

The Constellations PART 1

Instructional Objectives

After viewing the program and participating in the accompanying activities, the student will be able to:

1. describe the movement of the stars around the North Star and explain why many stars rise and set in the night sky,
2. describe at least one way people have used the stars and their movements as working tools of daily life, and
3. appreciate the diversity of legend in a variety of cultures.

Synopsis

Dr. Eric Chaisson opens the show with "HST Data Stream." He shares some of the latest information received from the Hubble Space Telescope.

In Program 20, "Science Links" provides an opportunity to engage students whose interests lie in literature and cultural history. The program begins with American slaves escaping to their freedom in the north. The song, "Follow the Drinking Gourd," served as a reminder of the celestial guide which pointed southern slaves in a northward direction. Graphics are then used to present the movement of the stars, specifically the Big Dipper, around the North Star.

Greek myths and Native American legends surrounding some of the more familiar constellations are told. Many of these stories provided explanations of the seasons and natural phenomena of the world to these and other ancient cultures.

In "The People Behind the HST," we meet Ed Weiler. Ed is the Chief of Ultra Violet and Visible Astrophysics at NASA Headquarters in Washington, D.C., as well as the Hubble Space Telescope Program Scientist.

Vocabulary

Astrology - The study that claims to predict the future through the movement and position of the stars and planets.

Astronomy - The study of all aspects of the stars and other objects in the sky.

Constellation - A group or configuration of stars which forms patterns of particular objects, persons, or animals. Astronomers around the world have recorded the names and locations of eighty-eight constellations.

Drinking Gourd - A hollowed out gourd or squash used as a ladle.



Ecliptic - The path through which the sun, moon and most planets travel around the sky in one year. The constellations of the Zodiac are located around the ecliptic.

Horizon - The line at which the earth and sky appear to meet.

Hyades - A V-shaped subconstellation located in the constellation Taurus. One of its brightest stars, Aldebaran, forms the right eye of the bull.

Orion - In Greek mythology, Orion was a mighty hunter. Although he was able to kill wild beasts, he was killed by the sting of a scorpion. The constellation of Orion is always behind the horizon by the constellation of the Scorpion. The three bright stars of his belt make this one of the easiest constellations to identify.

Pleiades - A subconstellation which forms the shoulder of the constellation Taurus.

Polaris - The North Star. Polaris is the star at the end of the handle of the Little Dipper.

Subconstellations - Also called asterisms, these are groups of stars that form easily recognizable shapes, but are parts of one or more constellations. Examples of subconstellations are The Big Dipper (part of Ursa Major), the Pleiades, and the Hyades (both parts of Taurus).

Taurus - Taurus the Bull, a constellation of the Zodiac. The best time to observe Taurus is from October to March.

Ursa Major - The Great Bear. The constellation of which the Big Dipper is a part. The Great Bear is a source of mythology for many ancient cultures.

Zodiac - A 16° band of the sky, centered on the ecliptic. The Zodiac is divided into twelve equal parts named for the constellations which move through it during one year.

Previewing

Talk about folklore and mythology and its place in culture. Discuss the connection between observable physical phenomena and legend. Encourage discussions as to why people throughout history have sought ways to explain their lives through legend.

Review program 19, "Ancient Astronomers." Remind students of ancient civilizations' dependence upon the sky to predict seasons and plan their lives. Before written communication was commonly used, naming star groups, or constellations, provided a framework with which to remember the locations of the stars. This way, stories that enabled people to remember star groups and locations could be passed down through generations.

Read or tell some Greek mythology to the class. Have students share any mythological stories with which they are familiar.

Discuss the Underground Railroad. Use it as an example of a recent use of stars as navigational tools. Ask students how they think escaping slaves, who traveled without lights or maps, could find their way north. Highlight the use of the North Star and the Big Dipper. Have students compare a picture of a dipper, a drinking gourd, and the Big Dipper constellation.

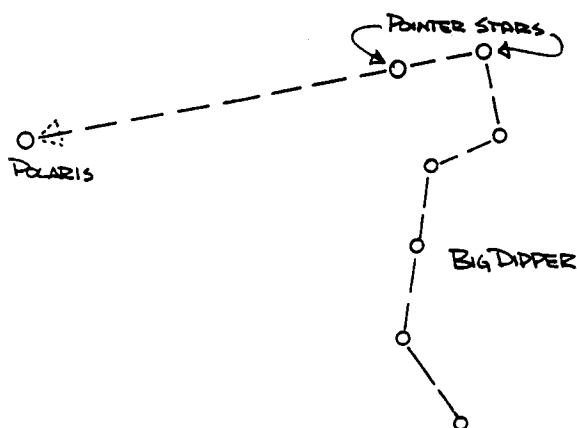
Discuss the relationship that ancient civilizations believed existed among the gods, the sun, the stars, and natural events that took place in their world.

Ask students to name a constellation. Make a list on the board. Explain that the Big Dipper is not a constellation. It is a subconstellation of Ursa Major, the Great Bear.

Ask students to name their astrological sign. Make a list on the board. Explain that astrological signs are actually named for a specific band of constellations, called the Zodiac. This is a good time to point out the differences between astronomy and astrology.

Prepare students for the fact that patterns and images in the constellations are seldom seen clearly. Even those with vivid imaginations will have trouble seeing named images. You may wish to have books available which show the outlines around the stars.

HOW TO LOCATE POLARIS



Draw a diagram to show students how to locate the North Star. Discuss the fact that the North Star is not the brightest star in the sky (there are 49 brighter stars). Using

a globe, ask students to indicate the location at which the North Star would be directly overhead. It would not be directly overhead unless they are located at the North Pole.

Postviewing

If your school has a celestial globe, bring it out to show students. Tell them that in the next show they will be learning how to use the celestial globe.

Have students research the legends of as many cultures as possible surrounding one star group, such as the Pleiades. Legends arose surrounding this cluster of stars because of the time of year it appears and moves across the dome of the sky. In the Northern Hemisphere, the time when it reaches its highest position in the sky coincides with the time the days grow shorter and the cold season begins. Therefore, in the northern latitudes, it represents death. However, in the southern latitudes, the Pleiades marked the oncoming arrival of summer. The heliacal rising of the Pleiades, or the first day when it rises over the horizon just before the sun, was a signal for the beginning of spring. In ancient times, this occurred right at the time of the spring equinox. Early societies used this occurrence to plan their agricultural activities.

Have students each research the movement of one star group in relation to their geographic location. They will need to determine at what time of the year the star group is visible from their location. Using this information, have them create a story that relates both the pattern of the stars to a familiar shape, and the season of its arrival in the sky to a seasonal event.

Hang seasonal star maps in the room and show students how to use them. Highlight the map of the current season. Have students make their own star chart which shows the major constellations.

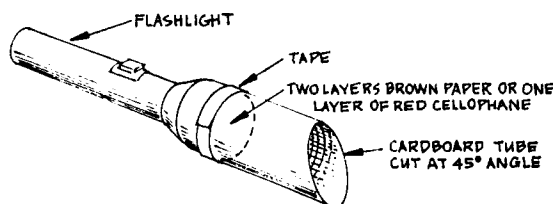
Point out that even though the stars in a constellation, or subconstellation, seem close, they are actually very far apart and usually have separate directions of motion. Over hundreds of thousands of years, patterns of the stars will change. For example, five of the stars of the Big Dipper are moving in roughly the same direction, but two stars are moving in the opposite direction. Many astronomy books have diagrams which illustrate the movements of these stars.

Polaris has not always been the North Star. Have students discover and locate on a star map the star that used to be the North Star (Thuban) and the star that will be the next North Star (Vega). Polaris, Thuban, and Vega alternately become the North star in 26,000 year cycles.

Impress upon students that they do not need a telescope to find the constellations. Make sure they know that the best time to go out and view the stars is on a clear night and at the time of a new moon.

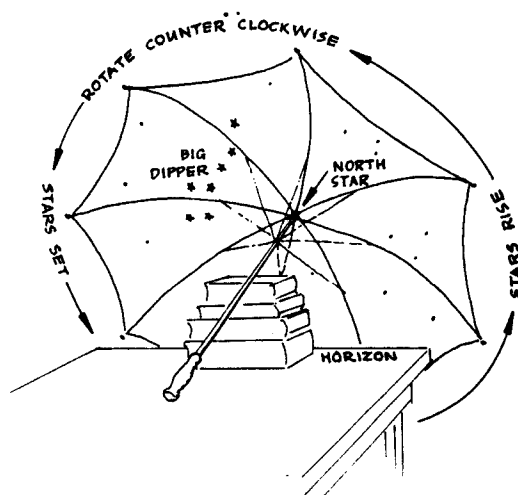
Active Involvement

Tell students that when they are out observing stars, they should allow at least 10–15 minutes for their eyes to adjust to the dark. It is important to keep their eyes used to the dark. Even a brief glimpse of white light will require another period of adjustment. Red light is used by astronomers when they need to read in the dark. Help



students make an astronomer's flashlight so they can read their star charts. Take apart an ordinary camper's flashlight. Insert a piece of red cellophane or two layers of brown paper to dim the light. Reassemble the flashlight. Trim a cardboard tube (or a tube of rolled paper) to a 45° angle and tape to the front of the flashlight.

You can illustrate the rising and setting of stars in the night sky with the help of an umbrella. The center of the umbrella represents the North Star. Paste or paint the Big Dipper and other stars on the inside of the umbrella. Prop the umbrella on a stack of books and lay across a table so that the lower portion falls below the edge of the table. The table edge will represent the horizon. Slowly rotate the



umbrella counter clockwise to simulate the movement of the night sky. Point out rising stars in the east, setting stars in the west, the fixed position of the North Star, and the fact that the Big Dipper never appears to fall below the horizon.

STARFINDER

PROGRAM 20

Have students make their own planetarium to use in a darkened classroom. Make copies of constellations from star charts in any astronomy book. Students then tape these to the closed end of a coffee can or oatmeal box. With hammer and nails, poke holes where stars are indicated using larger nails for larger stars. Place a flashlight in the open end and project the constellation on the ceiling of the room. Have students see how many they can identify.

Visit a local planetarium.

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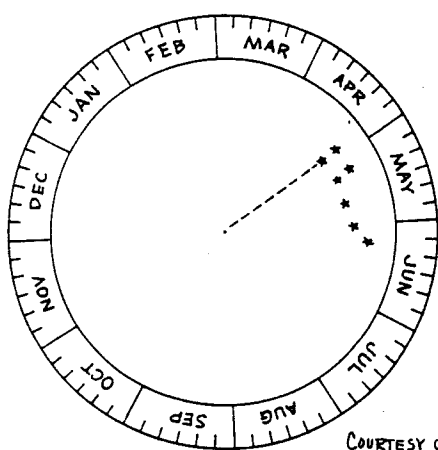
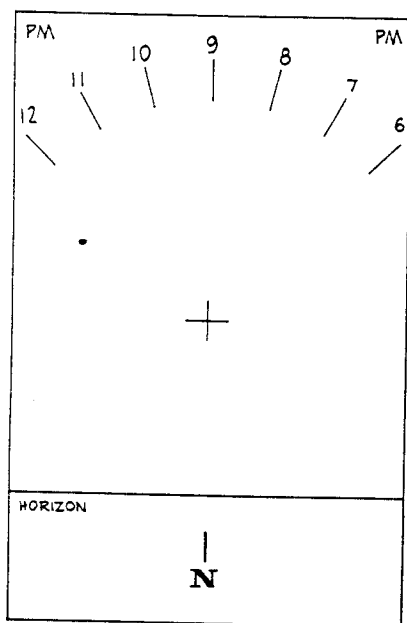
See for Yourself: Experiments/Projects

Star Clock

The Big Dipper can serve as an evening clock. This Star Clock will help you learn how. With practice, you may be able to impress your friends by simply looking up at the sky and telling the time.

► MATERIALS:

- star clock (2 pieces reproduced from this page)
- cardboard
- brad



COURTESY OF H. NEUMAN

► DIRECTIONS:

Reproduce the star clock pieces from this page. If you have access to a copier that enlarges, you may enlarge the pieces. Glue clock pieces onto stiff paper or cardboard. Cut around edges. Poke a hole in each piece where indicated. Insert brad so that the circular dial moves freely.



How to tell time with your Star Clock

1. Face in a northward direction.
2. Locate the position of the Big Dipper in the sky and rotate the dial so that the Big Dipper on the dial is in the same position over the horizon as the stars of the Big Dipper are in the sky.
3. Find the approximate location of the date on the dial. (Use the hash marks in each month's section to help locate the approximate date.) Determine with what hour on the clock the date is in line. This will give you the time of night. Remember, this clock is set up for standard time. You may need to make adjustments for daylight savings time.
4. Think about the rotation of the earth and its revolution around the sun.
 - a. Why are the clock hours indicated in a counterclockwise direction?
 - b. Why is the order of the months arranged in a clockwise direction?
 - c. How will you have to adjust for daylight savings time? Why?
 - d. Why would this clock not work with the Orion constellation?

The Zodiac

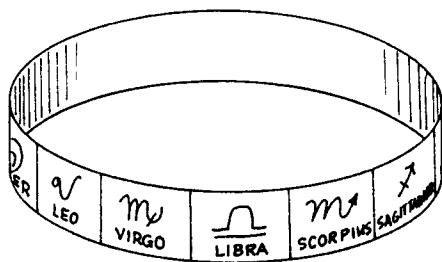
Do you know the constellations of the Zodiac? Many people know the "sign" under which they were born, but are not aware that these signs are actually a band of twelve constellations that form the path along the sky on which the sun, moon, and planets travel. This path is called the ecliptic.

If you were to paint all the stars as they appear in the sky on a dome over your head, you would see a part of what is called the celestial sphere. Of course the sun would also travel across this surface, as well as the moon and the planets.

Ancient astronomers thought that the sun, moon, planets, and stars revolved around the earth. They did not realize that each celestial object had its own movement around the sun or through the universe. As the sun, moon, and planets passed along the dome of the sky, they appeared to move through a group of constellations. These twelve constellations are evenly spaced around the belt of the ecliptic. They appear in this order: Aries, the Ram; Taurus, the Bull; Gemini, the Twins; Cancer, the Crab; Leo, the Lion; Virgo, the Virgin; Libra, the Scales; Scorpio, the Scorpion; Sagittarius, the Archer; Capricorn, the Sea-Goat; Aquarius, the Water Carrier; and Pisces, the Fish.

Form groups and design a Zodiac project to present to your class or to another group of students. Choose and assign tasks that can be completed independently or with a partner, and then combine your work with that completed by other members of the group. Your completed project might include the following.

- Draw or paint a Zodiac chart. There are many examples of the Zodiac in astronomy books from which you can design yours. Look at those of various cultures before you decide on the style you will use.



- Create a 3-D Zodiac band. You can do this by decorating both sides and attaching twelve cards in a circle. You may want to include constellation pictures and names, actual star patterns, and zodiac symbols. You can hang the ring around a globe at the correct angle.

- Poll or survey your family and friends. Ask how many constellations they can name. Then ask how many astrological signs, or signs of the horoscope, they can name. Could they name more signs than constellations? Did they know that each sign represents a constellation? Record your information and display in a graph or chart. You may wish to print the survey in your school paper, and then report the results in the next edition.

- Research ancient astronomy and determine how and when what we now refer to as astrology developed as a separate field. Create a time line showing trends or beliefs. Discover the differences between natural astrology, a study of time and predictions of observable occurrences,

and judicial astrology, which is primarily story telling horoscopes. Trace the differences between the phases the Zodiac as signs and as constellations.

- Do some sleuthing to discover why Aries is the first sign of the Zodiac and why it represented the new year to many ancient cultures. Why did Hipparchos (150 B.C.) decide that relying on the Zodiac would not make an accurate calendar. Hint: Find out under what sign the spring equinox fell during Hipparchos' life time. Under what sign does the spring equinox fall now? Under what sign will the spring equinox fall in 400 years?

- The sun enters the constellation Ophiuchus in early December. Ophiuchus is not part of the Zodiac. Discover why and report on how this can be. Hint: Look up precession.

- Research each of the twelve stories that surround the constellations of the Zodiac. Can you find variations in these stories? Present each constellation in story and picture form to the class.

- Zodiac means "wheel of life." Write a poem about the Zodiac which uses this phrase.

- Create a card game or board game that will teach the constellations and Zodiac to a younger child.

Career Profile

ED WEILER

Chief of Ultra Violet and Visible Astrophysics
NASA Headquarters
Hubble Program Scientist

Education: B.A. Astronomy
M.S. Astrophysics
Ph.D. Astrophysics



General Responsibilities

Ed Weiler is a man who actually has two jobs. As chief of Ultra Violet and Visible Astrophysics, he manages two other astronomers, and together, their branch is responsible for managing the Space Astrophysics Research Program for the United States. This includes projects such as the Hubble Space Telescope, the Astro Program, the Extreme Ultraviolet Explorer, which will be launched in 1991, and several other projects. In addition to the scientific aspects of these missions, the branch also manages a program of research grants. They receive proposals, review them, and make decisions on how much money scientists should receive to complete their research.

But these days, Ed spends most of his time on the Hubble Space Telescope project. It is presently his full time responsibility to guarantee the scientific integrity of the HST mission. There are hundreds of scientists involved in this program, each one worried about his or her own responsibilities. Ed must look at the broader issues, to make sure that the project as a whole receives the money and support that it needs from NASA and the people who make the decisions.

Ed is also one of the main spokespeople for the HST project. He finds this part of his job is like riding an emotional roller coaster. It has taken him from the excitement and anticipation that so many people were feeling about the project before launch, to the disappointment surrounding the mirror problems shortly after the launch. At this point, he is glad that he can present the optimism of the scientists who are receiving exciting data from space.

A Typical Day

Ed usually arrives at work around 7:30 in the morning. He always turns on his computer and checks his electronic mail, where he may have received as many as forty messages since the previous day. Frequently, the messages on his electronic mail bring surprises, and his day's plans may need to be altered to meet unanticipated challenges. Although he communicates with other scientists around the world, most of his contacts are in the United States, mainly with people who work on the HST.

After checking the mail on his computer and adjusting his schedule, he will spend a great deal of time dealing with issues over the phone. Because Ed prefers to communicate through the electronic mail or over the phone, he rarely corresponds through the mail. Generally, the main focus of Ed's day is determined by what is going on with the Hubble Telescope at the time. The main issues right after launch were technical, but he is now busy helping to determine policy.

One typical issue Ed needs to address might deal with how observing time on the Hubble Space Telescope should be given out to observers. On another day, he might work out solutions to other dilemmas. He knows that if there is only enough time and money to add one new instrument to the HST, someone will need to decide which instrument should be made first. He will be among those who try to make sure the best answers to these questions are found.

Usually he will attend many meetings which deal with the same issues he handles over the phone and electronic mail. These meetings, held with various groups, are very interactive and could include the Director of the

Science Institute, the Principal Investigators, or representatives of any or all of the science teams. Meetings can last hours and frequently require a lot of psychology and management skills in order for the group to make progress.

To be effective, it is important for Ed to go where the instruments are being built and where the scientists are working. Therefore, Ed must travel frequently and take part in day long meetings. He may need to go to other NASA facilities and check on the status of the science, or he may meet with the press, other scientists, or student groups.

Career Viewpoint

Science and engineering can open up careers that are not only important for you, your country, and the world, but are also fun. People are naturally curious creatures and some of the most exciting questions revolve around why we are here, why the earth is here, how it all got here, where it is going, and whether we are alone in the universe. Although many of these questions may never be answered, it is the scientists that will eventually help find some of the answers.

Ed feels it is going to be the next generation of scientists that will solve the world's energy problems. As students today are well aware, the earth has limited resources, and once these resources are gone they can never be replaced. If solutions are not found to these scientific problems, you and your children may live in a world without the resources we have today and may never get a chance to experience the benefits these resources offer.

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