

National Aeronautics and Space Administration



Sq' Baa Hane' Story of the Stars

Educational Activities
Weaving
NASA Science and Navajo Knowledge

For use in Classrooms and Community-Based Educational Events

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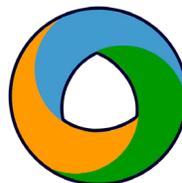
NASA and the Navajo Nation Project

The 2005 NASA Explorer Institute Project entitled “NASA and the Navajo Nation” was led by the NASA Astrobiology Institute in collaboration with ArtReach International. The project was carried out in partnership with The Navajo Nation Council, Office of the Speaker.

The project evolved from a 2004 NASA Explorer Institute Focus Group conducted by ArtReach International. In the Focus Group, members of the Navajo education community identified needs and desires in partnering with NASA on educational initiatives. The educational materials created within the NASA and the Navajo Nation project, this activity booklet and a short film, both entitled “Sq’ Baa Hane’ - Story of the Stars,” are a direct result of the Focus Group’s findings.

The activities and film weave together NASA astrobiology science and Navajo cultural teachings relating to the stars to create a “dual-learning” environment wherein the cultural and scientific concepts are explored together, equally.

This product is for non-commercial, educational use only.



liná Dóó Óhoo' Aah Bindii' A'

Overall Diné Education Philosophy

From the Diné Culture and Language Curriculum Framework
Office of Diné Culture, Language, and Community Services

We are the Holy People of the Earth. We are created and placed between our Mother Earth and Father Sky. Our home, the Four Sacred Mountains, with the entrance to the East, embodies our Way of Life. It provides strength and peace within us.

Spirituality, intellect, planning, and life have been instilled within us; through these attributes we attain knowledge and wisdom. We shall combine the best learning and knowledge of other societies with that of our own for the benefit of our future.

With that, our children will walk with beauty before them, beauty behind them, beauty beneath them, beauty above them, beauty around them, and will always be respectful and live in harmony with natural law. Our children will go forth in life endowed with what is required to achieve their ultimate aspirations.



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HOW TO USE THE ACTIVITIES IN THIS BOOKLET

As a Community Night Event

The six activities and the film were designed to be delivered through the educational model of a Community Event. The materials, when presented together in such an event, reinforce each other, and provide learning opportunities for a range of ages – “from K – Gray.” Bringing together parents, grandparents, family, and friends in a community setting, these Events extend the depth of the activities. When families or groups learn together, family stories and memories can be brought forward to enhance the concepts explored in the activities, and inter-generational learning is encouraged! The following are guidelines on HOW TO HOST A COMMUNITY NIGHT EVENT.

USE YOUR CREATIVITY!

The activities are presented with suggested guidelines. The best way to conduct them is to use existing resources and your own creativity to create an Event that is best for your community. Doing all the activities is not required, and making additions to the program is encouraged.

WHEN? WHERE?

We suggest hosting these events on a Saturday or weekday evening after school. Pick a location that is easy to get to for attendees, has adequate parking, and is centrally located within the community such as a school gym, town hall, chapter house, or community center. Consider having safety personnel in attendance.

SUGGESTED LAYOUT OF THE EVENT

In the space that you’ve selected, organize the event into “stations,” each representing one activity. Each station should have at least one facilitator. All facilitators should be familiar with the activity and its background information. Label each station with a large sign on the wall behind it. Separate the Story Time activity from the others, as that activity needs a quiet space. The Moving with the Stars activity can be the noisiest. If you are in a school, utilizing the gym as the main space is recommended, and making use of classrooms or other places in the building may be useful.

Providing food or hosting a community pot-luck is recommended. Beginning the event with a group meal is desirable and contributes to a successful evening. Either during the meal or right afterward, consider showing the film as an official kick-off to the event. From there, small groups can make the rounds to each station. It is also useful to show the film continuously throughout the event, especially for those who care to sit and rest.

Activities that work best with small groups are: Moving with the Stars, Stories in the Sky, and Cycles in the Cards. Activities that are geared more to individuals are: Gemstone Constellations, and Exploring Stories Through Art. The Story Time activity can accommodate a large group.



ADDITIONS TO THE PROGRAM AND SPECIAL FEATURES

Coordinating with other programs that provide telescope viewing opportunities is encouraged. The following resources may be available in your area: American Indian Mobile Educational Resources Program: <http://www.spacegrant.nau.edu/aimer/index.html>; and Sirius Lookers of Sedona: <http://www.users.qwest.net/~emwalczak/>. Combining the event with a school program such as a science fair, or a community program such as an astronomy-themed art show or public talk can help customize the event to your community.

Field testing revealed that the activities were also very useful in the classroom, especially in conjunction with a Community Event. It is recommended to work with teachers and students in a local school do the activities in the classroom before the event. The students can then become activity facilitators, event co-hosts, and/or set-up and clean-up crew. Students can also help by creating special touches for the activities before-hand, such as the “coffee can fire pit” for the Story Time activity, or creating a special invitation to the event to take home to family and friends. They can also help create and distribute flyers for advertising the event.

Consider creating a “passport” with a number for each activity that participants can carry around with them (perhaps as a “necklace”) to each station. Upon completing an activity, the facilitator can use a hole-puncher to punch-out the number of that activity. It can be structured so that the participants would only be able to enter the planetarium for the Story Time activity after completing the other activities. They would present their fully-punched passport as a ticket for admission into the planetarium. Also consider having give-away prizes for “best of” in certain activities such as Stories in the Sky, Exploring Stories Through Art, and Gemstone Constellations.

DESIGNATING COORDINATORS

Designate an Event Coordinator

This person will have the responsibility for deciding which activities will constitute the program, finding a site to hold the event, coordinating with any additional programs or persons the event might include, and providing the enthusiasm and energy to make it happen. The event coordinator will meet regularly with the volunteer and publicity coordinators to ensure all needs are met in preparing to host the event. Allow approximately two months of lead time to successfully coordinate an event.

Designate a Volunteer Coordinator

This person will coordinate the staffing needs for this event, including recruiting activity facilitators, and set up and clean up volunteers. Resources to tap for staffing needs can include parents, teachers, local community clubs, and high school students.

Designate a Publicity Coordinator

This person will coordinate all publicity for the event. This could include working with school administrators, parents, newspapers, newsletters, radio, local TV, and city or local government officials. Working with school students to design and disseminate flyers is encouraged. Please feel free to use any artwork in this document in your publicity. Make sure to emphasize that this event and these activities are designed for family learning.

General Considerations for the Coordinators

When securing the location, be sure to enquire about tables and chairs, temperature regulators, lights, as well as AV equipment – a DVD player, TV or projector, and speakers will be needed. As hosting food has been suggested, enquire about rules and regulations, and things such as refrigeration, coffee services, and waste disposal. If there is a Home Economics class in a local school, consider coordinating with them or the school’s cafeteria to “cater” the event. If the event includes a telescope program after dark, some considerations may be adequate space in a parking lot or adjacent field, and the absence of lights which can interfere with clear observing.



Community Night Event – Field Test in Cameron, AZ

In the Classroom

Although they were originally designed for informal education settings, each of the six activities can be used in the classroom setting. The following grade levels are recommended:

- Exploring Stories Through Art:K-3; elementary
- Gemstone Constellations:K-5; elementary-middle
- Stories in the Sky:3-6; elementary-middle
- Moving with the Stars:K-6; elementary-middle
- Story Time:K-12; all ages
- Cycles in the Cards:5-12; middle-high

The following alignments have been made with the Arizona State Standards, Arizona Early Learning Standards, and the New Mexico State Standards.

ALL ACTIVITIES

Arizona Early Learning Standards

Social/Emotional Standard

STRAND 2: SOCIAL INTERACTIONS WITH OTHERS

Concept 2: Cooperation

The child demonstrates the ability to give and take during social interactions.

STRAND 3: RESPONSIBILITY FOR SELF AND OTHERS

Concept 1: Self-Control

The child follows and understands rules and routines in various environments.

STRAND 4: APPROACHES TO LEARNING

Concept 1: Curiosity

The child is inquisitive about new experiences.

Concept 4: Creativity

The child demonstrates the ability to express his/her own unique way of seeing the world.

Exploring Stories Through Art

Arizona Early Learning Standards

Fine Arts Standard

STRAND 1 – VISUAL ART

Concept 1: Creating Art

The child uses a wide variety of materials, media, tools, techniques and processes to explore and create.



Arizona State Standards – ART

Visual Art – Standard 1 – Creating Art - READINESS

1AV-R1. Identify and use a variety of art media and techniques to communicate ideas, experiences and stories.

PO 1. Create a variety of artworks using various art media.

PO 3. Produce a variety of artworks to communicate ideas, experiences and stories

1AV-R2. Recognize that the visual arts are a form of communication.

PO 1. Identify art forms such as painting, drawing, sculpture, and collage as a form of communicating thoughts and ideas.

PO 2. Use the elements of art in various art forms to communicate feelings and ideas.

1AV-R3. Identify various subject matter, ideas, and symbols used in one's own work and work of others to convey meaning.

PO 6. Use a variety of symbols to convey meaning in one's own works of art.

New Mexico State Standards – ARTS

Visual Arts – Standard 2 - Use dance, music, theatre/drama, and visual arts to express ideas.

Grades K-4

B. Know and use art to interpret personal ideas, feelings, and experiences through visual form.

Grades 5-8

B. Use subjects, themes, and symbols when expressing ideas in art works.

Gemstone Constellations

Arizona Early Learning Standards

Fine Arts Standard

STRAND 1 – VISUAL ART

Concept 1: Creating Art

The child uses a wide variety of materials, media, tools, techniques and processes to explore and create.

Concept 2: Art in Context

The child uses art as he/she begins to make sense of the environment and community.

Arizona State Standards – SCIENCE

STRAND 6 – Earth and Space Sciences – Concept 3 – Earth in the Solar System

Grade 5

PO 3. Describe various objects in the sky (e.g., asteroids, comets, stars, meteors/shooting stars).

Grade 7

PO 5. Identify the following major constellations visible (seasonally) from the Northern Hemisphere: • Orion • Ursa Major (Great Bear) • Cygnus • Scorpius • Cassiopeia.

Arizona State Standards – ART

Visual Art – Standard 1 – Creating Art - READINESS

1AV-R1. Identify and use a variety of art media and techniques to communicate ideas, experiences and stories.

PO 1. Create a variety of artworks using various art media.

PO 3. Produce a variety of artworks to communicate ideas, experiences and stories

1AV-R2. Recognize that the visual arts are a form of communication.

PO 1. Identify art forms such as painting, drawing, sculpture, and collage as a form of communicating thoughts and ideas.

PO 2. Use the elements of art in various art forms to communicate feelings and ideas.

1AV-R3. Identify various subject matter, ideas, and symbols used in one’s own work and work of others to convey meaning.

PO 6. Use a variety of symbols to convey meaning in one’s own works of art.

Visual Art – Standard 1 – Creating Art - FOUNDATIONS

1AV-F1. Select and use subjects, themes and symbols in works of art.

PO 2. Use themes in a work of art.

PO 3. Use symbols in a work of art.

New Mexico State Standards – ARTS

Visual Arts – Standard 2 - Use dance, music, theatre/drama, and visual arts to express ideas.

Grades K-4

B. Know and use art to interpret personal ideas, feelings, and experiences through visual form.

Grades 5-8

B. Use subjects, themes, and symbols when expressing ideas in art works.

Stories in the Sky

Arizona Early Learning Standards

Fine Arts Standard

STRAND 1 – VISUAL ART

Concept 1: Creating Art

The child uses a wide variety of materials, media, tools, techniques and processes to explore and create.

Concept 2: Art in Context

The child uses art as he/she begins to make sense of the environment and community.

Language & Literacy Standard

STRAND 3: PRE-WRITING PROCESS

Concept 1: Written Expression

The child uses writing materials to communicate ideas.



Arizona State Standards – ART

Visual Art – Standard 1 – Creating Art - READINESS

1AV-R1. Identify and use a variety of art media and techniques to communicate ideas, experiences and stories.

PO 1. Create a variety of artworks using various art media.

PO 3. Produce a variety of artworks to communicate ideas, experiences and stories.

1AV-R2. Recognize that the visual arts are a form of communication.

PO 1. Identify art forms such as painting, drawing, sculpture, and collage as a form of communicating thoughts and ideas.

PO 2. Use the elements of art in various art forms to communicate feelings and ideas.

1AV-R3. Identify various subject matter, ideas, and symbols used in one's own work and work of others to convey meaning.

PO 6. Use a variety of symbols to convey meaning in one's own works of art.

Visual Art – Standard 1 – Creating Art - FOUNDATIONS

1AV-F1. Select and use subjects, themes and symbols in works of art .

PO 2. Use themes in a work of art.

PO 3. Use symbols in a work of art.

New Mexico State Standards – ARTS

Visual Arts – Standard 2 - Use dance, music, theatre/drama, and visual arts to express ideas.

Grades K-4

B. Know and use art to interpret personal ideas, feelings, and experiences through visual form.

Grades 5-8

B. Use subjects, themes, and symbols when expressing ideas in art works.

Moving with the Stars

Arizona Early Learning Standards

Fine Arts Standard

STRAND 2: MUSIC AND CREATIVE MOVEMENT

Concept 2: Music and Creative Movement in Context

The child uses creative movement and music as he/she begins to make sense of the environment and community.

Arizona State Standards – SCIENCE

STRAND 6 – Earth and Space Sciences – Concept 3 – Earth in the Solar System

High School

PO 1. Describe the scientific theory of the origin of the solar system (solar nebular hypothesis).

STRAND 6 – Earth and Space Sciences – Concept 4 – Origin and Evolution of the Universe

High School

PO 2. Describe the fusion process that takes place in stars.

Arizona State Standards – ART

Dance – Standard 1 – Creating Art - READINESS

1AD-R3. Imitate and mirror basic body movements and shapes.

PO 1. Follow movements and shapes of a designated leader.

1AD-R5. Identify and demonstrate knowledge of moving as an individual and as part of a group.

PO 3. Demonstrate unison movement.

Dance – Standard 1 – Creating Art - ESSENTIALS

1AD-E5. Transfer accurately a visual pattern to a physical motion.

PO 1. Demonstrate shapes with body parts.

Dance – Standard 1 – Creating Art - PROFICIENCY

1AD-P3. Create and perform combinations in a variety of dynamic ranges and movement qualities.

PO 2. Demonstrate several movement qualities in a choreographed work.

New Mexico State Standards - SCIENCE

Strand II – Content of Science

Standard III – Earth and Space Science

9-12 Benchmark I - Examine the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.

Grades 9-12

6 Describe how stars are powered by nuclear fusion, how luminosity and temperature indicate their age, and how stellar processes create heavier and stable elements that are found throughout the universe.

New Mexico State Standards – ARTS

Dance – Standard 1 - Learn and develop the essential skills and technical demands unique to dance, music, theatre/drama, and visual arts.

Grades K-4

B.1 Illustrate through movement and maintain personal space, general space, working space, working alone, with a partner and in a group.

Story Time

Arizona Early Learning Standards

Language & Literacy Standard

STRAND 1: ORAL LANGUAGE DEVELOPMENT

Concept 1: Listening and Understanding

The child listens with understanding to directions, stories, and conversations.

STRAND 2: PRE-READING PROCESS

Concept 6: Comprehending Stories

The child shows an interest in books and comprehends stories read aloud.



Arizona State Standards – SCIENCE

STRAND 6 – Earth and Space Sciences – Concept 3 – Earth in the Solar System

Grade 5

- PO 3. Describe various objects in the sky (e.g., asteroids, comets, stars, meteors/shooting stars).
- PO 6. Describe efforts to explore space (e.g., Apollo missions, space shuttles, Hubble space telescope, space probes).

Grade 7

- PO 5. Identify the following major constellations visible (seasonally) from the Northern Hemisphere: • Orion • Ursa Major (Great Bear) • Cygnus • Scorpius • Cassiopeia.

New Mexico State Standards - SCIENCE

Strand II – Content of Science

Standard III – Earth and Space Science

- K-4 Benchmark I – Know the structure of the solar system and the objects in the universe.

Grade 3

- # 4 Observe that different constellations can be seen in different seasons.

- 9-12 Benchmark I - Examine the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.

Grades 9-12

- #3 Understand how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models).

Cycles in the Cards

Arizona State Standards – SCIENCE

STRAND 4 – Life Science – Concept 2 – Life Cycles

Grade 1

- PO 1. Identify stages of human life (e.g., infancy, adolescence, adulthood).

STRAND 6 – Earth and Space Sciences – Concept 3 – Earth in the Solar System

Grade 5

- PO 3. Describe various objects in the sky (e.g., asteroids, comets, stars, meteors/shooting stars).
- PO 6. Describe efforts to explore space (e.g., Apollo missions, space shuttles, Hubble space telescope, space probes).

High School

- PO 1. Describe the scientific theory of the origin of the solar system (solar nebular hypothesis).

STRAND 6 – Earth and Space Sciences – Concept 4 – Origin and Evolution of the Universe

High School

- PO 2. Describe the fusion process that takes place in stars.
- PO 4. Compare the evolution (life cycles) of stars of different masses (low and high mass).

New Mexico State Standards - SCIENCE

Strand II – Content of Science

Standard III – Earth and Space Science

5-8 Benchmark I – Describe how the concepts of energy, matter, and force can be used to explain the observed behavior of the solar system, the universe, and their structures.

Grade 6 – Universe

#1 Describe the objects in the universe, including different sizes, temperatures, and colors of stars in the Milky Way galaxy.

Grade 6 – Solar System

#3 Identify the components of the solar system, and describe their defining characteristics and motions in space, including sun as a medium sized star; sun's composition (i.e., hydrogen, helium) and energy production.

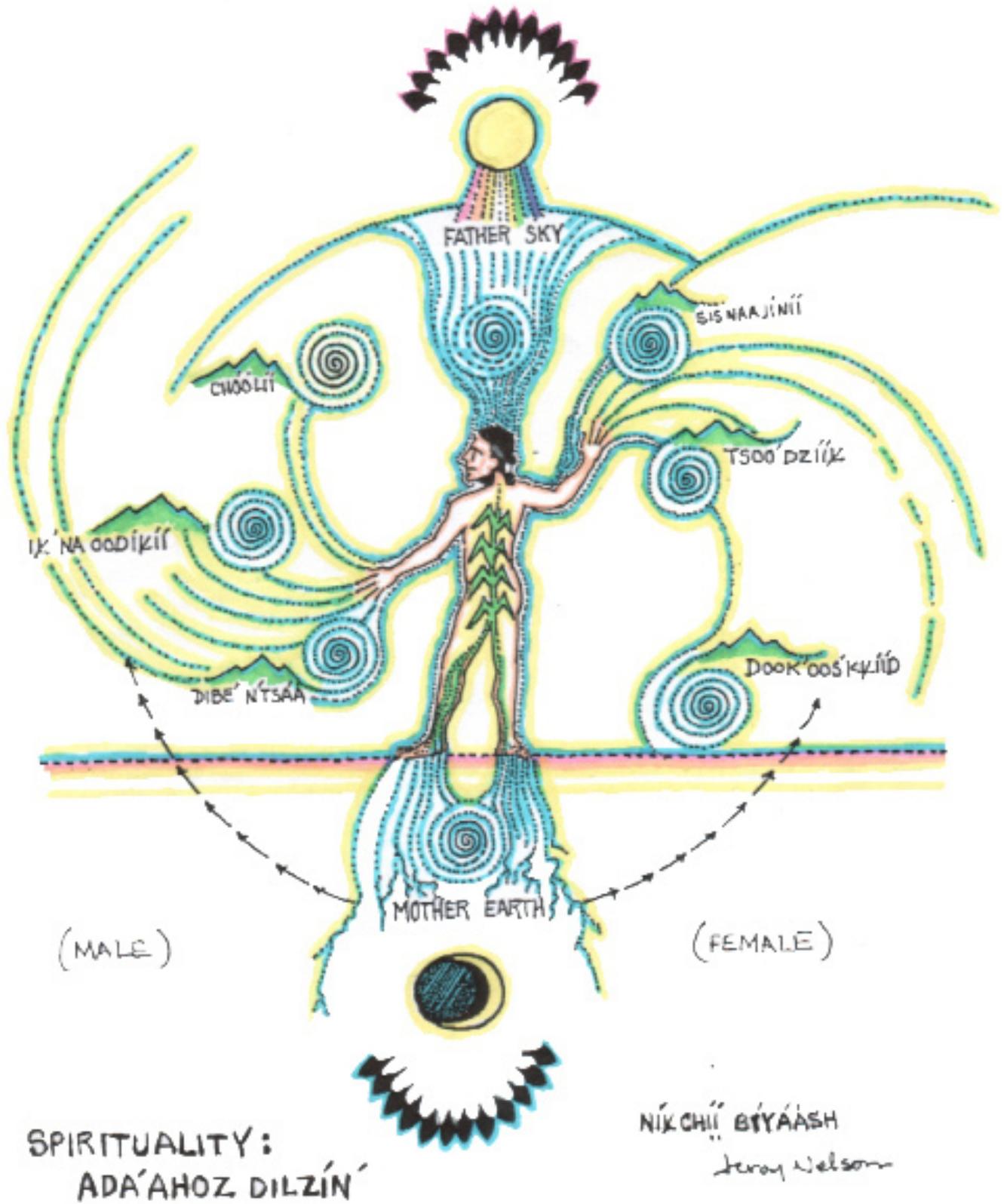
9-12 Benchmark I - Examine the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.

Grades 9-12

#3 Understand how knowledge about the universe comes from evidence collected from advanced technology (e.g., telescopes, satellites, images, computer models).

6 Describe how stars are powered by nuclear fusion, how luminosity and temperature indicate their age, and how stellar processes create heavier and stable elements that are found throughout the universe.

Exploring Stories Through Art



Overview

Objective – Through the process of making art, explore scientific concepts of stellar evolution, the Sun as a star, and the presence of organic material throughout space, and Navajo stories and concepts of the creation of star patterns and the relationship between humans and stars.

Age Range – This activity is designed for younger, elementary school aged children.

Materials Needed – 3 coloring sheets (provided as black line masters); crayons, markers, and/or colored pencils; a copy machine to reproduce the masters; NASA imagery (provided), background information for the facilitator (provided).

Set Up – Use one or two tables surrounded by chairs. Make the appropriate number of copies of each coloring sheet. Spread the coloring sheets and crayons around the table to provide easy access to them. Display the NASA imagery prominently on the table, a wall, or other visible space.

Estimated Time – 30 – 45 minutes; approximately one class period if used in a classroom.

Facilitator or Teacher Pre-Work – Before conducting the activity, read the science background information and Navajo stories pertaining to the coloring sheets. Have that material on hand while conducting the activity if desired.

How To

Guidelines for Facilitating the Activity

Assemble a group, ask them to choose a coloring sheet, and hand out crayons. Let them begin working. Start asking questions about what they're coloring. Use the background information and your creativity to ask appropriate questions and story-tell to make sense of what they're coloring (see below). If possible, read aloud the Navajo story *Sq' Diyin Dine'é*, and *The Diné Astronomy* (provided). Refer to the NASA imagery for artistic inspiration. Encourage the use of bright colors for the stars in Cassiopeia (which represent gemstones in the Navajo story), and in the CassA Supernova Remnant. Encourage the use of more than one coloring sheet. If you're working in a Community Event, encourage parents and other family members to interact. The facilitator for this activity should be fluent in communicating with younger children. The children should take home their creations.



Community Night Event – Field Test in Cameron, AZ

In Coloring Sheet #1, “The Building Blocks of Life Are Not Just Here on Earth,” show the provided image of the galaxy M81. Explain that this galaxy is very far away from Earth, and can only be seen with a telescope. Point out that the pink color represents the presence of the building blocks of life. Explain that the image on the coloring sheet which looks like a piece of chicken wire fence is what makes up that pink color, and is found in many living things on Earth, like humans. Ask the students if they think life is possible elsewhere in the universe.

In Coloring Sheet #2, “Náhookqs Ba’áadii * Cassiopeia Shows a Supernova,” refer to the provided image of the CassA Supernova Remnant. Explain that this is an image of a star exploding at the end of its life, and that new stars can form from all the material it blasts out into space. Point out that with a telescope, CassA can be seen right next to the Navajo star pattern Náhookqs Ba’áadii, or Female Revolver, also known as the constellation Cassiopeia.

In Coloring Sheet #3, “Our Sun – Our Star – Our Life,” refer to provided image of the Sun, and the excerpt from The Diné Astronomy story. Explain that, according to that story, humans were made in the likeness of stars with five “points.” And, according to scientists, the “stuff” we are made of actually does come from stars that lived long ago.

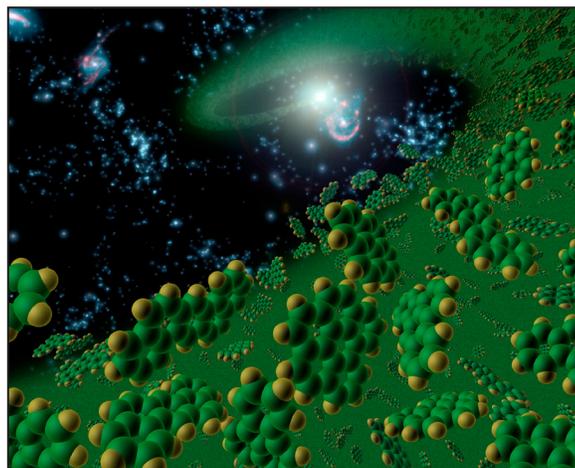
Background

Coloring Sheet #1: “The Building Blocks of Life Are Not Just Here on Earth”

This coloring sheet combines actual images (the galaxy), and graphic elements (the molecule and the Hogan). Nothing is shown to scale. The scientific concept themes for this coloring sheet are: Telescopes can see very far into space and detect very specific materials that exist in space. The same “stuff” that we are made of is found elsewhere in the universe in abundance. Are we alone? Could there be life elsewhere? Would it be like us?

SCIENTIFIC BACKGROUND

Spitzer, M81, and PAH’s: The image of the galaxy (called M81; 12 million light years away from Earth and visible within the constellation Ursa Major through binoculars or a small telescope) was taken by the NASA Spitzer Space Telescope in 2003. Spitzer does not “see” like human eyes which rely on visible light. Rather, Spitzer “feels the heat” of objects, and creates an image of them. The original image, provided here as part of this activity, shows a pink color (false color) in the spiral arms of the galaxy. This color represents very interesting material – extremely tiny bits of rocky material such as silicates (similar to beach sand), and organic (meaning carbon-containing) molecules. The organic molecules that Spitzer found are most interesting because they are similar to molecules central to life here on Earth, such as chlorophyll, which is made by plants and enables their growth. The molecules Spitzer found, represented by the chicken-wire shaped graphic in the coloring sheet, are called Polycyclic Aromatic Hydrocarbons, or PAH’s for short. PAH’s are flat molecules, shaped like chicken-wire, and can have many different shapes. The one shown contains nitrogen, which makes it even more Earth-life-like. Many of the molecules of life that are part of our bodies are related to PAH’s found in space. Even chocolate and caffeine are simple PAH’s!



PAH's From A Distant Galaxy (artist's rendition) NASA/JPL-Caltech/T. Pyle (SSC)

The Spitzer Space Telescope has directly observed the tell-tale signature of PAH's throughout space, in fact, these molecules seem to be just about everywhere. They are common in our own Milky Way galaxy and in distant galaxies such as M81. PAH's are chemically very stable and don't break apart in the high radiation environment in space. PAH's may become part of newly forming planets around other stars where they could be incorporated into other living things. The discovery of PAH's in other galaxies in such abundance makes scientists wonder about the possibility of life elsewhere.

Coloring Sheet #2: "Náhookqs Ba'áadii - Cassiopeia Shows a Supernova"

This coloring sheet combines graphic elements (the Hogan, the Stars of Náhookqs Ba'áadii, and the CassA Supernova Remnant). Nothing is shown to scale. The scientific concept themes for this coloring sheet are: Telescopes can see further and deeper into space than our eyes can see, beyond the stars of the night sky. The elements necessary for life and found in all life forms on Earth were made long ago in stars, and were recycled into space to be incorporated by the next generation of stars, planets, and possibly life.

SCIENTIFIC BACKGROUND

Chandra and CassA: In 1999, the NASA Chandra X-Ray Observatory, a telescope orbiting Earth and "pointing" away from the Earth, was able to take a picture of a supernova remnant in the constellation Cassiopeia (which is also the Navajo star pattern Náhookqs Ba'áadii). Just like Spitzer, Chandra does not "see" as human eyes do. Chandra measures X-rays, which are similar to rays of visible light, but of a much higher frequency. The provided image of CassA shows the X-rays the star let out at the end of its life.

Stellar Evolution: Throughout the universe, stars form, mature (often with planetary systems), and then die. In so doing, the star recycles the materials created within it back into space. When very large stars come to the end of their life, they do not go quietly! Such a dying star blasts off its outer layer in an energetic explosion, casting material out into the surrounding space. The star that produced the CassA Supernova Remnant came to such a fate 300 years ago.

This part of the life cycle of some stars, the supernova, is linked to the possibility of life elsewhere in the universe and the recycling of materials throughout the cosmos. Some of the elements that are cast out into space during a supernova event – oxygen, carbon, and nitrogen to name a few – are elements that are necessary for life as we know it. The only place these elements are made is within the superheated core of a star. If this process were not in place, our Solar System would not be the way it is! Current scientific theory states that our Solar System incorporated the material cast off by a nearby supernova event, and our planet and the life on it was made from that material. We, indeed, are made of star stuff. What will become of the material cast out from the CassA Supernova? Could new stars and solar systems form in its wake?



An Excerpt From:
Sq' Diyin Dine'é

Told by Irvin K. James, 2001
Transcribed by Sylvia Jackson

The Holy Ones discussed the growing process, as they observed and understood it. If all living things return to the Earth and are replaced with new life, then there is a growing process in place. The Holy Ones met, discussed, planned, and laid out the constellations by which the People will understand the passage of time, growing, and aging.

One day was set aside for everyone to participate. Haashch'éélti'í placed a flawless buckskin on the ground. Other Holy Ones brought precious gems of all colors, sizes, and shapes to produce specific patterns and designs to depict their character and ability. First man constructed a pattern he called Náhookqs Biká'íí, the Big Dipper. He chose seven colorful stones in the pattern. First Woman constructed a pattern she called Náhookqs Ba'áadii, Cassiopeia, and had five stones in the pattern. They placed the patterns in the northern sky around the North Star, with their own fire hearth between them. The pair will revolve around their fire hearth, Náhookqs Bikq', the North Star. Everyone was satisfied with the arrangements.

The constellation patterns placed in the sky were discussed and designed for specific purposes such as the Náhookqs Biká'íí and the Náhookqs Ba'áadii and the fire hearth, Náhookqs Bikq'. The pattern exhibits changes of the season. In the early spring, Náhookqs Ba'áadii will be visible in the northeastern sky. Náhookqs Biká'íí will be visible in the same location in the early fall evening. Náhookqs Bikq', the North Star, remains in one location all the time. All constellations revolve around the North Star.

The traditional understanding is that the constellation patterns depict proper roles and responsibilities of families. Náhookqs Biká'íí reigns over the fall and winter seasonal activities for the People. Yé'ii Bicheii and Ilnáshjinjí hataál are winter healing ceremonies. Ndáá' and Hózhóqjí ceremonies are the spring and summer healing ceremonies under the reign of Náhookqs Ba'áadii. Being aware of the purposes of the constellations helps in understanding the traditional practices of Diné Way of Life.



Coloring Sheet #3 “Our Sun – Our Star – Our Life”

This coloring sheet combines actual images (the Sun), and graphic elements (the Hogan and the stars). Nothing is shown to scale. There are two themes for this coloring sheet: Our Sun as a star, and the five-points of a human (torso, two arms, two legs) mimicking the five-points of a star.

SCIENTIFIC BACKGROUND

The Sun: Our Sun is a star in its main sequence phase. It is the largest object in our Solar System and contains approximately 98% of the total solar system mass. One hundred and nine Earths would be required to fit across the Sun’s disk, and its interior could hold over 1.3 million Earths.

The Sun formed just as other stars do. The concept of star formation begins with diffuse material in clouds of **gases** such as carbon monoxide and hydrogen gas, **dust** meaning small rocky particles such as silicates like beach sand, minerals such as olivine, organic particles like charcoal dust, and **ices** such as water ice. The particulate matter and gases have a random motion. A pressure blast, or “wind” such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density at certain points which will eventually become discreet stars. A small, growing star is surrounded by a circumstellar disk of spinning dust and gas, like a music CD or Frisbee, with the young star in the center. Through a process called accretion, the material will condense further. The more mass it gains and the larger it gets, the more material will be attracted to it. In this way, it gains even more mass and gets even larger. Please refer to the film for a visual explanation of this. Eventually, the density of material reaches such a high level that the nuclei of the atoms in the gas and dust are under such pressure that they fuse, and begin to form new elements. Huge amounts of energy are given off in the process which we observe as heat and light. We on Earth are intricately linked to the Sun whose light and heat are responsible for maintaining life.

The Sun is an average star, in that there are other stars which are much hotter or much cooler, and intrinsically much brighter or fainter. However, since it is by far the closest star to the Earth, it looks bigger and brighter in our sky than any other star. The Sun is mostly made up of hydrogen (about 75% of the mass). Helium can also be found in the Sun (about 25% of the mass). The remainder is made up of heavier elements, mainly carbon, nitrogen, oxygen, neon, magnesium, silicon and iron. The Sun is neither a solid nor a gas but is actually plasma. This plasma is tenuous and gaseous near the surface, but gets denser down towards the Sun’s core.

The Sun is not just a big bright ball. It has a complicated and changing magnetic field, which forms things like sunspots and active regions. The magnetic field sometimes changes explosively, spitting out clouds of plasma and energetic particles into space and sometimes even towards Earth.

Scientists think that stars like the Sun shine for nine to ten billion years. The Sun is about 4.5 billion years old, judging by the age of moon rocks and meteorites. Based on this information, current astrophysical theory predicts that, in five billion years, the Sun will puff up into a red giant and “swallow” much of the Solar System.



NAVAJO STORY

5-Pointed Stars: The 5-pointed stars in the image represent the Navajo story which describes how humans were made in the likeness of stars. Both humans and stars have “5-points.”

An Excerpt From:

The Diné Astronomy

From the Chinlé Unified School District
Dedicated to Dr. Dean C. Jackson

After the creation of the Earth, sky, and the atmosphere, the Holy people realized that the whole universe was entirely dark. There was no form of light to illuminate the universe. So the Holy people reconvened to discuss how to remedy this situation. Since there was no source of light, there was no order and direction, and no measurement of time. Once they had a means of measuring time and having light to see with, they would set about organizing the rest of the world.

They gathered all different types of materials that they thought would be good as a light source. While they were debating on an adequate instrument that could give out light, a certain young man came forward and pulled out a turquoise spherical object from his cloak. “This will be the instrument that will be the container of light. The ‘First Fire,’ Áłtsé Kq’, will be the source to energize it with light and heat. We will put this fire in the turquoise sphere,” he announced. “But you must place all your prized possessions of gems and other valuable items on the buckskin.”

The people did not know who this young man was or why he wanted their precious possessions, but they did as he instructed. They brought forth turquoise, Doot’izhii, whiteshell, Yoołgai, abalone, Diichilí, black jet stones, Bááshzhinii, obsidian, Noolyínii, coral, Tséchéí, and many other precious gems. They also brought forth other beautiful and prized material possessions. They piled these on the buckskin as they were instructed. They were all curious and awed by his assumption of authority in the matter. This young man seemed to know what he was doing.

At length, the quiet young man came forth again. He said, “These precious gems and other belongings that you have brought forth will be placed within the turquoise sphere and it will be known as ‘One That Travels During the Daytime’ or Sun, Jíhonaa’éeí. It will send its rays to the Earth and these rays will embody all these valuables that you have given, the Sun will give wealth and goodness to the Earth and all its inhabitants.” The people placed features on the face of the sphere. They also placed arms, legs and torso on it. The young man was instructed to place emotions in the sphere so that it would feel compassion, anger, sadness, and happiness. The Sun must be like Earth people so he could understand their needs and be forgiving when they neglected to do their duties. The



young man took a portion of First Fire, *Áítsé Kq'*, and ignited the sphere with it. Immediately the sphere burst into flames. The heat and light from it were so hot and bright that many shrank from it and shielded themselves. The ground beneath and around the Sun burned from the great heat it radiated. It was clear to the People that the Sun could not remain on or near Earth as they had originally planned. Another alternative had to be found before the whole Earth was burned to a crisp.

Suggestions were given quickly due to the urgency. Some said the Sun should be hung from the sky, others thought that placing it on a high mountain would solve the problem. Still others suggested that the wind could blow it in the sky and retain it there. The most practical ideas were tried. There was great confusion and panic as they tried to solve the problem as quickly as possible. As others ran about in a state of frenzy, the young man came forward again. Very calmly he said, "Perhaps someone should carry the Sun above the Earth. In this way the whole sky could be filled with light and warmth rather than having small portions being filled at a time." The young man instructed that someone with great power should have to enter the Sun and ascend above the Earth and remain in the sky. Once more there was a scramble as volunteers came forward. Each of the volunteers tried using all his powers and strength to carry the Sun, but none was successful. Even Coyote entered the sphere as the others had done. Summoning every ounce of strength in his body, straining every muscle, he heaved and heaved pulling tendons and ligaments, but even he could not lift the Sun. After several heroic tries, even Coyote had to admit that he could not lift the burning Sun. Exhausted, he went to the sidelines and waited with the others.

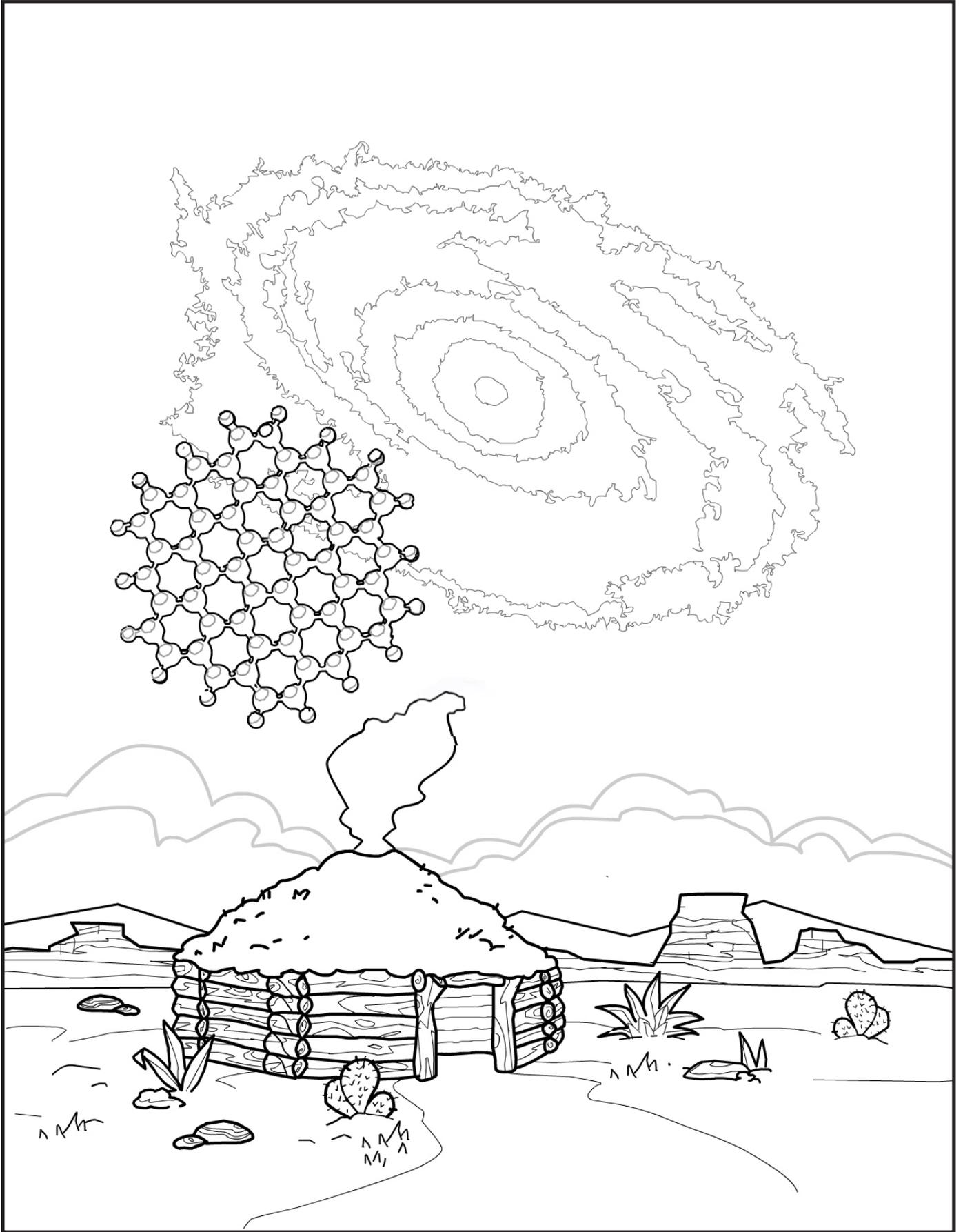
The young man came forth again and announced that he would carry the Sun. But he decreed that for every day he carried the Sun, a life on Earth would be taken. "This will be my payment," he said. The people gathered and had to agree for there was no other way. The young man entered the Sun and ascended into the sky. He did not have to struggle as the others had because he was the only one that possessed the power and knowledge to exert influence and great force to make it function properly.

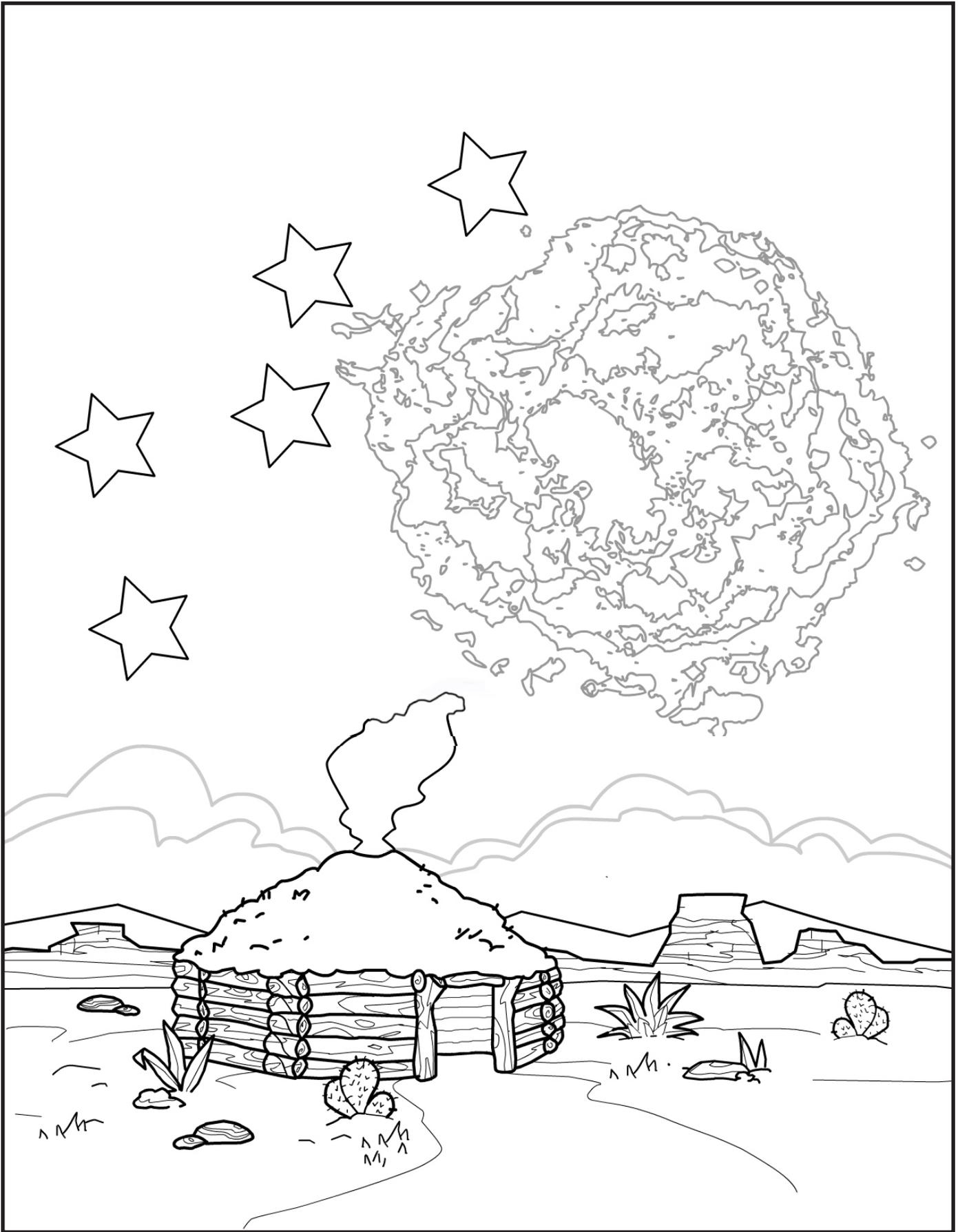
It was also declared by the people that the Sun would rise from the east and set in the west. This set the four cardinal directions for the people. He must travel in a circle in a counter clock direction, *Shábik'ehgo*. This would induce and require complete cycles for all life on Earth. Another order to everything was made.

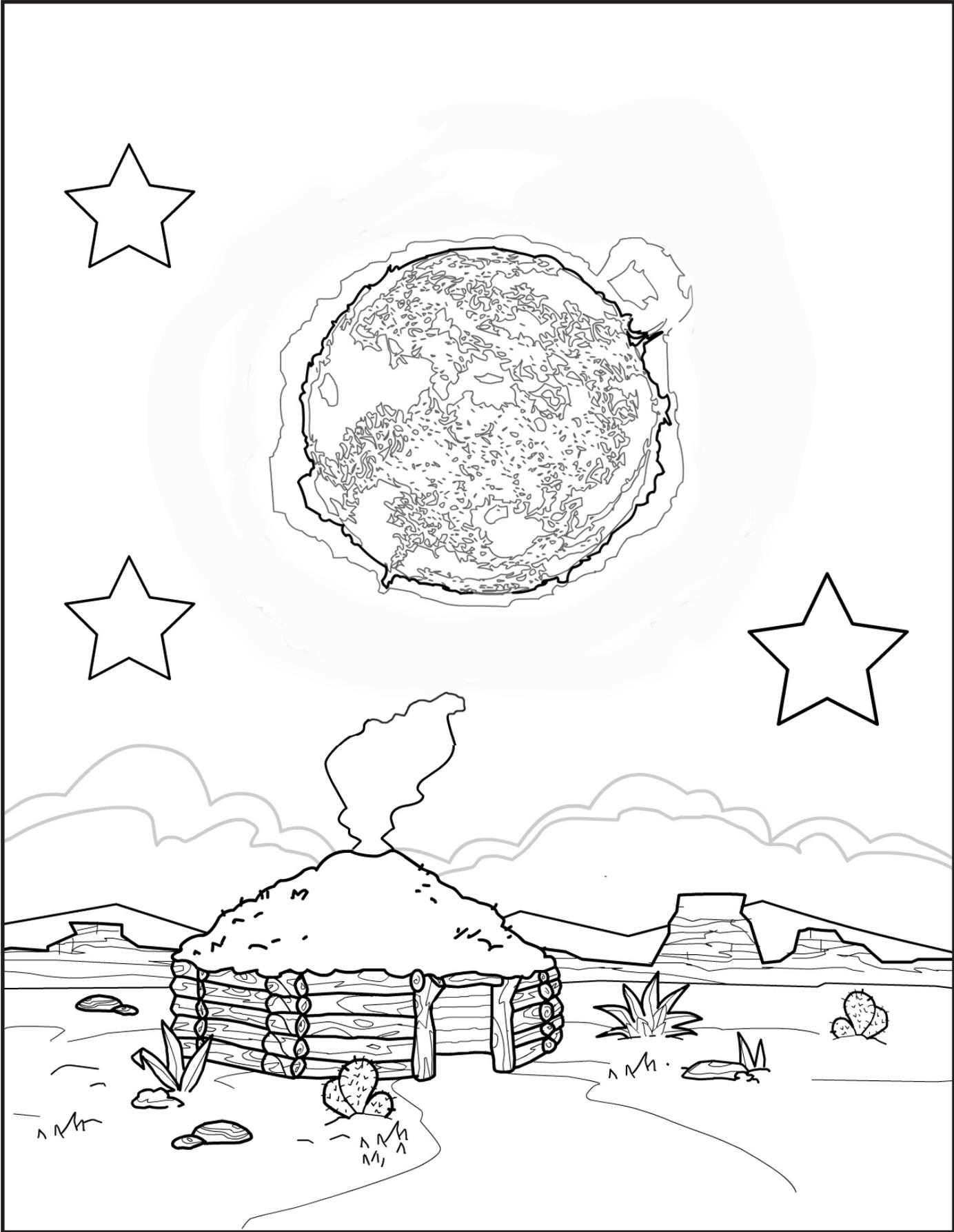
Graphics

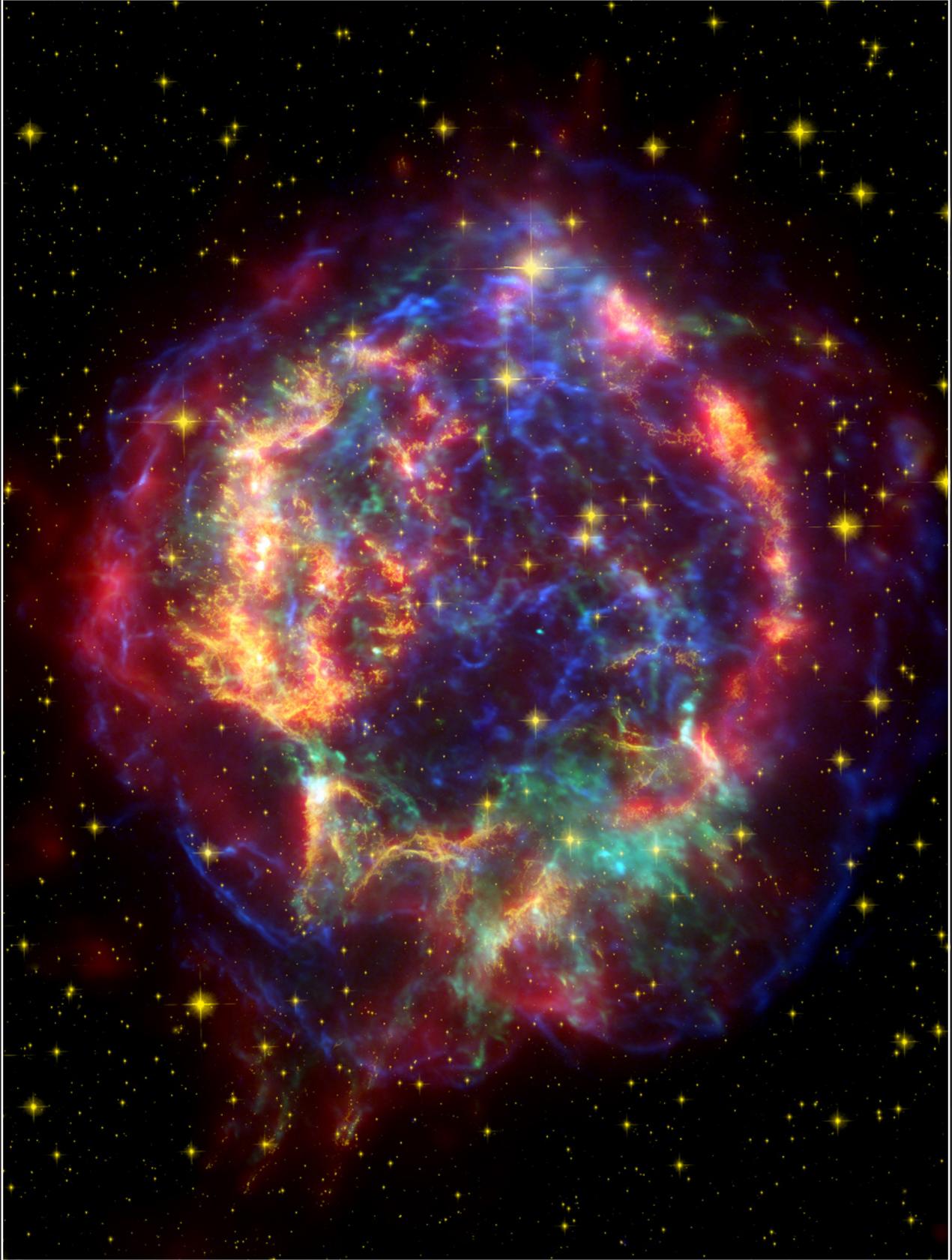
The following several pages contain the provided graphics for this activity: black line masters of the three coloring sheets for photocopying, plus reference images of CassA, M81, and the Sun that can be cut out of the booklet and displayed while conducting the activity.











Cassiopeia A Supernova Remnant

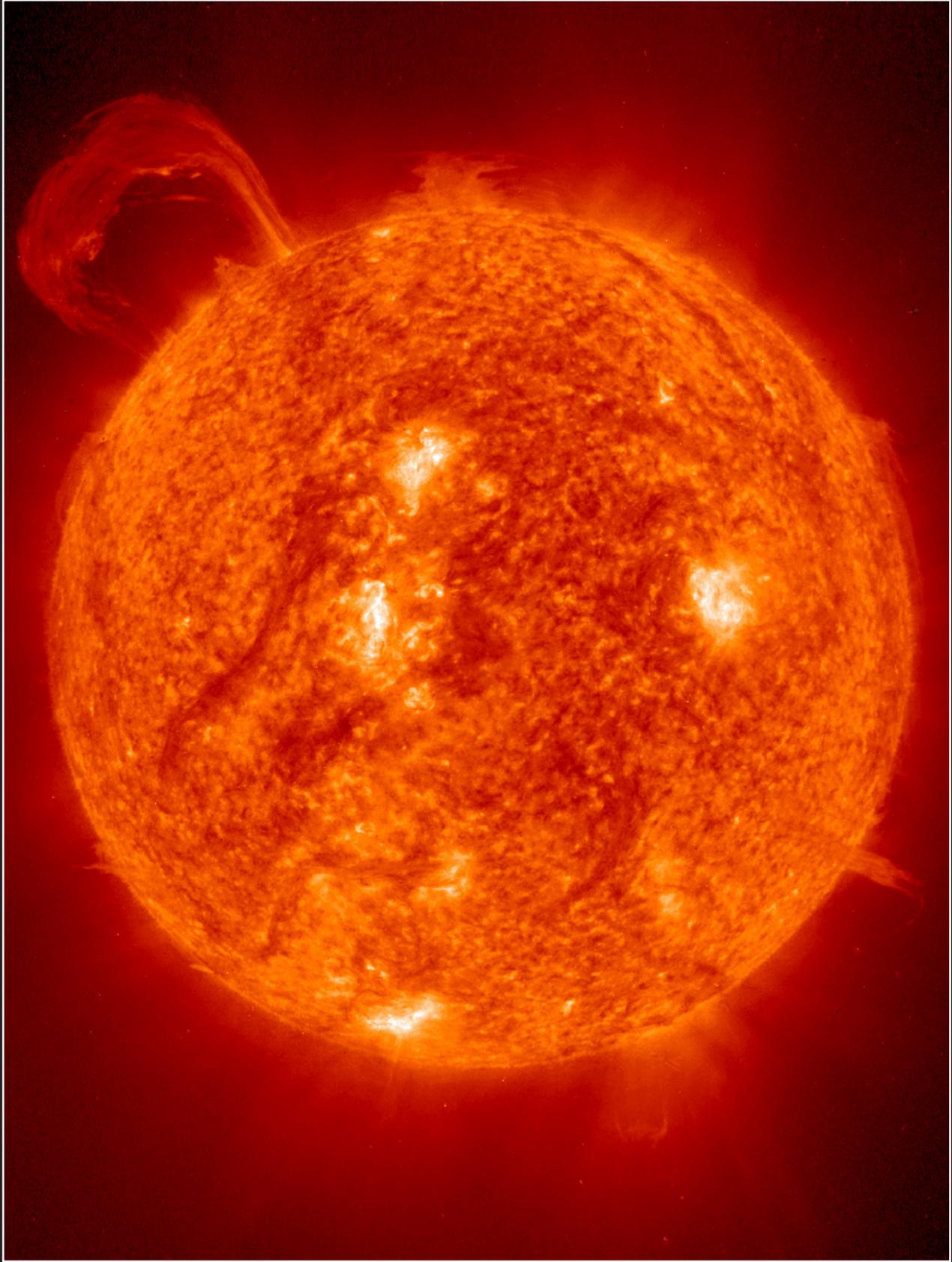
Spitzer Space Telescope • MIPS / HubbleSpace Telescope • ACS / Chandra X-Ray Observatory
NASA/JPL-Caltech / D. Krause (Steward Observatory)



Spiral Galaxy M81

Spitzer Space Telescope • IRAC

NASA / JPL-Caltech / S. Willner (Harvard-Smithsonian CfA)



The Sun

NASA Solar and Heliospheric Observatory

Gemstone Constellations



Jeroy Nelson

Overview

Objective – Explore the Navajo story of First Man and First Woman creating the Navajo star patterns Náhookqs Biką’íí, Náhookqs Ba’áadii, and Náhookqs Bikq’ (Big Dipper, Cassiopeia, and the North Star).

Age Range – This activity is designed for elementary and middle school aged children.

Materials Needed – Different colors of construction paper, or other brightly colored papers; small white poster boards, or a roll of white butcher paper; scissors; scotch tape; glue; crayons, markers, and/or colored pencils; star pattern guides (provided); background information (provided). An option is to work with other materials like fabric, paint, or star stickers to create and place the “gemstones” on the “buckskin.”

Set Up – Use one or two tables with chairs. You may wish to make copies of the star pattern guides and display them on the tables. Spread the colored paper and crayons around for easy access.

Estimated Time – 30 – 45 minutes; approximately one class period if used in a classroom.

Facilitator or Teacher Pre-Work – Read the Navajo story Sq’ Diyin Dine’é, and have a copy of it on hand to read aloud. Pre-make all the gemstones needed to make a sample layout of the star patterns on the buckskin. Do not glue the gemstones onto the buckskin, so you can mimic placing them onto it as you read along in the story.

How To

Guidelines for Facilitating the Activity

Assemble a group and ask what they know about how the star patterns and constellations came to be in the sky. Ask what they know of Náhookqs Biką’íí, Náhookqs Ba’áadii, and Náhookqs Bikq’. Read the story aloud, and as you go along, lay out the poster board or piece of butcher paper as if it were the buckskin in the story. Using your pre-made gemstones, mimic the placement of them onto the buckskin at the appropriate point in the story. Then, present each person with a buckskin (poster board or piece of butcher paper) of their own.



Community Night Event – Field Test in Cameron, AZ

Demonstrate how to tear off or cut a piece of colored paper and make it into a “gemstone.” They will each make 7 gemstones of varying size, shape, and color for Náhookqs Biką’íí, 5 for Náhookqs Ba’áadii, and 1 or more for Náhookqs Bikq’ (see the provided guides). They will place them, with tape or glue, in the patterns according to the provided guides. Encourage the kids to make drawings around the gemstones on the poster board – images perhaps that represent concepts associated with each star pattern, or whatever else they desire. If working in a Community Event, encourage parents and other family members to interact. The facilitator for this activity should be fluent in communicating with young children. The children should take home their creations.

Background

NAVAJO STORY

An Excerpt From:
Sq' Diyin Dine'é

Told by Irvin K. James, 2001
Transcribed by Sylvia Jackson

The Holy Ones discussed the growing process, as they observed and understood it. If all living things return to the Earth and are replaced with new life, then there is a growing process in place. The Holy Ones met, discussed, planned, and laid out the constellations by which the People will understand the passage of time, growing, and aging.

One day was set aside for everyone to participate. Haashch'éélti'í placed a flawless buckskin on the ground. Other Holy Ones brought precious gems of all colors, sizes, and shapes to produce specific patterns and designs to depict their character and ability. First man constructed a pattern he called Náhookqs Bikq'ij, the Big Dipper. He chose seven colorful stones in the pattern. First Woman constructed a pattern she called Náhookqs Ba'áadii, Cassiopeia, and had five stones in the pattern. They placed the patterns in the northern sky around the North Star, with their own fire hearth between them. The pair will revolve around their fire hearth, Náhookqs Bikq', the North Star. Everyone was satisfied with the arrangements.

The constellation patterns placed in the sky were discussed and designed for specific purposes such as the Náhookqs Bikq'ij and the Náhookqs Ba'áadii and the fire hearth, Náhookqs Bikq'. The pattern exhibits changes of the season. In the early spring, Náhookqs Ba'áadii will be visible in the northeastern sky. Náhookqs Bikq'ij will be visible in the same location in the early fall evening. Náhookqs Bikq', the North Star, remains in one location all the time. All constellations revolve around the North Star.

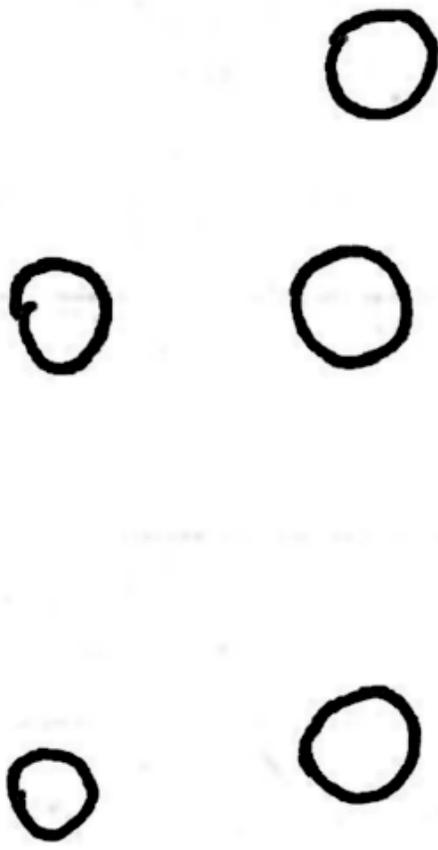
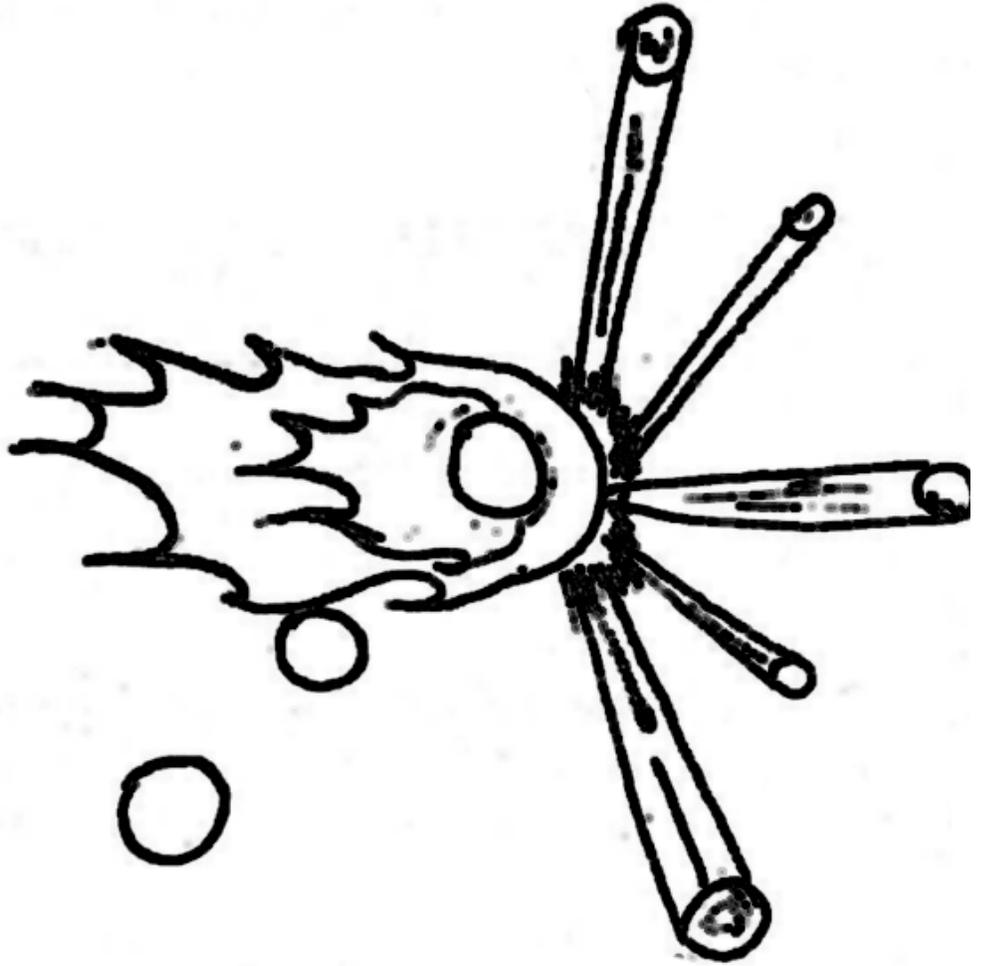
The traditional understanding is that the constellation patterns depict proper roles and responsibilities of families. Náhookqs Bikq'ij reigns over the fall and winter seasonal activities for the People. Yé'ii Bicheii and Ilnáshjinjí hataál are winter healing ceremonies. Ndáá' and Hózhóqjí ceremonies are the spring and summer healing ceremonies under the reign of Náhookqs Ba'áadii. Being aware of the purposes of the constellations helps in understanding the traditional practices of Diné Way of Life.



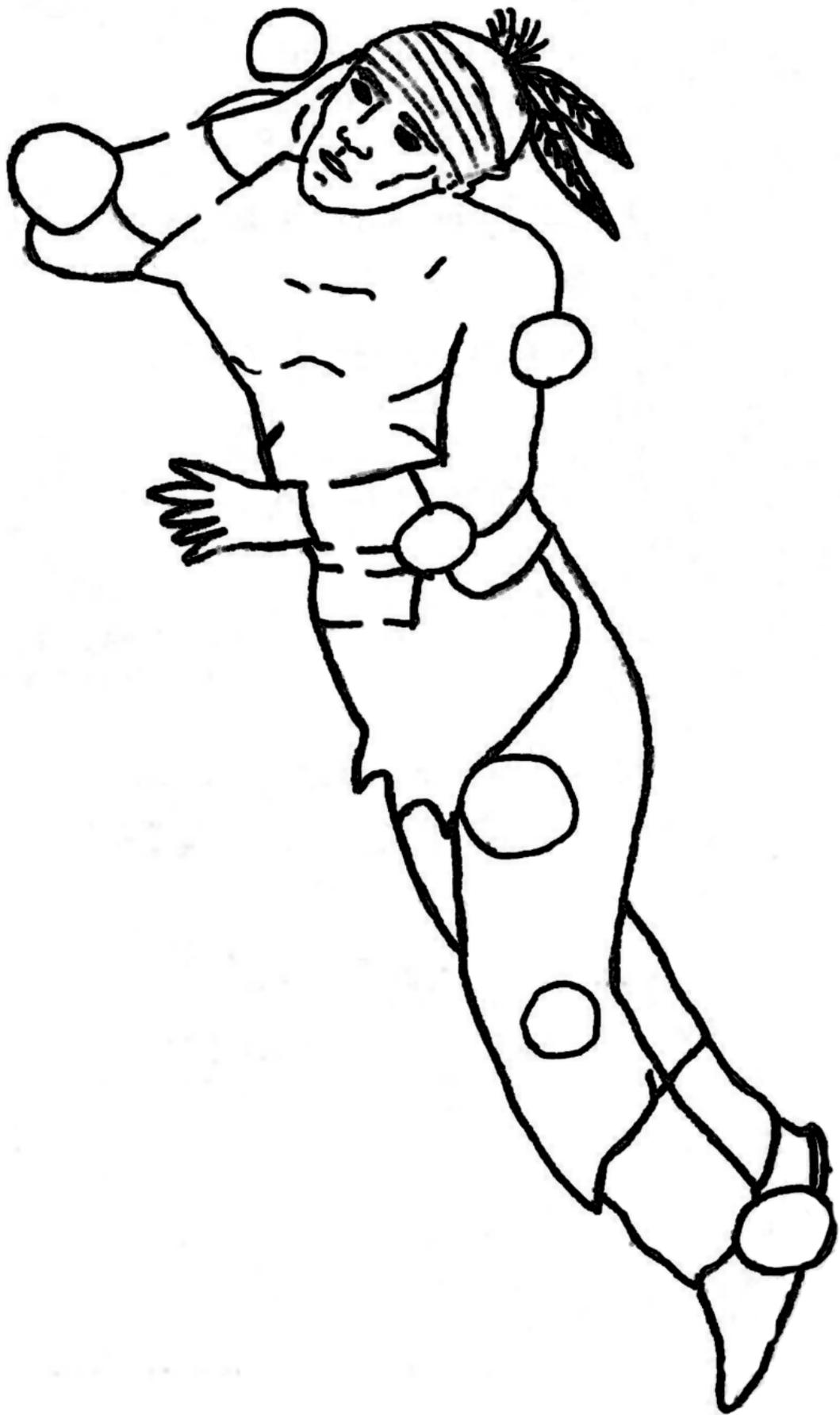
Graphics

The following several pages contain the provided graphics for this activity: the three star pattern guides as black line masters which can be photocopied and displayed while conducting the activity.









Stories in the Sky



Overview

Objective – Examine the idea that constellations and star patterns exist in the sky and represent certain ideas.

Age Range – This activity is designed for younger, elementary and middle school aged children.

Materials Needed – Worksheet (provided); copy machine to make copies; colored pencils, crayons, and/or markers; star stickers (optional); instructions on how to create your own planetarium (provided); pens or sharp pencils to poke star patterns into the walls of the homemade planetarium; flashlight for reading stories inside the planetarium; materials to create your own planetarium. Please see the DVD for a short video on how to assemble the planetarium:

- “4 mil” black plastic sheeting (thinner material lets too much light through) - size will vary depending on size of space and group (20ft x 50ft for a large group)
- 1 large roll of duct tape
- 1 large black plastic trash bag (to fit over fan)
- 1 window or floor level fan with extension cord

Set Up – Follow the instructions and make the planetarium, setting it up in a quiet space and near to an electrical outlet to plug in the fan. Mimicking a traditional Hogan, place the planetarium so the entrance faces East. Set up one or two tables with chairs nearby. Make the appropriate number of copies of the worksheet, with extras for kids to start over if necessary. Spread the worksheets and crayons around the tables so kids can have easy access to them.

Estimated Time – 30 – 45 minutes; approximately one full or two half class periods if used in a classroom.

Facilitator or Teacher Pre-Work - A few facilitators are necessary for this activity – some to work with the kids who are drawing, some to assist poking the star patterns/constellations into the planetarium walls, and some to manage the activity in the planetarium. Involve teachers, older students, parents! This activity does NOT have to include the planetarium; it can consist only of creating the star pattern and writing a short description of it.

How To

Guidelines for Facilitating the Activity – Assemble a group and ask what they know about constellations. Ask what a constellation is and if they can name some constellations (Constellations are specific groupings of stars designated and named by the International Astronomical Union, IAU; all other groups of stars the sky are known as star patterns.). Ask if they ever thought about creating their very own star pattern/constellation. Present them with a worksheet and crayons. It may be useful to limit them to six or seven stars. If using star stickers, have them work out their pattern first with a pencil, then give each person only the stickers they need.

By asking about their lives (where they live, who are the important people in their life, important activities or hobbies they have), provide some suggestions of possible patterns they can create such as a Hogan, a Pinon Pine tree, a mountain, a coyote or other local animal, or something or someone special in their lives. As they create their star pattern, assistance may need to be given as to where to place stars on the object they draw so the stars successfully form its outline. As they're drawing, help them articulate why the object they've chosen is meaningful.

On the lines provided on the worksheet, have (or help) each person write a short, descriptive story explaining the significance of their star pattern/constellation, and why they chose it. They can use the back of the sheet if necessary.

The facilitator then leads each person or group into to the planetarium where they will poke holes representing each new star pattern/constellation into the plastic walls with a ballpoint pen or sharp pencil. Reserve the overhead "dome" of the planetarium if the Story Time activity is also being conducted. Place the worksheet on the plastic wall of the planetarium. Poke a hole through each star-point on the paper. Each hole is one star in their constellation. Assistance may need to be given poking holes in the plastic.

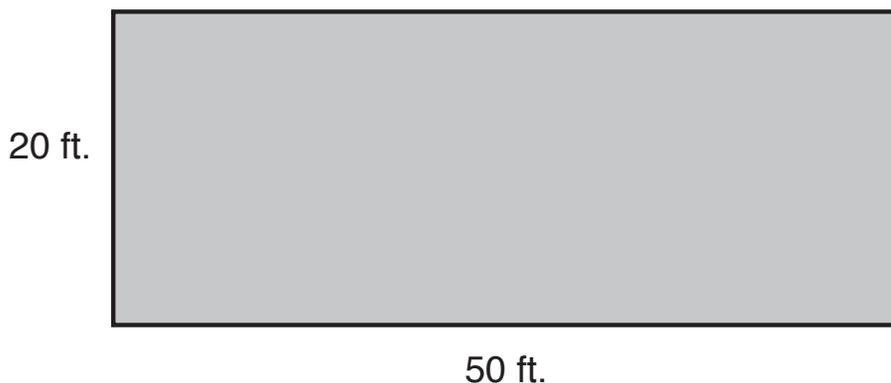
If working in a classroom, assemble the class or small groups inside the planetarium when all the star patterns/constellations are complete. One by one, have each person tell their story. Other students can try to guess what they are. If working in a Community Event, work in small groups to read the stories aloud. Worksheets can be collected for display, and then taken home.

Background

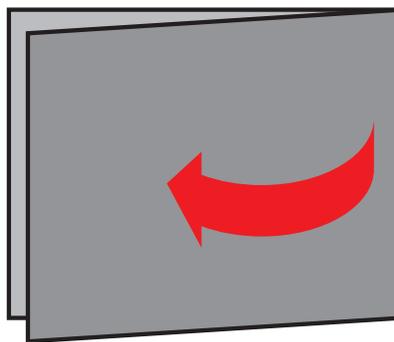
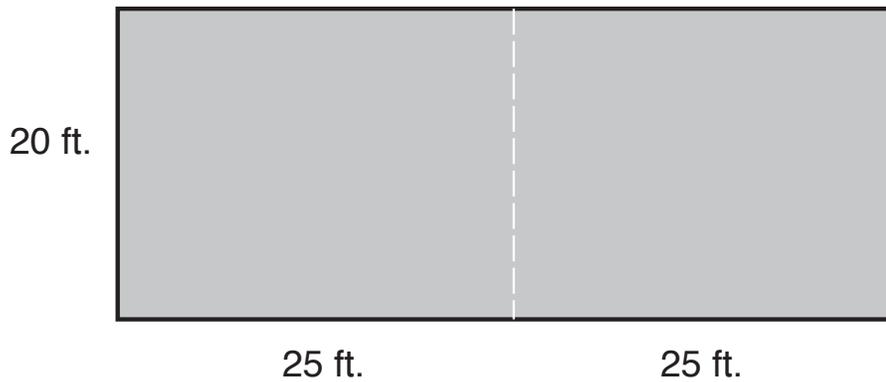
How to assemble and use the planetarium - please see the DVD for a short video on how to assemble the planetarium.

Construction of the Planetarium

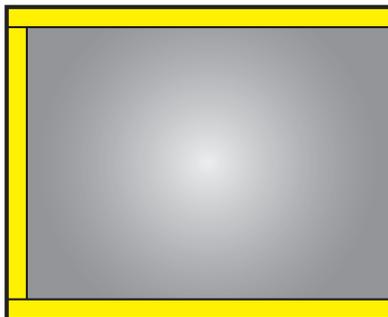
1. Open the roll of black plastic, unroll the plastic and unfold until the full size is lying on the ground. This will take a big space, perhaps a clean space outside. The ground needs to be smooth and level underneath.



2. Take the corners and fold the plastic in half the long way.



3. Tape the “open sides” with duct tape being sure to roll the two plastic sheets together a little so that there will be no “light gaps.”



Building the Dome Inflation System

4. Using scissors, opposite from the end that will have the entrance/exit, cut a hole that is the size of the open end of the trash bag.
5. Cut the bottom out of the trash bag, insert it in the hole in the planetarium and duct tape it to the plastic of the planetarium.
6. In the same way, insert the unplugged fan in the other end of the trash bag and duct tape them together so that the air from the fan blows through the trash bag tube into the planetarium.



7. Now plug in the fan and the planetarium will inflate.

Building the Entrance/Exit

8. Access to the planetarium may be accomplished by a simple slit made with scissors or the creation of more elaborate cardboard doors with duct tape hinges. An entrance and exit opening separated by a few feet is advised. In an emergency, open up a side with scissors for an exit.
9. Carpet on the bottom of the planetarium will prevent slipping on the plastic.

Job Descriptions When Running the Planetarium (3 persons total at all times)

One supervisor inside the planetarium to monitor behavior and the total number of people inside, help with hole punching, and use flashlight to guide walking and viewing. In case of electrical failure, this person will guide participants out of the planetarium. The dome will remain inflated for several minutes allowing for orderly exit through the normal doors but the plastic can easily be cut with scissors for emergency exiting. Large cuts will deflate the dome more rapidly.

One exterior manager to help people in and out of the planetarium from the outside.

One materials manager to supervise the fan, electricity and general condition of the planetarium (generally from the outside). The fan may require continuous management. Begin inflation with the fan on a high setting. After a bit, the dome will be over-inflated. Turn the fan setting down to medium to allow it to deflate so people can access the entrance. When the entrance is open and people are entering, the dome will deflate slightly. Turn the fan back onto a high setting to re-inflate. Turn the fan setting up or down to monitor the size of the dome while people are inside. The dome will deflate slightly as people begin to exit. Wait until the dome is re-inflated sufficiently to allow the next group inside.

Safety Notes

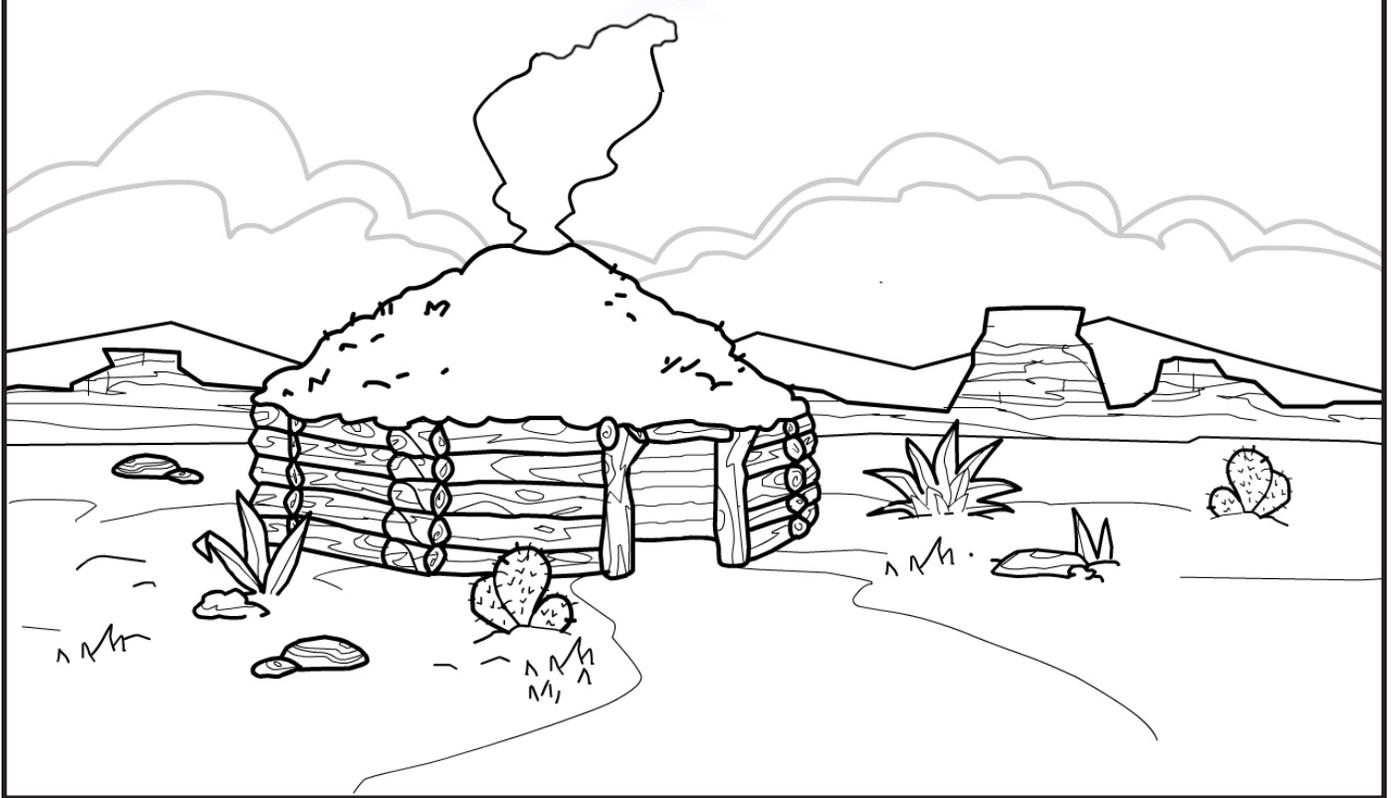
Although the interior volume is large and it does not get completely dark inside, facilitators should be aware of signs of claustrophobia or unease.

At no time should an open flame be allowed anywhere inside or near the outside of the planetarium.

Graphics

The following page contains the included graphic for this activity: a black line master of the worksheet to be photocopied for using during the activity.





Moving with the Stars



Overview

Objective – Promote kinesthetic, experiential learning. Through movement, weave together the concepts of star formation, “we are made of starstuff,” and the Diné Life Standards (courtesy of Diné College).

Age Range – This activity is designed for ALL ages.

Materials Needed – Masking or duct tape; a large floor space; background information for the facilitator (provided).

Set Up – Using the tape, make a very large, 5-pointed star on the floor. Write out the Diné Life Standards on a blackboard or large sheet of paper taped to a wall so the group can easily see (optional).

Estimated Time – 20 – 30 minutes; approximately one-half class period if used in a classroom.

Facilitator or Teacher Pre-Work – Before conducting the activity, the facilitator should read the scientific background information and Navajo story pertaining to this activity. This activity works best with a group of 10-15 people.

How To

Guidelines for Facilitating the Activity – Assemble a group, and begin by asking the group about their ideas pertaining to stars – What are they? How do they form? What is our relationship to them? Explain that they are going to take part in a movement activity which combines scientific and Navajo knowledge about stars and our relationship to them. Then, according to the background information: (1) explain and demonstrate the sequence of movements described below to the group, (2) do a rehearsal with the group where the facilitator demonstrates the movements and the group practices them, (3) perform the “real thing,” where everyone does the movements together.

The first sequence of movements mimics the scientific concept of star formation. All the action should center on the 5-pointed star shape taped on the floor. From the center of the taped star, the group should disperse and each person should be randomly wandering around the space, sometimes touching, mostly on their own, moving in all directions – but not too far away from one another – mimicking the random movement of particles in a nebula. The facilitator, or another person who is not moving around randomly, then moves through the group, arms out wide, mimicking the energy wave of a nearby supernova event.



Community Night Event – Field Test in Cameron, AZ

This person moves in one direction, quickly, through the group (for example – left to right), as a shockwave. The randomly moving people respond to this energy. In its wake, they begin to cluster, and spiral in toward each other. First two people find each other and stick together. Then more join them in a swirling pattern. Eventually all the people are together, very tightly packed into a round shape – mimicking a sphere; the shape of the Sun.

Their individual movements in this tightly packed group are fast – arms and legs and heads and torsos swaying randomly, everyone pressing together and moving throughout the sphere, but maintaining the shape of a sphere. This sphere of people should center on the taped star on the floor. On cue from the facilitator, everyone raises their arms above their head and begins wiggling their fingers – mimicking the “ignition” of the star. Their wiggling fingers are mimicking the burning fire of the star.

The second sequence of movements transitions from exploring scientific concepts to exploring Navajo concepts. The group, still wiggling their fingers with arms raised, moves to the edges of the taped star and lines up – one next to the other – along the edges of the pattern, facing inward. Each person then stretches out their arms and legs into a five-pointed star pattern (torso, left arm, right arm, left leg, right leg). Each person, moving in place and remaining standing on the taped star pattern on the floor, spins while still holding their arms and legs in the star pattern. This movement represents that humans are made in the likeness of a star and have 5 points just like the star.

The third sequence of movements outlines the 6 Diné Life Standards: Beauty Before Me, Beauty Behind Me, Beauty Below Me, Beauty Above Me, Beauty All Around Me, With Beauty I Speak. While still standing on the taped star pattern, each person speaks each phrase while doing the accompanying movement: Beauty Before Me – sweep one arm out across the body, going from the body out into the center of the taped star; Beauty Behind Me – sweep one arm behind the body while the torso turns around to look behind; Beauty Below Me, both arms sweep down toward the floor while bending at the waist; Beauty Above Me – both arms sweep up toward the ceiling while the head tilts up; Beauty All Around Me – spin with arms and legs stretched out in a 5 pointed star pattern as before; With Beauty I Speak – facing inward again, cup the hands around the mouth while speaking the phrase. Encourage speaking the final phrase with much enthusiasm, promoting each individual to find and express their own voice. The kids may want to shout. Repeat this section as often as desired. End with much clapping and fanfare! Practice this series a few times during the rehearsal so you can move through it seamlessly.

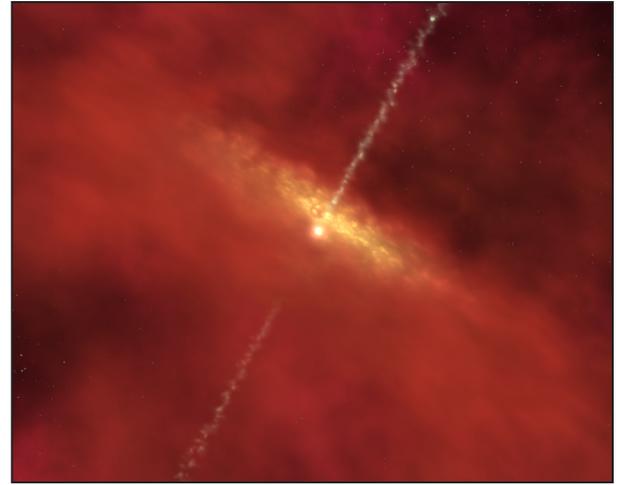
Background

The first sequence of movements corresponds to scientific theory of star formation.

SCIENTIFIC BACKGROUND

Star Formation: Stars form in regions of space called nebulae, where the raw material and conditions necessary for formation are present. The concept of star formation begins with diffuse material in clouds of **gases** such as carbon monoxide and hydrogen gas, **dust** meaning small rocky particles such as silicates like beach sand, minerals such as olivine, organic particles like charcoal dust, and **ices** such as water ice.

The particulate matter and gases have a random motion. A pressure blast, or “wind” such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density at certain points which will eventually become discreet stars. A small, growing star is surrounded by a circumstellar disk of spinning dust and gas, like a music CD or Frisbee, with the young star in the center. Through a process called accretion, the material will condense further. The more mass it gains and the larger it gets, the more material will be attracted to it. In this way, it gains even more mass and gets even larger. Please refer to the film for a visual explanation of this. Eventually, the density of material reaches such a high level that the nuclei of the atoms in the gas and dust are under such pressure that they fuse, and begin to form new elements. Huge amounts of energy are given off in the process which we observe as heat and light.



Jets of Outflowing Gas Burst from a Forming Star
NASA/IPAC/R. Hurt

The **second sequence of movements** corresponds to the Navajo story in which it is described that humans were formed in the likeness of the Sun – a star – with five points (torso, left arm, right arm, left leg, right leg). Both humans and stars have “5-points.”

NAVAJO STORY

An Excerpt From:
The Diné Astronomy

From the Chinlé Unified School District
Dedicated to Dr. Dean C. Jackson

After the creation of the Earth, sky, and the atmosphere, the Holy people realized that the whole universe was entirely dark. There was no form of light to illuminate the universe. So the Holy people reconvened to discuss how to remedy this situation. Since there was no source of light, there was no order and direction, and no measurement of time. Once they had a means of measuring time and having light to see with, they would set about organizing the rest of the world.

They gathered all different types of materials that they thought would be good as a light source. While they were debating on an adequate instrument that could give out light, a certain young man came forward and pulled out a turquoise spherical object from his cloak. “This will be the instrument that will be the container of light. The ‘First Fire’, Áłtsé Kq’, will be the source to energize it with light and heat. We will put this fire in the turquoise sphere,” he announced. “But you must place all your prized possessions of gems and other valuable items on the buckskin.”

The people did not know who this young man was or why he wanted their precious possessions, but they did as he

instructed. They brought forth turquoise, Doot'izhii, whiteshell, Yoołgai, abalone, Diichií, black jet stones, Bááshzhinii, obsidian, Noolyínii, coral, Tséłchí'í, and many other precious gems. They also brought forth other beautiful and prized material possessions. They piled these on the buckskin as they were instructed. They were all curious and awed by his assumption of authority in the matter. This young man seemed to know what he was doing.

At length, the quiet young man came forth again. He said, "These precious gems and other belongings that you have brought forth will be placed within the turquoise sphere and it will be known as 'One That Travels During the Daytime' or Sun, Jíhonaa'éí. It will send its rays to the Earth and these rays will embody all these valuables that you have given, the Sun will give wealth and goodness to the Earth and all its inhabitants." The people placed features on the face of the sphere. They also placed arms, legs and torso on it. The young man was instructed to place emotions in the sphere so that it would feel compassion, anger, sadness, and happiness.

The Sun must be like Earth people so he could understand their needs and be forgiving when they neglected to do their duties. The young man took a portion of First Fire, Áłtsé Kq', and ignited the sphere with it. Immediately the sphere burst into flames. The heat and light from it was so hot and bright that many shrank from it and shielded themselves. The ground beneath and around the Sun burned from the great heat it radiated. It was clear to the People that the Sun could not remain on or near Earth as they had originally planned. Another alternative had to be found before the whole Earth was burned to a crisp.

Suggestions were given quickly due to the urgency. Some said the Sun should be hung from the sky, others thought that placing it on a high mountain would solve the problem. Still others suggested that the wind could blow it in the sky and retain it there. The most practical ideas were tried. There was great confusion and panic as they tried to solve the problem as quickly as possible. As others ran about in a state of frenzy, the young man came forward again. Very calmly he said, "Perhaps someone should carry the Sun above the Earth. In this way the whole sky could be filled with light and warmth rather than having small portions being filled at a time." The young man instructed that someone with great power should have to enter the Sun and ascend above the Earth and remain in the sky. Once more there was a scramble as volunteers came forward. Each of the volunteers tried using all his powers and strength to carry the Sun, but none was successful. Even Coyote entered the sphere as the others had done. Summoning every ounce of strength in his body, straining every muscle, he heaved and heaved pulling tendons and ligaments, but even he could not lift the Sun. After several heroic tries, even Coyote had to admit that he could not lift the burning Sun. Exhausted, he went to the sidelines and waited with the others.

The young man came forth again and announced that he would carry the Sun. But he decreed that for every day he carried the Sun, a life on Earth would be taken. "This will be my payment," he said. The people gathered and had to agree for there was no other way. The young man entered the Sun and ascended into the sky. He did not have to struggle as the others had because he was the only one that possessed the power and knowledge to exert influence and great force to make it function properly. It was also declared by the people that the Sun would rise from the east and set in the west. This set the four cardinal directions for the people. He must travel in a circle in a counter clock direction, Shábik'ehgo. This would induce and require complete cycles for all life on Earth. Another order to everything was made.

The third sequence of movements corresponds to the six principles of the Diné Life Standards.

Diné Life Standards Courtesy of Diné College

The Diné Life Standards have six principles for life. These standards are prerequisite to Sà'ąh Naaghéí Bik'éh Hózhóón. One has to achieve a certain amount of each principle to be a balanced individual.

The standards are as follows:

Beauty Before Me – This requires planning; short, intermediate, and long term planning on how one can complete his or her education to be self sufficient. One must speak both the Diné and English languages to fully comprehend the teachings of Sà'ąh Naaghéí Bik'éh Hózhóón.

Beauty Behind Me – This principle will help one to achieve self-identity. Where do you come from?

Beauty Below Me – What is your relationship with Mother Earth in terms of Diné and Western knowledge?

Beauty Above Me – What is your relationship with Father Sky in terms of Diné and Western knowledge?

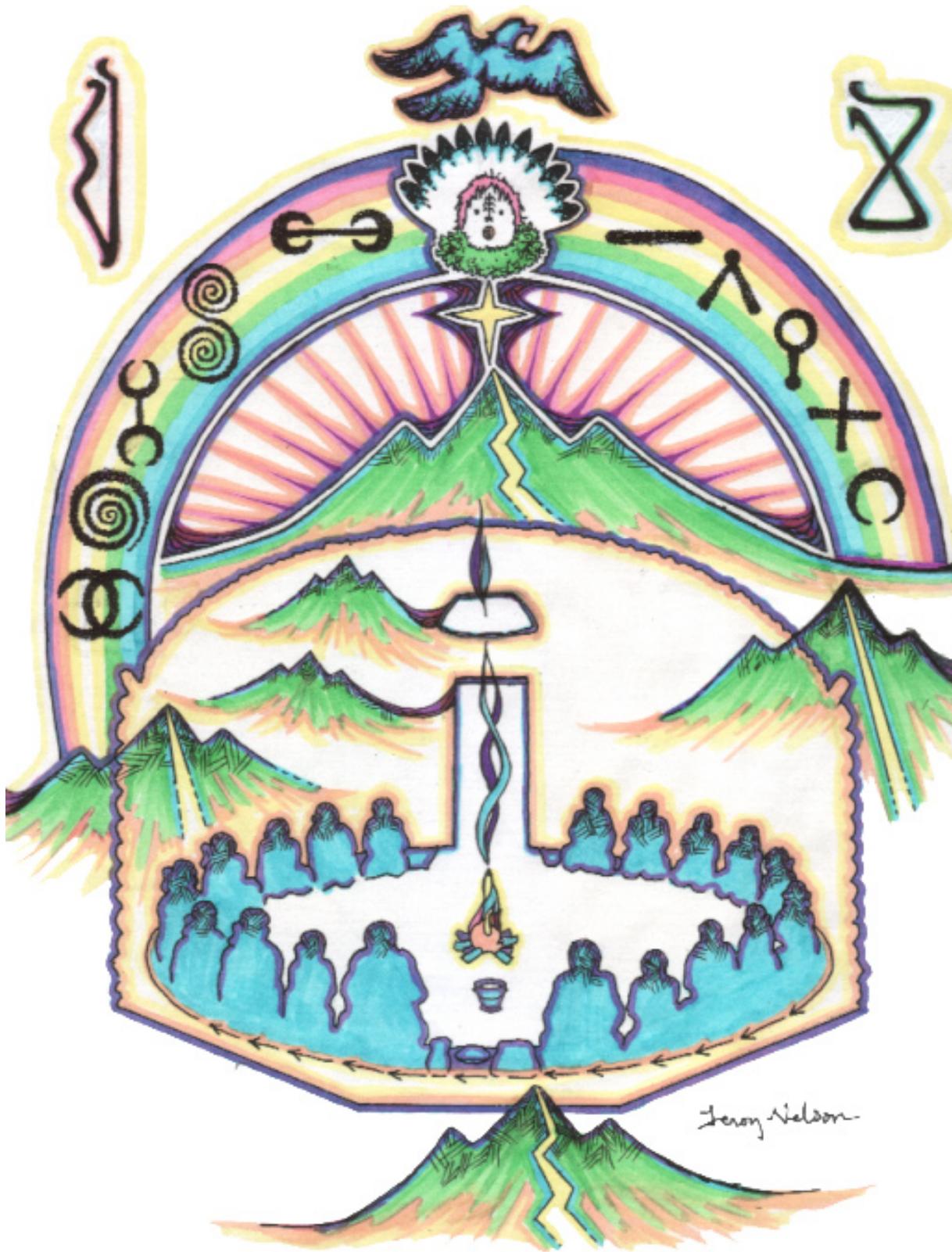
Beauty All Around Me – What is your relationship with your environment, including people and natural elements in terms of Diné and Western knowledge?

With Beauty I Speak – Do you have adequate Diné and Western knowledge internalized in you so as to use these knowledge sources effectively?

When one learns all the six principles together and utilizes it accordingly, this person is a balanced individual.



Story Time



Overview

Objective – Explain scientific concepts of stellar evolution and observational astronomy; convey lessons about the Navajo star patterns Náhookqs Biką’ij, Náhookqs Ba’áadii, and Náhookqs Bikq’ from the Navajo Story; weave the two together through story telling.

Age Range – This activity is designed for ALL ages.

Materials Needed – Background information (provided); images of CassA and M81 (provided); star chart (provided); flashlight; tape; homemade planetarium (see “Stories in the Sky” activity and DVD for instructions on how to assemble it).

Set Up – Follow the instructions and make the planetarium, setting it up in a quiet space and near to an electrical outlet to plug in the fan. Mimicking a traditional Hogan, place the planetarium so the entrance faces East. On the planetarium dome/ceiling, poke the Male and Female Revolver (Big Dipper and Cassiopeia) and Central Fire (North Star) star patterns into the plastic. Use the provided star chart to determine their relative positions. Space them out so they cover a large part of the dome. Tape the provided images of CassA and M81 onto the plastic, using the star chart to find their exact location relative to the star patterns, and taking care not to cover up any holes of the star patterns.

Optional Set Up - Create a central “fire” around which to gather inside the planetarium.

Materials:

- Battery-operated flashlight (extra batteries if necessary)
- 18” squares (approximate size) of colored clear cellophane (red, yellow and/or orange)
- #10 can (coffee, vegetable, fruit or other can)
- Small sticks or 5-10 sheets of brown construction paper

Start with a clean, large-sized vegetable or fruit can (#10 can), with the label removed. Stand or tape the flashlight upright on the bottom of the can, pointing upwards. Next, push the colored cellophane from the middle of the sheet to the bottom of the can around the flashlight (this should help stabilize it) so that the cellophane gives the appearance of flames coming out of the can. Use the small sticks to arrange around the can to give the appearance of a campfire. If you are using the brown construction paper instead of sticks, roll them up into small logs and fasten with tape. Turn on the flashlight right before you begin the activity.

Estimated Time – 30 – 45 minutes; approximately one class period if used in a classroom.

Facilitator or Teacher Pre-Work – Read through the background information. The facilitator for this activity should be chosen for his or her gift in storytelling. It is useful have two facilitators for the activity – one with expertise in the science concepts and the other with expertise in the Navajo story and lessons. The planetarium is suggested for this activity because it is a quiet, special space in which to interact with the “night sky” on the planetarium dome. If you are using the planetarium for the “Stories in the Sky” activity, coordinate with the facilitator of that activity to schedule accordingly, and keep the dome of the planetarium free for this activity.



How To

Guidelines for Facilitating the Activity – This activity is quite flexible. The storyteller’s job is to weave the scientific information and Navajo story together. The galaxy M81 and the CassA Supernova Remnant were chosen for this activity because of their “proximity” to the Navajo star patterns Male and Female Revolver. This means that from the perspective of Earth, these celestial phenomena appear to be near or within these star patterns, although they are invisible to the naked eye and require telescopes to see.

There are several links between the scientific concepts and the Navajo story and lessons. One connection centers on Náhookqs Bikq’ (The North Star) which represents the central fire of the Hogan, and can symbolize the scientific theory about the nature of a star and what occurs within the core of a star. The scientific background information below describes the concept that the elements required for life as we know it are made within the cores of stars. The suggested story telling outline below offers one way to weave these lines of thought together. As the stories weave, the storyteller can choose how much interaction with the audience he or she likes.

Suggested story-telling outline:

Begin by telling the story of Male and Female Revolver in as much detail as desired (incorporating how they were placed in the sky, how the Male and Female Revolvers influence planting and harvesting, certain ceremonies, and appropriate roles for families). Use the flashlight to indicate the counter-clockwise motion of the star patterns around the North Star. When the story describes the Central Fire (the North Star), indicating its properties and values, the storyteller can begin to ask the group questions about what goes on inside the star. A transition can be made at that point to describing the process of nuclear fusion within a star by which the elements necessary for life as we know it are made (see the scientific background below).

From there, the story can go on to describe how these elements, created in the core of a star, are recycled into space via supernova events (please note only high mass stars become supernovae – refer to the scientific background). Convey that supernovas have been observed by NASA telescopes. Ask everyone to pretend they’re looking through a telescope, and shine the flashlight on the image of CassA taped to the dome. Use the observation of CassA as a way to tell about the star cycle of star birth, maturity, death, and recycling of elements for the next generation of stars, planets, and possibly life.



Community Night Event – Field Test in Cameron, AZ

Go on from there to ask for people's thoughts about the possibility of life elsewhere in the Universe. Have them pretend again that they're looking through a telescope, and shine the light on the image of M81 taped to the dome. Tell that the building blocks of life – organic molecules very similar to those found on Earth and even in our own bodies – have been observed through NASA's telescopes. Explain that the pink color in the image represents these building blocks of life in a far away galaxy. Ask whether there is a little or a lot of it (there's a lot!). Tell them that these building blocks are found all throughout space, which means that the building blocks of life are in abundance in the Universe. Ask what they think that means in terms of the possibility of life elsewhere.

Background

SCIENTIFIC BACKGROUND

Star Formation: Throughout the universe, stars form, mature (often with planetary systems), and then die. In so doing, the star can recycle the materials created within it back into space. Stars form in regions of space called nebulae, where the raw material and conditions necessary for formation are present. The concept of star formation begins with diffuse material in clouds of **gases** such as carbon monoxide, hydrogen, and helium, **dust** meaning small rocky particles such as silicates (like beach sand), minerals such as olivine, and organic (carbon-containing) particles like charcoal dust, and **ices** such as water ice. The particulate matter and gases have a random motion. A pressure blast, or "wind" such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density at certain points which will eventually become discreet stars. A small, growing star is surrounded by a circumstellar disk of spinning dust and gas – like a music CD or a Frisbee, with the young star in the center. Through a process called accretion, the material will condense further. The more mass it gains and the larger it gets, the more material will be attracted to it. In this way, it gains even more mass and gets even larger. Please refer to the film for a visual explanation of this.

Nuclear Fusion Within a Star / Stellar Maturity: As a star continues to form, temperature and pressure slowly increase until the center of the star reaches 15 million degrees Celsius, and the nuclei of the individual atoms begin to fuse. The intense pressure causes hydrogen atoms to fuse into heavier helium atoms. This process gives off tremendous amounts of energy which we observe as light and heat. As stars grow older, they exhaust their supply of hydrogen. The energy released from fusion is no longer enough to counteract the inward force of gravity, and the star's core collapses, increasing pressure and temperature there, eventually up to 100 million degrees Celsius. This new pressure causes helium atoms to then fuse into heavier elements like carbon, nitrogen, and oxygen which are elements essential to life as we know it. Large stars with higher pressures can keep the fusion going and create even heavier elements like calcium, aluminum, magnesium, sulfur, cobalt, nickel, and iron.

Stellar Death and Recycling of Elements: Depending on size and mass, stars can have different fates. Very small stars will stay much as they were. Sun-like stars will move from the Red Giant phase into planetary nebulae, making a space for new stars to potentially form. Very large stars will explode in supernovae. This powerful, explosive event provides the energy to create even heavier elements such as gold and titanium. The supernova event distributes all the elements the star made during its lifetime back into space, to one day be incorporated into new stars, new planetary systems, and maybe new life.



Cass-A: In 1999, the NASA Chandra X-Ray Observatory, a telescope orbiting Earth and “pointing” away from the Earth, was able to take a picture of a supernova remnant in the constellation Cassiopeia (which is also the Navajo star pattern Náhookqs Ba’áadii). Chandra does not “see” as human eyes do. Human eyes require visible light to image objects. Chandra measures X-rays, which are similar to rays of visible light, but of a much higher frequency. The provided image of CassA shows the X-rays the star let out at the end of its life in a supernova event 300 years ago.



The Mark of a Dying Star NASA/JPL-Caltech/ESA/J. Hora (Harvard-Smithsonian CfA), C.R. O'Dell (Vanderbilt University)

This part of the life cycle of some stars, the supernova, is linked to the possibility of life elsewhere in the universe and the recycling of materials throughout the cosmos. The elements that are cast out into space during a supernova event – oxygen, carbon, nitrogen, etc. – are elements that are necessary for life as we know it. The only place these elements are made is within the core of a star. If the process of star birth, maturation, death, and recycling were not in place, our Solar System would not be the way it is! Current scientific theory states that our Solar System incorporated the material cast off by a nearby supernova event, and our planet and the life on it was made from that material. We, indeed, are made of star stuff. What will become of the material cast out from the CassA Supernova? Could new stars and solar systems form in its wake?

M81: The image of the galaxy (called M81; 12 million light years away from Earth and visible within the constellation Ursa Major through binoculars or a small telescope) was taken by the NASA Spitzer Space Telescope in 2003. Like Chandra, Spitzer does not “see” like human eyes which rely on visible light. Rather, Spitzer “feels the heat” of objects, and creates an image of them. The original image, provided here as part of this activity, shows a pink color (false color) in the spiral arms of the galaxy. This color represents very interesting material – extremely tiny bits of rocky material such as silicates (similar to beach sand), and organic (meaning carbon-containing) molecules. The organic molecules that Spitzer found are most interesting because they are similar to molecules central to life here on Earth, such as chlorophyll, which is made by plants and enables their growth. The molecules Spitzer found are called Polycyclic Aromatic Hydrocarbons, or PAH’s for short. PAH’s are flat molecules, shaped like chicken-wire, and can have many different shapes. Many of the molecules of life that are part of our bodies are related to PAH’s found in space. Even chocolate and caffeine are simple PAH’s!

The Spitzer Space Telescope has directly observed the tell-tale signature of PAH’s throughout space, in fact, these molecules seem to be just about everywhere. They are common in our own Milky Way galaxy and in distant galaxies such as M81. PAH’s are chemically very stable and don’t break apart in the high radiation environment in space. PAH’s may become part of newly forming planets around other stars where they could be incorporated into other living things. The discovery of PAH’s in other galaxies in such abundance makes scientists wonder about the possibility of life elsewhere.

An Excerpt From:
Sq' Diyin Dine'é

Told by Irvin K. James, 2001
Transcribed by Sylvia Jackson

The Holy Ones discussed the growing process, as they observed and understood it. If all living things return to the Earth and are replaced with new life, then there is a growing process in place. The Holy Ones met, discussed, planned, and laid out the constellations by which the People will understand the passage of time, growing, and aging.

One day was set aside for everyone to participate. Haashch'ééłti'í placed a flawless buckskin on the ground. Other Holy Ones brought precious gems of all colors, sizes, and shapes to produce specific patterns and designs to depict their character and ability. First man constructed a pattern he called Náhookqs Biką'įį, the Big Dipper. He chose seven colorful stones in the pattern. First Woman constructed a pattern she called Náhookqs Ba'áadii, Cassiopeia, and had five stones in the pattern. They placed the patterns in the northern sky around the North Star, with their own fire hearth between them. The pair will revolve around their fire hearth, Náhookqs Bikq', the North Star. Everyone was satisfied with the arrangements.

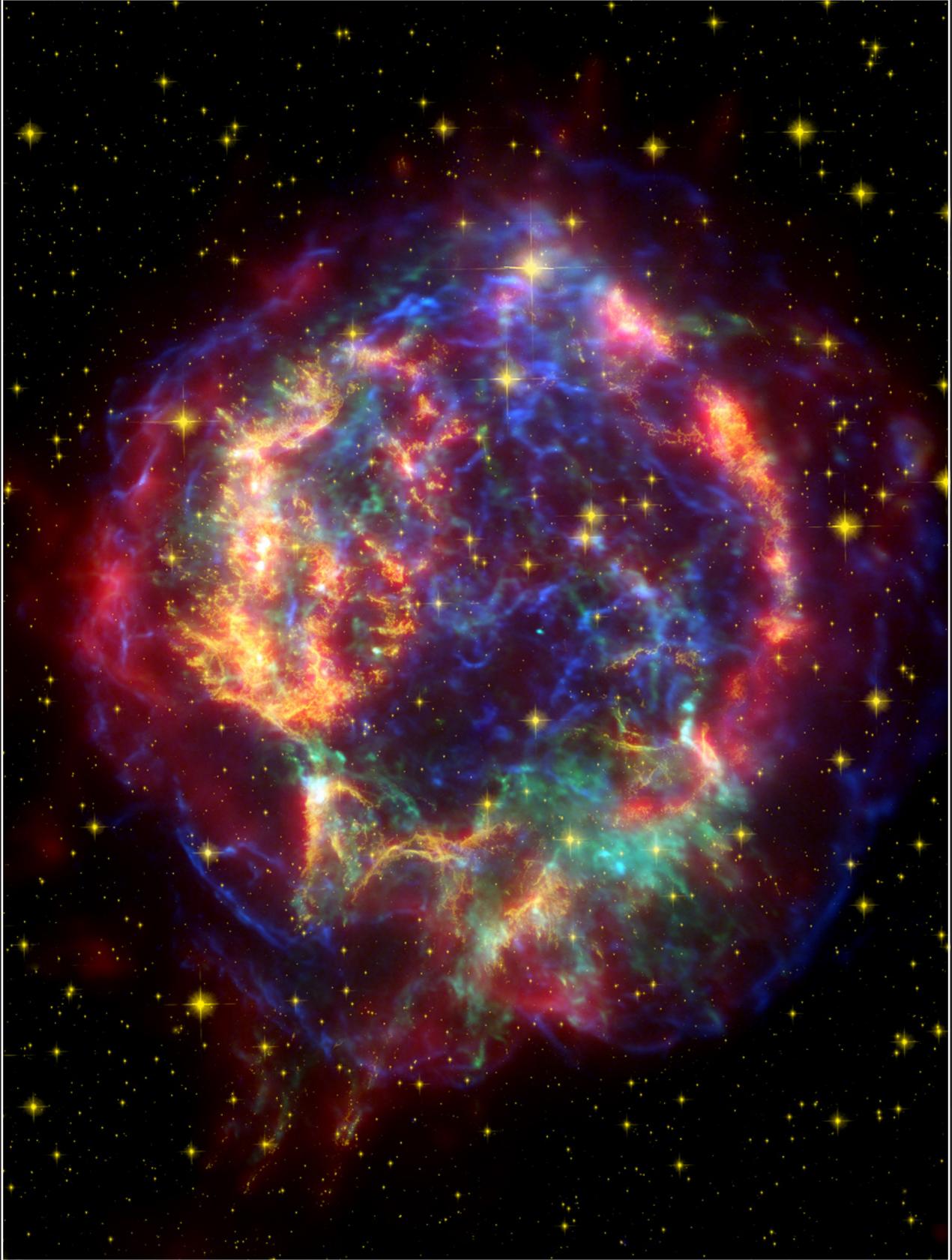
The constellation patterns placed in the sky were discussed and designed for specific purposes such as the Náhookqs Biką'įį and the Náhookqs Ba'áadii and the fire hearth, Náhookqs Bikq'. The pattern exhibits changes of the season. In the early spring, Náhookqs Ba'áadii will be visible in the northeastern sky. Náhookqs Biką'įį will be visible in the same location in the early fall evening. Náhookqs Bikq', the North Star, remains in one location all the time. All constellations revolve around the North Star.

The traditional understanding is that the constellation patterns depict proper roles and responsibilities of families. Náhookqs Biką'įį reigns over the fall and winter seasonal activities for the People. Yé'ii Bicheii and Iłnashjinjí hataál are winter healing ceremonies. Ndáá' and Hózhq'óǵjí ceremonies are the spring and summer healing ceremonies under the reign of Náhookqs Ba'áadii. Being aware of the purposes of the constellations helps in understanding the traditional practices of Diné Way of Life.



Graphics

The following several pages contain the provided graphics for this activity: the images of CassA and M81 to be cut out and pasted on the dome for the activity, and the star chart to guide placement of the holes in the planetarium dome.



Cassiopeia A Supernova Remnant

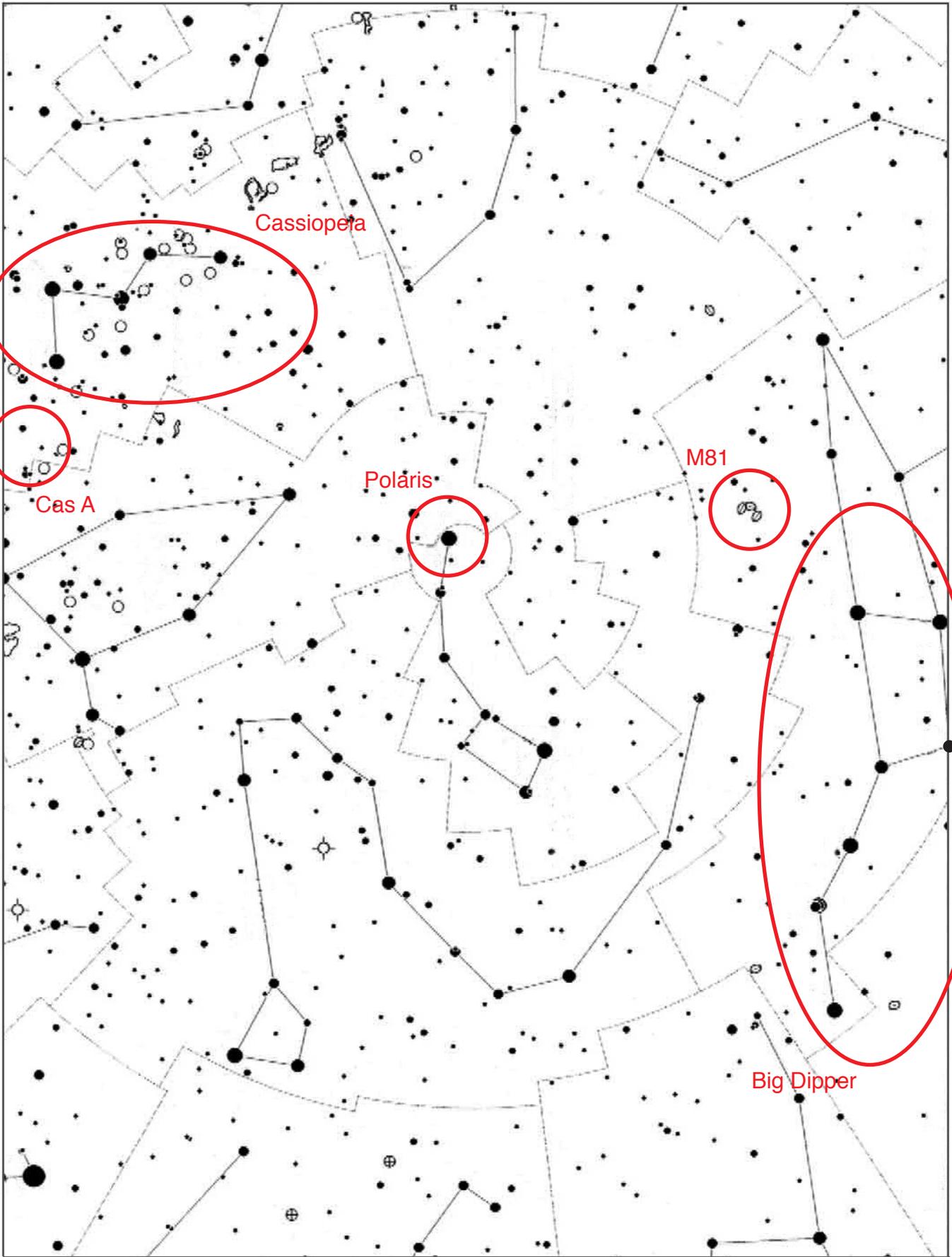
Spitzer Space Telescope • MIPS / HubbleSpace Telescope • ACS / Chandra X-Ray Observatory
NASA/JPL-Caltech / D. Krause (Steward Observatory)



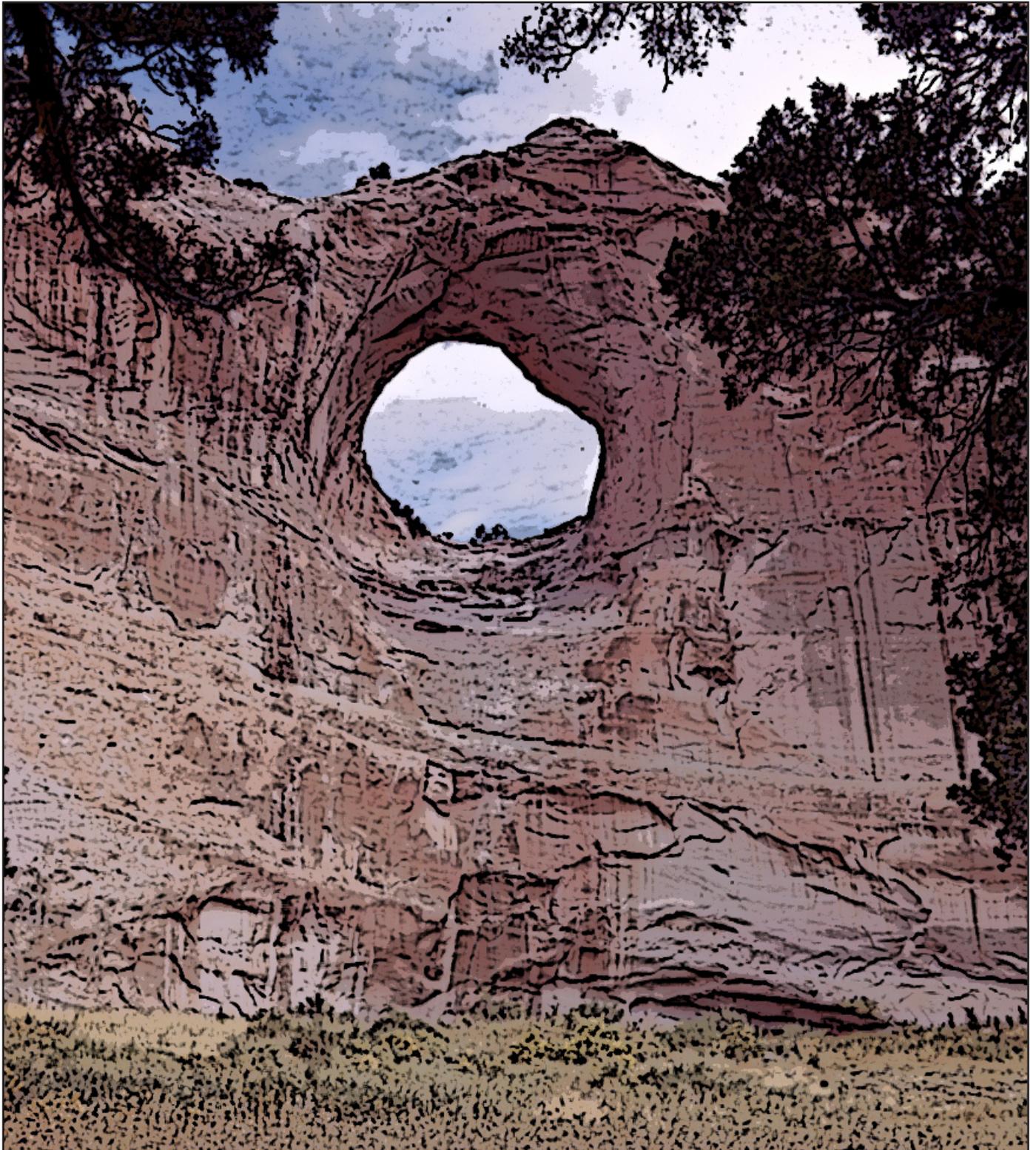
Spiral Galaxy M81

Spitzer Space Telescope • IRAC

NASA / JPL-Caltech / S. Willner (Harvard-Smithsonian CfA)



Cycles in the Cards



Northern Arizona University, Cline Library, Special Collections and Archives



Overview

Objective – Explore the ideas of “life” cycle and transformation inherent in the scientific concept of stellar evolution, and the essential “properties” of the four sacred directions as told in a Navajo creation story, Dahadíníisá / The Beginning.

Age Range – This activity is designed for older, middle and high school aged children, and adults.

Materials Needed – Two sets of cards – one “Star Cycle” set (one set of four cards - provided), and one “Navajo” set (eight sets of 4 each, and two sets of two each for a total of 36 - provided); background information for the facilitator (provided).

Set Up – This activity can be set up with one long or one round table and chairs. The interactions are optimized when small groups of 5 or 6 play together.

Estimated Time – 40 - 45 minutes; approximately one class period if used in a classroom.

Facilitator or Teacher Pre-Work

Before conducting the activity, read the provided scientific background information and Navajo story “The Beginning.” CUT OUT ALL THE CARDS (laminating them is recommended), and organize them into piles of four. Consider working with a co-facilitator or another teacher. The activity works best when scientific and Navajo cultural expertise work together. Be advised that the Navajo story contains many Navajo words, and working with a native speaker may enhance the experience greatly. If you are working in a Community Event with parents and grandparents, it is wonderful to involve them and draw out their own personal knowledge as part of the experience.



Community Night Event – Field Test in Cameron, AZ

The object of the “game” is to learn the stories while working with the cards. First you will work through the Star Cycle cards, put them aside, then work through the Navajo card sets. As you go through the Navajo story (which is provided in sections to match the cards, as well as in its entirety), the players will place the cards in a pattern on the table that ultimately will resemble a “+”. Then you will return to the Star Cycle cards and overlap them onto the Navajo cards that you’ve placed on the table.

From where you will sit to conduct the activity, determine which wall of the room faces East, which South, which West, and which North. This will be important as you place the cards during the activity.

How To

Guidelines for Facilitating the Activity – Assemble a group and briefly show them the card sets. Tell them they're going to be working with the cards to explore both the scientific concept of the star cycle, and Navajo creation stories. Ask about their concept of life – when they think about life, what shape comes to mind? Square? Triangle? Circle? Accept all answers. Tell them they're going to explore this concept with the cards and through the stories.

PART ONE - The Star Cycle Cards

Begin – Display the 4 Star Cycle Cards in a row on the table. Tell the players that these images represent four stages in the life cycle of a star – pre-formation, formation, maturity, and death/dying. Ask the players to describe what they are seeing in each of the images. Answers might include: clouds, gas, color, energy, stars, circles, forming, coming together, breaking apart, exploding, movement, etc. Accept all answers.

One – Ask the players to select the card which best describes A PLACE WHERE STARS FORM; a stellar nursery. Ask them about their choices, helping them to select Card #1, and place it on the table in the direction of EAST. Help them to notice that the scene in Card #1 is predominantly “disorganized;” that nothing is taking shape just yet. Point out that the image on Card #1 was taken by the NASA Hubble Space Telescope.

Two – Ask the players next to select the card which best describes the scene when a star is BEGINNING TO FORM. Ask them about their choices, helping them to select Card #2, placing it in the direction of SOUTH. Help them to notice that the forms and shapes in Card #2 are coalescing, or coming together. Point out that the image on Card #2 is an artist's rendition of the process of star formation. Scientists cannot currently directly observe this process at this level of detail, so an artistic interpretation of theory and data is necessary.

Three – Ask the players to select the card which best describes an image of a star at MATURITY. Ask them about their choices, helping them to select Card #3, placing it in the direction of WEST. Help them to notice that there are no shapeless clouds in the image; that the sphere has a distinct and discreet shape. Point out that this is an image of our Sun, taken with the NASA SOHO (Solar and Heliospheric Observatory) Telescope.

EXTRA ACTIVITY – Ask the players what is happening within the fiery core of a mature star. Explain that the temperature is so high, and the pressure is so great, that the star is actually fusing materials together to form bigger, heavier material. Have the students place their two forefingers together, touching at the tips. Have them (carefully) push their fingertips together with all their might, and imagine that if they pushed hard enough, their two separate fingers would become one. Explain that the heavier materials formed by the star in this way are actually elements such as carbon, nitrogen, and oxygen which is the “stuff” we humans are made of.

Four – Place the remaining card in the direction of NORTH. Ask the players what they see in the remaining card, Card #4. Help them to notice that there is motion and movement again in the shapes. Ask them what they think this represents, helping them to see an explosive, outward energy. Explain that this is an image of a supernova remnant called CassA, taken with the NASA Chandra X-Ray Observatory Telescope and so named because of its proximity to the constellation Cassiopeia.



Explain that when a star “goes supernova,” it expels all the materials it created within its core during its mature phase into the surrounding space, providing the raw materials for the next generation of stars to form, and possibly planets, and possibly LIFE!

EXTRA ACTIVITY – Refer to the provided Stellar Evolution Poster (small version is provided – for larger version, download here: http://chandra.harvard.edu/edu/formal/stellar_ev/). Explain that, depending on their size, stars have different fates. Larger mass stars explode in supernova events, whereas lower mass stars will puff up into Red Giants, or turn into White Dwarfs.

Finish Part One – Put the Star Cycle cards aside for now, and tell the players they will revisit them, but are now going to explore a Navajo creation story.

PART TWO – The Navajo Cards

First, place the Ni’hodíłhił Card on the table. Ask each player to describe and explain what they see. Accept all answers, including light, color, energy, clouds, etc. Tell the first part of Dahadíníisá / The Beginning story (below). When the story refers to “a gaseous, foggy substance,” and “dark mist, moisture, and light,” point to the image. When you have finished reading this section of the story, explain that this is an image of the Orion nebula taken by the NASA Hubble Space Telescope, and illustrates this part of the story well. A nebula is an expansive region in space made up of a large cloud of dust and gas. Star and planetary systems often form within nebulae.

Dahadíníisá / The Beginning

Hajíníé hane’ begins with the understanding that Ni’naakits’áadah dasikaad is where the Níłch’i Diyin Dine’é, Spirit People, come from. The First World, Ni’hodíłhił, the Black World, is told the beginning. Ni’hodíłhił, as perceived by carrier and guardian of medicine bundles, means there was not a world yet, only endless darkness existed. There were yet no light, water, air, or surface. Traditional storytellers tell of a mist like substance, a gaseous foggy substance, formed in the atmosphere and in the heaven and was the beginning.

Within the center of the atmosphere, Ni’hodíłhił, dark mist, moisture, and light gathered and formed clouds. This became the Divine Níłch’i Diyin Dine’é, Yá’alníí’neeyání, the mysterious power. This Holy One, Níłch’i Diyin Dine’é, Yá’alníí’neeyání, is characterized to be of Crystal Spirit and the Holy Wind, air. The Holy One possessing a female and male character strength, power, and is referred to as Sa’ah Naaghéi Bik’eh Hózhóón.

Next, making sure to align black with North, place the Color Wheel Card on top of the Ni’hodíłhił card, and ask the players to identify what they see. Ask each player if they are familiar with the four directions. Ask if they can describe essential properties or qualities in each one. Ask if they know how those qualities were formed or assigned. Pass out the 4 Directions Cards, and ask the players to place them next to the appropriate color on the color wheel (white = East, blue = South, yellow = West, black = North).

Explain that the story goes on to describe how all things were brought about, according to and within the four sacred directions.



Read the passage from the story below. When you are finished, hand the players the 4 Gems Cards and ask them to place each card next to the position on the color wheel where it belongs. White Shell with white, Turquoise with blue, Abalone Shell with yellow, and Obsidian/Jet with black.

With this power, surface formed. White shell, turquoise, abalone shell, and obsidian formed the surface, land, earth substance. Next, words were heard and languages were identified. It is believed that various gems formed the languages, words, sounds uttered by the Yá'ahníí'neeyání.

Read aloud the next passage from the story below. When you are finished, pass out the 4 Winds Cards to the players and ask them to place each card next to the position on the color wheel where it belongs. Because the interaction of wind with Earth's surface helps to shape mountains, next pass out the 4 Sacred Mountains Cards, and ask them to place those around the wheel as well.

Ní'hodíthit / Black World

Within the Black World, Yá'ahníí'neeyání was very much alone and lonely, so he used the intelligence that he possessed to bring forth four elements. He spoke with the spirit of the white shell language and brought forth light and placed it within the eastern direction. He spoke with the spirit of the turquoise language and brought forth moisture and placed it within the southern direction. He spoke with the spirit of the abalone shell language and brought forth four types of air, wind, and he placed them within the western direction. Yá'ahníí'neeyání spoke the language of the obsidian, and pollen formed which became the dirt substance, and he placed it within the northern direction. Later, he placed wind within the four directions; to the east he placed the white wind; to the south the blue wind; to the west the yellow wind; and to the north the black wind.

Read aloud the following passages which go into detail about the essential "properties" of each direction. As you read the section describing each direction, distribute the Houses Card that corresponds to that direction and ask the players to place that card in the appropriate place.

It is said, Yá'ahníí'neeyání brought forth Dawn and placed life and light into it and placed it with the eastern direction. Spirits of Dawn, Hayoókááł At'ééd dóó Hayoókááł Ashkii, were identified and placed within the eastern direction. Their purposes were to provide direction to the lives of the earth surface living beings and means by which they will travel, Gáál. Within the House of Dawn, Hayoókááł Beehooghan, Yá'ahníí'neeyání placed the Crystal Light. By the aid of Crystal Light the earth surface beings will be capable of developing the ability to process thinking, forming ideas, to be inquisitive and a need to know, Nitsáhákees.

Yá'ahníí'neeyání brought forth Blue Twilight, Nihodeet'iizh At'ééd dóó Nihodeet'iizh Ashkii, and he placed them within the southern direction in the House of Blue Twilight, Nihodeet'iizh Beehooghan. It was part of the great plan for earth surface people to develop knowledge by which to construct plans for living from one generation to the next. This is referred to as Nahat'á ályaa. Yá'ahníí'neeyání brought forth Yellow Evening Twilight, Nihootsoi At'ééd dóó Nihootsoi Ashkii, for the western direction and placed Ayóó'óní for social development and family unity in the House of Yellow Evening Twilight, Nihootsoi Beehooghan.

Yá'ahníí'neeyání brought forth Folding Darkness, Chahałheef At'ééd dóó Chahałheef Ashkii, for the northern direction and placed life, home and rest within the House of Darkness, Chahalheel Beehooghan. Yá'ahníí'neeyání also placed development of awareness and protection within the House of Darkness.



Read aloud the following passage. When you have finished, pass out the 4 Seasons Cards, and ask the players to place them accordingly – Spring = East, Summer = South, Autumn = West, Winter = North.

With all the elements and the power of the four directions in place, Yá’áłníí’neeyáńí brought forth four types of moist substances, Níłch’í łigai, Níłch’í dootłizh, Níłch’í łitso, Níłch’í Dìłhił, and placed them within the four directional clouds. It is told by the elder the four types of moisture impacts the four seasons, Dąągo, Shíłigo, Aak’eego, dóó Haigo.

Read aloud the following passage. As you go along in the story and say the name of each Spiritual One, distribute the corresponding card, and ask the players to place the Spiritual Ones Card in the appropriate direction. See if they can predict where each card will go before they hear it in the story.

Yá’áłníí’neeyáńí, still very much alone and lonely, created four Spiritual Ones from the same power from which he, himself, had come. One Formed at the Center of Heavens, Yá’áłníí’neeyáńí, brought forth Haashch’éeýáłti’í, First Talking God, and was assigned to oversee the activities to the eastern direction. Be’gochídí, the Spirit for Growth, was brought forth and assigned to oversee activities to the southern direction. Haashch’éeé Hooghan, the Spirit for Home, was brought forth and assigned to oversee activities in the western direction. Haashch’éeeshzhiní, the Spirit of Darkness, was brought forth and assigned to oversee activities to the northern direction.

Read the following, final passage aloud. See if the players can fill in the words “Father Sky” and “Mother Earth” before you say them. When you have finished, give the players the Father Sky and Mother Earth Cards. Allow them to place the cards on the table with the other cards without too much direction. Many have placed the Mother Earth card in the very center of the pattern, and the Father Sky card can “float” above the table, as well as below it, signifying the surrounding presence of Father Sky.

Yá’áłníí’neeyáńí, his helpers Haashch’éeé Dine’ée, the four elements, and the four winds gathered and constructed a plan for creation. They used their powers to create Yábii’astíín, Within Upper Creation Spirit, which became known as Father Sky. He was assigned to oversee all activities and control the functions of the upper creation. The Spiritual Ones gathered again and decided to create a counterpart for the upper creation, Nahasdzáán Bii’astíín, Within the Lower Creation Spirit. They created Mother Earth to control and oversee all activities in the lower creations. Yábii’astíín and Nahasdzáán Bii’astíín are known to breathe, think, talk and are all knowing as they control the balance of the creation. They constantly coordinate, cooperate, collaborate, and communicate through the elements of their being.

To Finish Part Two, have a brief discussion with the players about the essential properties, or meanings of each direction. Bring in other elements to relate to the four directions such as time of day (morning, noon, evening, night), or a human life cycle (birth, growth, maturity, death).

PART THREE – Bringing The Two Parts Together

Leaving the Navajo cards on the table as they are, bring out the Star Cycle cards again. Display them or hand them out to the players. Ask them to place each one in one of the four directions, and to explain why they chose the placements they made.

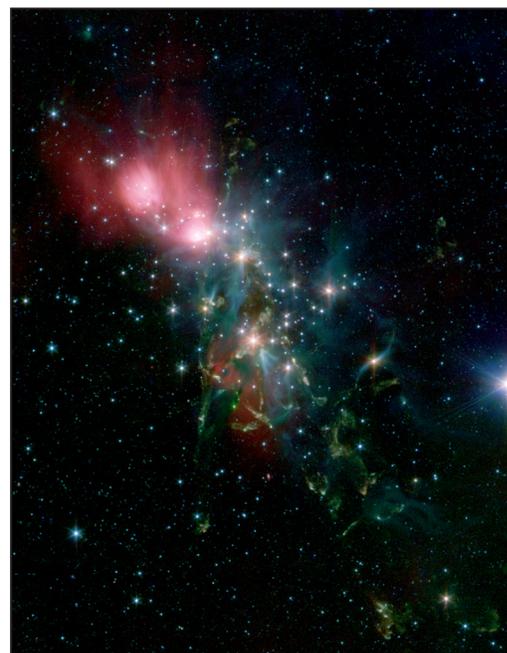
If needed, help them to place Card #1 in the EAST, because the image represents a stellar nursery; a place where the conditions are right for stars to form. Help them to place Card #2 in the SOUTH, because the image represents a star forming. Help them to place Card #3 in the WEST, because the image represents a fully mature star. Finally, help them to place Card #4 in the NORTH, because the image represents a star dying, and recycling its contents back into space as raw material from which the next generation of stars can form.

Emphasize the circular, cyclical nature of the stellar life cycle pattern, and how each stage of a star's "life" relates to the essential properties and teachings of each of the four sacred directions explored in the Navajo story.

Background

SCIENTIFIC BACKGROUND

Star Formation: Throughout the universe, stars form, mature (often with planetary systems), and then die. In so doing, the star can recycle the materials created within it back into space. Stars form in regions of space called nebulae, where the raw material and conditions necessary for formation are present. The concept of star formation begins with diffuse material in clouds of **gases** such as carbon monoxide, hydrogen, and helium, **dust** meaning small rocky particles such as silicates (like beach sand), minerals such as olivine, and organic (carbon-containing) particles like charcoal dust, and **ices** such as water ice. The particulate matter and gases have a random motion. A pressure blast, or "wind" such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density at certain points which will eventually become discreet stars. A small, growing star is surrounded by a circumstellar disk of spinning dust and gas – like a music CD or a Frisbee, with the young star in the center. Through a process called accretion, the material will condense further. The more mass it gains and the larger it gets, the more material will be attracted to it. In this way, it gains even more mass and gets even larger. Please refer to the film for a visual explanation of this.



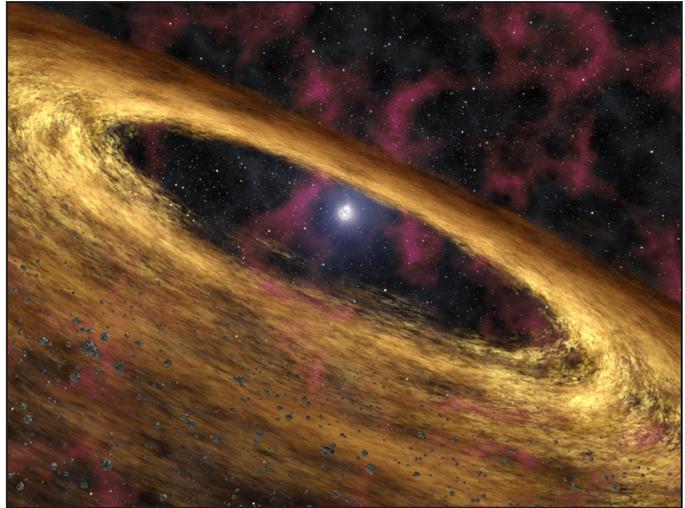
Chaotic Star Birth
NASA/JPL-Caltech/R. A. Gutermuth
(Harvard-Smithsonian CfA)

Planetary System Formation: Often, depending on radiation conditions in the local nebula (star forming) environment, the contents of the spinning circumstellar disk can give rise to a planetary system in which discreet bodies – planets – orbit the star in the center. Depending on the elements that were present and available during the formation of the star and planets, the planets that form can be gaseous like Jupiter, or rocky like Mars. Solar systems, much like our own Solar System, can and do form. Scientists have observed many different kinds of systems in our local galactic neighborhood, with unusual planet types such as "Hot Jupiters," and "Pulsar Planets." These strange planets are orbiting other types of stars as well, different from our Sun. As we know from our own experience on Earth, life can form on planets! Is there life on the other planets that we've observed in space?

Nuclear Fusion Within a Star and Stellar

Maturity: As a star continues to form, temperature and pressure slowly increase until the center of the star reaches 15 million degrees Celsius, and the nuclei of the atoms begin to fuse. The intense pressure causes hydrogen atoms to fuse into heavier helium atoms. This process gives off tremendous amounts of energy which we observe as light and heat. As stars grow older, they exhaust their supply of hydrogen. The energy released from fusion is no longer enough to counteract the inward force of gravity, and the star's core collapses, increasing pressure and temperature there, eventually up to 100 million degrees Celsius. This new pressure causes helium atoms to then fuse into heavier

elements like carbon, nitrogen, and oxygen which are elements essential to life as we know it. Large stars with higher pressures can keep the fusion going and create even heavier elements like calcium, aluminum, magnesium, sulfur, cobalt, nickel, and iron. Sun-sized stars that are in this phase of creating newer, heavier elements "puff up" into Red Giants which eventually "swallow" many of the planets surrounding them.

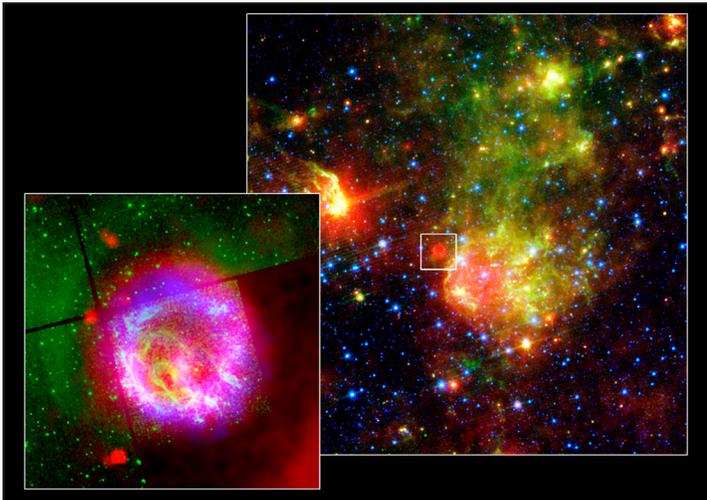


Stellar Rubble May Be Planetary Building Blocks
NASA/JPL-Caltech/R. Hurt (SSC)

Stellar Death and Recycling of Elements: Depending on size and mass, stars can have different fates. Very

small stars will stay much as they were. Stars like the Sun will "puff up" into Red Giants, and then move from the Red Giant phase into planetary nebulae, where new stars can potentially form. Very large stars will explode in supernovae. This powerful, explosive event provides the energy to create even heavier elements such as gold and titanium. The supernova event distributes all these elements back into space, including the ones made within the star during its lifetime, to one day be incorporated into new stars, new planetary systems, and maybe new life. Refer to the NASA Chandra Stellar Evolution Poster provided in this activity for a visual explanation of the different fates of stars:

http://chandra.harvard.edu/edu/formal/stellar_ev/



Dusty Death of a Massive Star NASA/JPL-Caltech/S. Stanimirovic (UC Berkeley)

Dahadíníisá / The Beginning

From
Amásáni dóó Acheii Baa Hane'
Grandmother and Grandfather Stories

Produced by the Office of Diné Culture, Language, and Community Services

Hajíínéí hane' begins with the understanding that Ni'naakits'áadah dasikaad is where the Níłch'i Diyin Dine'é, Spirit People, come from. The First World, Ni'hodíłhił, the Black World is told the beginning. Ni'hodíłhił, as perceived by carrier and guardian of medicine bundles, means there was not a world yet, only endless darkness existed. There were, yet, no light, water, air, or surface. Traditional storytellers tell of a mist like substance, a gaseous foggy substance, formed in the atmosphere and in the heaven and was the beginning.

Within the center of the atmosphere, Ni'hodíłhił, dark mist, moisture, and light gathered and formed clouds. This became the Divine Níłch'i Diyinii, Yá'ałníí'neeyání, the mysterious power. This Holy One, Níłch'i Diyinii, Yá'ałníí'neeyání, is characterized to be of Crystal Spirit and the Holy Wind, air. The Holy One possessing a female and male character strength power and is referred to as Saq'ah Naaghéi Bik'eh Hózhóón. With this power, surface formed. White shell, turquoise, abalone shell and obsidian formed the surface, land, earth substance. Next, words were heard and languages were identified. It is believed that various gems formed the languages, words, sounds uttered by the Yá'ałníí'neeyání.

Ni'hodíłhił / Black World

Within the Black World, Yá'ałníí'neeyání was very much alone and lonely, so he used the intelligence that he possessed to bring forth four elements. He spoke with the spirit of the white shell language and brought forth light and placed it within the eastern direction. He spoke with the spirit of the turquoise language and brought forth moisture and placed it within the southern direction. He spoke with the spirit of the abalone shell language and brought forth four types of air, wind, and he placed them within the western direction. Later, he placed wind within the four directions; to the east he placed the white wind; to the south the blue wind; to the west the yellow wind; and to the north the black wind. Yá'ałníí'neeyání spoke the language of the obsidian and pollen formed which became the dirt substance and he placed it within the northern direction.

It is said, Yá'ałníí'neeyání brought forth Dawn and placed life and light into it and placed it with the eastern direction. Spirits of Dawn, Hayoółkááł At'ééd dóó Hayoółkááł Ashkii were identified and placed within the eastern direction. Their purposes were to provide direction to the lives of the



earth surface living beings and means by which they will travel, Gáál. Within the House of Dawn, Hayookkáál Beehooghan, Yá'ahní'neeyání placed the Crystal Light. By the aid of Crystal Light the earth surface beings will be capable of developing the ability to process thinking, forming ideas, to be inquisitive, and a need to know, Nitsáhákees. Yá'ahní'neeyání brought forth Blue Twilight, Nihodeet'iizh At'ééd dóó Nihodeet'iizh Ashkii, and he placed them within the southern direction in the House of Blue Twilight, Nihodeet'iizh Beehooghan. It was part of the great plan for earth surface people to develop knowledge by which to construct plans for living from one generation to the next. This is referred to as Nahat'á ályaa. Yá'ahní'neeyání brought forth Yellow Evening Twilight, Nihootsoi At'ééd dóó Nihootsoi Ashkii, for the western direction and placed Ayóó'óní for social development and family unity in the House of Yellow Evening Twilight, Nihootsoi Beehooghan. Yá'ahní'neeyání brought forth Folding Darkness, Chahałheel At'ééd dóó Chahałheel Ashkii, for the northern direction and placed life, home and rest within the House of Darkness, Chahałheel Beehooghan. Yá'ahní'neeyání also placed development of awareness and protection within the House of Darkness. With all the elements and the power of the four directions in place, Yá'ahní'neeyání brought forth four types of moist substances, Níłch'i łigai, Níłch'i dootłizh, Níłch'i łitso, Níłch'i diłhił and placed them within the four directional clouds. It is told by the elder the four types of moisture impacts the four seasons, Daągo, Shįįgo, Aak'eego, dóó Haigo.

Yá'ahní'neeyání, still very much alone and lonely, created four Spiritual Ones from the same power from which he, himself, had come. One Formed at the Center of Heavens, Yá'ahní'neeyání, brought forth Haashch'ééyáłtií, First Talking God, and was assigned to oversee the activities to the eastern direction. Haashch'éé Hooghan, the Spirit for Home, was brought forth and assigned to oversee activities in the western direction. Be'gochídí, the Spirit for Growth, was brought forth and assigned to oversee activities to the southern direction. Haashch'ééshzhiní, the Spirit of Darkness, was brought forth and assigned to oversee activities to the northern direction.

Yá'ahní'neeyání, his helpers Haashch'ééh Dine'é, the four elements, and the four winds gathered and constructed a plan for creation. They used their powers to create Yábii'astíín, Within Upper Creation Spirit, which became known as Father Sky. He was assigned to oversee all activities and control the functions of the upper creation. The Spiritual Ones gathered again and decided to create a counterpart for the upper creation, Nahasdzáán Bii'astíín, Within the Lower Creation Spirit. They created Mother Earth to control and oversee all activities in the lower creations. Yábii'astíín and Nahasdzáán Bii'astíín are known to breathe, think, talk and all knowing as they control the balance of the creation. They constantly coordinate, cooperate, collaborate, and communicate through the elements of their being.

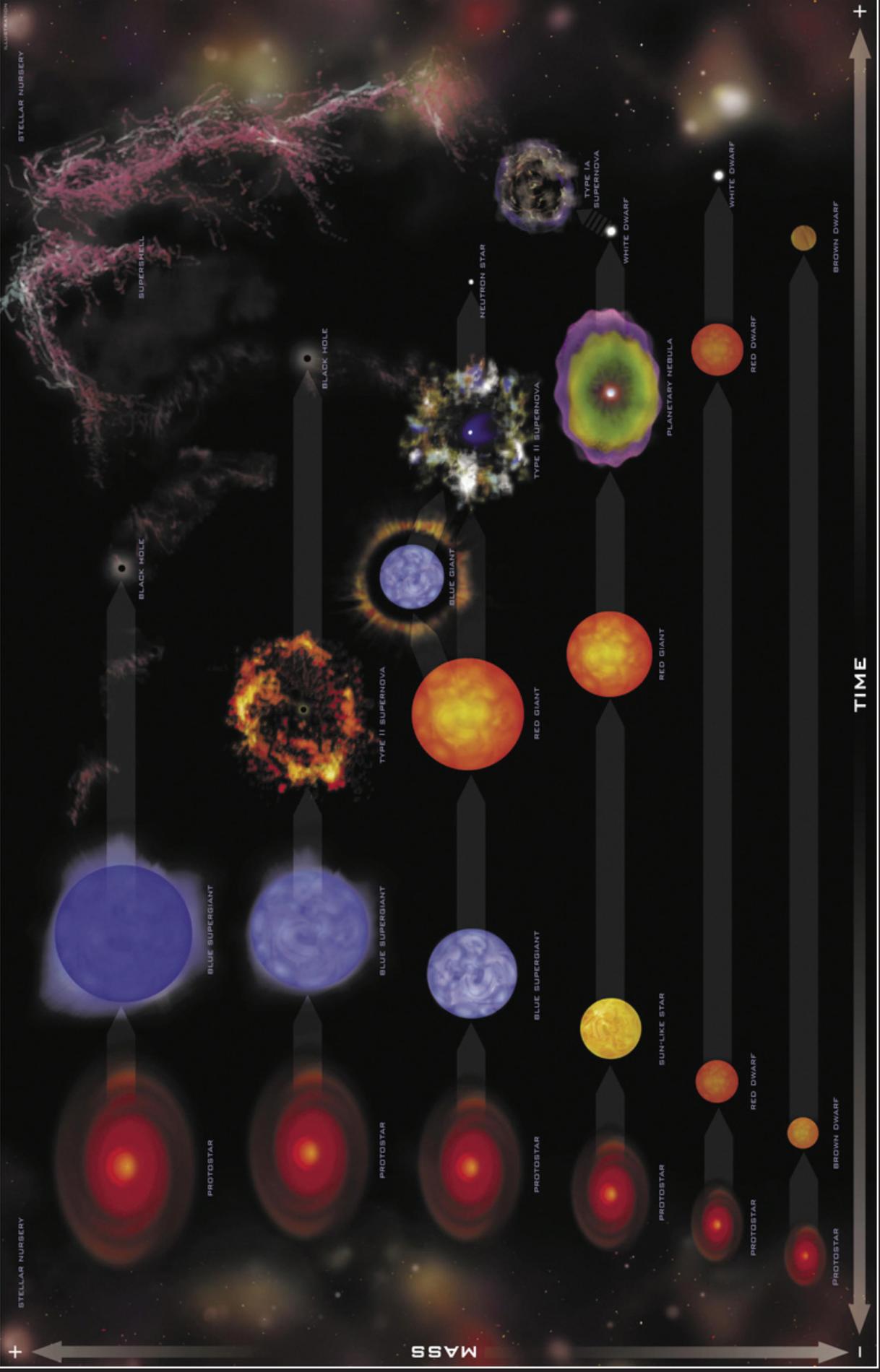
Graphics

The following pages contain the provided graphics for this activity:

- Stellar Evolution Poster
- Star Cycle Cards (4 cards)
- Ni' hodihiit / Color Wheel Card Set (2 cards)
- Directions Cards (4 cards)
- Gems Cards (4 cards)
- Winds Cards (4 cards)
- Sacred Mountains Cards (4 cards)
- Houses Cards (4 cards)
- Seasons Cards (4 cards)
- Spiritual Ones Cards (4 cards)
- Mother Earth / Father Sky Card Set (2 cards)



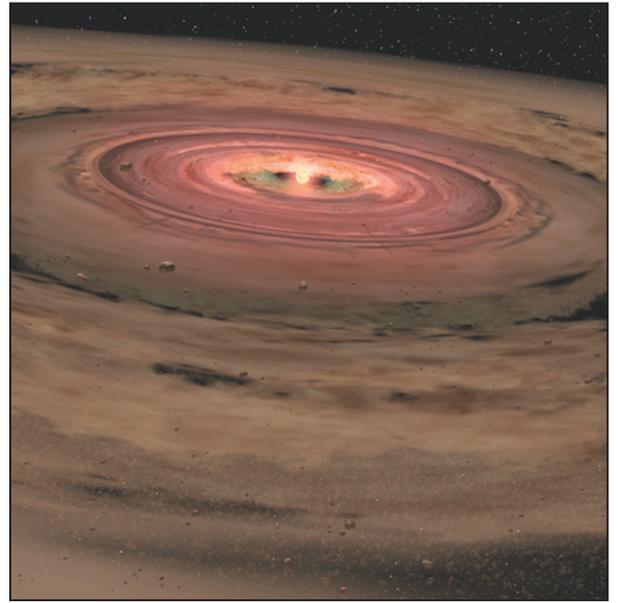
STELLAR EVOLUTION: A JOURNEY WITH CHANDRA





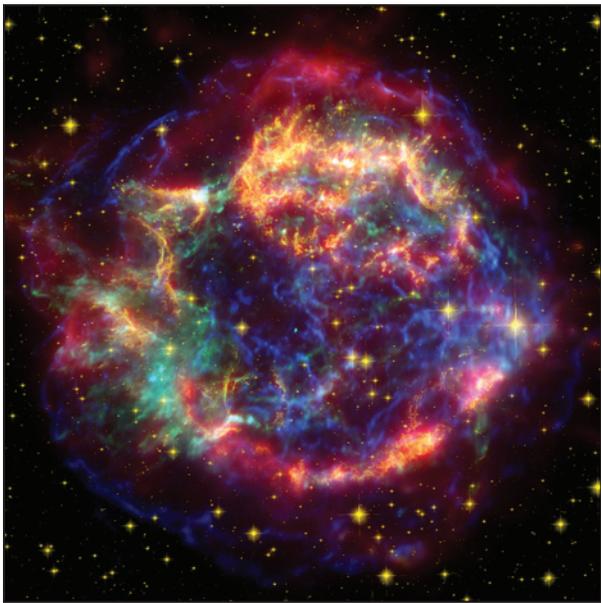
Credit: NASA, ESA, and The Hubble Heritage Team (STScI/AURA)

STAR CYCLE



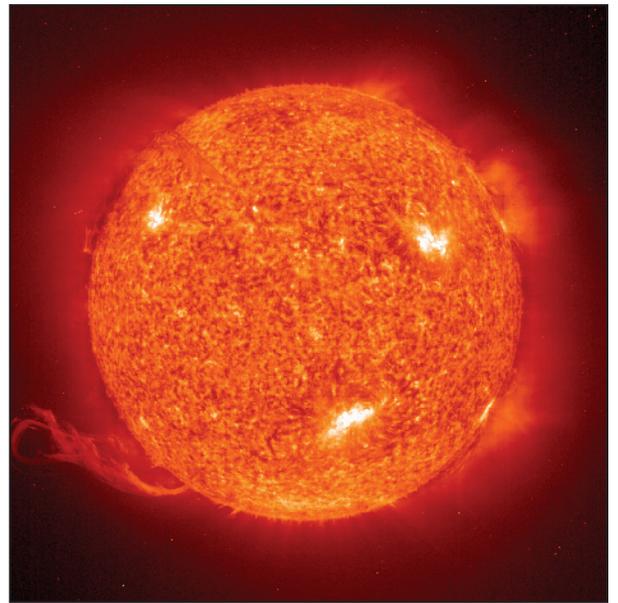
Credit: NASA/JPL-Caltech/T. Pyle (SSC)

STAR CYCLE



Credit: NASA/JPL-Caltech/O. Krause (Steward Observatory)

STAR CYCLE



Credit: NASA/SOHO

STAR CYCLE

2

A Star Forms

This artist's concept shows a brown dwarf surrounded by a swirling disk of planet-building dust. NASA's Spitzer Space Telescope spotted such a disk around a surprisingly low-mass brown dwarf, or "failed star." The brown dwarf, called OTS 44, is only 15 times the size of Jupiter, making it the smallest brown dwarf known to host a planet-forming, or protoplanetary disk.

STAR CYCLE

1

Before a Star Forms

Close inspection of the 2006 Hubble Space Telescope color mosaic of the Orion Nebula (M42) reveals numerous treasures that reside within the nearby, intense star-forming region. Deeply contrasting areas of light and dark blend with a palette of colors to form rich swirls and fluid motions that would make even the best artists stand back in admiration.

STAR CYCLE

3

A Mature Star

This image of the Sun, taken by NASA's Solar and Heliospheric Observatory on Sept. 14, 1999, features a huge, handle-shaped prominence. Prominences are huge clouds of relatively cool dense plasma suspended in the Sun's hot, thin corona. At times, they can erupt, escaping the Sun's atmosphere. In this image, the Sun's upper chromosphere is at a temperature of about 60,000 degrees K.

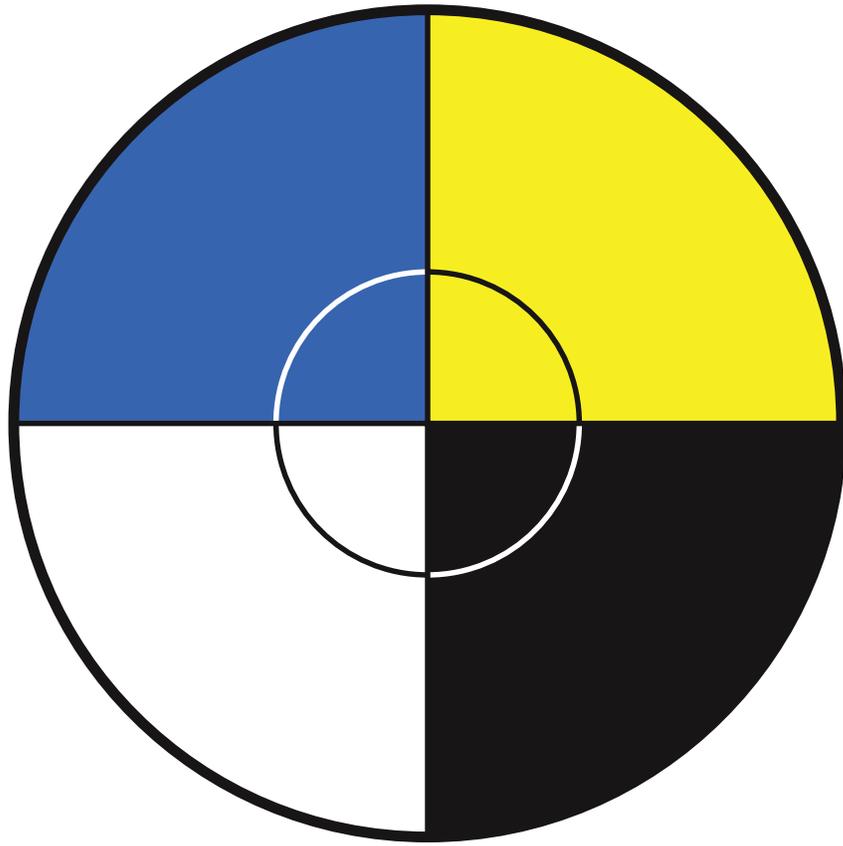
STAR CYCLE

4

A Star Dies

This stunning false-color picture shows off the many sides of the supernova remnant Cassiopeia A. It is made up of images taken by three of NASA's Great Observatories, using three different wavebands of light. Infrared data from the Spitzer Space Telescope are colored red; visible data from the Hubble Space Telescope are yellow; and X-ray data from the Chandra X-ray Observatory are green and blue.

STAR CYCLE



Sq' Baa Hane' - Story of the Stars

Navajo Color Wheel

Sq' Baa Hane' - Story of the Stars

Black World

Ni'hoodiit

Image of the Orion Nebula
From the NASA Hubble Space Telescope

East

Ha'a'aah

DIRECTIONS

South

Shádi'ááh

DIRECTIONS

North

Náhookqs

DIRECTIONS

West

E'e'aah

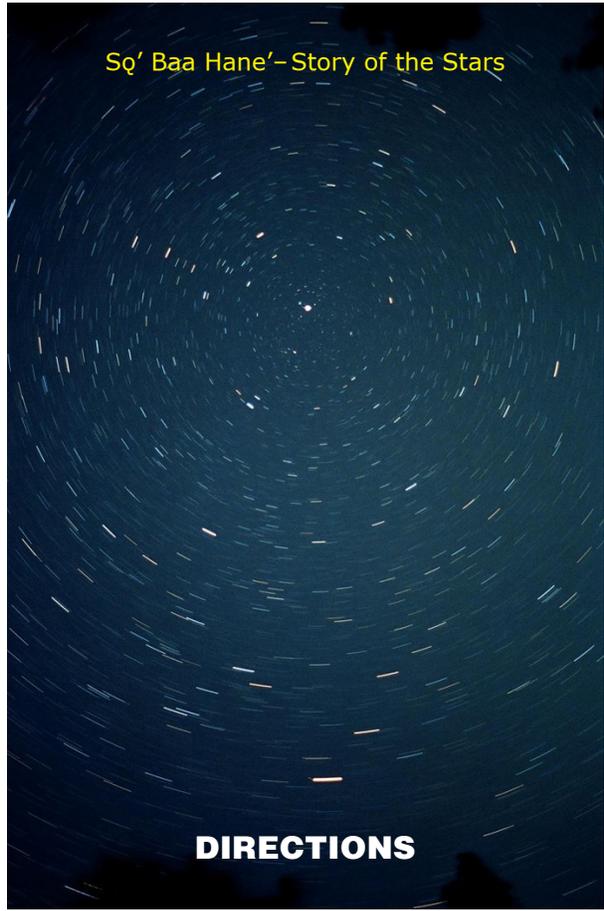
DIRECTIONS

Sq' Baa Hane' - Story of the Stars



DIRECTIONS

Sq' Baa Hane' - Story of the Stars



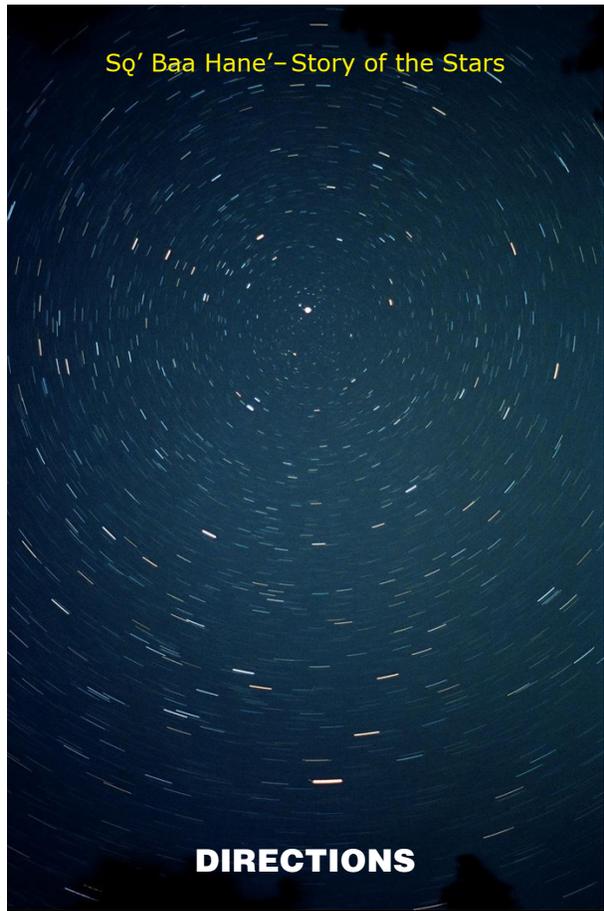
DIRECTIONS

Sq' Baa Hane' - Story of the Stars

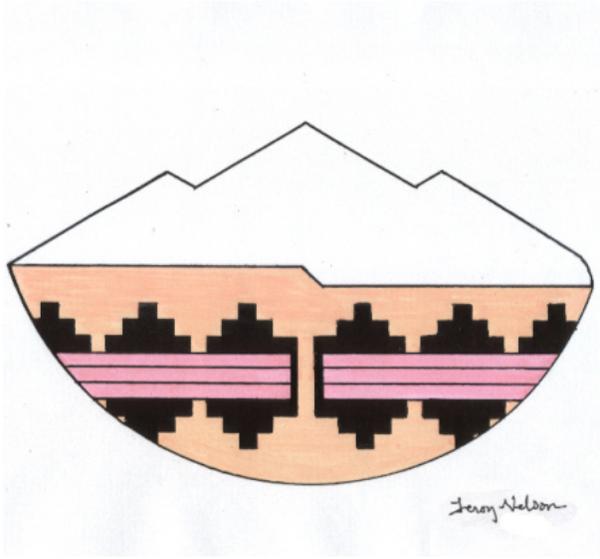


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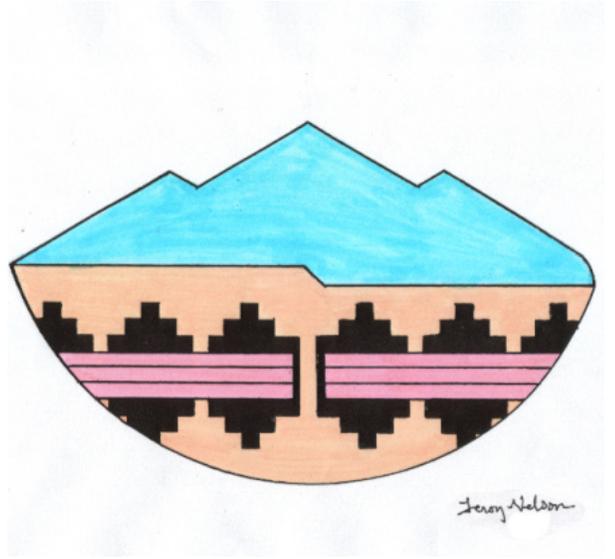
Sq' Baa Hane' - Story of the Stars



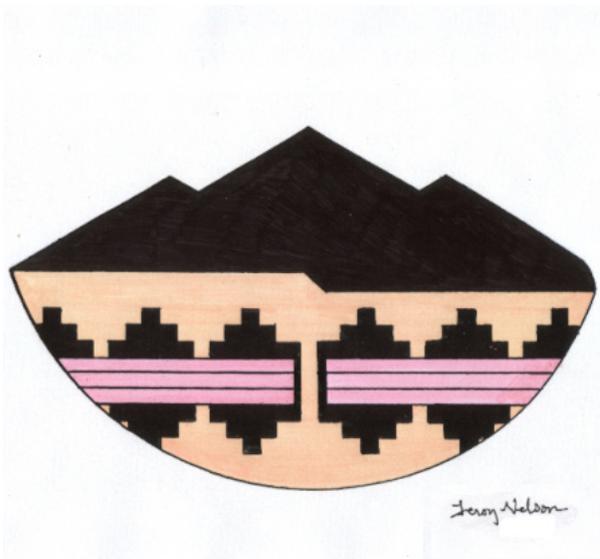
DIRECTIONS



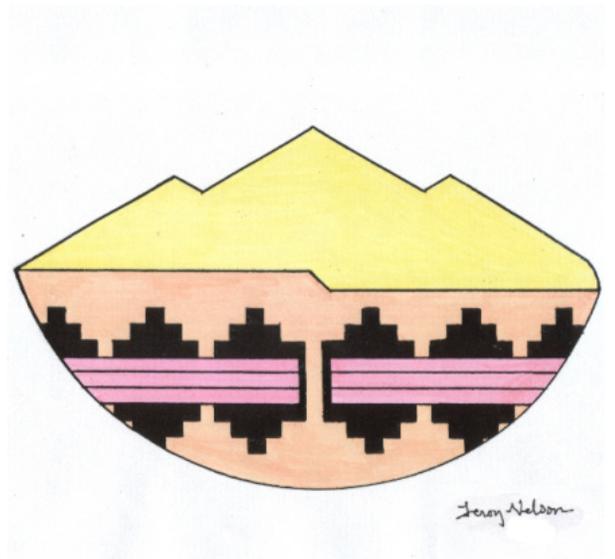
GEMS



GEMS



GEMS



GEMS

Sq' Baa Hane' - Story of the Stars

Turquoise

GEMS

Sq' Baa Hane' - Story of the Stars

White Shell

GEMS

Sq' Baa Hane' - Story of the Stars

Abalone

GEMS

Sq' Baa Hane' - Story of the Stars

Jet/Obsidian

GEMS



WINDS



WINDS



WINDS



WINDS

Sq' Baa Hane' - Story of the Stars

Blue Wind

WINDS

Sq' Baa Hane' - Story of the Stars

White Wind

WINDS

Sq' Baa Hane' - Story of the Stars

Yellow Wind

WINDS

Sq' Baa Hane' - Story of the Stars

Black Wind

WINDS



SACRED MOUNTAINS



SACRED MOUNTAINS



SACRED MOUNTAINS



SACRED MOUNTAINS

Sq' Baa Hane' - Story of the Stars

Mount Taylor,
New Mexico

Tsoodzil

South

SACRED MOUNTAINS

Sq' Baa Hane' - Story of the Stars

Sierra Blanca Peak,
Colorado

Sis Naajini

East

SACRED MOUNTAINS

Sq' Baa Hane' - Story of the Stars

San Francisco Peak,
Arizona

Dook'o'oosliid

West

SACRED MOUNTAINS

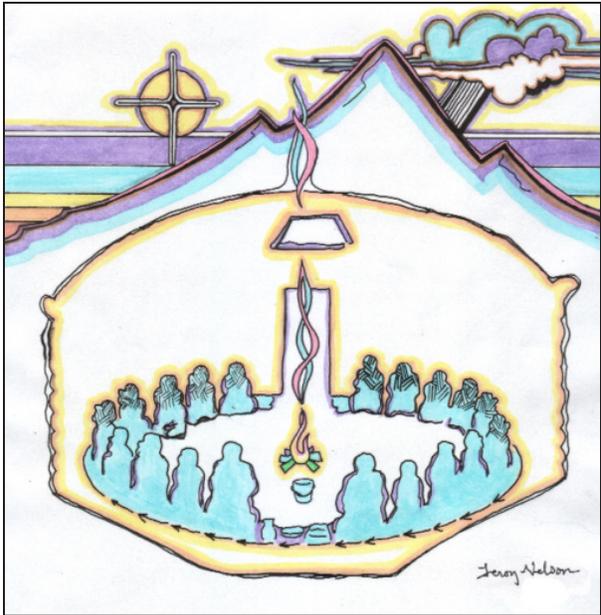
Sq' Baa Hane' - Story of the Stars

La Plata Mountains,
Colorado

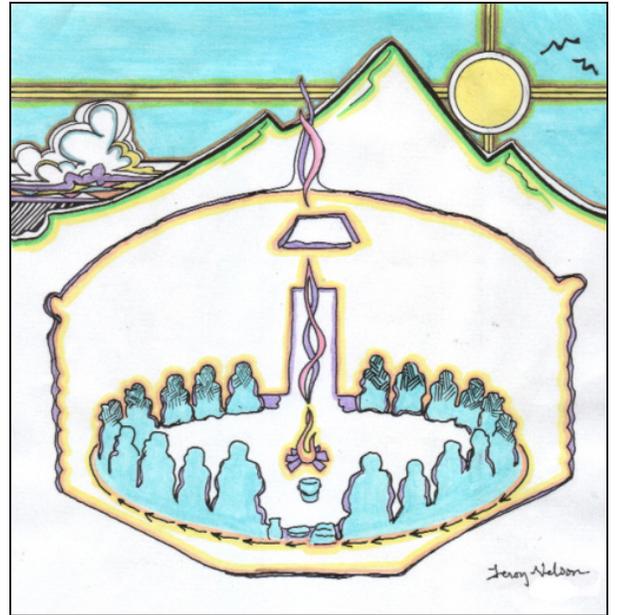
Dibe Nitsaa

North

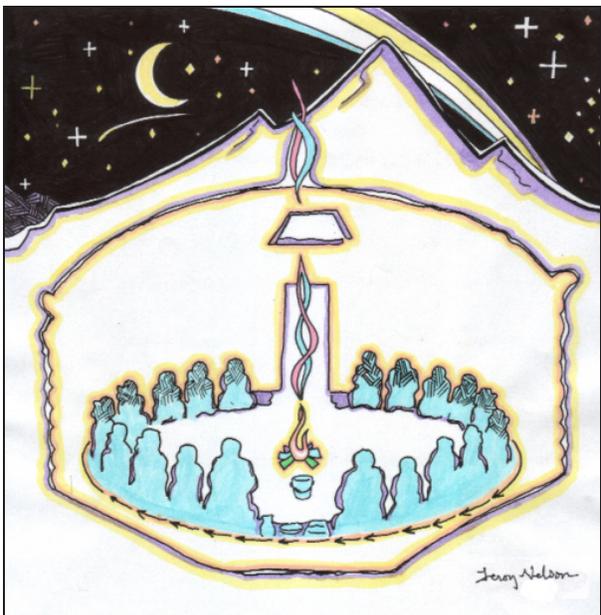
SACRED MOUNTAINS



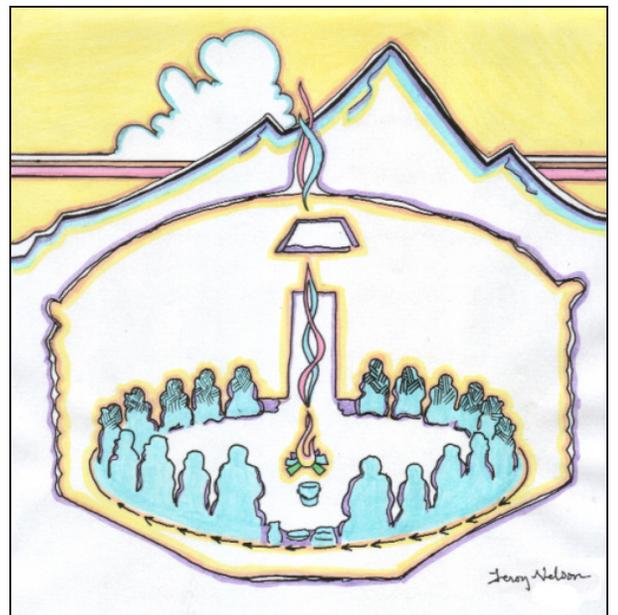
HOUSES



HOUSES



HOUSES



HOUSES

Sq' Baa Hane' - Story of the Stars

House of Blue
Twilight

Nihodeetł'iizh
Bee Hooghan

HOUSES

Sq' Baa Hane' - Story of the Stars

House of
Dawn

Hayoot Káál
Bee Hooghan

HOUSES

Sq' Baa Hane' - Story of the Stars

House of Yellow
Evening Twilight

Nihootsoi
Bee Hooghan

HOUSES

Sq' Baa Hane' - Story of the Stars

House of
Darkness

Chahaltheel
Bee Hooghan

HOUSES

Spring

Daan

SEASONS

Summer

Shí

SEASONS

Winter

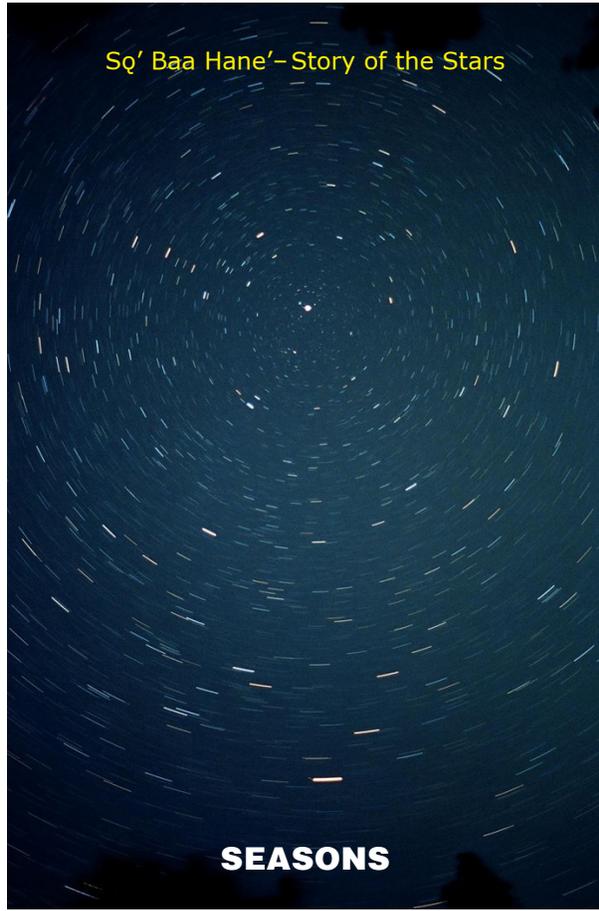
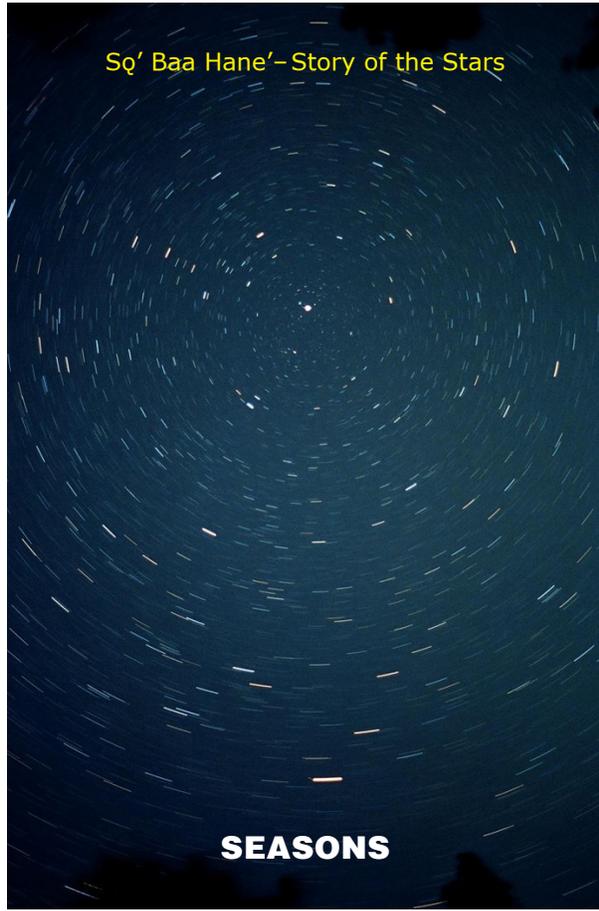
Hai

SEASONS

Autumn

Aak'eeh

SEASONS



First Talking God

Haashch'éeéh Yáłti'íí

SPIRITUAL ONES

Spirit for Growth

Be'gochídí

SPIRITUAL ONES

Spirit of Darkness

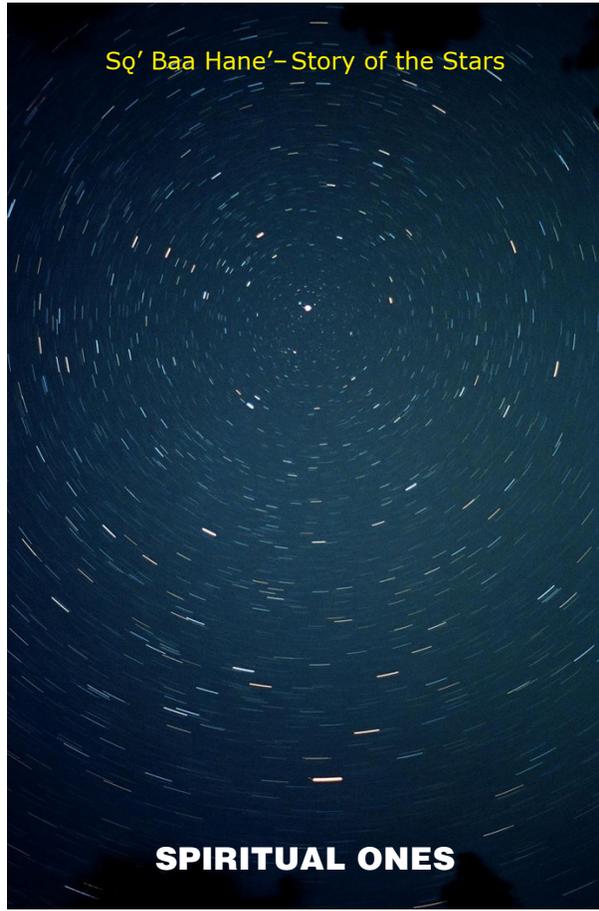
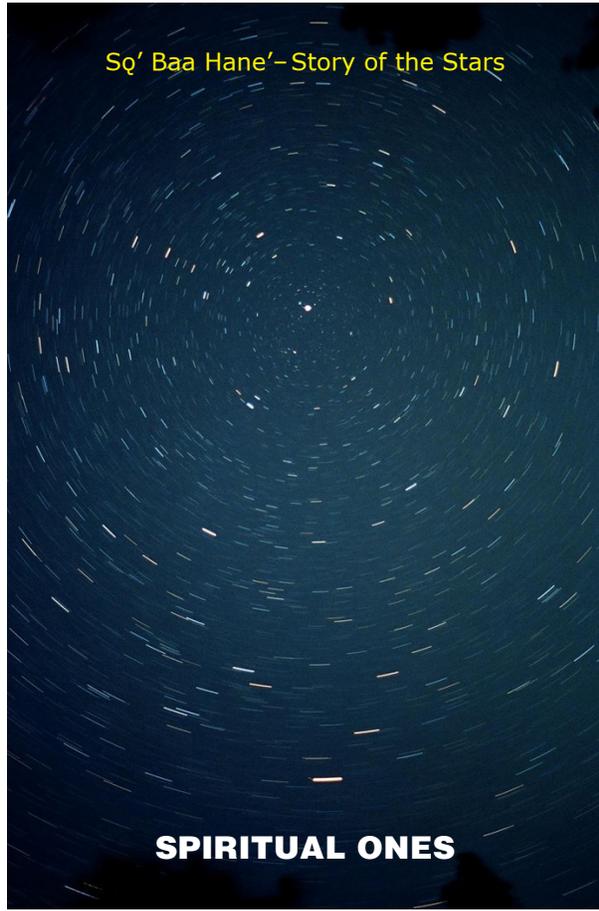
Haashch'éeeshzhiní

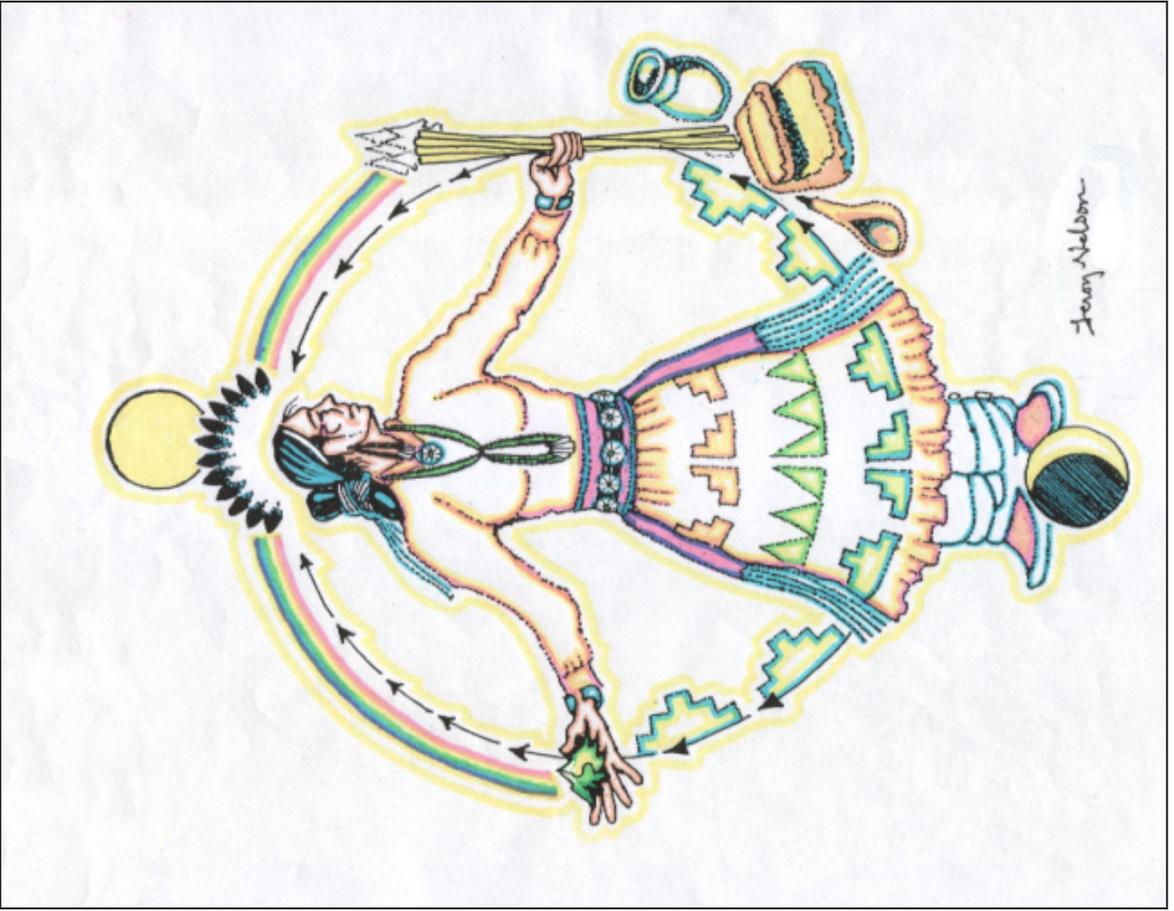
SPIRITUAL ONES

Spirit for Home

Haashch'éeé
Hooghan

SPIRITUAL ONES





Sq' Baa Hane' - Story of the Stars

Mother Earth

Nahasdzáán
Bii'astíín

Sq' Baa Hane' - Story of the Stars

Father Sky

Yá Bii'astíín

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- Alice Carron, ArtReach International
- Barbara Laval, UCLA Center for Astrobiology
- Jessie Antonellis, University of Arizona Conceptual Astronomy and Physics Education Research Center
- Sheri Klug, Arizona State University Mars Education Program

Navajo Stories

- Office of Culture, Language, and Community Services, Division of Diné Education
- Chinlé Unified School District
- Diné College

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- Leroy Nelson, Navajo Traditional Practitioner - Original Artwork
- Diné Culture Based Curriculum – Office of Diné Culture, Language, and Community Services and The American Indian Institute

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- NASA Chandra X-Ray Observatory
- NASA Spitzer Space Telescope
- NASA Solar and Heliospheric Observatory

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- Mary Dussalt, Science Education Department, Harvard-Smithsonian Center for Astrophysics

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- Florinda Jackson, Chinlé Unified School District
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- Daniel Tillman, ArtReach International
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- Barbara Laval, UCLA Center for Astrobiology
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- Jessie Antonellis, University of Arizona Conceptual Astronomy and Physics Education Research Team

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- Yvonne Yazzie, Cradleboard Teaching Project
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