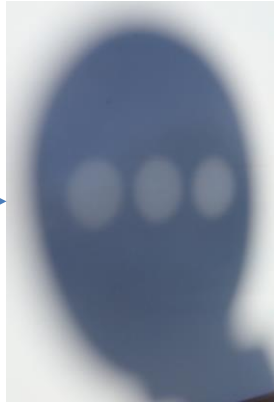
Four “Aha” learning moments for outdoor use with the Sun



Start with the Projector close enough to the projection surface that the shapes of light are the shapes of the holes



**Aha 1:** When learners see all three shapes of light turn round as the projector is pulled away from the projection surface...



**Aha 2:** When learners see the three images of the round Sun become larger than the holes as the projector is pulled farther away...



**Aha 3:** When learners confirm that the shape of the light source is round by observing the Sun directly with solar protection glasses...



**Aha 4:** When learners see pinhole images of the Sun that are formed by irregularly shaped gaps between leaves and recognize this as the same phenomenon caused by the holes of the Projector.



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# Pinhole Projection of the Sun



During solar eclipses it's easy to tell that we are seeing real images of the Sun formed by small gaps between plant leaves.



Image by [Cantavestrella](#).



Image by R. Bigelow



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# Pinhole Projection of the Sun



Pinhole images of the Sun are all around us without eclipses. Look for them wherever sunlight streams through small gaps between leaves or pine needles. *Learn to see them!*



Image by C. Morrow



Image by C. Morrow

Go on a pinhole image  
*Scavenger Hunt*  
in  
your neighborhood!

When the Sun is lower in the sky (early morning and late afternoon) it is easier to see pinhole images of the Sun on a vertical surface. When the Sun is higher in the sky (during midday) you can find them among shadows under your feet.



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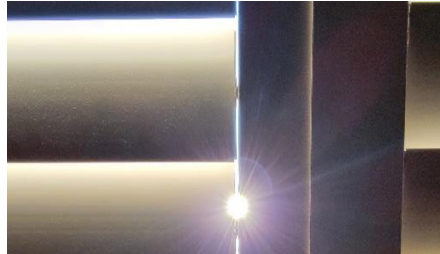


# Pinhole Projection of the Sun



Look for pinhole images of the Sun indoors when sunlight passes through narrow gaps at the edges of window blinds.

These small gaps at the edges of the blinds are long, thin rectangles



But see how perfectly round are the images of the Sun they project on the wall!



Image by C. Morrow



Image by C. Morrow



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# Using an Indoor Light Fixture as a Light Source



Being observant and playful leads to cool discoveries!

In Dec 2022, PUNCH team members and collaborators contributing to a public engagement program at the Adler Planetarium in Chicago discovered that our projector could project images of the ceiling lights! As you can see below, at the Adler, **the spotlights in the ceiling are star-shaped!**



## 3-Hole PUNCH Pinhole Projector

**DO NOT use this card to look directly at the Sun!**

1. With your back to the Sun, hold this card so that the Sun's rays pass directly through the holes onto a smooth surface like a wall or sidewalk (depending on the height of the Sun). Move the card closer until you see triangular, round, and square shapes of light on the surface.
2. Observe the shapes of light as you slowly move the card farther from the surface. When all three shapes change to round, each hole is forming an image of the round Sun! Making images using only a small hole is called "pinhole projection."
3. Try using this card during a solar eclipse to see inverted images of the Moon partly blocking the Sun!
4. Small gaps between plant leaves can also form "pinhole images" of the Sun. Look for round shapes of light mixed in with the shadows!

What's going on? Visit the website on the other side of this card to learn more!



The images are star-shaped because the light source is star-shaped.



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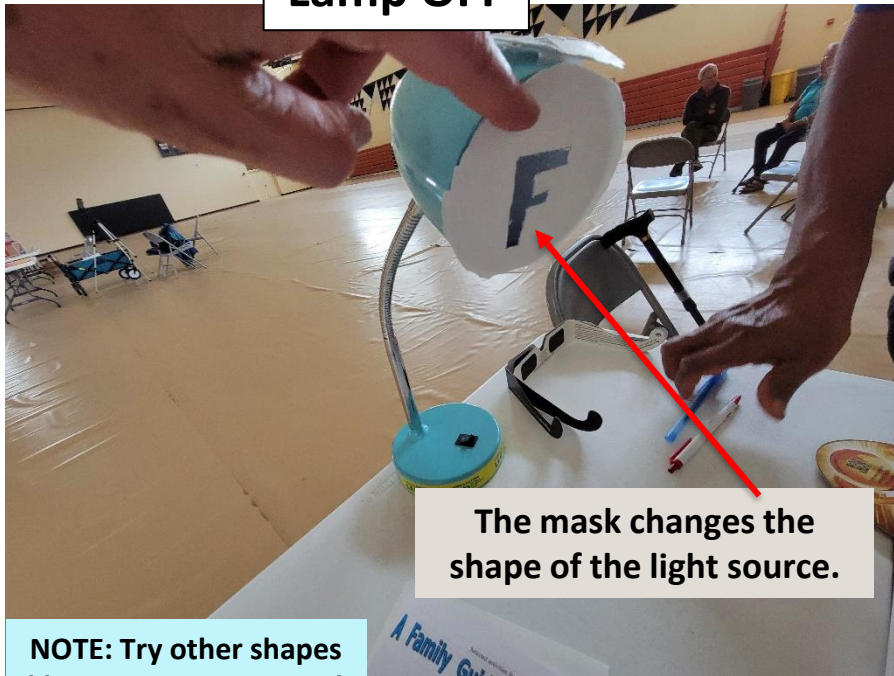


# Using a Masked LED Desk Lamp as a Light Source



The cut-out mask makes the light source F-shaped.  
The Projector forms inverted images of the light source.

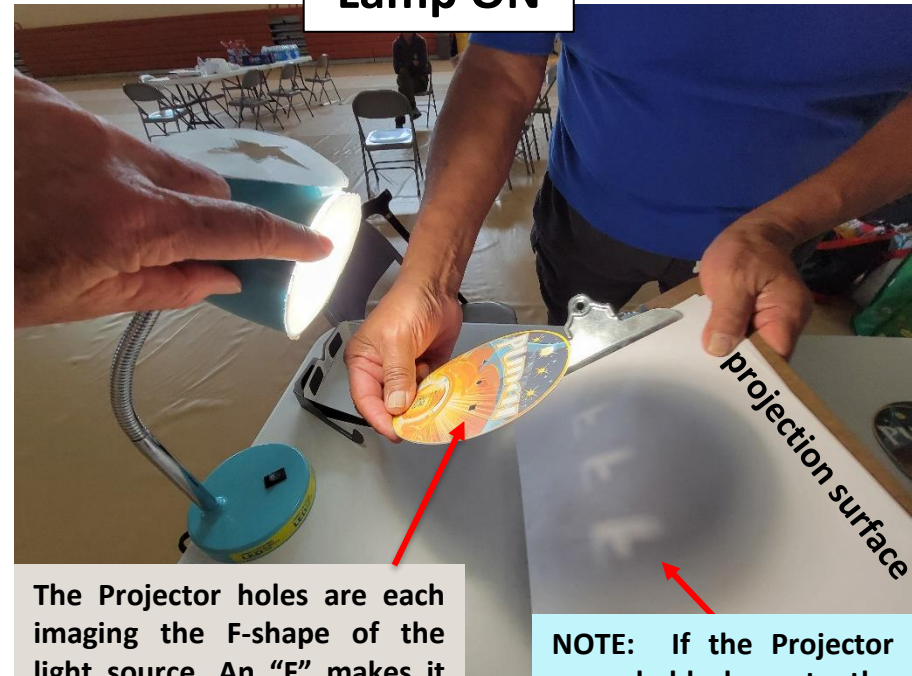
Lamp OFF



The mask changes the shape of the light source.

NOTE: Try other shapes like a star or a crescent!

Lamp ON



The Projector holes are each imaging the F-shape of the light source. An "F" makes it easy to see how pinhole images are flipped both upside down and left-to-right.

NOTE: If the Projector were held closer to the surface, we would still see the triangular, round, and square-shaped holes.



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# How Does the Inversion Work?



Imagine your own eye looking out from the projection surface toward the pinhole. What part of the F would you be able to see through the pinhole from positions 1, 2, 3?

For example, position 1 is on the upper part of the projection surface, but only receives light from the bottom of the F-shape.

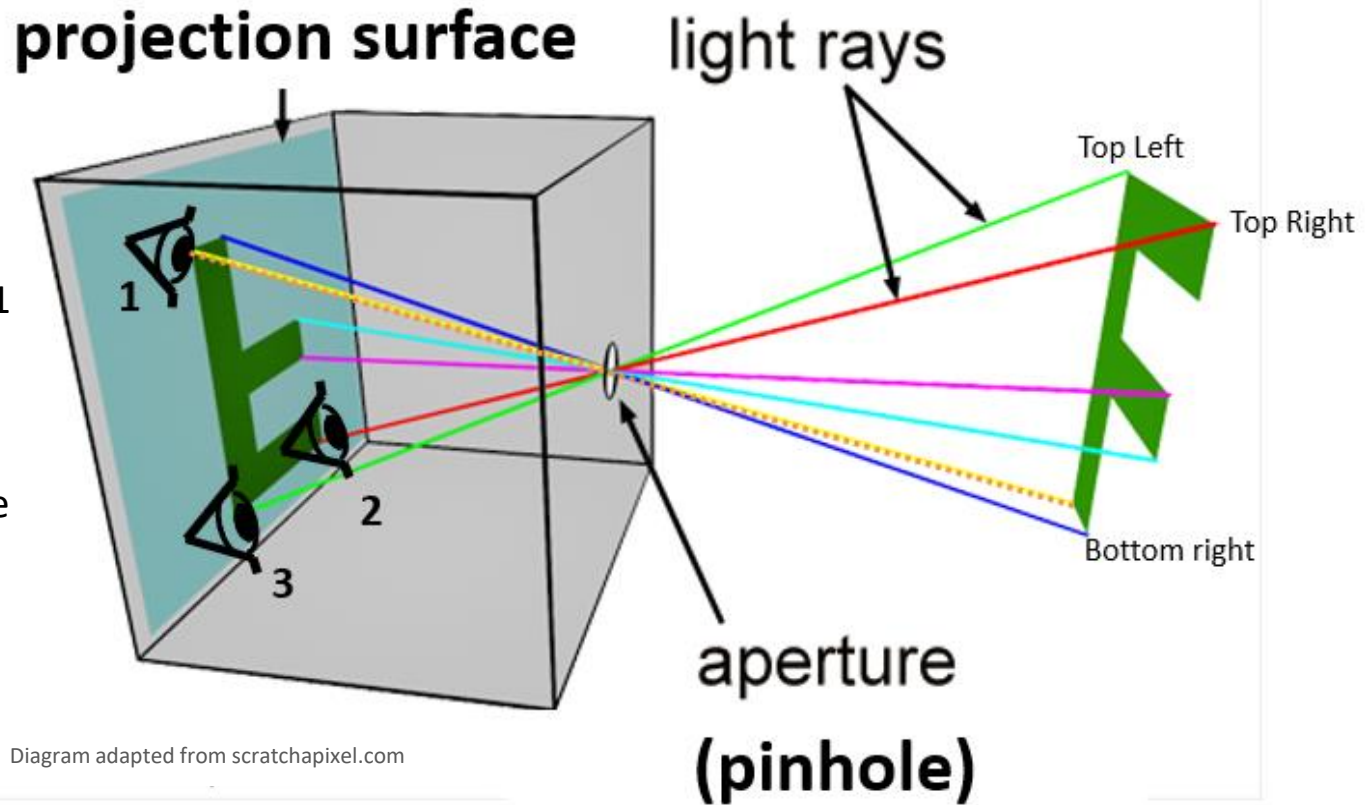


Diagram adapted from scratchapixel.com





# How does a pinhole image compare to the view through solar protection glasses?



21 Aug. 2017 from Roberts, ID at 10:52 am



1. Pinhole images of the round Sun being partially eclipsed by the Moon: Card and Hand methods.



2. Here's what you would see through solar protection glasses *at the same time.*



CM observing a solar eclipse



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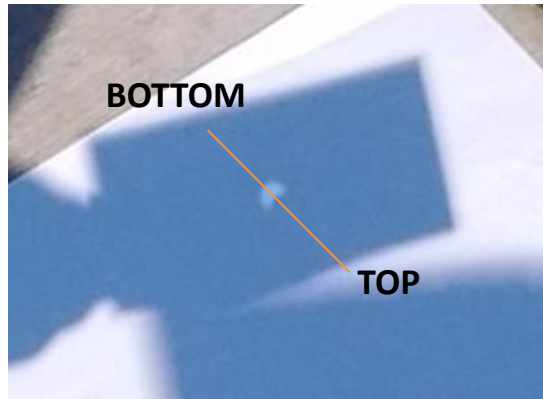


# How Does the Inversion Work?

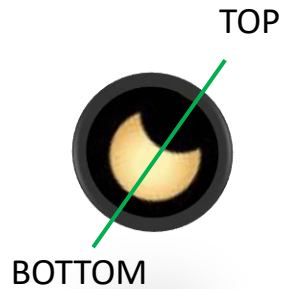


The key to reconciling the pinhole image with the direct observation is to identify the line of symmetry of the partial eclipse

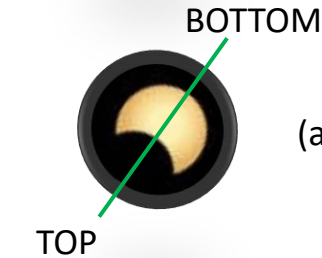
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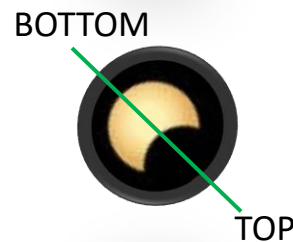
Pinhole image of the Sun partially eclipsed by the Moon



Appearance through solar protection glasses (re-created using Starry Night)



Flipped top-to-bottom (along the green line of symmetry)



Then flipped left-to-right\* (looks like the pinhole image)

\* Same if we'd flipped left-to-right first before flipping top-to-bottom

