

# Making Sense of Data

## Instructional Objectives

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

1. describe the need for charts and star catalogs in astronomy and science, and
2. explain the use of right ascension and declination as tools of reference for locating celestial objects.

## Synopsis

Program 1 introduces students to the scientific need for an accurate system to record and communicate data. Students receive a brief introduction to the right ascension and declination coordinates and their use in charting stellar location. The video introduces viewers to the largest star catalog ever made, the Guide Star Catalog at the Space Telescope Science Institute. Students see a demonstration of how workers at the Science Institute locate the target and guide stars for Hubble Space Telescope observations. The role of a guide star analyst at the Space Telescope Science Institute is highlighted in "The People Behind the HST." The analyst talks about what set her on her career path and then walks viewers through the guide star system.

## Vocabulary

*Celestial Sphere* - The imaginary sphere of the sky, centered on the Earth, and on which the sun, moon, planets, stars and galaxies can be visualized as all the same distance from the earth.

*Declination* - With right ascension, part of a coordinate system fixed to the stars. A vertical, or north-south angle on the celestial sphere, the celestial equivalent to geographic latitude.

*Guide Stars* - Pairs of stars which, when correctly located within the HST's field of view, position the telescope to lock on to its target.

*Latitude* - The horizontal circles of the geographic coordinate system. The distances or locations north or south of the equator.

*Longitude* - The vertical circles of the geographic coordinate system. The distances east or west of the prime meridian.

*Pickles* - The arcs within the Hubble Space Telescope's field of view in which the guide stars must be located in order for the HST to locate and lock on to a target.



*Right Ascension* - With declination, part of a coordinate system fixed to the stars. The horizontal angle on the celestial sphere, the celestial equivalent to geographic longitude.

*Spherical Aberration* - When the light reflecting from the inner and outer edges of the mirror in a telescope cannot be brought to the same focal plane, causing the light to be scattered.

*Star Catalog* - A compilation of information about the stars in the sky. A star catalog may list only star positions, or may include such information as positions, magnitudes, identification numbers, and spectral class, as well as estimates of errors in these measurements.

*Star Map* - Pictures or charts representing star locations in a particular part of the sky.

## Previewing

Ask students how they think scientists on the ground could possibly direct the HST to aim at a particular star.

Discuss the role of longitude and latitude in geographic mapping.

Have one student look out the window, find an object, and then direct other students to find that same object. Discuss how they were able to accomplish this.

## Postviewing

Discuss the latest information received from the HST.

Ask students to discuss the career of the guide star analyst.

If a celestial sphere is available, introduce students to its use. Give them an opportunity to see it up close and locate familiar star groups, such as the Big Dipper.

## Active Involvement

Have students determine the approximate longitude and latitude of their home town.

Discuss the need for different types of charts and graphs as a means to display information. Hang many examples, such as bar graphs, pie charts, and coordinate systems, around the room. Poll students and determine the answers to such questions as hair color, height, or how they get to school, and record the numbers on the board. Now split the class into groups of three or four and have each group devise a graph to display this information about the class. Discuss why they chose one particular format to display their information. Have class discuss other means to display data.

Bring in a street map that uses a grid system (letters marking horizontal lines; numbers marking vertical). Discuss the advantages of using this type of map to locate geographic locations. Have students practice locating streets and landmarks on the map. Make up a grid for students to chart locations of classroom furniture according to the measurements of the room, or have them use floor or ceiling tiles as a guide. As a follow-up activity, draw furniture in different locations onto a grid. Have students rearrange actual furniture to match what is represented on the grid.

## Bibliography

*For high school readers:*

Brogdon, Bill. "How to Read Chart Scales: The Proper Use of Latitude." *Motor Boating and Sailing*, December 1980, 146, 24-26.

Chartrand, Mark R. III. *Skyguide, A Field Guide for Amateur Astronomers*. Racine, WI: Western Publishing Co., 1982.

Levitt, I.M. and Roy K. Marshall. *Star Maps for Beginners*. New York: Simon and Schuster, Inc., 1983.

Wold, Allen L. *Computers in Space*. New York: Franklin Watts, 1984.

*For middle school readers:*

DeBruin, Jerry and Don Murad. *Look to the Sky*. Carthage, IL: Good Apple, Inc., 1988.

Maron, Joseph and Sarah Lee Lippincott. *Point to the Stars*. New York: McGraw-Hill Book Co., 1977.

Mayer, Ben. *Starwatch*. New York: Putnam Publishing, 1984.

Thomas, David. *Math Projects for Young Scientists*. New York: Franklin Watts, 1988.

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# See for Yourself: Experiments/Projects

# STARFINDER

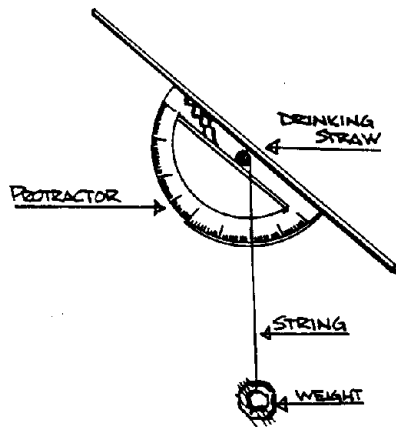
PROGRAM 1

## Make an Astrolabe to Find Your Latitude

An astrolabe is a tool which records the number of degrees a celestial body is above the horizon. You can use this information to determine your latitude by sighting Polaris, or the North Star. A simple calculation lets you discover your distance, in miles, from the equator.

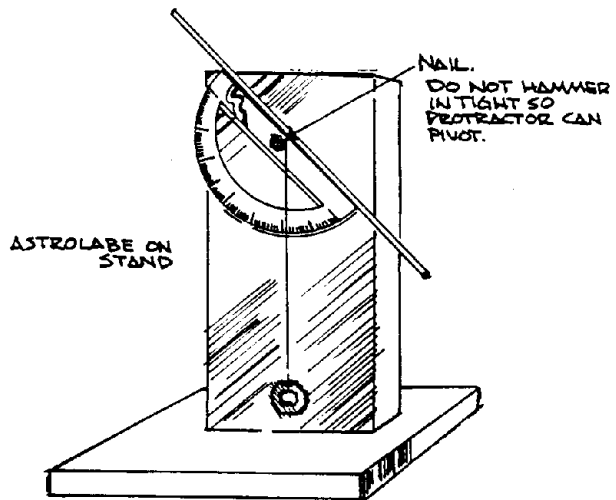
### ► MATERIALS:

- protractor
- drinking straw
- wood scrap or stiff cardboard
- string
- small weight, such as a washer
- wood for stand



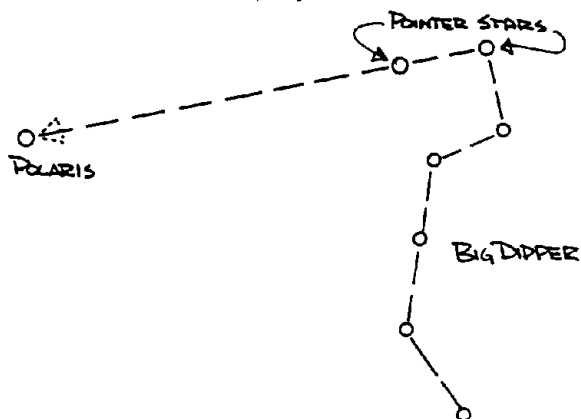
### ► DIRECTIONS:

To make your astrolabe, tape the drinking straw along the flat edge of the protractor. First, you may wish to glue the protractor to a scrap of wood or a piece of stiff cardboard. Hang a piece of string with a weight attached from the center of the protractor. Mounting the astrolabe to a simple wooden stand will stabilize the instrument and increase accuracy of readings.



1. Locate Polaris, the North Star. First find the Big Dipper and extend an imaginary line from the two stars at the outer edge of the bowl. This will lead to Polaris (see diagram). Now, look through the straw of your astrolabe and find Polaris, centering it in the straw. Your sighting will be more precise if you keep both eyes open. Read the number on the protractor where the string intersects. Record this number.
2. The altitude of Polaris is determined by the number of degrees the string is from the 90 degree mark. Determine this and record your answer.
3. Turn the instrument around and repeat Step 2, sighting Polaris through the opposite end of the straw. Record your answer.
4. Determine the average of your answers from Steps 1 and 2 by adding the numbers together and dividing by

### HOW TO LOCATE POLARIS (FOR USE WITH ASTROLABE)



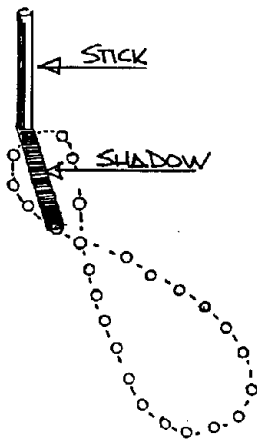
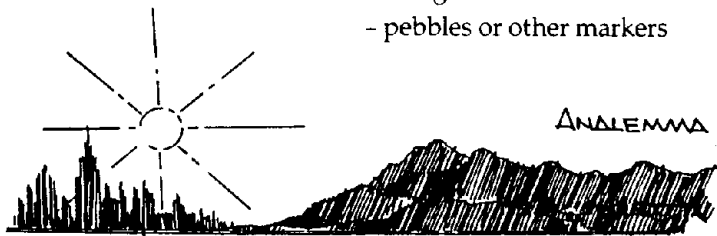
- two. This will give you the number of degrees Polaris is above the horizon, which will equal your latitude.
5. Because each degree of latitude equals 69.1 statute miles on earth's surface, multiply your latitude by 69.1 to determine your distance from the equator. Record your answer.

## Chart the Path of the Sun's Analemma

An analemma shows the path of the sun and its declination throughout the year. If the grounds around your school are level, you can chart the shape of the analemma with just a stick and some pebbles or other markers.

### ► MATERIALS:

- straight stick
- pebbles or other markers

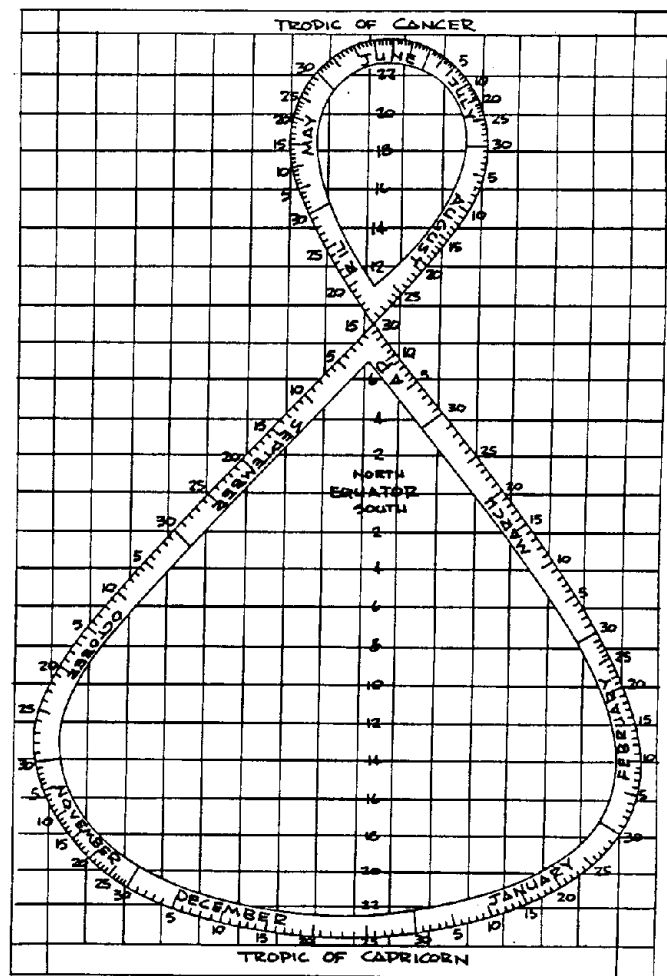


### ► DIRECTIONS:

1. Choose a location that will receive direct sunlight throughout the year and where the ground is very level. Put a stick in the ground, making sure it is straight. Measure and draw a diagram of the area on graph paper, one foot on the ground equaling one square on the graph paper.
2. Every week, preferably on the same day of the week, at the same time of day, mark the tip of the stick's shadow on the ground. Record the location along with the date on your graph.
3. After several weeks, predict where the shadow will fall. Record your prediction on the graph. Use a different color pencil for your predictions.
4. Continue Steps 2 and 3 as far through the year as possible. After six months, the shape of the analemma will continue as a mirror, or symmetrical image to that

of the first six months. Circle the first days of fall and winter on the chart. Predict where you think the first days of spring and summer will be located on your graph.

5. Think about why one loop is smaller than the other. The summer loop is going to be smaller in the northern hemisphere because of the apparent faster motion of the sun. Write down what differences you think you would find in the southern hemisphere.
6. Compare the shape of your analemma with the one on this page. Using this analemma, you can determine where the sun is directly overhead at noon on any day of the year. For instance, at the Tropic of Capricorn, the sun would be directly overhead on December 21, and at the equator, the sun would be directly overhead on September 23 and March 21. At what latitude would the sun be directly overhead on the first day of summer? Choose five days of the year and record at what latitude the sun would be directly overhead.



# Science Career Profile

## VICTORIA G. LAIDLER

Guide Star Analyst

Computer Science Corporation

Hubble Space Telescope Science Institute

Education:

B.S. Physics-Astronomy

Graduate courses in Astronomy



### **Chief Responsibilities**

As a guide star analyst, Vicki is responsible for supporting activities in the Guide Star Selection System (GSSS). This includes enhancing the Guide Star Catalog, assisting Space Telescope Science Institute staff members and HST observers in using the resources of the GSSS, and developing software and tools with which to build an updated version of the Guide Star Catalog.

Building the Guide Star Catalog involved digitizing photographs of the entire sky. These photographs are still at the GSSS, both in the original form on glass and in computerized form. The microdensitometers, special instruments used to digitize the photographs, are still available. The photographs and instruments are available to HST observers so that they can obtain the precise positions of their targets, and to staff members to support research which uses ground-based observatories.

Another version of the Guide Star Catalog is needed because stars move very slowly across the sky. Over the years, the Guide Star Catalog will go slowly out of date unless these motions, called proper motion, are predicted and corrected for. In addition to including proper motion, the Science Institute plans to improve the catalog overall so it will be more accurate and more useful for scientific research.

### **A Typical Day**

In addition to the long-term projects that she works on, Vicki is often called on to investigate problems that come up in the routine work of catalog maintenance or observer support. These problems may come in by computer mail, phone call, or a note on her desk. When there is a problem, she may need to examine computer files and databases to see if the problem has happened before, or run tests on the software that is broken to try to identify exactly what has happened. Sometimes she can solve the problem or recommend a way to work around it so that work can continue. In other cases, she finds that the problem needs to be solved by a system manager, engineer, or another programmer.

In the morning, after checking her computer mail to see if there are any problems, Vicki spends some time getting organized, and then gets down to work on one of her ongoing projects. This may involve computer programming, analyzing image data, or working with the microdensitometers. In the afternoon, she often meets with one of the other scientists in the group to report progress, analyze results, or determine the next steps to be taken in one of the long-term projects. She may also spend some time customizing procedures and programs so that day-to-day operations can be streamlined and run smoothly.

Vicki spends a few hours a week working with the Science Institute astronomers on research projects and attending scientific talks to keep up with progress in other areas of astronomy.

### **Career Viewpoint**

During the six years that Vicki has worked with guide stars, her job has gone from one of routine operational support to one which is intellectually challenging and mainly investigative. She believes that science is not a collection of facts, but the process of asking questions and answering them — and then asking the next questions. Learning to see which questions to ask next is more important than being able to answer any specific question. That is how a scientific investigation progresses. An experiment or observation is a scientist's way of asking the universe a question.

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