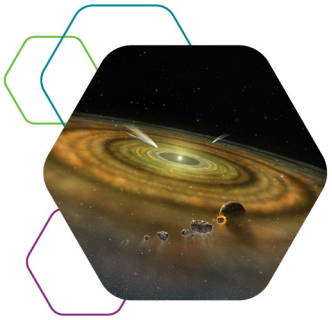

FACILITATOR GUIDE

Observe the Sun

Learning objectives

Learners engaged in this activity will explore these main ideas:

- The Sun, a hot ball of glowing gas, is the star at the center of our solar system
- Special tools allow scientists to carefully and safely observe the Sun.
- Some NASA scientists study solar activity to better understand how Earth and the rest of the solar system respond to the Sun.

Materials

- Solarscope™ & viewing instructions on box
- Solarscope user's guide (from Solarscope)
- Sign, sign stand, information sheets, and activity and facilitator guides
- Tactile Sun sheets
- "Tips for Leading Hands-on Activities" sheet
- "Solar Observation" sheet (optional)
- Tape (optional)
- Scissors (optional)
- Pencil (optional)

The Explore Science toolkit comes complete with all necessary materials for this activity. Materials are also readily available to create or restock activity kits. The Solarscope can be purchased from Solarscope.com. All graphic files can be downloaded from www.nisenet.org.

Safety

Never look directly at the Sun without proper eye protection. Permanent eye damage or blindness can occur. Sunglasses are NOT sufficient.

Advance preparation

Before you begin:

- Construct the Solarscope by following the directions on the Solarscope assembly sheet. Setting the Solarscope up for the first time can be a little time consuming and tricky, so give yourself plenty of time. Once assembled, the scope folds up to pack a way.
- Be especially careful placing the small mirror into the mount. Seat the mirror convex side down and be sure it is level!
- Find a location outside where the Sun can be viewed without obstruction, and place the Solarscope on a stable, raised surface.
- *Optional:* Prepare the "Solar Observation" sheet for visitors by cutting along the dotted line to create a 2-inch hole to fit over the Solarscope.

Notes to the presenter

Review safe solar viewing practice with visitors before starting the activity. Never look directly at the Sun without proper eye protection. Permanent eye damage or blindness can occur. When using the Solarscope, participants should look at the projected image of the Sun inside the box (**not** directly at the Sun, through the box, or through a lens!)

Any small movements to the Solarscope will cause the image of the Sun to move. The facilitator may need to help hold the Solarscope in place as the participant observes (or chooses to trace) the Sun.

The Sun has periods of high *solar activity*, and periods of quiet. During these quiet periods, it's probably enough to encourage participants to just observe the Sun using the Solarscope; there won't be a lot to trace or draw.

For young children, try to set realistic expectations but also create excitement about the Solarscope as a tool: it is dangerous to look directly at the Sun since it could hurt our eyes, so this tool allows us to observe the Sun safely. Young children may not fully understand that the circle of light they see is an image of the Sun, but ask them to describe what they notice, and encourage them to trace out their observations if there are any sunspots present.

Optional extensions

During periods of increased solar activity, and especially if sunspots are present, participants can observe and record them. To do so, tape the "Solar Observation" sheet onto the white screen inside the Solarscope. Have the participant gently trace the Sun's disk and any sunspots onto the paper and record the date and time of their observation.

Due to Earth's rotation, the Sun moves across our sky. Since the Solarscope magnifies the image of the Sun, the image appears to move more quickly than the Sun does in the sky. To make an accurate tracing of the Sun and its surface features, visitors will have to trace quickly. First, have visitors outline the Sun's disk and then move on to the sunspots. As the image starts to move out of the drawn circle, adjust the Solarscope to keep up.

If visitors are present for multiple days in a row (e.g., participants in a camp, workshops, etc.), this activity can be extended to observe the Sun over several days and compare any changes. To do so, observe the Sun at roughly the same time of day, from the same location, and with the same orientation in the Solarscope in order to accurately track changes in the Sun. Have participants use the same piece of paper for each observation, aligning the Sun's image with the disk that they traced the first day and using a different colored pencil for each day's observation. Even for a one-day event, you can make observations a few days ahead of time and share those with participants.

After taking observations over a period of time, compare your images!
What can we learn about the Sun from observing it over long periods of time?

Learn more about sunspot behavior:

- How fast do sunspots change? Do they change size or disappear completely? Do they appear to move? View close-up images of the Sun at http://explorescience.org/sun
- Track solar activity to better understand the Sun's magnetic field and solar cycle. Look at near-real-time images of the Sun in different wavelengths from NASA's Solar Dynamics Observatory at https://www.nasa.gov/mission_pages/sdo/the-sun-now/index.html
- Find correlations between solar activity and Earth's space weather. View NOAA's space weather conditions and predictions at https://www.swpc.noaa.gov/
- NASA has put together a list of frequently asked questions about solar storms and space weather at https://www.nasa.gov/mission_pages/sunearth/spaceweather/index.html#q12

Difficult concepts

The Sun appears to be static, but it changes all the time. While the Sun is shaped like a ball, it isn't solid like one. The Sun is made up of energetic gasses, or *plasma*, that churn around as it spins. This movement causes sunspots to form on the surface of the Sun. All this churning and spinning leads to massive changes in the Sun's magnetic fields and flings plasma and radiation out into the solar system.

The Sun appears to be moving across our sky; this apparent motion is caused by the Earth rotating on its axis. Some visitors may need to be reminded that the Sun produces light all of the time and doesn't "go to sleep" at night. People on Earth experience night when the area they live in rotates away from the Sun, moving them into the shadowed side of the planet.

The Sun is not a ball of fire. The processes inside the Sun that release tremendous amounts of energy are very different from the processes inside a fireplace or campfire.

The Sun is actually the only star in our solar system. It is much closer to Earth than other stars, which are far beyond the orbit of the dwarf planet Pluto. This difference in distance makes our star look much larger than the stars in the night sky.

Staff training resources

Refer to the "Tips for Leading Hands-on Activities" sheet in your activity materials.

- An activity training video is available at vimeo.com/304240589
- A content training video is available at vimeo.com/304240494
- Additional training videos on misconceptions and facilitation can be found at vimeo.com/album/4249834
- The NISE Network has a curated list of programs, media, and professional development resources that directly relate to the toolkit. These resources can be viewed and downloaded from www.nisenet.org/earthspacekitextensions.

Credits and rights

This activity was developed for the NISE Network by the Museum of Life and Science and the Sciencenter.

Images of the Sun during one solar cycle and artist's impression of the Parker Solar Probe approaching the Sun courtesy NASA

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