How Big is the Universe?

STARFINDER

PROGRAM 6

Instructional Objectives

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

1. state an analogy that conveys the concept of the scale of the universe, and
2. appreciate the attempts of people over time to describe the vastness of the universe.

Synopsis

The program attempts, through several approaches, to help the students grasp the vastness of the universe and our position within it. This show is designed to intrigue the philosopher in all of us. It should be accessible to students who struggle with science and a point of departure to the avid student of science. Poetry, facts and figures, analogy, and art are all used to evoke the immensity of space. The concept of light-year and the idea that looking at starlight is the same as looking back in time are discussed.

Franklyn Branley is featured in the career segment. He is a distinguished and prolific author of children's and young adults' books on science. Inclusion of his career profile continues the outreach of this program to the student more inclined to the arts or humanities.

Vocabulary

Alpha Centauri—The nearest star to our solar system. Alpha Centauri is 4.3 light-years from earth and is part of our Milky Way Galaxy.

Andromeda Galaxy—The closest galactic neighbor to the Milky Way Galaxy. The Andromeda Galaxy is approximately two million light-years away.

Clusters of Galaxies—Most galaxies are part of a cluster of galaxies. These clusters of galaxies may have just a handful of members or may have hundreds of members. In any case, they are very large scale phenomena. One interesting question to ask is whether these clusters of galaxies are in turn grouped into clusters of clusters—superclusters. Current evidence supports this. Our Local Group, the several similar groupings nearby, and the Virgo Cluster form one such cluster of clusters called the Local Supercluster.

Light-Year—The distance light travels in space in one year. A light-year is equal to 9.46 X 10 cm or about 6 X 10 mi. A light-year is used to describe distances in space because of the vastness of space.

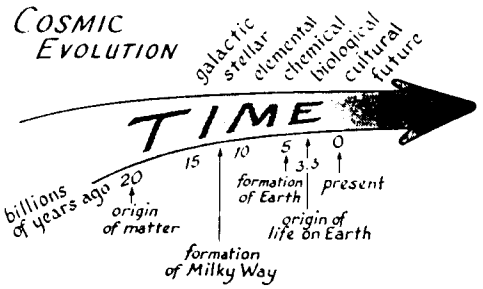
Previewing

Ask the students to describe the distance from the classroom to a location in the school building. Follow up with other nearby distances to be described such as from the school to the firehouse, to their home, or to the movie theatre.

Have students describe distances from your town or city to another city. Encourage the students to think of distance in ways other than miles or kilometers.

Ask students to describe the distance between the earth and the moon in as many ways as they can. Do the same for the distance to one of the planets. Encourage responses that are non-mathematical but display alternative perceptions based on space travel time, speed of light or sound, etc.

Copy the time arrow graphic onto the board or overhead. Familiarize the student with the concept of looking out into space as looking back into time. Dr. Eric Chaisson's program segment will address this.



Postviewing

Discuss Dr. Eric Chaisson's themes of space and time.

Return to the previewing activity. Ask students to describe the distance between the earth and the moon and the earth and the planets again.

Ask students to describe in writing or in pairs what it would be like to travel in a space ship to Jupiter for two years or Pluto for 15 years.

Have the students locate poetry or prose that attempts to articulate the vastness of space. The students can copy the lines down and create artwork to accompany the author's words.

Active Involvement

Various researchers, including Frank Drake, Carl Sagan, I.S. Shklousky, and others, have tried to estimate the number of civilizations in the Milky Way Galaxy with which we could communicate. They generally identify seven factors that are required for the estimate. They are as follows:

1. number of stars in the Galaxy
2. fraction of those stars with planetary systems
3. mean (average) number of planets suitable for life per planetary system
4. fraction of those planets on which life has actually developed
5. fraction of those planets with life on which intelligent organisms have evolved
6. fraction of those intelligent organisms that have developed communicative civilizations, and
7. mean (average) lifetime of those civilizations in relationship to the mean lifetime of the star supporting the planetary system (longevity of a civilization).

Have the students classify these factors as astronomical, biological, or sociological. Which factors can be most easily estimated? Why? Which factors are the most difficult to estimate? Why?

Ask the students working in pairs or small groups to determine estimates of the time spans necessary for communication with other planets. Specifically, suppose we could have two-way radio communication with another civilization. What is the length of time we would have to wait for a response from:

1. Jupiter (when nearest to the earth)
2. planet revolving around Alpha Centauri, and
3. planet in the Andromeda Galaxy.

Have students, working in groups, create a model space station. Have the students include as a minimum the following: landing base, launch base, decontamination center, control center, living quarters and computer center. Let the students develop the rationale for other functions and a model for what they might look like. Encourage the students to describe the function of each portion of the model and the interconnection between portions.

Bibliography

For high school readers:

Chaisson, Eric. *The Life Era: Cosmic Selection and Conscious Evolution.* New York: W. W. Norton & Co., 1987.

Hoyle, Fred. *The Black Cloud.* Norwalk: Easton Press, 1990.

For middle school readers:

Branley, Franklyn M. *Space Colony: Frontier of the 21st Century.* New York: Lodestar Books, 1982.

Gallant, Ray A. *Once Around the Galaxy.* New York: Franklin Watts, 1983.

Hirst, Robin & Sally Hirst. *My Place in Space.* New York: Orchard Books, 1988.

A production of

MARYLAND STATE DEPARTMENT OF EDUCATION
MARYLAND INSTRUCTIONAL TECHNOLOGY • INTEC

11767 Bonita Avenue
Owings Mills, Maryland 21117
(301) 356-5600

Major funding provided by

MARTIN MARIETTA

and

U.S. Department of Education

Office of Educational Research and Improvement

Fund for the Improvement and Reform of Schools and Teaching

Dwight D. Eisenhower National Mathematics and Science Program

See for Yourself: Experiments/Projects

STARFINDER
PROGRAM 6

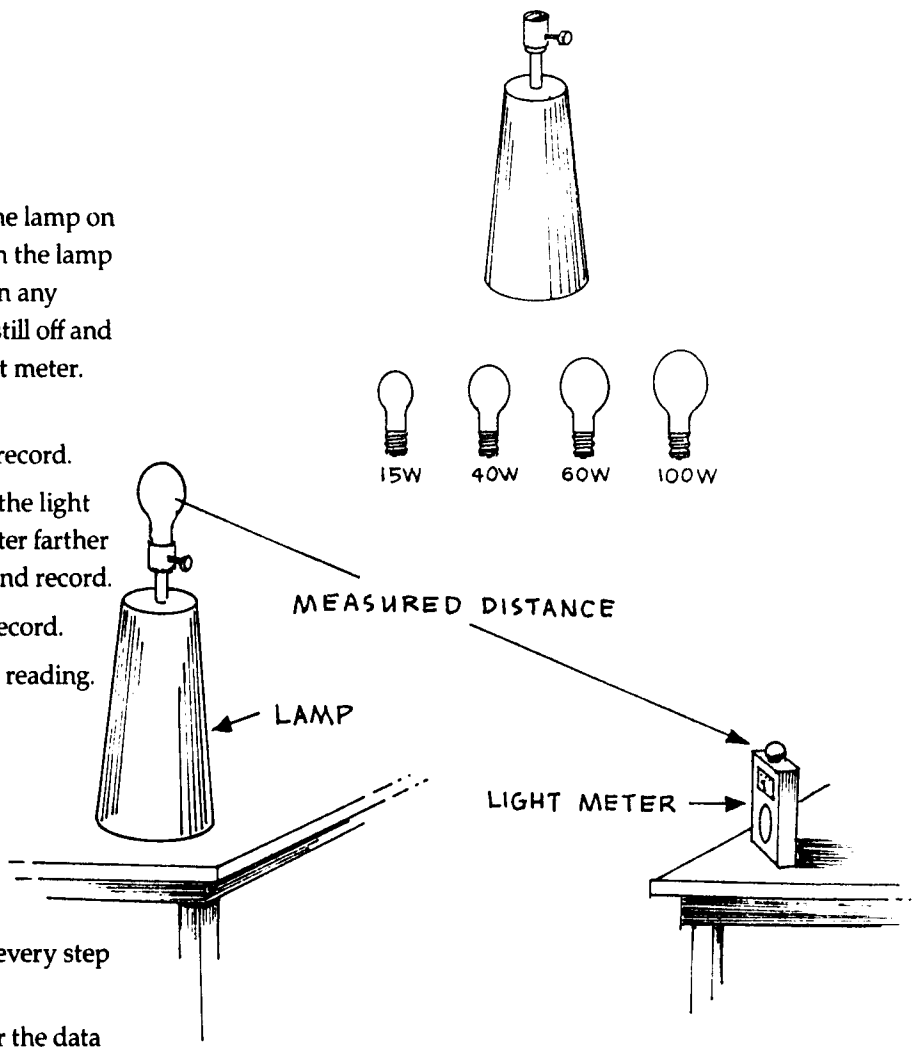
Relationship Between Distance and Brightness

▶ MATERIALS:

- graph paper
- 2 disks or small tables of similar height
- lamp
- bulbs of wattage 15, 40, 60 and 100
- light meter
- meter stick

▶ DIRECTIONS:

1. Insert the 15 watt bulb into the lamp. Place the lamp on a desk. Place the second desk one meter from the lamp and place the light meter on the desk. Darken any overhead lights in the room. With the lamp still off and the light meter facing the lamp, read the light meter. Record (see diagram).
2. Turn the lamp on. Read the light meter and record.
3. Change the distance between the lamp and the light meter by moving the desk with the light meter farther away from the lamp. Measure the distance and record.
4. Read the light meter with the lamp off and record.
5. Turn the lamp on and record the light meter reading.

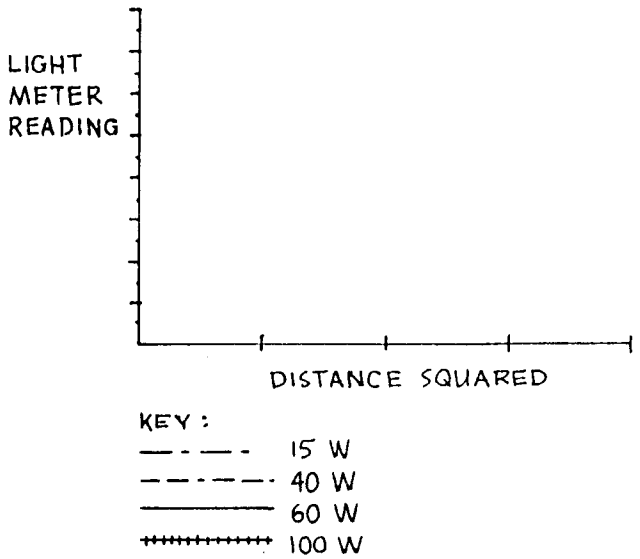


6. Repeat steps 3–5 two more times. Record at every step as indicated.
7. Complete a table similar to the one below for the data you collected.

Bulb Wattage	Distance	Distance^2	Darkened Room	Lamp Reading	Difference (Lamp reading-darkened room)

8. Change the wattage of the bulb and repeat steps 1–7 for each of the remaining bulbs.

9. On graph paper, plot distance squared against the difference between the meter readings. Distinguish between each bulb used (see diagram).
10. What do you notice about your graphs?
11. What relationship do you detect between the light meter readings and the distances squared?
12. What are the logical next steps you would take if you continued this experiment? Carry out your ideas. Record your observations or deductions.
13. Look up the term illumination. Try to explain your findings using this term.



Computer Application

▶ **MATERIALS:**

- Logo software or other graphic software
- computer

▶ **DIRECTIONS:**

Write a Logo or other graphic program to demonstrate the concept that illumination of an object decreases as the distance increases. The graphic you end up with should show light as a source and detail it spreading out across the area it covers. You probably want to use lines to represent light rays. The end result might resemble a fan.

▶ **MATERIALS:**

- BASIC, Pascal, or other computer language
- computer

▶ **DIRECTIONS:**

Using the data from your table as a guide, write a program to accept the input from the experiment and produce a graph to plot the points. Plot several sets of data on your graph. What are your conclusions?

Science Career Profile

FRANKLYN M. BRANLEY
Author
Chairman Emeritus, Hayden Planetarium
Education: New Paltz Normal School
B.A. - Elementary School Administration
M.A. - Education
Ed.D. - Science Education

Have you ever read a book that has helped you gain a better understanding of the world around you, and maybe has even made you want to learn more? If so, then it just might have been written by Franklyn Branley, a well-known author of science books for young people.

Science was not usually taught to children in the elementary grades when Franklyn was young, so he did not receive a lot of science education before high school. Even years later when he was teaching, it was necessary to get permission to offer science education in elementary grades. Eventually his intense curiosity, his ever increasing knowledge of science, and his teaching background enabled him not only to be one of the first teachers to offer science in an elementary classroom, but to become a science writer, and an associate astronomer and Chairman of the Hayden Planetarium in New York.

Branley began his writing career soon after he started to teach. He first wrote for professional teachers' magazines but soon began writing science books. His first books were published when he was only twenty-four years old– about fifty years ago, and they are still selling today. He now has 140 books in print.

"Straightforward science" is how Branley refers to the topics of his books, but he rarely writes textbooks. He doesn't find them fun to read—or write. His books are never dull or dry. He looks for topics that intrigue him, then he can be assured that they will probably spark an interest in his readers as well. For example, he wondered what it would be like to go into a black hole, and so he wrote the book, *Journey Into a Black Hole.*

Although his books are written for young people, many adults tell him that they learn from his books too. He is able to make science understandable, and explain mysterious phenomena in ways that most people can easily understand. He views this as a challenge. Not only must he know what to write, he must decide what to leave out so that the subject does not become overwhelming.

A Typical Day

Because Dr. Branley has retired from teaching and his work at the Hayden Planetarium, he has time to write each morning. He does not view this as a chore, but as a pleasure, because there are so many things he wants to understand and write about. He feels that if he wants to understand something, probably other people will want to also. It gives him great pleasure to make these ideas meaningful.

In his leisure, he enjoys working in his vegetable garden, swimming, or taking a walk. He always makes time for reading, most of which is informational. Because there's so much new science with which to keep up, he mainly reads professional journals and science magazines, often cover to cover.

Career Viewpoint

Franklyn Branley thinks it is unusual for a young student to have only one interest from which to choose a life-long career. In fact, he feels that even in college, students may not be ready to make up their minds on a career. It is more important to be exposed to as many ideas as possible, and one way to do this is to read.

Reading is exercise for your brain and books are brain builders that exercise your mind. Branley feels that it doesn't matter when and it doesn't matter what, but everyone should read a little each day. There is a lot happening in the world to know and read about—if you don't do it, you won't know what you're missing!

Content Consultants for STARFINDER - Program 6

Eric Chaisson
Space Telescope Science Institute
Operated by AURA for NASA

Greg Helms
Arundel High School

Teacher's Guide

Writers
Pat Murphy
Barbara Bourne

Editor
Kate Harrison

Illustrators
Robert Jones
Lola Judith Chaisson

Logo Design
Dave Weaver

Graphic Design
Bob Lindler
The Design Co-op

Typesetting
Blue Heron Typesetters

If you are interested in receiving the size and scale poster offered by the Space Telescope Science Institute in this program, teachers may send the written request to:

Space Telescope Science Institute
Size and Scale Poster
3700 San Martin Drive
Baltimore, MD 21218