Welcome to Section 3:

Exploring Pinhole Projection with Your Own Hands

NASA PUNCH website:
https://punch.space.swri.edu /

Scan here to access all PUNCH Outreach products or visit:
https://punch.space.swri.edu/punch_outreach_products.php

For questions or to request our 1-page monthly newsletter:
Contact PUNCHOutreach@gmail.com

Photo: Alan Friedman

[*Really*] Understanding Pinhole Projection of the Sun

Outreach for the **NASA** PUNCH mission

Follow along with our playful learning adventure!

FRONT

And **PLEASE** give us feedback on these questions at the link below:

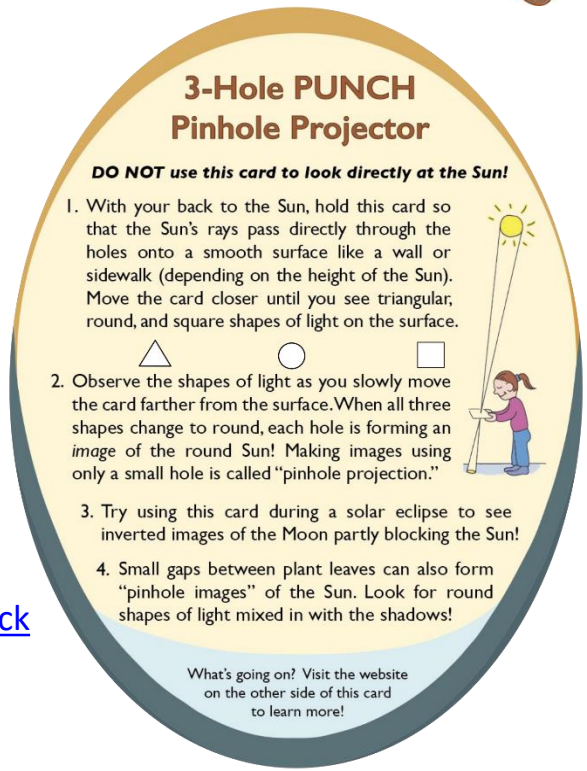
Insights gained?

Remaining questions?

Ideas for improvements?

https://tinyurl.com/PinholeFeedback

MARK 3 Version
Final Release for use up to and including the Annular Eclipse on 14 Oct 2023



BACK

Essential viewing:

6-minute “how-to-facilitate” video

[https://punch.space.swri.edu/punch_outreach_pinholeprojector.php]

Outreach for the **NASA** PUNCH mission

Polarimeter to UNify the Corona and Heliosphere

Home | About | Science | Media | Outreach

3-HOLE PUNCH PINHOLE PROJECTOR

The PUNCH Outreach team designed the 3-Hole PUNCH Pinhole Projector (3HPPP) so that everyone can experience and explore the wonder of how a small, lens-less hole of any shape works to create real images of the Sun or other bright light sources, both indoors and outdoors.

Image credit: Vivian White

Our projector allows you to observe the Sun safely during eclipses or on any sunny day!

The 3HPPP is NOT your ordinary pinhole projector nor a simple give-away like a sticker or button, but a powerful learning tool when safely and effectively facilitated.

This **6-minute “how-to” video** shares what we’ve learned about how to facilitate use of the 3HPPP to excite a lifetime of curiosity and wonder in learners of all ages.

[*Really*] Understanding Pinhole Projection of the Sun

Outreach for the **NASA** PUNCH mission

Introducing Bhanu

[BAH-noo]

Bhanu means "ray of light" in Sanskrit

Bhanu helps guide our way through these Sections. You are in Section 3 of 5.

Section	Title of Section	Description of Section
1	How to Use the 3-Hole PUNCH Pinhole Projector	introduces the 3-Hole PUNCH Pinhole Projector, demonstrates how to use it both outdoors and indoors, and describes its differences from a pinhole camera/viewer.
2	Observing Pinhole Images of the Sun in Our Everyday Environments	teaches you how to observe the phenomenon of pinhole images of the Sun in our everyday world, both indoors and outdoors.
3	**Exploring Pinhole Projection Using Your Own Hands**	**invites you to explore the behavior of pinhole projection by experimenting with your own hands (try both palms up!)**
4	Explaining and Understanding How Pinhole Imaging Happens	interactively guides your quest for explanations and deeper understanding of how pinhole imaging happens. After this, you will *really* understand why small, lens-less holes can create images.
5	APPENDICES A-E: More Insights & Fun Resources	offers more insights & resources (e.g., explaining the relationship between pinhole images and the view through "eclipse" glasses)

CONTACT:
Dr. Cherilynn Morrow, Outreach Director for the NASA PUNCH mission [cherilynn.morrow@gmail.com]

Pinhole Projection of the Sun

Outreach for the **NASA** PUNCH mission

3. EXPLORING PINHOLE PROJECTION USING YOUR OWN HANDS

Bahnu says: Keep exploring! Exploring is like playing and can be really fun! Watch for pinhole images of the Sun on every sunny day. And discover what happens when you try different ways to make your pinhole images with the fingers of your own hands! Not so easy for me.

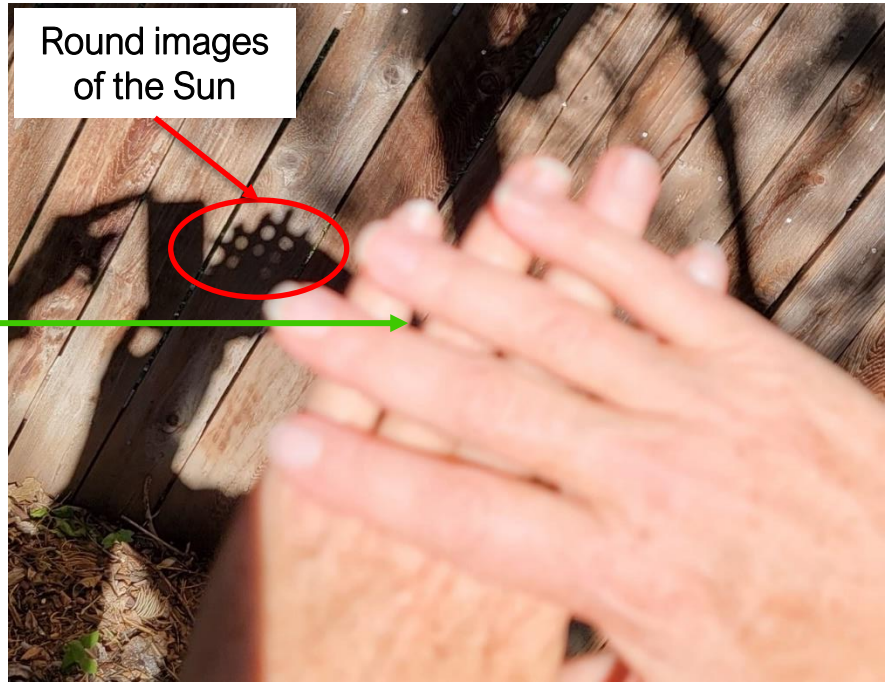
CONTACT:
Dr. Cherilynn Morrow, Outreach Director for the NASA PUNCH mission [cherilynn.morrow@gmail.com]

Pinhole Projection of the Sun

Play with sunlight shining through the gaps between your fingers to make round shapes of light on a projection surface.

Outreach for the **NASA** PUNCH mission

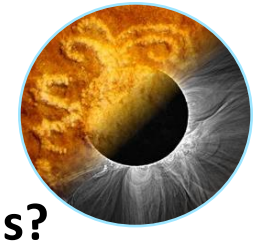
Gaps between crossed fingers are like the holes in the pinhole projector,



- **Our crossed fingers form the holes of the pinhole projector (left).**
- **The wooden fence is the projection surface.**
- **The round shapes of light are images of our nearest star, the Sun!**

Outreach for the **NASA** PUNCH mission

Pinhole Projection of the Sun



How many images of the Sun can you create with your hands?

Be playful! Explore different ways. What works best for you?

- Try different positions of your hands and fingers.
- Different times of day.
- Different types of projection surfaces.
- Different distances between your hands and the projection surface.
- Have fun playing with this to see what you can discover.

Pinhole Projection of the Sun

Outreach for the **NASA** PUNCH mission

Use a fence, a wall, sidewalk, or paper for the projection surface depending on the time of day and how high the Sun is in the sky.

Projecting on a vertical fence with morning sunlight

Can you find the shadow of the cell phone camera? Can you tell where the photographer is located?

Projecting on a sidewalk with midday sunlight

8th graders at the Haak'u Community Academy at the Pueblo of Acoma invented a palms-up approach.

Can you find other ways to make pinhole images of the Sun using your hands? Try one palm up and the other facing down?

Pinhole Projection of the Sun

Look closely at the back of the hands.

What shapes are the gaps between the crossed fingers? Are they round?

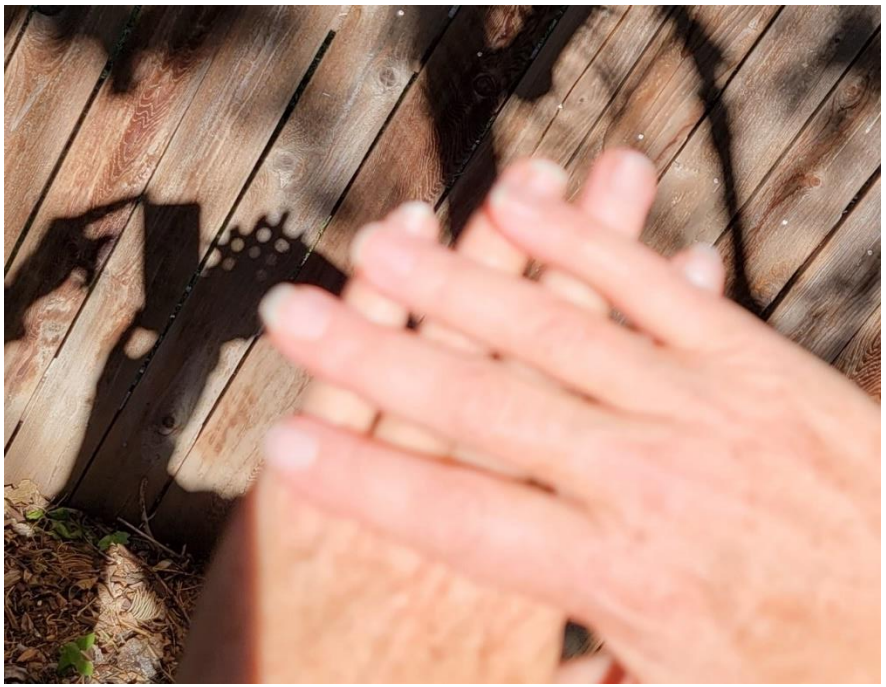
Gaps between crossed fingers are like the holes in the pinhole projector,

What do you think would happen to the images of the round Sun if the hands were moved closer and closer to the fence? Would the shapes of light between the fingers stay round?

Outreach for the **NASA** PUNCH mission

Pinhole Projection of the Sun

No, the gaps between the fingers are not round.
They rectangular or square-shaped (left image).
If the hands were close enough to the fence, we'd see the shapes of the gaps on the fence instead of images of the round Sun.



Then why do *round* shapes of light show up on the fence?

KEY QUESTION: How can small, non-round holes through leaves, window blinds, hats, and fingers act like lenses to create images of the round Sun?

Pinhole Projection of the Sun

Observing the 2017 solar eclipse using a simple pinhole projector with a single square hole and also with crossed fingers

Outreach for the **NASA** PUNCH mission

Pinhole images of the Sun being eclipsed by the Moon

Outreach for the **NASA** PUNCH mission

ADDITIONAL INFORMATION

Link for Feedback

Valuable References

Credits & Acknowledgements

Links to PUNCH & PUNCH Outreach Products

CONTACT:
Dr. Cherilynn Morrow, Outreach Director for the NASA PUNCH mission [cherilynn.morrow@gmail.com]

PLEASE GIVE US YOUR FEEDBACK

We take all feedback very seriously and are using it to keep improving our projector and this presentation.

Outreach for the **NASA** PUNCH mission

Please scan the QR code or go to this URL to give us feedback

https://tinyurl.com/PinholeFeedback

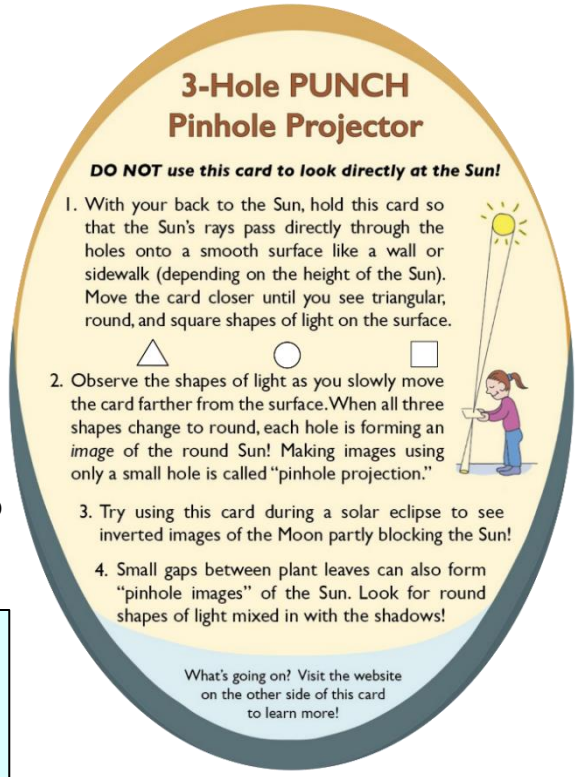
FRONT

Insights gained?

Remaining questions?

Ideas for improvements?

MARK 3 Version
Final Release for use up to and including the Annular Eclipse on 14 Oct 2023



BACK

Valuable References

1. Lenses and Pinholes: What Does “In Focus” Mean?

A brief and clear explanation about what it means to be “in focus”:
https://www.physicsforums.com/insights/lenses-pinholes-focus-mean/

2. How a Pinhole Camera Works (Part 1)

Excellent diagrams:
https://www.scratchapixel.com/lessons/3d-basic-rendering/3d-viewing-pinhole-camera

3. Real image: Collection of focus points made by converging light rays

We love the simple but insightful stick-figure:
https://www.wikiwand.com/en/Real_image

4. Your Eyes See Upside Down and Reversed

Lucid explanation by an eye doctor (MD) relating human eye to a pinhole camera:
https://bceye.com/retinal-image-inverted-reversed/

5. Camera Obscura

The history of this wondrous effect, including reference to a possible paleo-camera:
https://en.wikipedia.org/wiki/Camera_obscura http://paleo-camera.com/archeo-optics/

6. Making, Measuring and Testing the “Optimal” Pinhole

A thorough and playful journey through the technical details of pinhole photography:
https://www.35mmc.com/26/10/2020/making-measuring-and-testing-the-optimal-pinhole-pinhole-adventures-part-3-by-sroyon/

Credits & Acknowledgements

Primary Authors of the Explanatory Presentations:

Cherilynn Morrow, Robert Bigelow, and Mike Zawaski

cherilynn.morrow@gmail.com , arca965@gmail.com, and mjzawaski@gmail.com

Research & Development Team for the *3-Hole PUNCH Pinhole Projector*

Cherilynn Morrow (editor-in-chief, concept development, field testing, photos)
Robert Bigelow (concept development, technical specifications, text reviewer, photos)
Briana Ingermann (graphic design, text developer, field testing, procurement of printing, photos)
Mike Zawaski (reviewer/consultant on explanatory presentation, graphic support, photos)

Sanlyn Buxner (head of field testing and evaluation, photos)
Jason Trump, Nina Byers, Geoff Skelton (text reviewer, field testing, reviewer of explanatory presentations)
Marisa Bevington & Marialis Rosario Franco (text reviewers, Spanish language translation)
GB Cornucopia, Bobbye Middendorf, Jeremy Osowski, Stacy Wolff (text reviewers, field testers, photo collaborators)

Craig DeForest (PUNCH PI, product review and approval, field tester)
Sarah Gibson (PUNCH Project Scientist, product review and approval)
Nicki Viall (PUNCH Mission Scientist, field tester, product review and approval)
Ronnie Killough (PUNCH Program Manager, field tester)
Gilly Gilbert (PUNCH Associate Investigator, field tester)
Countless others (who participated in field testing events and gave us their feedback)

Thank you also to our web developer Don Kolinski for posting and updating our work on the PUNCH website.

Please proceed to Section 4:

Explaining and Understanding How Pinhole Imaging Happens

NASA PUNCH website:
https://punch.space.swri.edu /

Scan here to access all PUNCH Outreach products or visit:
https://punch.space.swri.edu/punch_outreach_products.php

For questions or to request our 1-page monthly newsletter:
Contact PUNCHOutreach@gmail.com

Photo: Alan Friedman