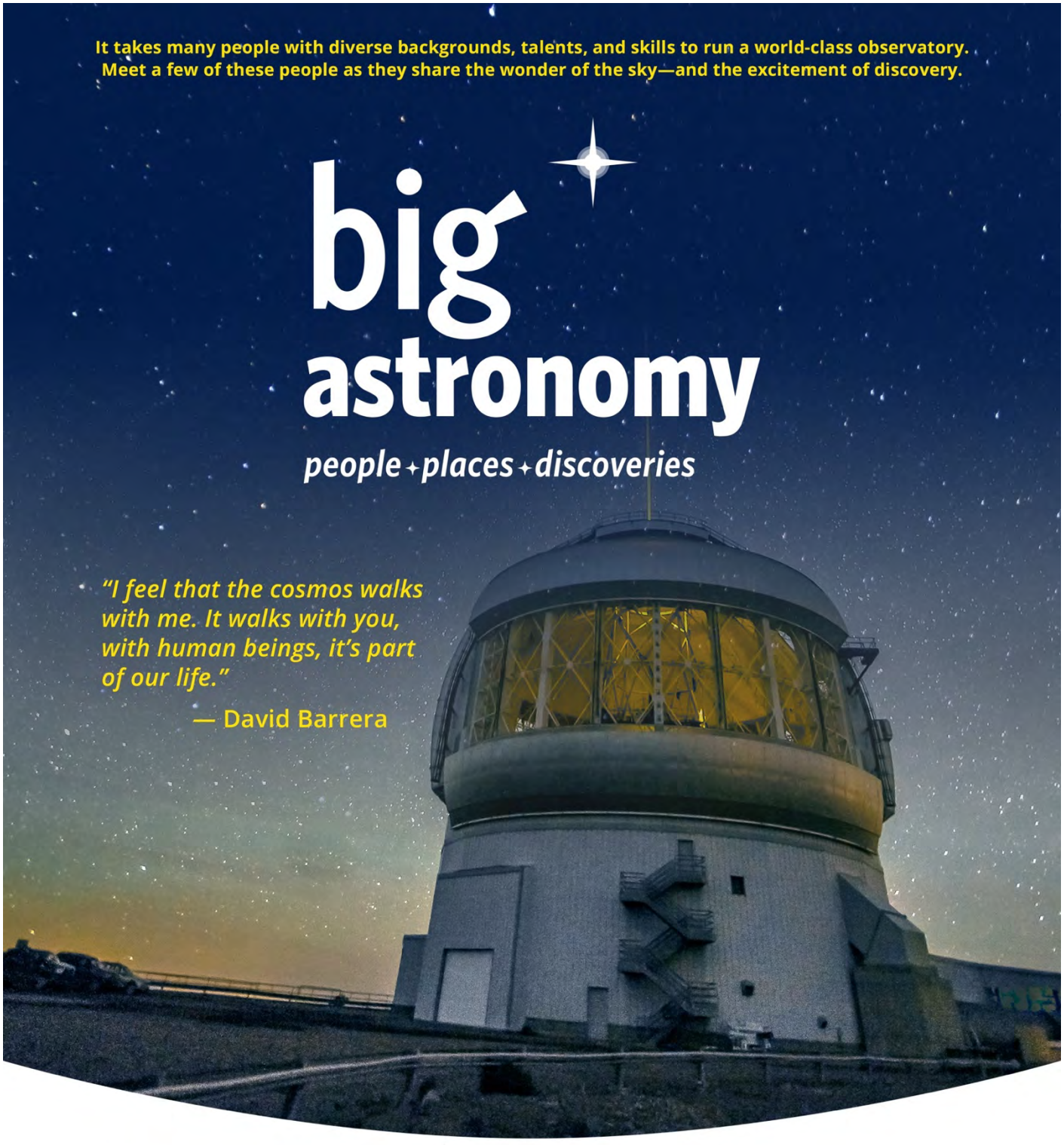

Outreach Toolkit

Table of Contents

Manual and more: bit.ly.bigastro

Welcome to the Big Astronomy Outreach Toolkit, a collection of activities and demonstrations supporting the Big Astronomy planetarium show. This Toolkit has four themes covered within six activities and demonstrations designed for use by amateur astronomers and museum professionals:

- Multi-wavelength astronomy gives a more complete picture of the cosmos.
- Astronomers need clear, dark skies for observing - all found in Chile.
- Astronomy is open to everyone, and there are many ways to become involved.
- The study of astronomy is deeply rooted in cultures around the world.

Each activity has a **Public Page** to engage audiences with open-ended questions and a **Facilitators Page** to give additional support, background, and extensions. This stimulates conversation with visitors and adds to their authentic understanding of the concepts. Also included are examples of online components for holding virtual events.

Find all Toolkit materials, along with supporting activities and extensions on the Night Sky Network website: bit.ly/bigastro
The **Night Sky Network** is a group of more than 400 astronomy clubs across the US dedicated to sharing the sky with their communities.

The **Big Astronomy planetarium show** debuts on September 26, 2020, and includes supporting live conversations with astronomers, educators, observatory staff, and more for the following 2 years. All of these resources, as well as an Educator Guide with activities for classroom instruction, are available on the Big Astronomy website: bigastronomy.org

The Toolkit activities were designed and tested by the **Astronomical Society of the Pacific** (ASP), a nonprofit organization committed to increasing science literacy through astronomy since 1889. astrosociety.org

This Toolkit is dedicated to the memory of Bill Bogardus, avid amateur astronomer, Astronomical League President, lover of life to its fullest, and dear friend of the Astronomy in Chile Educator Ambassador Program team. Ad Astra, Bill!

Big Astronomy is a collaboration between Abrams Planetarium at MSU, Associated Universities Inc. (AUI), Association of Universities for Research in Astronomy (AURA), Astronomical Society of the Pacific (ASP), California Academy of Sciences, Peoria Riverfront Museum, Ward Beecher Planetarium at YSU, Atacama Large Millimeter-submillimeter Array (ALMA), Vera C. Rubin Observatory construction project, NSF's NOIRLab facilities Cerro Tololo Inter-American Observatory (CTIO) and the international Gemini Observatory. Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

SHOW SUMMARY

This 2-page summary comes from the Big Astronomy Educational Guide for teachers. The full guide is found on the main website: bigastronomy.org

Big Astronomy: People, Places, Discoveries explores three observatories located in Chile, at extreme and remote places. It gives examples of the multitude of STEM careers needed to keep the great observatories working. The show is narrated by **Barbara Rojas-Ayala**, a Chilean astronomer.

A great deal of astronomy is done in the nation of Chile, due to its special climate and location, which creates stable, dry air. With its high, dry, and dark sites, Chile is one of the best places in the world for observational astronomy. The show takes you to three of the many telescopes along Chile's mountains.

The first site we visit is the Cerro Tololo Inter-American Observatory (CTIO), which is home to many telescopes. The largest is the Victor M. Blanco Telescope, which has a 4-meter primary mirror. The Blanco Telescope's mirror focuses light onto a large lens, which is part of an instrument called the Dark Energy Camera. Here we meet **Marco Bonati**, who is an Electronics Detector Engineer. He is responsible for what happens inside the instrument. Marco tells us about this job, and needing to keep the instrument very clean. We also meet **Jacoline Seron**, who is a Night Assistant at CTIO. Her job is to take care of the instrument, calibrate the telescope, and operate the telescope at night. Finally, we meet **Kathy Vivas**, who is part of the support team for the Dark Energy Camera. She makes sure the camera is producing science-quality data.

The Dark Energy Camera was designed to peer into the farthest reaches of the Universe. But it has also been used to find thousands of small icy bodies far out in the Solar System, beyond Neptune, in the Kuiper Belt. These small icy worlds help us understand the history of our Solar System.

On Cerro Pachón, we visit another telescope called the Gemini South Observatory, which has an eight meter primary mirror. We meet **Vanessa Montes**, an Electronics Engineer who describes how well the teams work together at the telescopes. We also meet **Alysha Shugart**, Science Operations Specialist, who operates the telescope at night. An instrument on Gemini South called the Gemini Planet Imager helps us see planetary systems as they are just forming.

We now travel farther north in Chile to the Atacama Desert, one of the driest places on Earth, to the Atacama Large Millimeter/submillimeter Array, or ALMA. People have observed the stars here for millennia. Here we meet **David Barrera**, president of the indigenous community of San Pedro de Atacama, which is near ALMA. He feels the cosmos walks with him. It is part of the community, part of their life. People and the cosmos make up a single unit. ALMA looks to unite scientific knowledge to indigenous knowledge.

ALMA is made of 66 radio antennas that work together, observing the sky in unprecedented detail, both night and day. The antenna array is located in an area known as the Chajnantor Plateau at an altitude of over 5000 meters. The extremely thin, dry air at Chajnantor is essential to successful observations at millimeter and submillimeter wavelengths. Each antenna dish weighs about 100 tons, and they needs to move from place to place to make different kinds of observations and receive maintenance. **Alfredo Elgueta** is one of only four people trusted to operate the transporter that moves the antennas. The antennas collect a huge amount of data. Because they work as a network, data from each antenna is compared to data from every other one. **Cella Verdugo**, an astronomer and data analyst, collects and studies these observations for astronomers around the world. ALMA has given us close up images of young planetary systems.

The show closes by previewing a new observatory that is being built in Chile, which will generate 20 terabytes of data every night. The data will be freely available to the world, enabling anybody to make the next great discovery.

All of the people we meet in the show come from different backgrounds, with many different talents and skills to contribute to Big Astronomy.

Visualize our Galaxy

Image of the Milky Way over Blanco Observatory
Credit CTIO/NOIRLab/NSF/AURA/D. Munizaga

Have you ever seen the Milky Way Galaxy?

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More activities: bit.ly/bigastro

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This model of the Milky Way Galaxy puts the night sky we see into perspective.

On our model, our Solar System, including the Kuiper Belt, is only about one nanometer in diameter – 100,000 could fit across a hair!

The stars visible to the unaided eye in the darkest night sky are between 4 and 4,000 light years away, or less than 2 inches from our Solar System in this model.

The Andromeda Galaxy (right) our nearest spiral neighbor, is about **13 Milky Way diameters** distant and nearly the same size as our galaxy.

Image of the Andromeda Galaxy
Credit: T.ARector and B.A.Wolpa/ NOIRLab/NSF/AURA

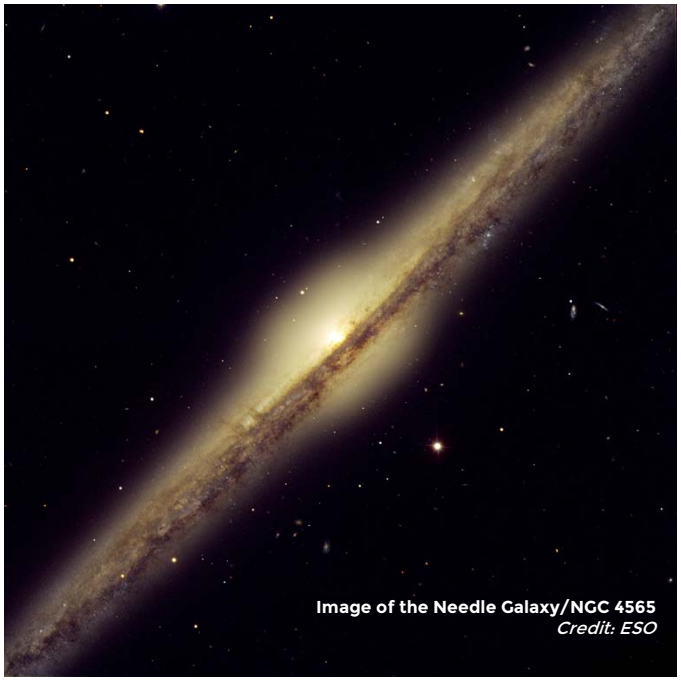

Image of the Needle Galaxy/NGC 4565
Credit: ESO

Seeing a galaxy from the edge gives us a glimpse of our perspective from within a similar structure.

Scientists study galaxies of all shapes and sizes to learn about their composition, formation, and evolution.

We also better understand our own galaxy through studying others.

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Notes for the Presenter

Visualize our Galaxy

Time: 10-15 minutes
Visitors: General audience, ages 10+, groups of 1-10
Venue: Indoor or outdoor, day or night. Paired with a telescope, more options are possible.

Learning Goals

- Understand that the Solar System is one of many star systems in the Milky Way Galaxy.
- Integrate the observation of the Milky Way in the night sky with the larger picture of the galaxy in which we reside.
- Understand that our galaxy is one of many galaxies, and we infer our model of the Milky Way partially through observing other galaxies.

Materials (and Sources)

- Model of the Milky Way Galaxy, additional umbrellas available (bit.ly/galaxyumbrella) or print your own poster from bit.ly/bigastro
- (Optional) Glow-in-the-dark paint

Advance Preparation

First time setup:

- (Optional) Use the glow-in-the-dark pen or paint to color in the stars of the Milky Way. For best adhesion, heat set with a hot hair dryer and leave umbrella open 12 hours.

Facilitation Notes

There are many ways to lead this demonstration using the model of our galaxy, depending on your goals. It is also a useful tool for answering common visitor questions.

Why does the Milky Way look like a band across the sky?
Show our place in the galaxy and note that on this scale, our Sun is too small to be visible. Note that the Milky Way Galaxy is flat like a disk and on this scale would be less than an inch thick. Tilt the model and show how our perspective shifts when seeing it edge-on. Imagine being within the disk and seeing a thick band of stars running across our night sky.

Have you ever had a chance to see a galaxy through a telescope?
If you have a telescope, point it to one of the many beautiful galaxies visible throughout the year. By looking at the nearest galaxies, we infer information about the structure of our galaxy.

How do we know we live in a galaxy?
Look up at the dark sky, and you may see a broad swath of bright cloud stretching across your view. Cultures worldwide noticed this, and for millennia have told stories about this "milky" cloud. We now know this "Milky Way" is our galaxy, composed of more than 200 billion suns. You might also notice dark patches; those are areas of dust and gas.

How far away are the stars we see at night?
The visible stars in the night sky are between 4 and 4,000 light years away, or an area on the model with a radius around the Solar System of less than 2".

Wrap-Up Questions:
Many of us find looking out into our galaxy and beyond an awesome yet humbling experience. Visitors may have a variety of thoughts and feelings after this experience. Gentle probing into their perspective is valuable as you check into both their thinking, and the effectiveness of the engagement.

- Do you have any new perspectives after this exercise?
- What are you thinking or feeling after this experience?
- What else does this make you wonder about?

Background Information

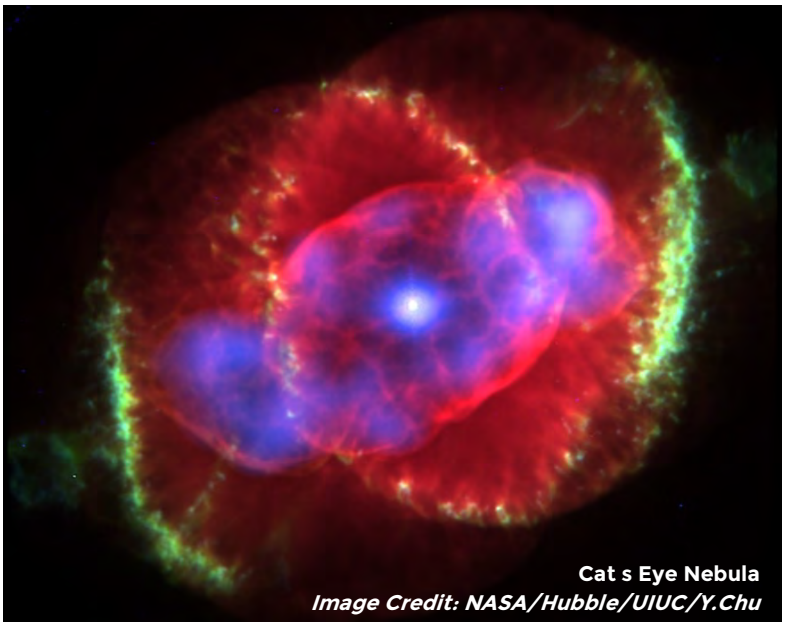
- All models have limitations! They don't show every detail, and are only approximations of the actual object. In this case, the umbrella is slightly curved, while the Milky Way is flat (and doesn't fold!). This can form the basis of a great discussion.
- It's a common misconception that we can see the Milky Way from above. The most distant picture we've ever taken is from the edge of our own Solar System. Our understanding of what the Milky Way looks like comes from images of distant similar galaxies as well as mapping the distribution of stars and dust in our own.
- Find more about this image by Robert Hunt: solarsystem.nasa.gov/resources/285/the-milky-way-galaxy/

Virtual and Hands-on Presentation Extensions

- A Universe of Galaxies activity from the Night Sky Network
  (a scale model from the closest galaxies to the Hubble Deep Field)
- Our Place in Our Galaxy activity
  (a scale model a quarter-sized Solar System in a US-sized galaxy)
- Get creative and make your own galaxy in pastels: www.ideamuseum.org/2020/04/30/pastel-galaxies/

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

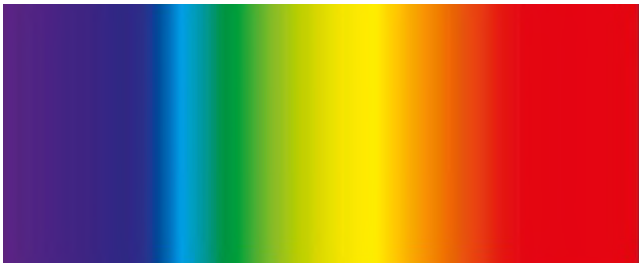
Clues to the Cosmos

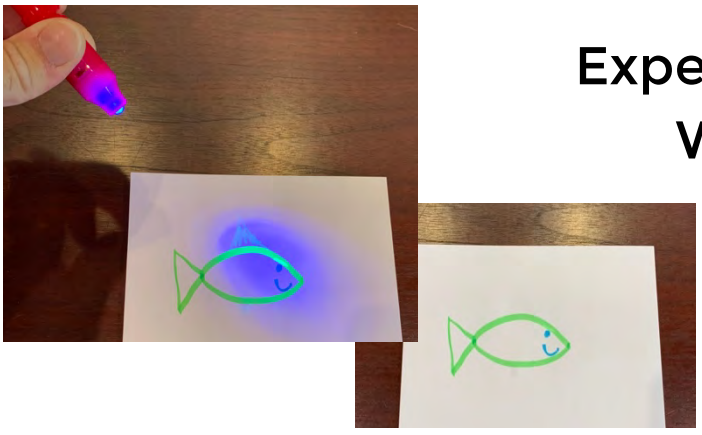


Cat s Eye Nebula
Image Credit: NASA/Hubble/UIUC/Y.Chu

Explore the images using different color filters.

What do you notice?
What do the filters do?





Experiment with the markers! Write a secret message or draw a picture that appears under UV light.

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More activities: bit.ly.bigastro

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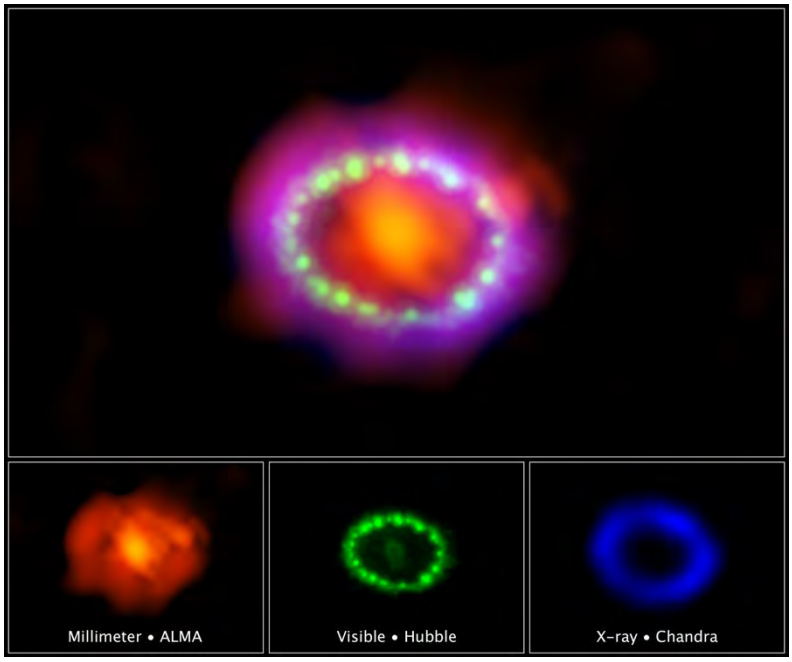
Astronomers use filters to help them focus on one type of light at a time.

Look at some of your favorite images with the filters. What can you discover by looking at different types of images?

- What do you notice about what you see through each filter?
- What is the filter doing?
- What color does each filter let through?



Supernova 1987A
Radio: ESO/NAOJ/NRAO/ALMA; Optical: NASA/STScI; X-ray: NASA/CXC/SAO/PSU/K.Frank et al.

Astronomers use *representational color* to show light we can't see with our eyes.
Above, X-rays are shown in blue.

Astronomers at the Gemini telescope in Chile use many spectrometers to view multiple objects at a time.
Credit: NOIRLab

Each filter gives clues about the temperature of a distant object, about its movement, and even its composition.

Some telescopes use instruments called *spectrometers* to gather information about the cosmos. They break the light up to see details that are otherwise hidden.

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Notes for the Presenter
Clues to the Cosmos

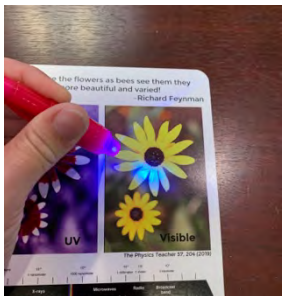
Time: 5-20 minutes
Visitors: General audience, ages 5+ with extensions for younger learners
Venue: daytime, table and writing surface needed

Learning Goals

1. Understand that there are more colors of light than our eyes can see and that different telescopes detect different types of light.
2. Understand that filters block all but one color or type of light and that artists, astronomers, and decoders use filters to help to focus on just one type of light at a time.
3. Understand that white light is made of many colors of light and that different types of light give us different information.

Materials (and Sources)

- 5 Clues to the Cosmos postcards (Print here: bit.ly/cluescosmos)
- 6 highlighters – 2 each of blue, green, and pink (Sharpie brand blue and pink work well, most greens work)
- 2 UV reactive pens with UV lights on the tops (search "spy pens")
- 6 filters – 2 each of blue, green, and red (Rainbow Symphony)
- Consumables (you provide) – scrap blank white paper for drawing
- (Optional) add another dimension to the drawing with black paper and red and blue crayons



Advance preparation

Before you begin:

- Use the UV reactive pen to on the yellow flower picture as shown. The UV light will make the ink fluoresce so you can see what you are drawing.

Setup:

- Place all of the images on the table picture-side up.
- Have an area for drawing with highlighters separate from the images.
- Keep a set of filters in each area.

Facilitation Notes

In this open-ended exploration, use the interests of your visitors to lead the discussion. There are often many misconceptions relate to how filters work. Encourage participants to discover on their own, using prompts such as, "That's interesting. What do you think would happen if…" and, "Tell me more about that." Often, they will come to the right answer on their own and the understanding of discovery is much more powerful than being told facts.

More activities: bit.ly.bigastro

Background Information

In this activity we touch on the idea of **representational color**, showing how astronomers use visible colors to represent light that we cannot see with our eyes. While scientists often refer to "false color images," in public outreach this term can cause misconceptions, so we try to avoid it. Representational colors help scientists pay attention to specific features like dust, energetic particles, or temperature and provides a more complete picture, even if it is not how the object appears to human eyes.

The idea that bees and other animals see in Ultraviolet (UV) light can be confusing. The ink in the included pens reacts when exposed to UV light, fluorescing the otherwise invisible ink. This approximates what a bee might see. Here again we are using representational color to create a more complete picture of the flowers, showing patterns not visible to our eyes.

Virtual Presentation Extensions

- Create your own multiwavelength images: public.nrao.edu/color/
- NSN's Universe in a Different Light activity gives examples of many places we use representational color, from cell reception to distant galaxies: bit.ly/different-light-nsn
- Recoloring the Universe coding project for middle school: chandra.harvard.edu/edu/pencilcode/pencil_paper.html
- See the ALMA live webcam: public.nrao.edu/alma-webcam/
- For very young visitors, simply observe colors – Play an "eye-spy" game on each other's screens. Virtual backgrounds add additional fun.

Additional Resources and Credits

This activity was adapted from the NISE Network activity Exploring the Universe: Filtered Light. There are many useful resources on that page to supplement this activity, including more images for use with the filters.

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

Good Light, Good Night

How to Use Light Wisely

Have you ever been under a really dark sky?

How did it feel?

What affects your ability to see the night sky?

Where do we put telescopes and why?

Can you think of other benefits of dark skies?

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Using our light wisely is important!

Shielding lights improves our safety, visibility, and vision of the night sky. It has health effects on animals, including people!

Light Pollution Uses Energy and Money

IDA estimates that least 30 percent of all outdoor lighting in the U.S. is wasted, mostly by lights that aren't shielded. Annually, we're wasting an estimated $3.3 billion and 21 million tons of carbon dioxide! (We'd have to plant 875 million trees to offset that.)

All of the lights pointed upwards are being wasted.

Baby sea turtles attracted by artificial light. (NIH)

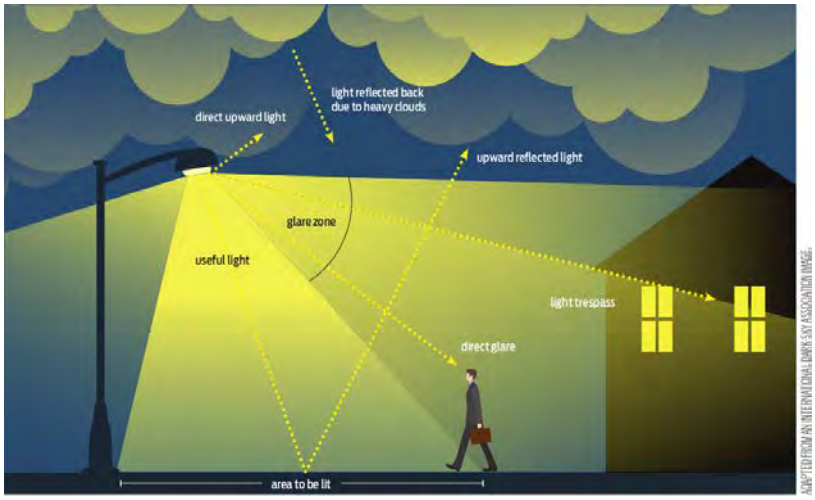
Hatchling turtles have followed the light towards the ocean but now bright artificial light draws them away from safety.

Artificial Lights Disrupt the World's Ecosystems

Light pollution radically alters the sleep of nocturnal animals.
Artificial light can cause birds to wander off course and toward the dangerous nighttime landscapes of cities.
Migratory birds depend on cues from properly timed seasonal schedules.

Exposure to Artificial Light Can Harm Your Health

Research suggests artificial light at night can negatively affect human health, increasing risks for depression, sleep disorders, diabetes, and more.



ADAPTED FROM AN INTERNATIONAL DARK-SKY ASSOCIATION IMAGE.

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More activities: bit.ly.bigastro

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Notes for the Presenter

Good Light, Good Night

Time: 10 minutes
Visitors: General audience, ages 7+
Venue: under a starry sky or in a darkened room with the

Learning Goals

1. Understand that well-directed light makes it easier to see the area, rather than using brighter light.
2. Understand the impact of lighting on their ability to see the night sky.
3. Notice lights around them and the effects of light on the environment.

Materials

- Flashlight with "candle mode," such as a Maglite
- Small figurine
- 1.5" PVC cap to focus light downward
- (If inside) Star Box, with light (See Advance Preparation)
- (Optional) Green felt

Facilitation Notes

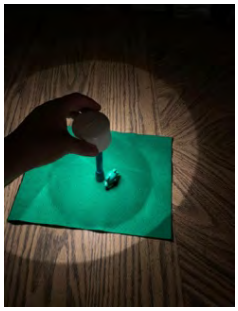
How could we use light more effectively?
Let's look at a model. We'll add a streetlight to the grass here.

Note: As you put the flashlight in the model, add the small figurine at the same time, in the dark area.

Have you seen streetlights like this? Where is the light shining? Where is the light needed?

(Optional) There are many types of light pollution:

- **Glare** is light so bright that it makes it hard to see, such as headlights.
- **Light Trespass** is light directed in places it's not needed.



How could we use this light better?
A lot of light is being wasted in places where it is not needed. Let's add a shield that will direct the light down - **what do we see now?**

Directing the light downwards shows that there was a bear hiding in the shadow. Also, the light is going to the place that needs to be lit. **What type of light do you think is safer?**

Look up at the stars. (Indicate lights from the Star Box, if indoors.)

Wrap-Up Questions:

- What can you do to use light wisely? (How can you share this message?)
- Have you had experiences when light shines where you don't want it?
- What are some other benefits to using light wisely?

See a video of this demonstration from the Palomar Observatory
youtu.be/XTjR4vef8JU

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Advance Preparation

First time setup, Star Box is used for an inside demonstration:

- In a 4" cardboard box, poke holes in the top with a pin.
- Place a bright light in the bottom of the box, shining up.
- Close the box and place in near the ceiling so that the stars can be seen when the light is shielded (*test this first*).

Setup to begin each time:

- Place green felt down on a flat surface.

Virtual and Hands-on Presentation Extensions

- **Globe at Night** is a website and app where individuals can measure their own sky brightness each month and contribute to a global map. globeatnight.org
- A full lab for use in classrooms plus many teacher resources from the **Dark Sky Rangers**. globeatnight.org/dsr
- Read the book "**There Once Was A Sky Full Of Stars.**"
- Build your own light shield activity with Star Power from SciGirls.
- If you are in a well-populated area, do a **light scavenger hunt**. Walk around your neighborhood taking pictures of lights - both lights that are shielded as good examples and poor examples of lights that are not properly directed.
- Talk to someone responsible for the **lighting in your neighborhood**: www.darksky.org/our-work/grassroots-advocacy/resources/

Additional Resources

- For more information on how light pollution affects us all and how to preserve dark skies: International Dark-Sky Association
- There are easy steps to making change! Conduct an outdoor lighting assessment on your own house: darksky.org/homelighting
- For articles on the particular effects of light pollution: Artificial Light at Night (ALAN) Research Literature Database
- Talk to someone responsible for the lighting in your neighborhood: darksky.org/our-work/grassroots-advocacy/resources

Background Information

This activity is adapted from NOAO's Quality Lighting Teaching Kit where you can find many more wonderful lighting activities noao.edu/education/qltkit.php

NOAO is the national center for ground-based nighttime astronomy in the United States and is operated by the **Association of Universities for Research in Astronomy** (AURA). under cooperative agreement with the **National Science Foundation**. If you would like information about solar astronomy, visit the **National Solar Observatory**. If you would like information about radio astronomy, visit the **National Radio Astronomy Observatory**.

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

Dark Sky Wheel

How Dark are Your Skies?

Image above of the Blanco telescope in Chile, with the Milky Way and Magellanic Clouds behind. *Image Credit: R. Smith/NOIRLab/NSF/AURA*

Have you ever been under a very dark sky?

How did it feel?

Find your view tonight on the Dark Sky Wheel.

Composite image below shows a global view of the Earth at night. *Image Credit: NASA/NOAA*

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More activities: bit.ly.bigastro

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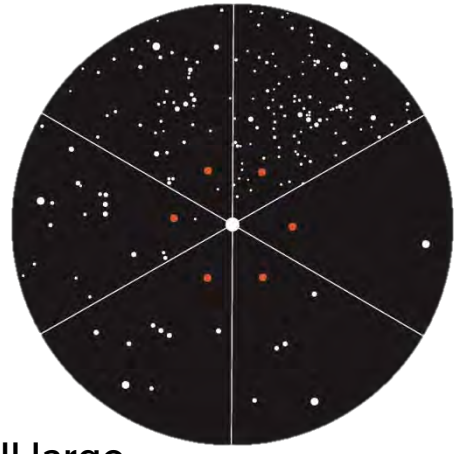
Dark skies are a precious natural resource.

The stars in Orion and Scorpius are legendary in cultures around the globe. The skies have held a fascination and a place of reverence for all of human history. We are losing our cultural connection to the night sky.



Try this: Find the constellation version that most closely mirrors what you see in the sky. Then wait 15 minutes without looking at lights. Do you notice any difference once your eyes become *dark adapted*?

Astronomers, both professional and amateur look for **clear dark skies** for observing the night sky. More than 70% of all large ground-based telescopes in the world are located in the mountains and high deserts of Chile because they have some of the darkest skies in the world.

- High mountaintops above much of the atmosphere
- Still, dry air that does not distort the light
- A commitment to dark skies shared by local communities
- Infrastructure and workforce to support big science projects

How many stars can we see in a very dark night sky?

From the middle of a city, you may only see the brightest stars in the sky. But with good eyes under the darkest skies, we can see around 5,000 stars on a moonless night.

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More activities: bit.ly.bigastro

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Notes for the Presenter
Dark Sky Wheel

Time: 5-10 minutes
Visitors: General audience, ages 10+
Venue: nighttime, Orion Jan - Mar, or Scorpius Jun-Aug (longer in S. Hemisphere)

Learning Goals
1. Notice how dark or bright our skies are.
2. Understand the impact of lighting on our ability to see the night sky.
3. Understand that stars do not all have the same brightness and color.
4. Notice how our eyes become dark adapted with more time away from light.

Materials (and Sources)
- Set of Dark Sky Wheels for visitors
  Print your own from the Night Sky Network Outreach Resources
- Brads for the center to keep them together and allow them to turn

Advance Preparation
First time setup:
- Use the glow-in-the-dark pen to mark the stars for use in the dark.

Setup:
- Make sure your star wheels are flipped for the correct season. Use the Orion side January through March, and the Scorpius side June-August.
- Insert the brad through the center.

Facilitation Notes
Does anyone recognize any constellations? Constellations are patterns that humans make up in the stars. All over the Earth and for all of recorded history, cultures have created these patterns to remember and understand the order of the stars at night. Have you heard stories about them?

Is that constellation always visible? We see different constellations at different times of year and at different times on the same night. As the Earth orbits the Sun, the night sky looks out at different parts of our galaxy.

How many stars are you usually able to see from your home? Do the number of stars you can see vary from night to night, and when you travel elsewhere? **What do you think is going on?** Lighting from the ground or the Moon can affect our ability to see the stars. Better lighting can mean darker skies!

Why do you think some stars are brighter than others? It could be their distance or how big and bright they are. Some stars are also different colors! See if you notice the red star Betelgeuse (in Orion) or Antares (in Scorpius).

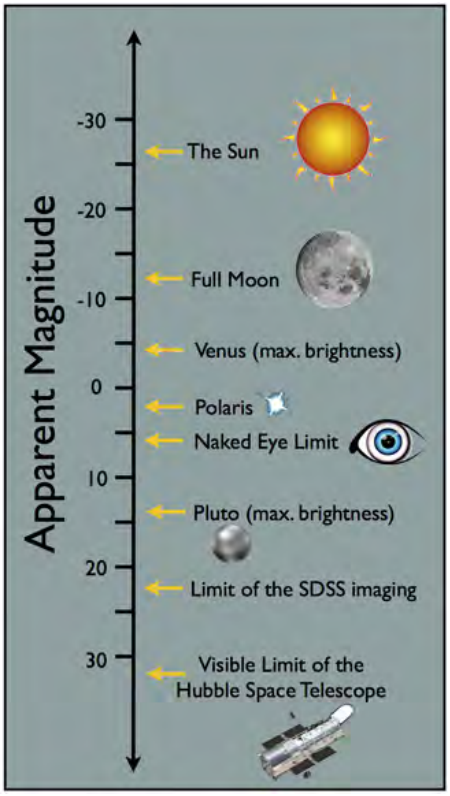
Be a scientist! Record your observations at globeatnight.org and add to a global database of sky brightness.

Background Information

Use a **red light** to help preserve visitors' dark adaptation, allowing them to see the most stars possible when looking up at the sky. Make sure when doing this activity to NOT use a white light to help people see the star wheel.

Have visitors note how many stars they can see when they first look up and then again 15 minutes later to demonstrate dark adaptation.

Magnitudes listed here are **apparent magnitudes**, or the brightness of an object *as seen from here on Earth* (as opposed to the absolute magnitude of an object, a measurement of the light it emits). It is an inverse log scale, with higher numbers indicating dimmer stars.



Scale of magnitudes from SDSS Voyages for teachers. Find more information and many exciting activities. voyages.sdss.org

Virtual and Hands-on Presentation Extensions

- This activity complements the light shielding activity **Good Light, Good Night** provided in the kit or at bit.ly/bigastro
- Tell constellation legends and have visitors create their own with the **Legends of the Night Sky** activity, also in this Toolkit.
- Explore the effects of light pollution on the night sky with Light Pollution Interactive globeatnight.org/light-pollution.php

Additional Resources and Credits

This activity was adapted from the magnitude charts of the Globe at Night Activity. globeatnight.org/magcharts

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

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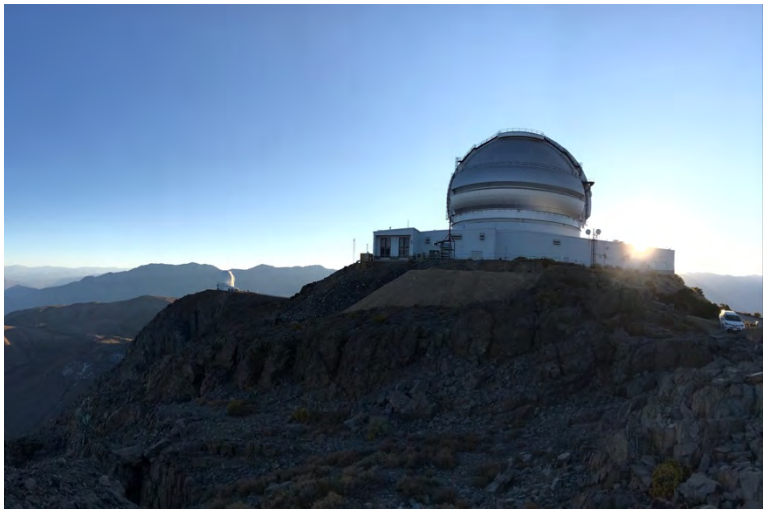
Space for Everyone

Diverse People and Skills Create Big Astronomy

Have you seen beautiful astronomy images like this one?

Where do they come from? Is it possible to take one with your phone?



Where are the telescopes?

Who brings us these images?

(Hint: It's not a lone astronomer.)

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More activities: bit.ly.bigastro

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Many people work to bring us the Universe.

All of the people on this banner work together to capture the beautiful images we see. Astronomy takes the efforts of groups from all over the globe, such as

- Technicians and engineers to run the observatory
- Astronomers to interpret the data
- People to house and feed astronomers
- Communicators to share discoveries

Becoming an astronomer is one way to learn more about the sky. There are also many other ways to participate in the joy of astronomy – there is space for everyone! How will you engage with our Universe?

A color-composite image of the Pleiades from the Digitized Sky Survey. Credit: STScI, Images: NASA/ESA/AURA/Caltech

- Learn more about Big Astronomy (bigastronomy.org)
- Join an astronomy club near you (nightskynetwork.org)
- Visit a planetarium or science museum (astc.org)
- Do some Citizen Science (scistarter.org)
- Borrow a library telescope (librarytelescope.org)
- Get inspired by Astronomy Picture of the Day (apod.nasa.gov)

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Notes for the Presenter

"Space for Everyone" Banner

Time: 5-15 minutes
Visitors: General audience, ages 7+, groups of 1-10
Venue: daytime or inside, need a place to hang the banner, display cards

In this activity, visitors will explore the banner and learn about the people involved in sharing Big Astronomy, and see how everyone can contribute to astronomy in different ways.

Goals:

1. Connect facilitators with their visitors' interests.
2. Understand how big teams work together make astronomy happen.
3. See how every individual can contribute to the study of astronomy.

Materials (Print all of these resources at bit.ly/bigastro)

- Banner & place to hang it with straps or cord
- Beautiful space image of your choice
- Four sheets describing people on banner
- Small cards to give away for followup

Facilitation Notes

This activity is good for opening a star party or outreach session. Making people feel capable and included is a great way to start your event!

Steps:

- Share the space image with visitor.
- Where do images like this come from? (Answer may be a telescope or an astronomer or something similar.)
- Where are these telescopes located and why? Why do you think these telescopes are so far away? (Telescopes need clear dark skies, less atmosphere, no light pollution - Chile is a great location!)
- Is it a lone astronomer? No – all of these people (indicate banner) make these images possible. (Share four sheets with audience and discuss their interests and how they might relate to astronomy.)

Some people think they need a lot of math and years of school to do astronomy. But astronomy needs all kinds of people -- amateur astronomers, Citizen Scientists, teachers, writers, artists, enthusiasts, politicians, everyone! Exploring the Universe is a big job, and we need all hands on deck!

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Conclude interactions by giving visitors a way to learn more with the small cards.

Background Information

The National Park Service has a motto for their programs:
Connect ~ Protect ~ Inspire
Connecting our audience with astronomy is the first step to having them protect the night sky and be inspired by the Universe. *If we make astronomy relevant and accessible to their lives,* we can start building those connections.

You can take a free introductory course from the National Park Service here: https://www.nps.gov/idp/interp/theprogram.htm

Virtual Presentation Tips

The banner and cards can be shown online. A quick way to engage virtual visitors is to show the banner and ask "Who on this banner does astronomy?" See more resources on the Night Sky Network: nightsky.jpl.nasa.gov

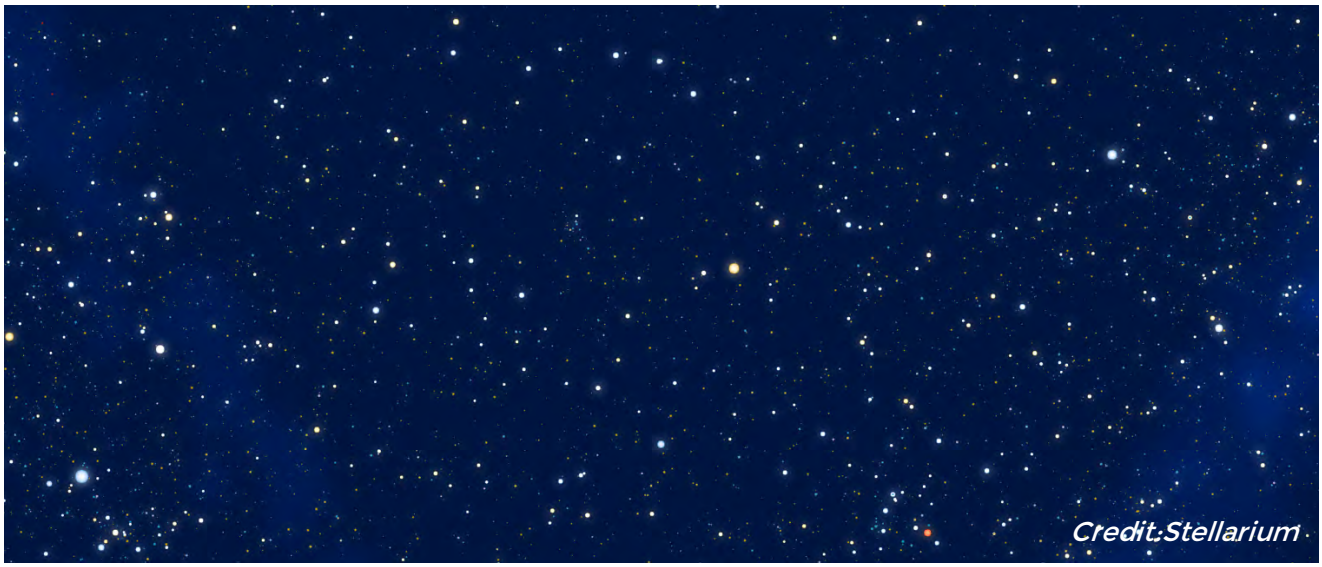
Additional Resources

- Where can I learn more about the banner and jobs in astronomy?
- Go to the Big Astronomy website: https://www.bigastronomy.org/ for interviews with participants in the Big Astronomy planetarium show and to see how their jobs support astronomy.
- The International Astronomical Union gives information about careers in astronomy: iau.org/public/themes/careers/
- The Bureau of Labor and Statistics give an overview in Space Careers: A universe of options.
- Hear interviews with Gemini Observatory staff: gemini.edu/careers

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

Legends in the Sky

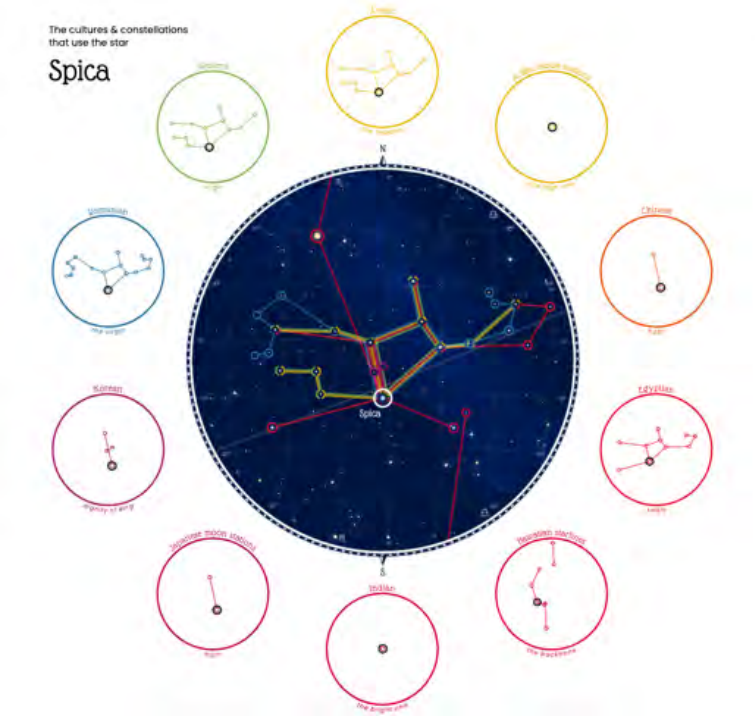
Everyone's Sky, Each Perspective Unique



Credit:Stellarium

Has anyone ever shown you a constellation in the sky? Who first helped you learn the sky?

Humans create patterns and mental maps to make sense of our world, including the stars in the sky.



Credit: Nadieh Bremer, Figures in the Sky

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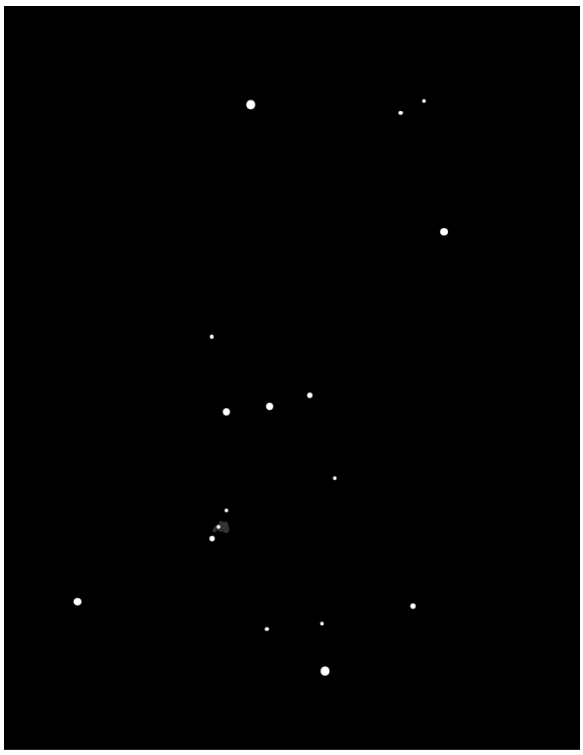
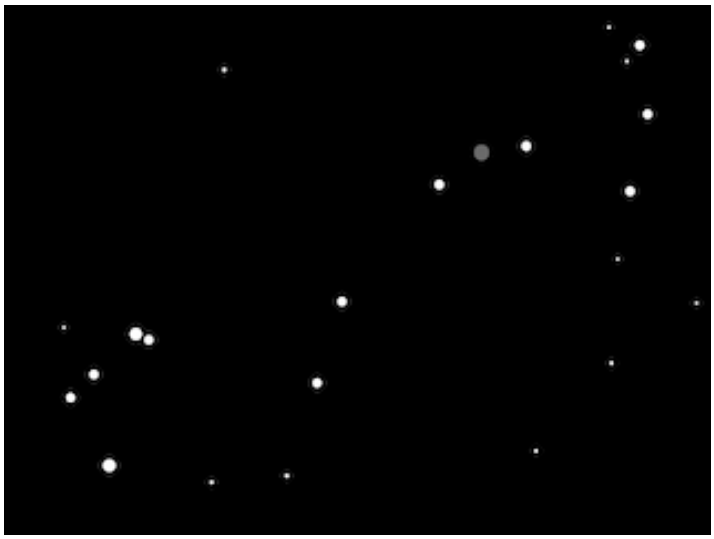
Cultures around the globe have made Legends in the Sky.



People everywhere have looked up and seen patterns among the stars. These constellations often honor things important to their culture – values, people, or animals – or indicate a time of year, such as a time for migration or planting. These legends are passed down through generations and share what each culture values.

You can create a pattern, too! Celebrate what you and your family treasure and respect.

What values are important to you? What stories do you like to share?



Do you have a hero, an animal, or object you would like to commemorate?

Do you see any patterns or bright stars in this star field?

Do you have a favorite sport that happens at this time of year?

Look at this star map and see if you can see a pattern. Bigger dots are brighter stars, so use those as anchors to your picture.

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More activities: bit.ly.bigastro

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Notes for the Presenter
Legends in the Sky

Time: 15 minutes
Visitors: General audience, ages 4+, groups from 1-30
Venue: daytime, inside, surface needed for writing

Explore the importance of the night sky to cultures around the world and create your own.

Learning Goals

1. Humans around the world create patterns to organize the night sky.
2. Cultures' constellation legends reflect both their environment and values.
3. Regular movement of the fixed constellations are used to tell time and make plans.
4. Astronomers use constellations to describe the locations of objects in the sky.

Materials

- 5 pages of sky stories (included are pages specific to each hemisphere)
- 1 copy of the current season's worksheet for each visitor
- Pencils, crayons, or markers for drawing
- A flat surface for writing
- (optional) Slide deck for larger presentations

Facilitation Notes

You don't have to know the constellations to facilitate this activity!

Respecting the legends of other cultures: It is important to understand that, far more than merely stories, the figures seen in the sky often represent ancestors, important Indigenous knowledge, and even stories not told outside a culture, or only told by certain revered members of the culture. By giving only the name of the figure, not the entire story, we are recognizing that the sky is important to cultures around the world and that the Greek constellations used by the astronomical community are just one way to interpret the sky.

We use the word "legends" not "stories" because for some cultures, these are more than stories – sometimes ancestors are memorialized in the sky or it is a part of a larger belief system. Some cultures do not use just stars to create constellations, but also use the dark spaces in the Milky Way, such as the Atacameñan Indigenous people in Chile.

More activities: bit.ly.bigastro

The International Astronomical Union divides the entire sky into 88 constellations – regions often surrounding the Greek version of the constellations. Amateur and professional astronomers use these to indicate where an object is in the sky in the same way one might use states to tell the location of a park. So, Zion National Park is in Utah while the Sombrero Galaxy is in the constellation Virgo. The boundaries of Utah and Virgo are both invented and useful.

The northern and southern hemispheres see the constellations flipped upside down from each other. So, the foot of a dancing man in Australia may be the shoulder of Orion to people in the Northern Hemisphere.

Background Information

To learn more:

- **Figures in the Sky:** http://www.datasketch.es/may/code/nadieh/
- **Native Skywatchers:** http://www.nativeskywatchers.com/
- **Astronomy of Many Cultures Resource Guide:** https://astrosociety.org/education-outreach/ resource-guides/multicultural-astronomy.html

Virtual Presentation Tips

This activity is easily done remotely. Send participants a link to the proper season page in advance, so they can print the pattern of stars. A slide presentation is also available at: bit.ly/legendsinthesky

Additional Resources / Extension Activities

- Big Dipper Sky Clock (for Northern Hemisphere): https://skyandtelescope.org/astronomy-resources/ make-a-star-clock/
- Southern Cross Clock (Pages 17-18): https://museumsvictoria.com.au/media/1896/vceastronomy-astrophysics-student-activities-1-10.pdf

Big Astronomy is supported by the U.S. National Science Foundation (Award #: 1811436)

Create Your Own Constellation

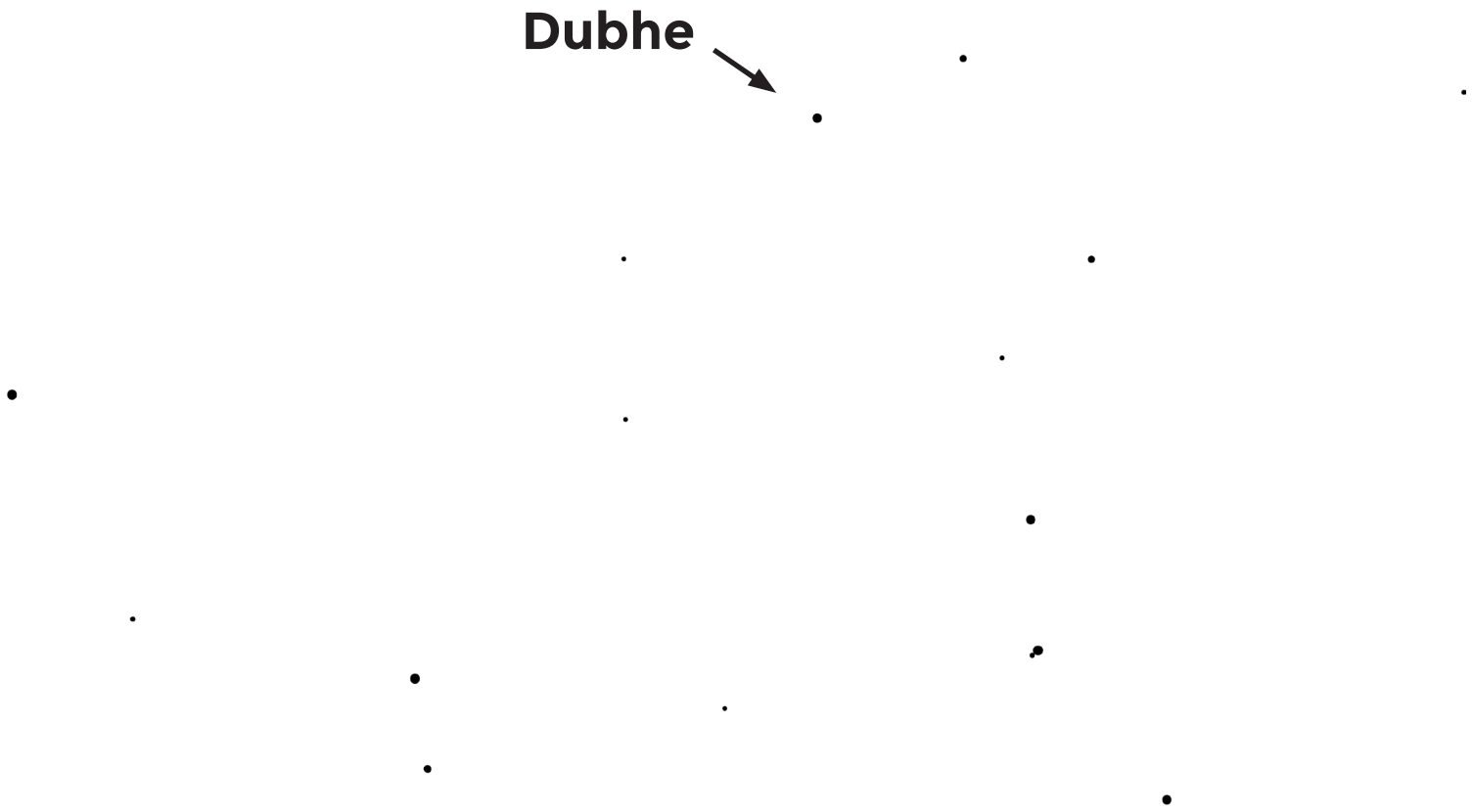
Betelgeuse

What image do you see in the stars this time of year?
Tell a story about how this represents a person or value close to you.

Your Constellation:

Story:

Create Your Own Constellation



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Tell a story about how this represents a person or value close to you.

Your Constellation:

Story:

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bigastronomy.org

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astrosociety.org

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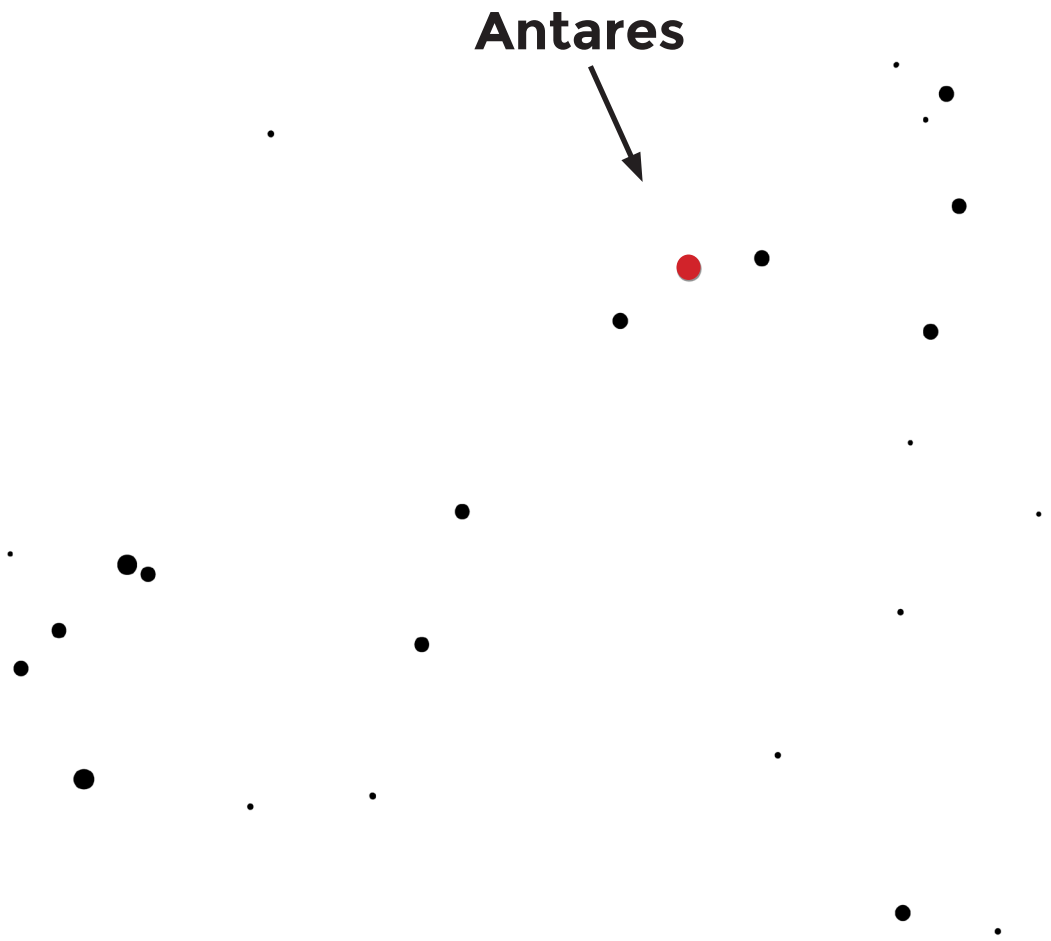

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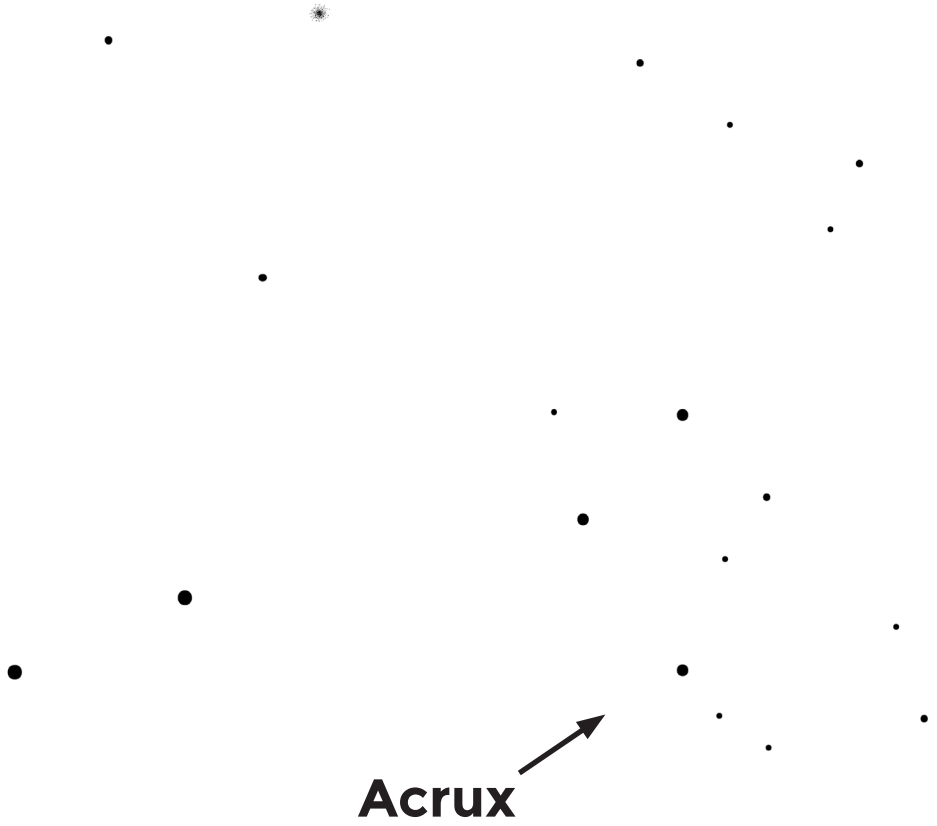

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Story:

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astrosociety.org

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Big Astronomy Needs Engineers

to maintain equipment, steer spacecraft, and program telescopes

Alysha Shugart's work as a **Science Operations Specialist** includes telescope operation, helping astronomers, data analysis, maintaining infrastructure, and engineering.

Professor Moriba Jah has worked as a **Spacecraft Navigator** at NASA JPL for five Mars missions, including the Mars Reconnaissance Orbiter.

Javier Rojas has been the **Senior Electronic Engineer** at the Cerro Tololo Inter-American Observatory since 1996. He oversees maintainence for everything on the mountain.

Eduardo Toro is an **IT and Software Engineer** in charge of networking at Gemini. He maintains the network to assure people worldwide have virtual access to the telescope.

Fabiola Cruzat does **Antenna Maintenance**, supervising a large group of engineers and mechanics. She is responsible for maintenance of the telescopes and instruments.

Mariah Burchard is an **Electronics Engineer**. She works on the analog and digital circuitry, such as the accelerometer on the mirror covers.

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More activities: bit.ly.bigastro

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Big Astronomy Needs Communicators

to spread the word about the latest discoveries

Valeria Foncea is the **Public Outreach Officer** for ALMA, sharing the excitement of the latest astronomy using her extensive experience in journalism and TV.

David Barrera is an **Indigenous Atacameñan Businessman**. He collaborates with the astronomy community to protect the land and people.

Sylvana Zuñiga is an **Artist**. She paints murals of stars and galaxies, inspiring others to imagine the Universe through art.

Ida Huntz is an **Amateur Astronomer**. She shares her love of the night sky with the community through a telescope.

Juan Carmelo is a **Cultural Cultivator**. He communicates the knowledge and traditions of the Atacameñan people, their ancestors, and Indigenous science.

Daniella Scalice is the **Education and Communications Lead** for the NASA Astrobiology Program. She shares the search for life in the Universe.

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Big Astronomy Needs Operations Staff

to keep the observatory running smoothly

Daniela Soto is a **Telescope Operator** at ALMA and has a background in physics and engineering. She worked in a planetarium in Santiago.

Alfredo Elgueta is a **Transport Driver** - one of only four people trusted to move the giant antennas at the ALMA Observatory.

Alex Barria is the **Safety Deputy** and a paramedic. The observatory is on a high desert, so he often distributes oxygen tanks to help workers and visitors who get altitude sickness.

Alex Jeraldo was a **Chef** when he first arrived at CTIO. Now as **Facilities Operations Manager,** he supervises the staff of the cafeteria and residences.

Modern astronomy takes large teams with diverse skills to unlock the secrets of the Universe.

No longer a lone astronomer behind a telescope, thousands of people support the largest observatories in the world dedicated to bringing Big Astronomy to light.

If you are interested in astronomy, there is space for you.

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Big Astronomy Needs Astronomers

to ask questions and translate data into big ideas

Celia Verdugo is a **Data Analyst** at the ALMA observatory. She studies star formation and loves seeing the big picture.

Astronomer Burçin Mutlu-Pakdil uses the world's biggest telescopes to study the nature of dark matter and galaxy formation. She has discovered new types of galaxies.

Astronomer and **Outreach Director** Xinnan Du researches distant star-forming galaxies. She also serves as a mentor, running a student internship program.

Brother Guy Consolmagno is an expert in meteorites and asteroids as **Director of the Vatican Observatory**. He is also fascinated with science fiction.

Priyamvada Natarajan is a **Professor** and **Theoretical Astrophysicist**, noted for her work in mapping dark matter and dark energy.

Thebe Medupe is a **Professor** and **Astrophyscist** who uses seismic waves to look inside stars. He also researches traditional African astronomy.

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More activities: bit.ly.bigastro

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