MONTANA SKIES

BLACKFEET ASTRONOMY

A+ Indian Education
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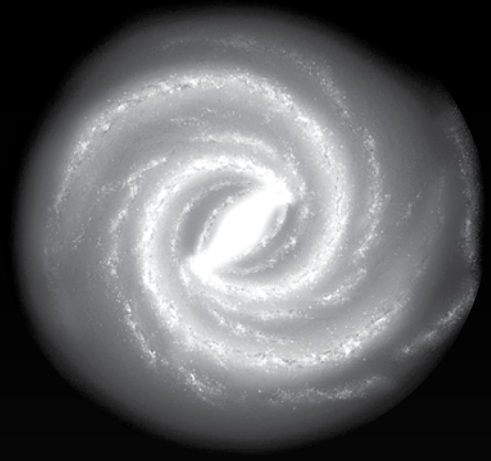
OFFICE OF PUBLIC INSTRUCTION
ELSIE ARNTZEN, STATE SUPERINTENDENT

MONTANA SKIES
Blackfeet Astronomy

Developed by Lynn Moroney

2011



MONTANA SKIES
Blackfeet Astronomy

Table of Contents

BLACKFEET ACKNOWLEDGMENTS

Thank you Blackfeet members Leo Bird, John R. Murray, and Calvin Weatherwax, for providing direction for initiation of this project.

Special thanks to Leo Bird, Browning High School teacher of Chemistry and Blackfeet Astronomy. Thank you Leo for the rich conversations that provided insights and understandings of the importance and ever present relationship between the Blackfeet people and the skies.

Thank you, also, to Cynthia Kipp and Leo Bird for editing the scripted stories and for helping the developers of the project understand the cultural significance of the stories to the Blackfeet.

Thank You

Tonia Ackerman - Beadwork Teacher at Browning High School, and her students. Thank you for demonstrating the generosity of the Blackfeet people. Thanks also to your bead work students, Lance Kicking Woman and Victoria Arredondo.

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Students of Browning High School - for your courtesy and helping hands when needed.

Stan Whiteman - Mr. Whiteman is a Blackfeet Language and Music teacher at Browning High School. He and his music students composed and recorded music and song to go with the three Blackfeet stories. The song may be heard in its entirety on the enclosed DVD.

Roger Zentzis - Browning Music Teacher and Sound Technician who recorded the song composed by Stan Whiteman and the Browning High School Singers.

Blackfeet Storytellers

The Woman Who Married a Star
Recorded by Tanisha Rattler and Cynthia Kipp
Scripted from printed sources
Edited by Leo Bird and Cynthia Kipp

Scarface
Recorded by Cynthia Kipp
Scripted from printed sources
Edited by Leo Bird and Cynthia Kipp

The Bunched Stars
Recorded by Leo Bird
Scripted from printed sources
Edited by Leo Bird and Cynthia Kipp

Cultural Connection

At the same time the early astronomers in Greece, China, and Arabia were charting the heavens and giving names to stars and constellations, the people we now know as the Blackfeet were coming to know the skies. So old is Blackfeet astronomy that the sun, moon, and stars have a place in the memory and sacred ceremonies of the Blackfeet people who can predict when various sky beings will appear. This familiarity with the sky serves to build a sense of place and beauty for the Blackfeet people not just in Montana, but in all the universe – not just for now, but for all time.

Science Connection

The arts and hands-on activities are designed to further and deepen the students' understanding of the science phenomena referred to in each of the three teaching units.

Introduction

The stories on the enclosed DVD are presented as an invitation to learn about Blackfeet Culture and Astronomy. On the DVD and in the student activities, they are referred to as Blackfeet Stories and Science Stories. We are able to touch upon only a small part of the rich traditions of the Blackfeet People and their deeply rooted relationship with the Sun, the Moon, and the Stars.

Both the traditional tales and the science explorations are offered with the understanding that neither story is superior to the other. Rather, the stories are presented together so that each in their own way may deepen the mystery of the human story and the universe in which we live.

Blackfeet members and Elders have proudly and generously shared their oral tradition of storytelling and their understanding and knowledge of the skies that the children of Montana may know something of their Blackfeet neighbors.

For more information on the Blackfeet Nation go to: *http://blackfeetnation.com/*

Links to Montana Essential Understandings and Content Standards

Essential Understanding Regarding Montana Indians

Essential Understanding 1- There is great diversity among the 12 tribal Nations of Montana in their languages, cultures, histories and governments. Each Nation has a distinct and unique cultural heritage that contributes to modern Montana.

Essential Understanding 3- The ideologies of Native traditional beliefs and spirituality persist into modern day life as tribal cultures, traditions, and languages are still practiced by many American Indian people and are incorporated into how tribes govern and manage their affairs. Additionally, each tribe has its own oral histories, which are as valid as written histories. These histories pre-date the "discovery" of North America.

Science Content Standards

4th Grade-

Science Content Standard 4. Students through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.
Benchmark 6. Identify objects (e.g., moon, stars, meteors) in the sky and their patterns of movement and explain that light and heat comes from a star called the sun
Essential Learning Expectations:
A. Define and model revolution and rotation
B. Model the orbit of the planets around the sun
C. Identify the patterns of movement between a planet, its moon, and the sun.
E. Identify other objects in the solar system (meteors, comets, and asteroids)

Social Studies Content Standards

4th Grade-

Social Studies Content Standard 6. Students demonstrate an understanding of the impact of human interaction and cultural diversity on societies.
Benchmark 2. Describe ways in which expressions of culture influence people (e.g., language, spirituality, stories, folktales, music, art, dance).

8th Grade-

Social Studies Content Standard 6. Students demonstrate an understanding of the impact of human interaction and cultural diversity on societies.
Benchmark 2. Explain and give examples of how human expression (e.g., language, literature, arts, architecture, traditions, beliefs, spirituality) contributes to the development and transmission of culture.

LISTENING TO THE BLACKFEET STORIES

For the Teacher:

Here are some suggestions to help prepare your students for the experience of listening to the stories on the enclosed DVD, Montana Skies: Blackfeet Astronomy.

- Explain that the stories they are about to hear come from the Blackfeet people and are told at night and often in winter.

- Darken your classroom as much as possible.

- Because of the high level of significance of the importance of oral stories in traditional and contemporary Blackfeet culture, it is imperative that listeners come to the stories with an equal level of respect. Communicate the expectation that students listen quietly and respectfully.

- Explain that they will hear Blackfeet stories told by members of the Blackfeet Tribe, and told much as they would be told to friends and family.

- It is best to plan this activity during a time when the stories will not be interrupted by school bells or announcements.

- Students will listen as they view only a starry night. This will seem unusual for students who are accustomed to TV. Explain that as with any story you (the teacher) or a visiting storyteller might tell, they will simply hear the stories and not see illustrations on the TV screen. Encourage your students to use their imaginations to create their own pictures as they listen to the stories.

- Some students may wish to close their eyes while listening.

- **Science Stories:** Watch the screen! Images are provided to help illustrate the concepts.

PLANETARIUM POSSIBILITIES

If possible, students' experiences would be greatly enhanced if they are able to hear the Traditional and Science stories while seated in a planetarium chamber. Use the regular screen or side wall of planetarium as the screen, and seat children uni-directionally. Ask the planetarium educator to have a very slow "Daily Motion" during the Traditional stories. After the Story units are over, enlist the help of the planetarium educator to enlarge upon the information presented.

Montana Planetaria / International Planetarium Society 09/10

1. Starlab Planetarium / 30 seats
Billings Public Educ. Foundation
415 North 30th Street #313
Billings, MT 59101-1252 USA
(406) 255-3567
Judy Henry/Stephanie Smith

2. Planetarium
Boulder School
P.O. Box 176
Boulder, MT 59632 USA
+1 (406) 225-3316
Shirley Elliot

3. Taylor Planetarium / 104 seats
Museum of the Rockies
600 W. Kagy Blvd.
Bozeman, MT 59717 USA
+1 (406) 994-2251 museum
+1 (406) 994-6874
www.montana.edu/wwwmor
J. Eric Loberg
+1 (406) 994-6891 Planetarium Manager
+1 (406) 994-2682 fax / eloberg@montana.edu

4. Starlab Planetarium / 30 seats
School District #1
215 South Sixth Street West
Missoula, MT 59801 USA
+1 (406) 728-2400x1077
+1 (406) 728-2400x1056

5. Starlab Planetarium / 30 seats
University of Montana
Missoula, MT 59812 USA
+1 (406) 243-2073
+1 (406) 243-5283
diane.friend@umontana.edu
j.naylor@mso.umt.edu

BLACKFEET STORIES AND SCIENCE STORIES
Recordings of the stories are on the enclosed DVD

THE WOMAN WHO MARRIED A STAR

EARTH ROTATION AND REVOLUTION

SCARFACE

MILKY WAY – GALAXIES

THE BUNCHED STARS

ACCRETION AND STAR FORMATION

THE WOMAN WHO MARRIED A STAR
ROTATION / REVOLUTION OF THE EARTH

Activity – The Rotation / Revolution Song

Soatsaki Sue-waat'-Tsa-gee FEATHER WOMAN	Ipisoahs ee Ee-biss'-sue-waa-ts MORNING STAR

Who? Students Grades 3-4

How long will it take? 60 minutes

What will you need?

For each child:
- A copy of the song sheet

For each group of 4-5 children:
- 1 Earth ball with axis (dowel rod)
- space to move

For the teacher:
- 1 styrofoam ball/Earth ball, approximately six inches in diameter
- 1 pencil, dowel rod, or wooden skewer for each group of 4-5 children
- 1 dark permanent marker
- Prepare a sign on a legal size sheet of paper for each: Gemini, Orion, The Pleiades (Bunched Stars), and Cassiopeia

Life Lessons:
- There are many cycles and patterns in life and nature. The pattern of Earth's movement that causes day and night and seasons is only one of those cycles.
- Things in life are not always as they appear! For example, from Earth it would "appear" that the stars are moving each night and throughout the seasons, yet we know now that it is not the stars that move at all. It is WE who are moving. Can you think of anything – or any situation – that turned out not to be as it originally appeared?

Science Lessons:
- The 24 hour ***rotation*** of the Earth causes day and night.
- The Earth spins on an imaginary line called an ***axis.***
- The **revolution** of the Earth takes 365 days, or one year.

- Because of the Earth's 24 hour rotation, the stars in the night sky "appear" to move from east to west.
- Because the Earth revolves around the Sun, the constellations appear in different positions at different times of the year.
- The Earth's axis always points toward one special star called Polaris -The North Star or "oo-YEES" - The Belly Button of the Sky, as it is called by the Blackfeet people.

Vocabulary:

- planet
- rotation
- axis
- Gemini
- Pleiades (Bunched Stars)
- Polaris
- night
- star
- revolution
- constellations
- Orion
- Cassiopeia
- day
- seasons

Resources:

Books:

Branley, Franklin. *What Makes Day and Night?* Bt Bound Publishers. ISBN 0808523775. 1999. Ages 7-8.

Caduto, Michael J. and Joseph Bruchac. ***Keepers of the Night: Native American Stories and Nocturnal Activities for Children.*** Fulcrum Publishing Co., ISBN 1555911773. 1994. Ages 10-15.

Fowler, Allan. T*he Sun is Always Shining Somewhere.* Children's Book Press. ISBN 0516449060. 1992. Ages 4-8.

Milord, Susan. *Tales of the Shimmering Sky: Ten Global Folktales with Activities from the Tales Alive Series.* Williamson Publishing. ISBN 1885593015. 1996. Ages 8-12.

Newton, Teddy. *Day and Night.* Disney Pixar. ISBN 0811876640. 2010. Ages 4-8.

Pluckrose, Henry. *Day and Night (Let's Explore Series)*. Gareth Stevens. ISBN 0836829581. 2001. Ages 4-8.

Websites:

Earth and Moon Viewer - Allows viewers to observe the distribution of Earth's daylight / darkness distribution from several viewpoints. Visitors can choose the location and time of viewing. *http://www.fourmilab.ch/earthview/.*

Enchanted Learning's Zoom Astronomy - Where young viewers ages 8–15 can find a list of the 88 constellations and short descriptions and clear illustrations of 33 of the more common ones. Links to definitions of terms such as "globular cluster" and "planetary nebulae" enhance the viewers' experience. *http://www.enchantedlearning.com/subjects/astronomy/stars/constellations.shtml.*

The Space Place: Why is Earth rotating? - This NASA site offers children ages 8-15 information about Earth's rotation and revolution. Requires Macromedia Flash Player. *https://spaceplace.nasa.gov/review/dr-marc-earth/earth-rotation.html*

Teacher Guide:

- Before beginning the activity, push the pencil, dowel rod or skewer all of the way through the center of each Styrofoam ball. The Styrofoam ball represents Earth and the wooden pole going through it represents the Earth's axis. The students should hold each end of the axis vertically. Draw a line around the ball vertically to parallel the line of axis in order to divide the Earth into day and night and mark each side appropriately.

- In the following activity, the concepts of day and night, seasons, rotation, and revolution will be reinforced by integrating song, science, and movement. The Rotation/Revolution song is sung to the tune "The Wheels on the Bus". The children may either sing the song a capella or, if you prefer to use music, you may access the tune at: *http://www.gardenofsong.com/midi/wheelsbus8.mid.* Singing the song a capella, however, may allow you more freedom to stop and discuss, or answer questions about particular concepts. And it will allow the children to learn the song at their own pace without feeling rushed to keep up with the music.

  As the children are learning the song, instruct them before each stanza regarding what actions they should perform with each particular set of words. Below is the song with teacher instructions, followed by a song sheet without instructions to copy for the children.

- **Distribute the Styrofoam ball Earths to each group of 4-5 children, and song sheets to each child.** Briefly explain, or demonstrate the concepts of day/night, seasons, rotation, revolution, and axis. For now, a brief explanation should be sufficient, as the children will be able to understand these concepts more clearly through their interaction with the song lyrics.

THE ROTATION / REVOLUTION SONG –
Teacher Guide

1. Have the children hold their Earth horizontally by both ends of the axis and spin their Earth around – counterclockwise - as they sing the first stanza

Stanza 1 - The Earth on its axis spins round and round – counterclockwise– 'round and 'round
And the axis through the Earth is up and down, as the Earth spins 'round and round.

~~~

2. Appoint one person from each group to be the Sun. Have that person stand across from the person holding the Earth. Standing in place, the Earth person should turn the Earth "one" complete rotation each time the words "rotation of the Earth takes 24 hours" is sung . Other than that, the Earth's "day" side should always face toward the Sun and the "night" side away from the Sun.

Stanza 2 - Rotation of the Earth takes 24 hours – day and night – dark and light.
Rotation of the Earth takes 24 hours – and that's one day and night.

~~~

3. Invite the Sun to stand in the center of the group and have the Earth travel around it as the song is sung.

Stanza 3 - Revolution of the Earth is going 'round the Sun. Goin' 'round the Sun, 'till one year is done.
Revolution of the Earth is going 'round the Sun, 'till one whole year is done!

~~~

4. The Sun should remain in the center. And the Earth should, again, travel around it throughout the song. This time, however, the Earth should tilt its axis 24 degrees. (Small children may need help to position their Earth). And, most importantly, the Earth "must keep" the axis tilted in the "same direction" the entire trip around the Sun. It is easier to do this if a particular spot on a wall is chosen to align with (for example, a wall clock or picture).

Stanza 4 - The Earth has a tilt that's 24 degrees. It's what causes winter, spring, summer and fall.
The tilt causes winter, spring, summer and fall. With no tilt we'd have no seasons at all!

~~~

5. After the children have learned and performed the song, invite one of them to be the Earth and the others to be the constellations Gemini, Orion, the Pleiades / Bunched Stars (known to the Blackfeet as Bunched Stars), and Cassiopeia.

6. Have the constellations stand side by side, in order, opposite the Earth. Invite the Earth to hold the Styrofoam ball at a 24° tilt, with the "night" side facing the stars.

7. Now have him or her very slowly turn the Earth, while also moving it in a slow sweeping motion across the constellations.

8. Can they see that, as the Earth moves at night, the constellations appear in different positions?

9. Can they also see that the axis continues to point to the same spot, toward the special star we call the Pole Star – or Polaris – or what the Blackfeet call "Ooyis" or the "Belly Button." Have the children take turns being Earth to observe this phenomenon!

10. Have children STOP during the song from time to time. Stop Rotation but continue Revolution. Stop Revolution but continue rotating. This will help them understand the difference between rotation and revolution.

THE ROTATION / REVOLUTION SONG – For the Student

Stanza 1
The Earth on its axis spins 'round and 'round - counterclockwise 'round and 'round
The axis through the Earth is up and down, as the Earth spins 'round and 'round.

Stanza 2
Rotation of the Earth takes 24 hours - day and night - dark and light.
Rotation of the Earth takes 24 hours - and that's one day and night.

Stanza 3
Revolution of the Earth is goin' 'round the Sun. - goin' 'round the Sun, 'till one year is done.
Revolution of the Earth is goin' 'round the Sun, 'til one whole year is done!

Stanza 4
The Earth has a tilt that's 24 degrees. It's what causes winter, spring, summer and fall.
It's the tilt that causes winter, spring, summer and fall. With no tilt we'd have no seasons at all!

THE ROTATION / REVOLUTION SONG – For the Student

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Revolution of the Earth is goin' 'round the Sun, 'til one whole year is done!

Stanza 4
The Earth has a tilt that's 24 degrees. It's what causes winter, spring, summer and fall.
It's the tilt that causes winter, spring, summer and fall. With no tilt we'd have no seasons at all!

SCARFACE
SPIRAL GALAXIES
Activity – Making the Milky Way

Poia	**Maa-ko-yoh-so-ko-yi**
Boo-yee	**Ma(w)-goo-yoo'h-soo-goo-yee**
SCARFACE	**WOLF TRAIL (MILKY WAY)**

Who? Students Grades 4-5

How long will it take? 60 minutes

What will you need?

For each child:
- 1 clear CD or DVD case (preferably 1cm thick, students can bring from home and/or teacher provides)
- Glitter in a variety of colors
- 1 large sequin or star shaped confetti
- Liquid school glue (not a glue stick)
- 3 pipe cleaners
- newspaper or scratch paper on which to work
- A copy of Worksheet #1 and Worksheet #2 (Student Activity: Making the Milky Way)

Life Lessons:
- Scarface made his journey to Sun's house even though he was afraid.
- Courage is when we do what we must, even though we are afraid.
- He asked for and welcomed the help of others.

Science Lessons:
- Our galaxy, The Milky Way, is a spiral shaped galaxy.
- There are billions of stars in our galaxy.
- Stars have different temperatures.
- There is a black hole in the center of our galaxy.
- Our galaxy looks to us like a thin milky band or path of pale light and sparkling stars in the night sky.
- It is actually in the shape of a spiral with several thick bands or arms each with billions of stars.

Vocabulary:
- galaxy
- spiral galaxy
- star
- black hole
- Milky Way Galaxy
- solar
- billion
- system

- planet
- moon
- inference (important to teach concept ahead of time, could be incorporated into reading instruction)

Books:

Asimov, Isaac. *Our Vast Home: The Milky Way and Other Galaxies.* Gareth Stevens Publishing. ASIN 083681195X 1995. Ages 10–18.

Kirkwood, Jon. *Stars and Galaxies (Look Into Space).* Copper Beech. ISBN 0761309179. 1999. Ages 9–12.

Simon, Seymour. *Galaxies*. Bt Bound. ISBN 0833580531. 1999. Ages 10–15.

Sipiera, Paul P. *Galaxies.* Children's Press. ISBN 0516203339. 1997. Ages 8–11.

Stryer, Andrea Stenn. *The Celestial River: Creation Tales of the Milky Way.* August House Publishers. ISBN 0874835291. 1998. Ages 10–13.

Vogt, Gregory. *The Milky Way (Galaxy).* Bridgestone Books. ISBN 0736813845. 2002. Ages 8–12.

Vogt, Gregory. *The Milky Way and Other Galaxies.* Raintree. ISBN 0739831070. 2000. Ages 10–14.

Welsbacher, Anne. *Galaxies*. Abdo & Daughters. ISBN 1562397192. 1997. Ages 9–11.

Websites:

Astronomical Society of the Pacific's Universe in the Classroom - provides children with a "tour of the Milky Way." They begin with Earth and work their way to the edges of our solar system, stopping to learn about the planets and their moons, and then continue to explore stars and nebula beyond. It is a fantastic site! *http://www.astrosociety.org/edu/publications/tnl/47/voyage.html*

Enchanted Learning's Zoom Astronomy - offers short, easy-to-understand explanations, with images, of each type of galaxy. Go to:
http://www.enchantedlearning.com/subjects/astronomy/stars/constellations.html then select galaxy or Milky Way.

NASA'S Space Telescope Science Institute - has an awe inspiring collection of galactic photos and other resources for teachers and students of all ages. Go to *http://www.stsci.edu/portal* then key in galaxy photos.

Windows to the Universe - offers three educational levels on a large selection of space topics. Information about galaxies is presented in a child-friendly format with dazzling Hubble images and links to galaxy terms. *http://windows2universe.org/the_universe/Galaxy.html*

Other:

Multiwavelength Milky Way Poster - Created by NASA's Goddard Space Flight Center, this impressive view of the Milky Way from ten wavelengths, with a short paragraph accompanying each wavelength image, is available on heavy paper stock and measures 65 cm × 98 cm. Order on line at: *http://mwmw.gsfc.nasa.gov/mmw_product.html.*

Teacher Guide:

You may wish to provide pictures of several spiral galaxies to help the children visualize what theirs should look like (see Resources-Websites). You may also want to mix the glitter colors ahead of time for convenience.

Making the Milky Way

Teacher Guide for Worksheet #1

Teacher: Hand out the worksheet #1 to each student. Before you begin, ask the children to answer the following questions and then discuss with the class:

1. **Which of the following do you have: brothers, sisters, parents, grandparents, aunts, uncles, cousins?**

2. **What is this group that they are a part of called?** It is a family. A family "system."

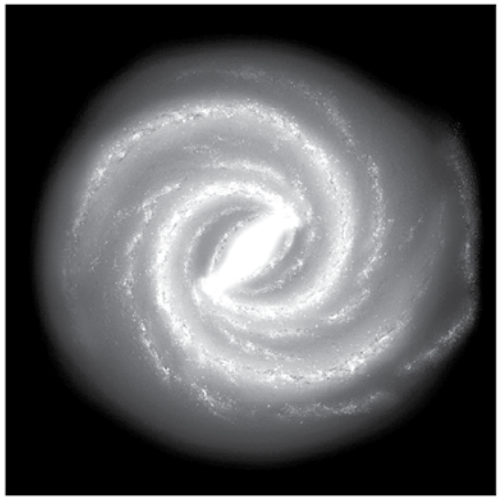
3. **What is a "system?"** A system is a group of parts that are related to form a whole. So you are "related" to your relatives and together you form a whole family system.

4. **Do the planets form a system?** Yes.

5. **What is that system called?** The Solar System.

6. **How is the Solar System like your family system?** Answers will vary.

7. **There are many other solar systems in our part of space and that they also work together to form an even bigger system. What is the name of that system?** The Milky Way galaxy.



Credit: NASA/JPL-Caltech/R. Hurt (SSC/Caltech)

8. **Explain why galaxies, like The Milky Way, are systems?** Because just as all our planets, moons, and Sun work together as a whole, so do all the solar systems and stars in our part of the universe work together as a galaxy system.

9. **Are all the members of your family system alike? Explain.** No. And neither are all the stars in our galaxy alike. Just like in your family, some stars are older, some younger, some stars are hotter, others cooler, some are bigger, and there are many different star colors, such as, blue, white, yellow, orange and red (in order of temperature, from hottest to coolest).
   Fun Fact: Artists teach us that Red is one of the "warm" colors and Blue is one of the "cool" colors. Artists are talking about the "feelings" and "moods" that are expressed with colors; Scientists teach us that the Red Stars are "cool" and Blue Stars are "hot." Scientists are talking about the "Temperatures" of stars.

10. **Do you think your family would appear the same to an outsider who doesn't really know them as it does to you? Explain.** Probably not. Neither does our galaxy appear the same from Earth as it does from deep space.

Making the Milky Way

Teacher Guide for Worksheet #2

1. Teacher may need to create a model ahead of time to show students what completed project will look like. Teacher may also choose to model the procedures as the activity takes place.

2. Spread some newspaper on your work surface.

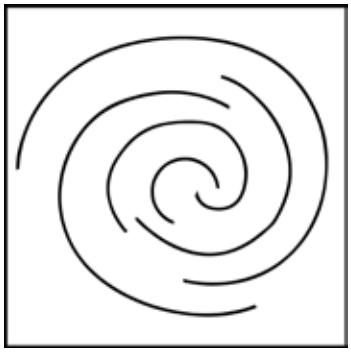
3. Hand out Student Worksheet #2.

4. Open the CD case and remove any paper.

5. Cut the pipe cleaners into the following size pieces: (1) 8", (1) 6", (1) 4", (1) 3", and (1) 2"

6. Shape each piece into a slight curve. The curved pieces will become the arms in your spiral galaxy.

7. Pour glue on the newspaper. Dredge the pieces of pipe cleaner through the glue to completely coat them.



8. Take the shortest piece and place it in the center of your CD case. One at a time, add each piece in a spiral shape in order of size. Make sure the pieces of pipe cleaner don't touch one another.

9. The arms of the Milky Way are close, but not exactly connected. Leave a small empty space in the middle.

10. After all the pieces are in place, sprinkle a heavy coating of glitter on them. Place the sequin or star on one of the outer arms of your spiral. Let the glitter dry, then, shake off the excess.

Teacher: After completing their Milky Way Galaxy, ask the students to write their answers on worksheet #2 and then discuss the following questions and ideas with their classmates:

1. **Why did we leave the center of the galaxy empty?** Can you guess what the empty space in the middle represents? Because at the center of our galaxy there lives a Black Hole. The Black Hole has gravity so strong that nothing can escape it, not even light.

2. **Describe how your galaxy looks if you hold it parallel to the ground and look into it from the thin side?** It looks like a single band of glitter.

3. **How does it appear different when viewed from the top?** Now it appears like several bands of glitter in the shape of a spiral.

4. **What inferences can you make about how our galaxy appears to us?** The reason we don't see our galaxy as a spiral is because of the position from which we are viewing it.

5. **What do you think each piece of glitter represents?** A single star.

6. **What do the different colors of glitter represent?** The different colors of glitter represent the different star temperatures. Young, hot stars are blue and older stars are red.

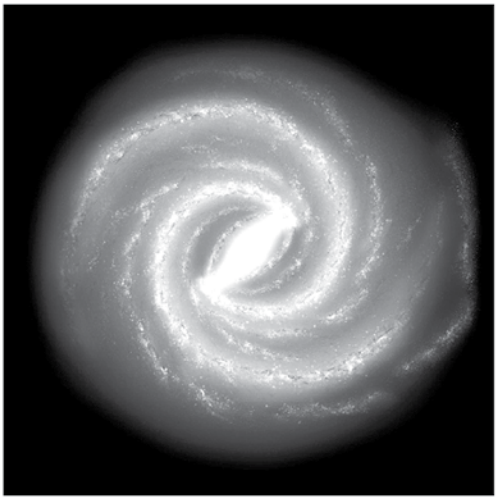
7. **What special location does the sequin or star shape represent?** That special sequin represents the location of our Sun and solar system within The Milky Way galaxy. (Our Sun is actually an average size star. We just made it larger so it would show up).

8. **Estimate how many pieces of glitter do you think are on your Milky Way?** Your guess is as good as mine.

9. **How many stars do you think are in just our galaxy alone?** There are about a couple of hundred billion stars in our little galaxy. And our neighbor, The Andromeda Galaxy, has about 500 billion stars. And there are a couple of hundred billion galaxies in our universe. And there may be even more universes than ours. Whew!

Making the Milky Way

Student Worksheet #1



Credit: NASA/JPL-Caltech/R. Hurt (SSC/Caltech)

Complete before doing the activity.

1. Which of the following do you have: brothers, sisters, parents, grandparents, aunts, uncles, cousins?

2. What is this group that they are a part of called?

3. What is a system?"

4. Do the planets form a system?

5. What is that system called?

6. How is the Solar System like your family system?

7. There are many other solar systems in our part of space and that they also work together to form an even bigger system. What is the name of that system?

8. Explain why galaxies, like The Milky Way, are systems.

9. Are all the members of your family system alike? Explain>

10. Do you think your family would appear the same to an outsider who doesn't really know them in the same way your family appears to you? Explain.

Making the Milky Way

Student Worksheet #2

STUDENT ACTIVITY: MAKING THE MILKY WAY

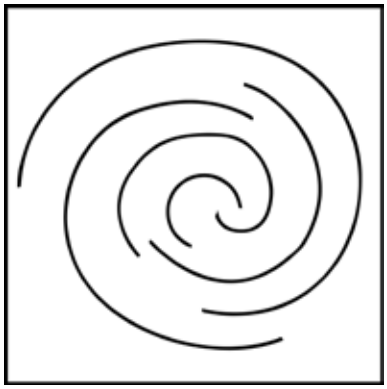
1. Spread some newspaper on your work surface.

2. Open the CD case and remove any paper.

3. Cut the pipe cleaners into the following size pieces: (1) 8", (1) 6", (1) 4", (1) 3", and (1) 2"

4. Shape each piece into a slight curve. The curved pieces will become the arms in your spiral galaxy.

5. Pour glue on the newspaper. Drag the pieces of pipe cleaner through the glue to completely coat them.



6. Take the shortest piece and place it in the center of your CD case. One at a time, add each piece in a spiral shape in order of size. Make sure the pieces of pipe cleaner don't touch one another.

7. The arms of the Milky Way are close, but not exactly connected. Leave a small empty space in the middle.

8. After all the pieces are in place, sprinkle a heavy coating of glitter on them. Place the sequin or star on one of the outer arms of your spiral. Let the glitter dry, then, shake off the excess.

Answer and then discuss the following questions and ideas with your classmates:

1. Why did we leave the center of the galaxy empty?

   _____

   _____

2. Describe how your galaxy looks if you hold it parallel to the ground and look into it from the thin side?

   _____

   _____

3. How does it appear different when viewed from the top?

   _____

   _____

4. What inferences (educated guesses) can you make about how our galaxy appears to us?

   _____

   _____

5. What do you think each piece of glitter represents?

6. What do the different colors of glitter represent?

7. What special location does the sequin or star shape represent?

8. Estimate how many pieces of glitter do you think are on your Milky Way?

How many stars do you think are in just our galaxy alone?

THE BUNCHED STARS
ACCRETION / STAR FORMATION
Activity – Modeling Accretion and Star Formation

Miohpoisiks
Mee-oo'h-boo'h-sicks
BUNCHED STARS

Who? Students Grades 4-6

How long will it take? 60 minutes

What will you need?

For each child:
- Copies of Student Activity pages

For each group of 4-5 children:
- 1 metal pie tin
- Newspaper
- 1/3 cup tap water
- 2 TBSP vegetable oil
- 1 cup, divided into 1/4 cup portions of rubbing alcohol
- red food coloring (the kind sold in individual bottles works best)
- 2 pinches, or about 1/8 tsp. of glitter (silver works best)
- spoon or stir stick
- flashlight
- small paper cups
- paper towels to clean up any mess

Each student needs:

Life Lessons:

- Families are like nebulae. Some families are large with many members, and some are smaller. Some nebulae are large with thousands of stars, and some are much smaller. But just like the stars within a nebula, it is a natural tendency for humans to remain close to their families.
- Within nebulae, gravity brings the star material together and holds the stars in place. For humans, many factors bring and bind family members together, such as love and loyalty … like gravity.

Science Lessons:

- Galaxies are formed by the accretion of interstellar gas and dust. Most of the gas is hydrogen.
- As the galaxy begins to accrete and form, so does the material within it begin to draw closer and closer.
- This material eventually draws so closely together that the hydrogen atoms collide, creating helium, and a star is born.
- Most stars are born in star families, or bunches, called star clusters.
- Nebulae vary in size as do the number of stars they contain. Some contain thousands of stars, while others have far fewer.
- The total number of stars in a cluster is rarely visible with the naked eye.
- There is a central bulge of older stars in the center of our Milky Way galaxy.

Clarifying Possible Misconceptions:

- EM Radiation- During the Bunched Stars Science Story, the narrator says "you are able to hear radiation when you listen to the radio." This statement could lead to a common misconception.
- To clarify, while EM radio waves brought the signal to your radio, what you are hearing is sound waves and they are something very different. Sound waves are compressional waves that require a medium to propagate while electromagnetic waves (of all wave length, including radio waves) are electromagnetic disturbances that need no medium to propagate. Therefore, you are "hearing" EM radiation because it is being translated into sound waves by your speakers.

Vocabulary:

- nebula (nebulae)
- gravity
- star
- accretion (accrete)
- interstellar gas & dust
- protostar
- hydrogen
- helium
- atom
- star cluster
- Central Bulge
- interstellar
- nucleus (Nuclei)
- proton
- nuclear fusion
- static

Resources:

Books:

Asimov, Isaac. Star Cycles: *The Life and Death of Stars* (Library of the Universe). Gareth Stevens Publishing, ISBN 0836812271. 1995. Ages 9-12.

Cole, Joanna. *The Magic School Bus Sees Stars* (A Book About Stars). Scholastic Inc., ISBN 0590187325. 1999. Ages 5-10.

Gallant, Roy A. *Stars* (Kaleidoscope: Space). Benchmark Books. ISBN 0761410368. 2000. Ages 8-12.

Kirkwood, Jon. *Stars and Galaxies* (Look Into Space). Copper Beech. ISBN 0761309179. 1999. Ages 9–12.

Oughton, Jerrie. *How the Stars Fell Into the Sky: A Navajo Legend*. Houghton Mifflin. ISBN 0395779383. 1996. Ages 5-8.

Simon, Seymour. *Galaxies*. Bt Bound. ISBN 0833580531. 1999. Ages 10–15.

Sipiera, Paul P. Galaxies. *Children's Press.* ISBN 0516203339. 1997. Ages 8–11.

Resources:

Websites:

Astronomical Society of the Pacific's The Universe in the Classroom - gives website visitors a "tour of the Milky Way" through images and Web pages of selected sites, beginning with Earth and continuing to the edges of our solar system. *http://astrosociety.org/edu/publications/tnl/47/voyage.html*

Discovery School - takes children ages 10-18 on a tour of the Milky Way and beyond. *http://school.discoveryeducation.com/schooladventures/universe/galaxytour/.*

Enchanted Learning's excellent Zoom Astronomy - website is for children ages 10-15. Basic information about star birth and death, galaxies and much more can be found. *http://www.enchantedlearning.com/subjects/astronomy/stars/index.shtml.*

The Life Cycle of Stars - an online book from StarChild, a Web site of Goddard Space Flight Center. For ages 5–13. *http://imagine.gsfc.nasa.gov/docs/teachers/lifecycles/SC_title.html.*

NASA's Imagine the Universe! - offers "The Hidden Life of Galaxies" for educators and children ages 12-18. *http://imagine.gsfc.nasa.gov/docs/teachers/galaxies/imagine/toc.html.*

NASA's Space Telescope Science Institute - a website for teachers and students of all ages. *http://amazing-space.stsci.edu/resources/explorations/galaxies-galore/teacher/grabbag.html#activities.*

StarChild: A Learning Center for Young Astronomers - a NASA website for children 5 and up and offers a treasure chest of stellar resources for both educators and children ages 5 and up. *http://starchild.gsfc.nasa.gov/docs/StarChild/.*

Where Do Stars Come From? And Where Do They Go? - a free downloadable poster from the Space Telescope Science Institute showing the star life cycle for ages 12 and up. *http://teachspacescience.org/graphics/pdf/10000508.pdf.*

The Windows to the Universe presents Stars - for the general public, teachers, and students of all ages.*https://www.nasa.gov/multimedia/imagegallery/image_feature_1154.html*

Modeling Accretion and Star Formation

Teacher Guide for Student Worksheet #1

- You may wish to pre-measure the water, oil, alcohol, glitter, and food coloring into small paper cups before beginning the activity. For older children, this would be a good opportunity for them to practice their measuring skills and fraction conversions.
- This activity is designed to be done together as a class in a step-by-step fashion, with students describing and recording their observations after each step on their Student Activity pages.
- Provide each student with a copy of the Student Activity pages.
- Divide the children into groups of 3-5. Before you begin the activity, ask them the following questions and invite them to discuss and record their answers on the Student Activity Pages.
- Student instruction are:

    - Today you will create a model of the process called "accretion" that you learned about in the Science Story.
    - You will see how "gravity" causes accretion and you will observe how this process creates "nebulae" (clouds of gas and dust in space).
    - You will observe how stars form in bunches or clusters of stars that are the same relative age and composition.
    - The activity sheet below will help guide you through the process of accretion and star birth.
    - Read each question carefully before proceeding to the next step.
    - You may wish to have group members take turns reading the questions.
    - Some questions include answers and explanations, but some you will need to answer yourself.
    - Make sure to record all your observations and ideas as instructed.
    - Have fun learning about star families.

- **Are all the children in your family – your brothers, sisters, cousins, nieces, nephews – and even close friends – all fairly close in age? Explain.** Compared to the life of the universe, if there is only a 5-10 year age difference, then that is pretty close.
- **List ways in which you are similar to your family members and friends?** You may share the same eye or hair color, be the same age or same body shape, or even just have the same likes and dislikes.
- **Stars are also born into clusters, or "families." How do you think that might happen?** A star cluster is a group of stars close to one another in space. They are much alike in several ways. Because the stars in the cluster favor one another, it is believed that they share a common origin.
- **Could you say the same thing about your family? Explain**.
- **The Bunched Stars in our story represented six brothers. How many "stars" are in your family?** As you complete the following activity, see if you can locate a star cluster that has the same number as your family.

Modeling Accretion and Star Formation

Teacher Guide for Student Worksheet #2

Guide students through the activity, taking time to allow them to respond to questions and discuss their findings as a group.

In the following activity you will create a model of the process you learned about in the Science Story called "accretion." You will also learn about the role "gravity" plays in accretion. You will see how this process creates "nebulae" clouds of gas and dust in space – and how stars can form in groups, or clusters…clusters of the same relative age and composition…just like the "stars" in your own family group.

1. Spread newspaper on your work surface and place all the supplies for the activity on the paper.

2. Pour 1/3 cup of water into the pie tin. You will soon be creating our Milky Way galaxy in the pie tin.

3. Now place about 3-4 drops of red food coloring in the water. Gently stir until mixed. The food coloring represents all the gas and dust in your young Milky Way galaxy.

4. Next, slowly pour 2 TBSP oil into the center of the pie tin.

   Observe with your flashlight and describe on your activity sheet what your galaxy looks like now.

5. Teacher: When the children pour the oil into the center of the pie pan, it creates a "hole" or blank spot. After the children have written their observations, share with them that this represents the "central bulge" that is located in the middle of the Milky Way galaxy. Tell them they will be observing it again in a few minutes to see how it changes.

6. With a spoon or your fingers, gently sprinkle the glitter on top of your Milky Way, making sure it is as evenly distributed as possible.

   Students will answer:
   a. What do you think the glitter you have sprinkled across your young galaxy represents?
   b. Describe how your galaxy looks now.
   c. Do you see very much movement or activity in your galaxy? Describe.

   Explain: The glitter they have just sprinkled represents "protostars" or star material, i.e. the hydrogen gas and dust that will eventually, through the force of gravity and the process of accretion, become stars. Ask them to record on their activity sheets how their Milky Way looks now and whether or not they observe very much movement or activity yet. At this point they should only see a relatively static (stationary) field of star material.

7. Stir the liquid slowly, moving the spoon around the edge of the pan 4-5 times.
   Did the look of your galaxy change? If so, in what way?

Students will answer:

d. Did the appearance of the galaxy change?
e. If so, in what way? Describe how it looks now.

Explain: As the mixture began to swirl, the oil creates "bubbles." The bubbles that were created represent the interstellar gas and dust that "accreted" to become nebulae (plural of nebula).

Observe the protostars in your galaxy. Remember that "protostars" have all the material they need to become stars, but they still aren't quite there yet. (Sort of like a cake.) You can have a bowl containing eggs, sugar, flour, chocolate, Yum! But, as yet you do not have a cake. You must mix the ingredients and then bake them in the oven.)

8. Do you remember from the Science Story what force has to be present to bring the star material close enough together – so close – that it will "explode" into real stars? **Discuss your thoughts with the group or class and record your conclusions on the activity sheet.** Some of the children may remember from the Science Story that the force of "gravity" is what pulls star material together to create nebula and, eventually, to create stars – most often in clusters.

9. **Are you ready to create stars? Bunched stars? Then we will have to add some gravity.**
To do that, one person in your group should again slowly swirl the galaxy, which contains **protostars,** around the pan. While that person is swirling your galaxy, another person in the group should get the cup of alcohol ready. After 7 or 8 swirls, stop. Now pour 1/4 of the alcohol around the inside edge of the pie tin. Observe. Wait about 10 seconds and pour another 1/4 of the alcohol a little further out from the edge than the first time. Observe. Wait 10 seconds and repeat with another 1/4 of the alcohol, wait, and then repeat it one last time, using the rest of the alcohol.

10. **Using the flashlight, observe your galaxy creation now**. If you look carefully you will see small "explosions" and twinkling.

Describe what your galaxy looks like on your activity sheet. Then, discuss with your group what you think the explosions and the twinkling you are seeing might represent and record your ideas. At this point the children should have created several nebulae (giant clouds of star material) within their pie pan galaxy, and there should be several stars that have "accreted" within each nebula. The star "material" that was once floating freely in interstellar space drew closer and closer together. So close that not only one star, but a "bunch" of stars were born, at relatively the same time. The tiny explosions represent star birth – or the nuclear reaction that happens within each protostar as four hydrogen nuclei (protons) combine, or fuse, to create helium. This is nuclear fusion. It is the process that causes a star to be born and that continues within a star's core until its death.

11. **Finally, compare these "bunched" stars to the members in your own family.** Do you see that some of the nebulae are larger than others? And some have more stars than others?

Find and explain how one of the nebulae within your galaxy is similar to your own family. You may need explain how students could include all those you they are close to, i.e. grandparents, cousins, aunts, uncles, and even friends, because – even though we may only see a few stars with our eyes - star clusters contain from tens to thousands of stars, all of the same age and same basic chemical composition.

Discuss with your group or class all the ways you can think of that these bunched stars are like your own family and record your thoughts. Answers will vary but should include comparisons such as "all the stars are made of the same thing" and "all the stars are close to each other, like the members of my family."

Share with the children that the most abundant star material is hydrogen, which is one of the basic components of water. About 70% of the human body is water.

Invite the children to repeat the step-by-step process of accretion and star/star cluster formation, then discuss the Life Lessons and Science Lessons.

Modeling Accretion and Star Formation

Student Worksheet #1

Instructions:

- Today you will create a model of the process called "accretion" that you learned about in the Science Story.
- You will see how "gravity" causes accretion and you will observe how this process creates "nebulae" (clouds of gas and dust in space).
- You will observe how stars form in bunches or clusters of stars that are the same relative age and composition.
- The activity sheet below will help guide you through the process of accretion and star birth.
- Read each question carefully before proceeding to the next step.
- You may wish to have group members take turns reading the questions.
- Some questions include answers and explanations, but some you will need to answer yourself.
- Make sure to record all your observations and ideas as instructed.
- Have fun learning about star families.

1. Are all the children in your family – your brothers, sisters, cousins, nieces, nephews – and even close friends – all fairly close in age? Explain. _____
   _____
   _____

2. List some ways in which you are similar to your family members and friends. _____
   _____
   _____
   _____

3. Stars are born into clusters, or "families." How do you think that might happen? _____
   _____
   _____
   _____

4. Could you say the same thing about your family? Explain. _____
_____
_____

5. The Bunched Stars in our story represented six brothers. How many "stars" are in your family? _____
_____
_____
_____ _____
_____
_____
_____
_____
_____

Modeling Accretion and Star Formation

Student Worksheet #2

In the following activity you will create a model of the process you learned about in the Science Story called "accretion." You will also learn about the role "gravity" plays in accretion. You will see how this process creates "nebulae" clouds of gas and dust in space – and how stars can form in groups, or clusters…clusters of the same relative age and composition…just like the "stars" in your own family group.

1. Spread newspaper on your work surface and place all the supplies for the activity on the paper

2. Pour 1/3 cup of water into the pie pan. You will soon be creating our Milky Way galaxy in the pie pan!

3. Now place about 3-4 drops of red food coloring in the water. Gently stir until mixed. The food coloring represents all the gas and dust in your young Milky Way galaxy, but nothing has accreted just yet.

4. Next, slowly pour 2 TBSP oil into the center of the pie pan.

5. **Observe with your flashlight and describe what your galaxy looks like now.** _____

_____

_____

_____

6. With a spoon or your fingers, gently sprinkle the glitter on top of your Milky Way, making sure it is as evenly distributed as possible.

a) **What do you think the glitter you have sprinkled across your young galaxy represents?**

_____

b) **Describe how your galaxy looks now.** _____

_____

_____

_____

c) **Do you see very much movement or activity in your galaxy? Describe.** _____

_____

_____

_____

7. Stir the liquid slowly, moving the spoon around the edge of the pan 4-5 times, then stop and use your flashlight to observe.

a) **Did the appearance of your galaxy change?** _____

_____

_____

b) **If so, in what way? Describe how it looks now.** _____
_____
_____
_____

Observe the protostars in your galaxy. Remember that "protostars" have all the material they need to become stars, but they still aren't quite there yet. (Sort of like a cake.) You can have a bowl containing eggs, sugar, flour, chocolate, Yum! But, you don't have a cake yet. You must mix the ingredients and then bake them in the oven.)

8. Do you remember from the Science Story what force has to be present to bring the star material close enough together – so close – that it will "explode" into real stars. **What is that force called**? _____
_____

9. Are you ready to create stars? Bunched stars? Then we will have to add some gravity.

To do that, one person in your group should again slowly swirl the galaxy, which contains protostars, around the pan.

While that person is swirling your galaxy, another person in the group should get the cup of alcohol ready.

After 7 or 8 swirls, stop.

Now pour 1/4 of the alcohol around the inside edge of the pie tin.
Observe.

Wait about 10 seconds and pour another 1/4 of the alcohol a little further out from the edge than the first time. Observe.

Wait 10 seconds and repeat with another 1/4 of the alcohol, wait, and then repeat it one last time, using the rest of the alcohol.

10. Using the flashlight, observe your galaxy creation now. Describe what it looks like. _____
_____
_____
_____

Discuss with your group what you think the explosions and the twinkling might represent and record your ideas. _____
_____
_____

11. Finally, compare these "bunched" stars to the members in your own family. Do you see that some of the nebulae are larger than others? And, some have more stars than others? Find and explain how one of the nebulae within your galaxy is similar to your own family. _____

_____

_____

_____

_____

_____

_____

_____

_____

The Browning High School Singers
The Blackfeet Star Story Song

LOOK AT

Morning Star: Ee-biss'-sue-waa-ts

WATCHING

Feather Woman: Sue-waat'-Tsa-gee

DANCING WITH

Star Boy: Ga-ga-doo-see

WHILE

Scar Face: Boo-yee

SINGS WITH

The Bunch of Stars: Mee-oo'h-boo'h-sicks

SAY IT IN BLACKFEET!

English	Phonetic Spelling	Blackfeet Dictionary Spelling
THE WOMAN WHO MARRIED A STAR		
Morning Star	Ee-biss'-sue-waa-ts	Ipisoahs
Feather Woman	Sue-waat'-Tsa-gee	Soatsaki
Star Boy	Ga-ga-doo-see' Skoo-ma-pi	Ka-ka-to-si' Sko-ma-pi
Star	Ga-ga-doo-see	Ka-ka-to-si
SCAR FACE		
Scar Face	Boo-yee	Poia
Wolf trail (Milky Way)	Ma(w)-goo-yoo'h-soo-goo-yee	Maa-ko-yoh-so-ko-yi
THE BUNCHED STARS		
Bunched Stars:	Mee-oo'h-boo'h-sicks	Miohpoisiks
Sun	Na-doo-see	Natosi
Moon	Goo'-goom-me-gee-soom	Ko'-koom-mi-ki-soom

RESOURCES

These stories, "The Woman Who Married a Star", "Scarface", and "The Bunched Stars" were offered to the *Montana Skies: Blackfeet Astronomy* project by Leo Bird, who learned them by means of traditional Blackfeet Oral Traditions.

Bullchild, Percy, *The Sun Came Down: The History of the World as My Blackfeet Elders Told It*. Lincoln, University of Nebraska Press: Bison Book, 2005.

Grinnell, George Bird, *Blackfoot Lodge Tales: The Story of a Prairie People.* Lincoln/ London: University of Nebraska Press. Bison Book, 1962.

McClintock, Walter, *The Old North Trail: Life, Legends and Religion of the Blackfeet Indian.* Lincoln: University of Nebraska Press. Bison Book, 1999.

Wissler, Clark and Duvall, D.C., *Mythology of the Blackfoot Indians.* Lincoln/London: University of Nebraska Press. Bison Book,1995.

Wissler, Clark, *Star Legends Among the American Indians*. New York: The American Museum of Natural History. Guide Leaflet Series No. 91, 1936.

Hubble Images courtesy of:
National Aeronautical and Space Administration (NASA)
The Space Telescope Science Institute (STSci)

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