National Aeronautics and Space Administration

NASA Helio Club

Session 2

Observing the Sun

NASA Heliophysics Education Activation Team

Session 2: Observing the Sun

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Time

120 minutes for the full progression of activities
-or- three **25 minute** activities that stand alone

Learning Goal

To give learners more tools and information about how to safely observe the Sun.

Full Session Overview

The last session provided learners with background information on the heliosphere and how the Sun influences the space environment. This session starts with a Know, Want-to-know, Learned (KWL) strategy for finding out what learners already know about observing the Sun and then has learners explore live images of the Sun from the Solar Dynamics Observatory (SDO). In the first activity learners make their own measurements of the Sun, using a simple pinhole projector and solar eclipse glasses. Learners are then introduced to the electromagnetic spectrum and experiment with the properties of light by examining images taken from SDO, NASA's Hubble Space Telescope, the Solar Dynamics, and the Solar Terrestrial Relations Observatory (STEREO) Mission, and by experimenting with UV beads and invisible (UV-reactive) ink. The session concludes with creating a coronagraph flipbook to model how NASA studies the Sun using coronagraphs.

- **Prior Knowledge:** What do you already know about observing the Sun? KWL (15 minutes)
- **Engage:** The Sun Now with NASA's Solar Dynamic Youth Guide (15 minutes)
- **Explore: Activity 1:** Safely Observing the Sun (25 minutes)
- **Explain**: **Activity 2:** What Color is the Sun? (25 minutes)
- **Extend: Activity 3:** How NASA Observes the Sun (25 minutes)
- **Evaluate:** KWL (15 minutes)

Materials

NASA Helio-Club Youth Guide (optional) includes all handouts for all six sessions.
Quantities are per learner.

Basics

- ☐ Writing tools (pens or pencils)
- ☐ Art supplies (markers or crayons)
- ☐ (1) pair of scissors
- ☐ (1) roll of tape

Prior Knowledge/Evaluate

- ☐ (1) Handout_KWL_Session 2

Engage

- ☐ digital resources only

Explore: Activity 1

- ☐ Handout_Build a Pinhole Projector
- ☐ Handout_Solar Observation Data Sheet
- ☐ Handout_2023 & 2024 Solar Eclipse US Map
- ☐ (1) pair solar eclipse glasses
- ☐ (2) pieces of 8.5”x11”white cardstock
- ☐ (1) 5”x 5” piece of aluminum foil
- ☐ (1) paperclip
- ☐ tape
- ☐ scissors

Explain: Activity 2

- ☐ Handout_Sample Data for Investigating the Sun
- ☐ Handout_The EM Spectrum
- ☐ Handout_UV Bead Data Sheet
- ☐ Handout_UV Bead Bookmark
- ☐ (10-15) UV-reactive beads
- ☐ (1) invisible ink pen (UV reactive ink)
- ☐ (1) UV light (often included with invisible ink pens)
- ☐ string

Extend: Activity 3

- ☐ Handout_Coronagraph Flip Book
- ☐ (1) medium binder clip
- ☐ scissors

Digital Resources

- Educator Resource: Educator Background Information
- Educator Resource: Slides_Session 2
- Video: How to Read a NASA STEREO Image
- Webpage: The 2023 & 2024 Solar Eclipses: Map and Data
- Webpage: NASA Hubble Space Telescope Homepage
- Webpage: Explore Light with the Hubble Space Telescope
- Webpage: NASA SDO Mission Homepage
- Webpage: The Sun Now
- Webpage: NASA STEREO Mission Homepage

Learning Objectives: At the end of the session, learners will be able to…

1. Identify and use multiple tools to safely observe the Sun.
2. Describe how different kinds of light can provide different kinds of information about an object.
3. Analyze and compare several different ways NASA observes and collects data about the Sun.

Key Vocabulary

- **Blackbody Radiation –** refers to the spectrum of light emitted by any heated object. Common examples include the heating element of a toaster and the filament of a light bulb.
- **Composite Image –** several images together taken in an overlapping sequence
- **Corona –** the upper atmosphere of the Sun
- **Coronagraph –** a specialized instrument designed to block out the light of the main body of the Sun so that scientists can view the corona
- **Electromagnetic (EM) Spectrum –** comprising all frequencies of electromagnetic radiation that propagate energy and travel through space in the form of waves
- **Frequency –** the number of waves that pass a fixed point in a given amount of time
- **Infrared Light –** a form of electromagnetic radiation invisible to the human eye with wavelengths longer than visible light
- **Nebulae –** enormous clouds of dust and gas occupying the space between the stars; **Stellar Nebulae** are where a sufficient mass of that gas and dust begin to collapse under its own gravitational attraction – as the cloud collapses, the material at the center begins to heat up and a star is born.

- **Pinhole Projector –** a convenient method for safely viewing the Sun by passing sunlight through a small opening (for example, a hole punched in an index card) and projecting an image of the Sun onto a nearby surface (for example, another card, a wall, or the ground)
- **Radio Waves –** a form of electromagnetic radiation invisible to the human eye with wavelengths longer than infrared light
- **Solar Eclipse -** a solar eclipse occurs when the Moon is between the Sun and Earth, casting a shadow on Earth's surface. There are four types of solar eclipses: total, partial, hybrid, and annular. The type of eclipse that people get to see depends on how the Moon aligns with Earth and the Sun, and how far away the Moon is from Earth.
- **Solar Eclipse Glasses –** a solar viewing tool that protects your eyes from harmful light from the Sun
- **Solar Flare –** energetic bursts of light triggered by the release of magnetic energy on the Sun
- **Sunspots –** cooler regions on the Sun's visible surface caused by a concentration of magnetic field lines
- **Telescope –** a tool that astronomers use to see faraway objects. Most telescopes, and all large telescopes, work by using curved mirrors to gather and focus light from the night sky
- **Ultraviolet (UV) Light –** a form of electromagnetic radiation invisible to the human eye with wavelengths shorter than visible light
- **UV-reactive Beads –** beads that turn colors in the presence of ultraviolet radiation
- **Visible Light –** a form of electromagnetic radiation that is visible to the human eye
- **Wavelength –** the distance over which a wave repeats itself
- **X-rays –** a form of electromagnetic radiation invisible to the human eye with wavelengths shorter than ultraviolet light

Review the Educator Background Information **for more information on major concepts.**

Next Generation Science Standards (NGSS) Connections

MS-ETS1-4. Engineering Design: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. In Activity 1 and Activity 3, learners compare tools used to observe the Sun.

MS-PS1-4. Structures and Properties of Matter: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. In Activity 2, learners explore the electromagnetic spectrum and how different materials react to UV light.

Targeted STEM Skills

Asking questions
In this session, learners ask questions using a KWL.

Making predictions
In this session, learners make predictions about the color of the Sun.

Planning and carrying out investigations [MS-PS4-2]
In this session, learners will experiment with UV light and UV-reactive materials.

Analyzing, organizing, and interpreting data
In this session, learners interpret real-time solar data.

Steps: Full Session

**Italics indicate recommended scripts to use with students.*

Use the accompanying slides to help keep learners engaged.

- **Prior Knowledge:** What do you already know about observing the Sun? KWL (15 minutes)
- **Engage:** The Sun Now with NASA's Solar Dynamic Observatory (15 minutes)
- **Explore: Activity 1:** Safely Observing the Sun (25 minutes)
- **Explain**: **Activity 2:** What Color is the Sun? (25 minutes)
- **Extend: Activity 3:** How NASA Observes the Sun (25 minutes)
- **Evaluate:** KWL (15 minutes)

Prior Knowledge: What do you already know about observing the Sun?

Overview (15 Minutes)	Materials
A KWL chart is an effective way to assess learners' prior knowledge, identify misconceptions, and measure growth. Use the guiding questions provided in the chart below to focus learners on the content that is explored in this session. As students share their ideas and predictions, don't give them the answers just yet; rather, encourage them to investigate their questions throughout the session. If you don't use the Youth Guide, have learners use a notebook to record their observations, draw diagrams, and collect data.	• Handout_KWL_Session 2 **Instructions** A. **Direct learners to page 14** in the NASA Helio-Club Youth Guide, or print the Handout_KWL_Session 2 B. Have learners complete the **[Know Column]** and the **[Wonder Column]** of the KWL chart. Instruct them to leave the [Learn Column] blank until the end of the session. [Slide 4]

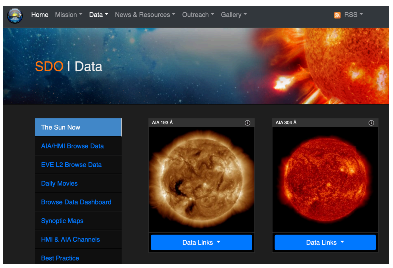
KWL

[K] – What do you already know?	[W] – What do you wonder about?	[L] – What did you learn?
What do you already know about observing the Sun? • *Which methods do you know are safe for observing the Sun?* • *When you think of the Sun, what color do you think it is?* • *Can humans see all the different kinds of light that the Sun emits?*	*Record questions you have about observing the Sun in this column.*	*Record what you learned about observing the Sun in this column.*

Engage: The Sun Now!

Overview
(15 Minutes)

This introduction activity is intended to excite learners by having them interact with solar data collected by NASA's Solar Dynamics Observatory (SDO).



Credit: NASA/SDO

There are a lot of features on this page that will not make sense to learners. Have them click on each image to enlarge it and make observations about what they see. You can also direct learners to "Browse Data Dashboard" to see movies of the Sun.

Encourage learners to record their observations in a data table.

Materials

- Digital resources

Instructions

A. **Direct learners to** The Sun Now, provided by NASA's Solar Dynamics Observatory (SDO), allows users to see images of the Sun captured in the last few days, taken in multiple wavelengths of light. [Slide 5]

B. **Provide Context:** *Each image shows the Sun in a different wavelength. You will see the letters "AIA" and then a number for each image.*

*AIA stands for Atmospheric Imaging Assembly, which refers to the four **telescopes** aboard SDO; the number refers to the **wavelength** of light the **telescopes** are collecting.*

***Wavelength** is the distance over which a wave repeats itself. These **telescopes** work together to give scientists high-resolution images of the Sun's **corona**, which is the outer atmosphere of the Sun, as well as some regions of the interior Sun, closer to the Sun's surface.*

*These **telescopes** operate in the **extreme ultraviolet (EUV)** portion of the **EM spectrum**. Because we can't see this type of light, the colors in the images are added so we can distinguish different **frequencies** of light from each other. Also, human eyes are very good at seeing many shades of color so that faint features on the Sun stand out better when we 'colorize' the data.*

*As you scroll through the images, you can see that different wavelengths of light show different features of the Sun. In some images you can clearly see **solar flares,** while other images show **sunspots** more clearly.*

	*Some images have more than one AIA number and have multiple colors. This is called a **composite image**, which combines multiple images into one. This allows scientists to see multiple layers of the Sun's atmosphere at once. The image on the cover of your NASA Helio-Club Youth Guide is a composite image, taken by SDO.* C. **Collect Data:** Give learners a chance to explore the images and record their observations. Have them consider the following questions: ○ *Does the Sun look the same in all the different wavelengths of light (the different colors)?* ○ *What features do you see in each different wavelength of light? For example, darker spots on the Sun, or maybe bright flashes or loops of light coming off of the Sun?*

Major Concepts

★ NASA's SDO views the Sun in multiple different **wavelengths**.
★ AIA stands for Atmospheric Imaging Assembly, the four **telescopes** aboard SDO.
★ Because we can't see extreme ultraviolet light, the colors in the SDO images are added so we can distinguish different **frequencies** of light from each other.
★ Scientists use **composite images** to overlay data to create a more dynamic image.

Featured NASA Mission: NASA's Solar Dynamics Observatory (SDO) is the first mission to be launched for NASA's Living With a Star (LWS) Program, a program designed to understand the causes of solar variability and its impacts on Earth. SDO is designed to help us understand the Sun's influence on Earth and Near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously.

Explore: Safely Observing the Sun

Overview of Activity 1 (25 Minutes)

This activity is intended to have learners make their own observations of the Sun using two safe methods.

Using **solar eclipse glasses**, learners will be able to see the orb of the Sun, but may not see much else. On days when the Sun is very active, learners may be able to view **sunspots**, which are darker, cooler spots on the Sun.

The **pinhole projection** of the Sun will show the shape of the Sun, and may also show sunspots on rare occasions.

Continue to emphasize the importance of eye safety throughout the activity.

Encourage learners to make careful observations and record details on the solar observation data sheets.

Simple Pinhole Projector
Credit: NASA / JPL

Materials

- Handout_Build a Pinhole Projector
- Handout_Solar Observation Data Sheet
- Handout_2023 & 2024 Solar Eclipse US Map
- (1) pair solar eclipse glasses
- (2) pieces of 8.5”x11”white cardstock
- (1) 5”x 5” piece of aluminum foil
- (1) paperclip
- tape
- Scissors

Instructions

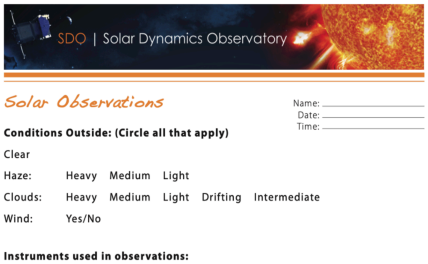
A. **Provide Context:** *In the last session, we learned that the Sun is a star. The Sun looks different from other stars because we are so close to it. At this distance, the Sun is very bright, which makes it hard to study without special equipment.*

   Never look directly at the Sun without special safety equipment. *We can safely observe the Sun using two different methods.*

   Safe Solar Viewing Method 1: Solar Eclipse Glasses *are designed to allow users, when used properly, to look directly at the Sun. Most often used to safely view solar eclipses, they can also be used to make other observations about the Sun, too.* [Slide 6]

   Safe Solar Viewing Method 2: Pinhole Projectors *are designed to view a projection of the Sun on a white piece of paper. This method of observation occurs with the Sun behind the observer.* [Slides 7-10]

B. **Construct: Direct learners to pages 15-16** in the NASA Helio Youth Guide, or use the Handout_Build a Pinhole Projector. Guide learners through the assembly process, step-by-step, demonstrating the steps, making sure they follow along and show you their progress.


SDO | Solar Dynamics Observatory

Solar Observations

Name:
Date:
Time:

Conditions Outside: (Circle all that apply)

Clear

Haze: Heavy Medium Light

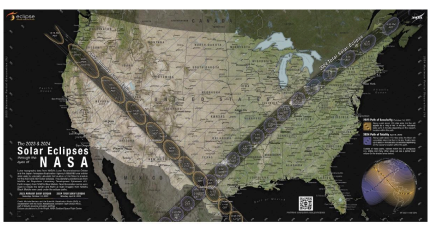
Clouds: Heavy Medium Light Drifting Intermediate

Wind: Yes/No

Instruments used in observations:

Solar Observations Data Sheet
Credit: NASA/SDO

There are multiple designs of a pinhole projector, including using a cereal box. Find instructions for that design here.



2023 & 2024 Solar Eclipse Map
Credit: NASA/ SVS

Find more information about how the solar eclipse map was made: The 2023 & 2024 Solar Eclipses: Map and Data.

C. **Observe (seasonal and weather permitting): Direct students to pages 17-21** of the NASA Helio Youth Guide, or have them use the Handout Solar Observation Data Sheet to record their observations of the Sun with both safe solar viewing methods. Provide them with several observation sheets to use to make observations over a number of days. Encourage learners to draw what they see and compare the accuracy of each method for viewing different features of the Sun. [Slide 11]

   Remind learners to always keep their back to the Sun when using a pinhole projector. After they have had time to make observations, allow time for learners to share their answers.

D. **Prepare: Direct students to page 22** of the NASA Helio Youth Guide, or use the Handout 2023 & 2024 Solar Eclipse US Map. *Examine the map. This map illustrates the paths of the Moon's shadow across the U.S. during two upcoming solar eclipses.* [Slide 12]

   *On Oct. 14, 2023, an **annular solar eclipse** will cross North, Central, and South America creating a path of annularity, shown in the dark path with the yellow circles.*

   *An annular solar eclipse occurs when the Moon passes between the Sun and Earth, while at its farthest point from Earth. Because the Moon is farther away from Earth, it does not completely block the Sun (only 90% of the solar disk). This will create a "ring of fire" effect in the sky for those standing in the **path of annularity. Solar eclipse glasses must be worn during the entire duration of the eclipse, or use a pinhole projector.*** (See Session 2)

   *On April 8, 2024, a **total solar eclipse** will cross North and Central America creating a **path of totality**, shown in the dark path with the purple circles. During a total*

	solar eclipse, the Moon is closer to the Earth, completely blocking the Sun while it passes between the Sun and Earth for those standing in the path of totality. The sky will darken as if it were dawn or dusk and those standing in the path of totality may see the Sun's outer atmosphere (the corona), if weather permits. ***Solar eclipse glasses may be removed by those in the path of totality, briefly, when the Moon completely blocks out the Sun.*** *Everyone in the continental US, and parts of Alaska, outside of the paths, will experience a* ***partial solar eclipse,*** during both the 20234 and 2024 eclipses. ***Solar eclipse glasses must be worn during the entire duration of the eclipse, or use a pinhole projector.*** **Ask learners:** *Where will you be during these two upcoming solar eclipses? What tools will you use to observe each one?* Allow time for learners to share their answers.

Activity 1 Major Concepts

- ★ The Sun is a star and is hard to observe because it is so bright.
- ★ Eye safety is important when observing the Sun.
- ★ **Solar eclipse glasses** are not the same as sunglasses, and block 100,000 times more light.
- ★ A **pinhole projector** projects an image of the Sun onto a surface.
- ★ A **solar eclipse** provides a great opportunity to make observations of the Sun.

Explain: What color is the Sun?

Overview of Activity 2 (25 Minutes)

Learners begin the activity with predicting what color the Sun is. They will then explore the electromagnetic spectrum and the different types of light the Sun emits. They will use UV beads and an invisible-ink pen to experiment with how different materials block UV light.

Sample Data
Credit: Stanford Solar center

When learners are making predictions, give them an opportunity to share their ideas about what they think the answer is, before revealing the "right" answer. Reinforce the idea that there can be more than one answer to a question and that thinking about the question is how we learn.

Materials

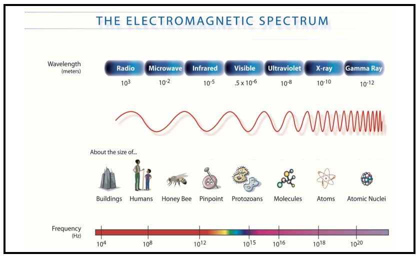
- Handout_Sample Data for Investigating the Sun
- Handout_The EM Spectrum
- Handout_UV Bead Data Sheet
- Handout_UV Bead Bookmark (optional)
- (10-15) UV-reactive beads
- (1) invisible ink pen (UV reactive ink)
- (1) UV light (often included with invisible ink pens)
- string

Instructions

A. **Predict: What color is the Sun?** After learners have observed the Sun through the **solar eclipse glasses** and the **pinhole projector**, ask them, what do you think the color of the Sun is? Have them record their predictions.

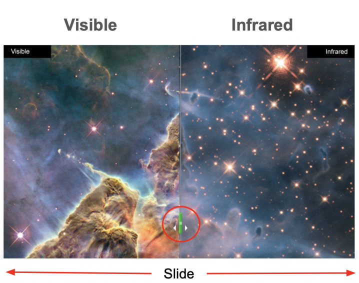
B. **Examine Data: Direct learners to page 23-24** of the NASA Helio Club Youth Guide**,** to the Handout_Sample Data for Investigating the Sun**.** *All of these images are of the Sun. Examine each one closely. Consider the following questions and record your observations.*
   - *What colors are the Sun in these images?*
   - *Why is the Sun different colors in different images?*
   - *What color do you think the Sun is based on both your observations of the Sun outside and of these images? What is your reasoning?*

C. **Provide Context: Direct learners to page 25** of the NASA Helio Club Youth Guide, or use the Handout_The EM Spectrum. *This diagram of the* ***electromagnetic spectrum****, or the 'EM spectrum' for short, shows all of the different kinds of light in the universe. Humans can only see a small part of*



Credit: NASA Afterschool Universe

So what color is the Sun? [**Answer:** Since the Sun emits radiation across ALL of the **EM spectrum**, you could say the Sun is all colors. The **black body radiation** emission spectrum of the Sun (light emitted by a heated object) peaks in the central, yellow-green part of the visible spectrum. In that sense, the Sun is more yellow than any other color.]



Credits: NASA, ESA, and M. Livio and the Hubble 20th Anniversary Team (STScI)

*the **EM spectrum**, the visible portion. Each color in the visible portion of the spectrum is defined by a different wavelength. Red light has longer wavelengths than blue light. Each type of light behaves differently because of properties like **wavelength**.* [Slide 14]

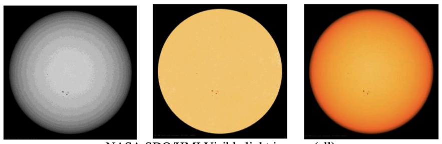
*All other parts of the spectrum are invisible to the human eye. You are probably familiar with some of the other types of light on the **EM spectrum**. We know that **UV light** can cause sunburn on our skin, but we can't see it. You may be most familiar with **infrared light**, which is heat. There are many other types of invisible light that can be harmful to humans, especially with high exposure, including **X-rays** and **gamma rays**, whereas other types of invisible light are not harmful, like **radio waves**.*

***Telescopes** are designed to collect light from different portions of the **EM spectrum,** providing more information than the human eye could detect on its own.*

*One of the most famous NASA telescopes, the [Hubble Space Telescope], can detect **visible light**, as well as a portion of **infrared** and **ultraviolet (UV)** wavelengths, which lie just beyond the visible spectrum.* [Slide 15]

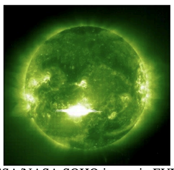
D. **Examine Data:** Direct learners to this NASA resource from the Hubble Space Telescope to explore more about the **electromagnetic spectrum**. Instruct learners to slide the divider back and forth to examine some of the most famous images taken by Hubble and compare the images between **visible** and **infrared light,** and between **visible** and **ultraviolet light.** [Slide 16]

Ask learners: *What differences can you see in the image between the two types of light?*

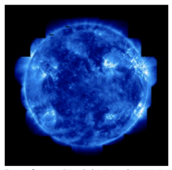


NASA SDO/HMI Visible light images (all)

Visible Light

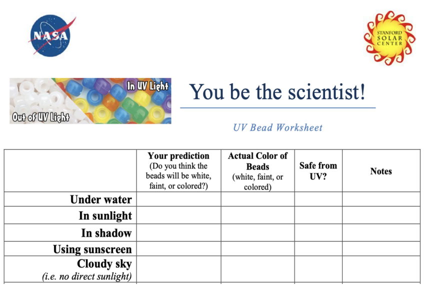


ESA/NASA SOHO image in EUV



Sun from SDO/AIA, in EUV

EUV Light



You be the scientist!

UV Bead Worksheet

	Your prediction (Do you think the beads will be white, faint, or colored?)	**Actual Color of Beads** (white, faint, or colored)	**Safe from UV?**	**Notes**
Under water				
In sunlight				
In shadow				
Using sunscreen				
Cloudy sky *(i.e. no direct sunlight)*				

UV Data Sheet

Note: The UV flashlight, commonly known as a blacklight, looks purple. Although we can't see UV light, it is very close to the purple end of the visible portion of the EM spectrum, giving the flashlight a slight purple glow. The purple light is visible light; you cannot see the UV light.

E. Provide Context: *The images of the Sun in* ***visible light,*** *at the bottom of* ***page 24,*** *probably look similar to what you observed with the solar eclipse glasses.*

But why are other images of the Sun in the data set in colors like green and blue? These images were taken with a telescope that collects light from the ***extreme ultraviolet (EUV)*** *portion of the* ***EM spectrum****, which is just high-energy* ***ultraviolet (UV) light****. Because we can't see* ***UV light****, color is added to the images so that we can see certain features of the Sun, like* ***solar flares.***

"Viewing" objects by collecting multiple types of light gives NASA scientists more information about the object.

F. Experiment: UV Beads *The white, translucent beads are UV-sensitive beads. They may not be white anymore if they have been exposed to sunlight. They turn color when they react to* ***UV light****. Because UV light can be harmful to humans, scientists are interested in the types of materials that we can use to protect us from UV light. What types of materials block UV light?* [Slide 17]

Direct learners to page 26 of the NASA Helio Club Youth Guide or use the Handout_UV Bead Data Sheet.

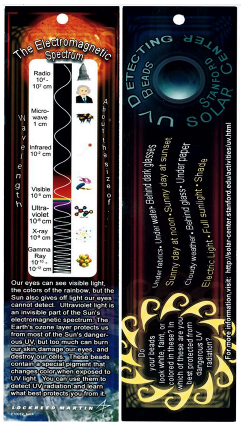
Use the UV-reactive beads to test different materials to see if they block the UV light.

Keep the beads in your pocket between experiments, to make them white again. Use the data sheet to record data. It is okay if you don't have all the materials on the list. You can add your own materials that you want to experiment with at the bottom of the data sheet.

If it is daytime, have learners go outside to experiment with the beads, or have them experiment by a window. If it is dark outside, have them use the UV flashlight. Learners can also experiment with the invisible-ink pen. Like the beads, the invisible ink also reacts to **UV light**.

Have learners write a message with the invisible-ink pen and then have them shine the UV light through different materials to see if they read the message. If they can read the message, then the material did not block the UV light.

Give learners 10-15 minutes to experiment with the beads and the invisible-ink pen. Allow time for learners to share their observations.



UV Bead Bookmark

G. **Optional Craft: Direct learners to page 27** of the NASA Helio Club Youth Guide or have learners cut out the Handout_UV Bead Bookmark. Give learners the option of adding the UV-reactive beads to the bookmark, using string. [Slide 18]

Activity 2 Major Concepts

- ★ The Sun gives off all types of light on the **electromagnetic (EM) spectrum**.
- ★ Humans can only see **visible light**. All other types of light on the EM spectrum are invisible to the human eye.
- ★ Scientists make observations of the Sun in multiple wavelengths of light, which gives them more detail of different features of the Sun, like solar flares and sunspots.
- ★ We can use UV-reactive beads and UV-reactive ink to investigate how different materials interact with **UV light**.
- ★ Since the Sun emits radiation across ALL of the **EM spectrum**, you could say the Sun is all colors. The **black body radiation** emission spectrum of the Sun (light emitted by a heated object) peaks in the central, yellow-green part of the visible portion of the spectrum. In that sense, the Sun is more yellow than any other color.

Featured NASA Mission: The Hubble Space Telescope, launched in 1990, views the universe in the ultraviolet through the visible (which our eyes see) and into the near-infrared. This range has allowed Hubble to deliver stunning images of stars, galaxies, and other astronomical objects.

Extend: How NASA Studies the Sun

Extend: How NASA Studies the Sun

Overview of Activity 3 (25 Minutes)

In this activity, learners will explore an additional tool used to observe the Sun's atmosphere, called a coronagraph.

Learners will watch a video about NASA's STEREO Mission and then create a flipbook of a coronagraph showing a solar flare.

The layers of the Sun are discussed in this activity but will be explored in more depth in other sessions.

Coronagraph
Credit: NASA SVS/ GSFC

Materials

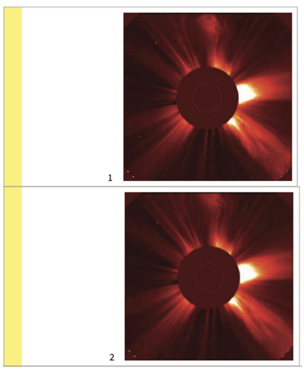
- Handout_Coronagraph Flip Book
- (1) medium binder clip
- scissors

A. **Provide Context:** Several of the images that learners examined in the previous activity were taken with instruments aboard NASA'S Solar Dynamics Observatory (SDO), which can take measurements in multiple different wavelengths simultaneously. SDO is just one of NASA's missions that study the Sun.

Another mission that studies the Sun is NASA's STEREO Mission (Solar Terrestrial Relations Observatory). Using two nearly identical observatories – one ahead of Earth in its orbit, the other trailing behind – STEREO has traced the flow of energy and matter from the Sun to Earth. [Slide 19]

*STEREO uses instruments called **coronagraphs** to study the Sun, which are images used to study part of the atmosphere of the Sun called the **corona**. **Coronagraphs** are equipped with a metal disk that blocks the bright light of the Sun's photosphere and makes it possible to study the detailed features of the surrounding **corona**. Otherwise, the Sun is too bright to view the **corona**. This mimics a **total solar eclipse**. When the Moon blocks the bright light of the Sun, it gives scientists an opportunity to study the Sun's **corona**.*

B. **Watch:** Show learners this short video, which shows how scientists read a coronagraph: How to Read a NASA STEREO Image. [Slide 20]


Credit: DYI Sun Science / Lawrence Hall of Science / UC Berkeley

Just like in the images we have been examining, (Handout_Sample Data for Investigating the Sun), colors are added to the ***coronagraph*** *to communicate information.*

The orange ball in the middle represents the hidden Sun behind the black circle, which is the result of the metal disk (occulting disk) used to block out the light of the ***photosphere****. The result of a* ***coronagraph*** *is images of the Sun's atmosphere, the* ***corona,*** *represented by the blue region. In the blue region we can see the* ***solar wind*** *(white light).*

C. **Create: Direct learners to page 29** of the NASA Helio Club Youth Guide, or use the Handout_Coronagraph Flip Book.

We are going to create a flipbook using ***coronagraphs*** *taken of a* ***solar flare*** *that occurred in 2000.* ***Solar flares*** *are* energetic bursts of light triggered by the release of magnetic energy on the Sun.

Just like the image in the video, colors are added to the ***coronagraph*** *to communicate information. The occulting disk is the dark, brownish-red circle in the center of the* ***coronagraph*** *image, and the outline of the Sun, which is behind the disk, is a faint, thin outline of a brighter circle in the center of the darker circle. The* ***corona*** *is represented by bright yellow-orange.*

1. *Cut out the images.*
2. *Put the images in order.*
3. *Clip the images together using the binder clip.*
4. *Flip through the book to see a* ***solar flare*** *in action!*

C. **Reflect**: *What advantages are there to making observations of the Sun using multiple methods? Provide evidence for your claim*.

Allow time for learners to share their answers.

Activity 3 Major Concepts

★ The Sun's atmosphere is called the **corona**.
★ It is challenging to study the Sun's corona, because the Sun is so bright, and the Sun's atmosphere is dimmer than the Sun's surface.
★ NASA uses **coronagraphs**, which use an occulting disk to block the Sun's light so that scientists can view the corona.
★ Using a coronagraph, scientists can observe features of the Sun, including the **solar wind** and **solar flares**.

Featured NASA Mission: NASA's STEREO Mission is a mission designed to help us understand the Sun's influence on Earth and near-Earth space by studying the solar atmosphere in many wavelengths simultaneously. Using two nearly identical observatories, one ahead of Earth in its orbit and the other trailing behind has traced the flow of energy and matter from the Sun to Earth.

Evaluate: What did you learn about observing the Sun?

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Overview of Activity
(15 Minutes)

At the end of the session, learners complete the KWL chart, adding what they learned to the L [Learn] column.

Encourage learners to look through Session 2 in the Helio Youth Guide, and to review the activities and the observations they recorded during the activities, to help them summarize what they learned during the session.

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Materials

- Handout_KWL_Session 2

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Instructions

A. **Direct learners to page 14** in their NASA Helio Club Youth Guide, or print the Handout_KWL_Session 2.

B. Have learners complete the **L [Learn Column]** of the KWL chart.

Emphasize to learners that they should also be correcting any misconceptions they had prior to the session, from the K [Know] column, and answering any questions from the W [Wonder] column, if they are able to.

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Session 2 Major Concepts

- ★ The Sun is a star and is hard to observe because it is so bright.
- ★ Eye safety is important when observing the Sun. **Solar eclipse glasses** and **pinhole projectors** are safe methods for observing the Sun.
- ★ The Sun gives off all types of light on the **electromagnetic spectrum**. Humans can only see **visible light**.
- ★ A **solar eclipse** provides a great opportunity to make observations of the Sun.
- ★ Scientists make observations of the Sun in multiple wavelengths of light, which gives them more detail of different features of the Sun, like solar flares and sunspots.
- ★ The Sun's atmosphere is called the **corona**.
- ★ It is challenging to study the Sun's corona, because the Sun is so bright, and the corona is dimmer than the Sun's surface.
- ★ NASA uses **coronagraphs**, which use an occulting disk to block the Sun's light so that scientists can view the corona.
- ★ Using a coronagraph, scientists can observe features of the Sun, including the **solar wind** and **solar flares**.

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